ORC

Annual Research Report 2021-2022

Programme Leader
Dr. Md. Abdul Latif Akanda

OILSEED RESEARCH CENTRE
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701
September 2022

ORC

Annual Research Report
2021-2022

Edited by

Dr. Md. Abdul Latif Akanda
Dr. Ferdousi Begum
Md. Sazzad Hossain
Dr. M. Shalim Uddin
Dr. Sheikh Hasna Habib
Dr. Rabiul Islam

Compiled by

Md. Masud Karim
Pryanka Roy
Krisna Chandra Saha
Towhidi Almas Mujahidi
Dr. Debi Rani Datta
Md. Ariful Islam
Ummy Kulsum Mukta

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Editorial Committee

Dr. Md. Abdul Latif Akanda
Dr. Ferdousi Begum
Md. Sazzad Hossain
Dr. M. Shalim Uddin
Dr. Sheikh Hasna Habib
Dr. Rabiul Islam

Compilation

Md. Masud Karim
Pryanka Roy
Krisna Chandra Saha
Towhidi Almas Mujahidi
Dr. Debi Rani Datta
Md. Ariful Islam
Ummy Kulsum Mukta

Word Processing

Mahmudul Hasan
Md. Kamruzzaman

Published by

Dr. Md. Abdul Latif Akanda
Director
Oilseed Research Centre
BARI, Gazipur-1701
Phone: +88-49270139, Cell: +8801716335626
E-mail: dir.orc@bari.gov.bd
Website: www.bari.gov.bd

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List of Contributors

Dr. Md. Abdul Latif Akanda, Director
Dr. Ferdousi Begum, CSO
Dr. M. Shalim Uddin, PSO
Dr. Mohammed Harun or Rashid, SSO
Dr. Sheikh Hasna Habib, SSO
Dr. Rabiul Islam, SSO
Md. Masud Karim, SSO
Pryanka Roy, SO
Krisna Chandra Saha, SO
Towhidi Almas Mujahidi, SO
Dr. Debi Rani Datta, SO
Md. Ariful Islam, SO
Ummy Kulsum Mukta, SO
Jashore,
Dr. Mohammad Anwarul Monim, SSO
Ishurdi,
Md. Razib Humauan, SSO
Jamalpur,
Dr. Md. Monjurul Kadir, CSO
Dr. Muhammad Khorshed Alam, SSO
Mukaddasul Islam Riad, SSO
Rahmatpur, Barishal,
Dr. Md. Alimur Rahman, SSO
Burirhat, Rangpur,
Md. Bikash Sarker, SSO
Hathazari, Chattogram,
Dr. Md. Muktadir Alam, PSO
Cumilla,
Dr. Mia Md. Bashir, SSO

PREFACE

Oilseed Research Centre (ORC) is one the important centre of Bangladesh Agricultural Research Institute. At present, it has been conducting research work on nine oilseed crops like rapeseed-mustard, groundnut, sesame, soybean, sunflower, linseed, niger, safflower and perilla of which the first five are considered as major. As per DAE estimate, 11.99 lakh metric ton oilseeds was produced from 8.54 lakh hectare in 2020-21. Edible oil is extracted only from rapeseed-mustard, sunflower and sesame. As per estimation, local production of edible oil meets only 12% of the quantity being consumed. The rest 88% is being imported spending a huge amount of foreign currency. Our need of edible oil is around 24 lakh metric ton but local production is only 3 lakh metric ton. Present government has given special attention to increase oilseed production. The government along with research, agricultural extension and BADC are going to implementing a three years plan to reduce 40% dependency on import of edible oil. ORC of BARI has already been developed 51 varieties of different oilseed corps having higher yield, short duration, dwarf and stress tolerant and their production technologies. Some of them have been popularized as mega variety.

Oilseed Research Centre of BARI is going to publish its Annual Research Report based on the implementation of research program during 2021-22. The area of research includes variety development, crop and soil management, disease management, insect pest management. It also includes technology transfer activities and seed production and distribution.

ORC of BARI is entrusted to the research works for the improvement of oilseeds for higher productivity and wider adaptation. Major thrust has given to develop high yielding oilseed varieties with special emphasis on short duration, adaptability to rice based cropping system, dwarf, water logged tolerant and diseases and insects resistant. Maintenance of germplasm, development of inbred lines, variations and recombination have been created through hybridization and mutation every year at ORC to generate new genetic stock and select climate resilient varieties. Emphasis has been given to develop and refine production technologies of oilseed crops especially on four crops based cropping patterns including at least one oilseed crop and inter cropping. Also research thrust on selection of suitable oilseed varieties and development of technologies for char, haor and saline areas and Barind tract. Besides, ORC produces breeder and truthfully labeled seeds for BADC, DAE, NGO, private sectors and farmers. Also conducts demonstrations, workshops and field days and arranges training to DAE, BADC, NGO personal and farmers and publishes booklets, leaflets etc.

It is a great pleasure that advanced lines of rapeseed-mustard and sesame have been evaluated by the Evaluation Committee and finally approved by the National Seed Board for release as BARI Sarisha-19, BARI Sarisha-20 and BARI Til-6 for commercial cultivation.

I convey may sincere thanks and gratitude to the BARI authority and Ministry of Agriculture for their extended cooperation and support for oilseed research and development in Bangladesh.

I acknowledge with great thanks, the contributions of the scientists of ORC who at the expenses of hard work and sincere devotion have completed this report. Also sincere thanks to OFRD scientists. Last but not the least, share of thanks goes to the scientific staffs for their help in collecting field data along with the scientists and office staff to make the research activities successful.

I hope the report will benefit to those who are concerned with Oilseed activities and production in Bangladesh.

Dr. Md. Abdul Latif Akanda
Director
ORC, BARI

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RESEARCH HIGHLIGHTS 2021-22

1. Technology Developed

A. Variety:

i) BARI Sarisha-20 (*Brassica rapa* L.)

Salient feature:

- Short duration variety (duration 80-85 days)
- Suitable for cultivation in between T. amon and Boro rice
- Plant height 85-110 cm
- Yellow flower & yellow seed (3-4% higher oil content than brown seed)
- Thousand seed weight 3.5-3.8 g
- Oil content 42-44%
- Seed yield 1800-2000 kg/ha

ii) BARI Sarisha-19 (*Brassica juncea* L.)

Salient feature:

- Saline tolerant variety (4-12dS/m)
- Duration: 90-105 days
- Plant height 120-130 cm
- Brown seed
- Thousand seed weight 2.5-4.0 g
- Oil content 40-42%
- Seed yield 1700-2500 kg/ha

iii) BARI Chinabadam-11

Salient feature:

- 3-4 kernel/pod
- Kernel size is large (100 kernel weight is about 50.00g)
- Kernel is light Red
- Duration: rabi 140-145 days & kharif 110-115 days
- Shelling percentage 73%
- Plant height : rabi- 90-94 cm & kharif- 102-110 cm
- No. of mature pods/plant 17-20
- Pod yield 2000-2100 kg/ha
- Market price is higher than existing varieties due to higher no. of kernel/pod.

iv) BARI Til-6

Salient feature:

- Black seed
- Duration 90-95 days
- Plant height 100-110 cm
- No. of pods/plant 65-70
- Seed yield 1600-1800 kg/ha
- Moderately waterlogged tolerant (it can tolerate 60-70 hours waterlog condition during flowering stage).

B. Crop and Soil Management

i. Intercropping of firingi with groundnut: One row of firingi in between two normal rows of groundnut was found economically viable for the farmers in intercropping system which increases total productivity in terms of groundnut equivalent yield.

Variety: BARI Chinabadam-8 & BARI Firingi-1
Sowing date: 23 November
Harvesting date: Firingi (15-20 February); Groundnut (19-22 May)
GEY: 7.97 t/ha and BCR: 8.4

ii. **Intercropping of pea as vegetables crop with dwarf type sunflower variety:** One row of pea in between two normal rows of sunflower would be agronomically feasible and economically profitable for the farmers in intercropping system.

Variety: BARI Sunflower-3, BARI Khesari-4 and BARI Motor-3
Sowing date: 21 November
Harvesting date: Sunflower (23 March), Khesari (31 February) and Motor (18-30 January)
SEY: 6.64 t/ha and BCR: 3.80

iii. Determination of fertilizer doses for BARI Sarisha-18 (canola variety): 20% more than recommended dose was found optimum and profitable dose of fertilizer to cultivate BARI Sarisha-18.

Variety: BARI Sarisha-18
Sowing date: 15 October
Harvesting date: 21 February
MEY: 1.91 t/ha and BCR: 2.50

3. Research Progress

A. Varietal Development

Rapeseed and mustard

- The line Nap-16013 (2245 kg/ha, DM:82-95 days) has been selected for higher seed yield while BARI Sarisha-8 as check variety produced only 1951 kg/ha in *Brassica napus*.
- The line BC-100614 (8)-4 (1442kg/ha) has been selected for higher seed yield while BARI-Sarisha14 as check variety produced only 1251 kg/ha in *B. rapa*.
- The line BJ 11536 (12)-1(1664kg/ha) produced the highest seed yield compared to check variety BARI Sarisha -11 (1618 kg/ha) in multi-location trial from *B. juncea*

Groundnut

- The entry ICGV 07219 and Jhaldhaka produced higher pod yield (2815 kg/ha and 2341 kg/ha, respectively) which was 56% and 30% higher than the check variety BARI Chinabadam-8 over two locations.
- The genotype ICGV 0207 produced the highest yield (2594 kg/ha) over two locations which was 21% higher pod yield than the check variety BARI Chinabadam-8.

Soybean

- ST-1 was produced the highest seed yield (2135 kg/ha) which was 24 % higher than the check variety BARI Soybean-7 in Joydebpur location.

Sunflower

- Medium dwarf composite-5 generation was developed with the average plant height of about 96 cm and takes 101 days to mature. This line will be tested in yield performing trial compared with check variety in the next *rabi* season to release as composite sunflower variety.
- A total of 234 single mutants from five different groups of gamma radiated BARI Surjamukhi-2 were harvested. M6 family mutants will be grown from bulk seed of each group in the next rabi season.
- A total of 425 single mutants from different groups of EMS treated BARI Surjamukhi-2 were harvested. The mutant family will be grown from each group, evaluated and inbreeds of mutants sunflower will be obtained.

B. Crop and Soil Management

- In case of newly released mustard variety (BARI Sarisha-18) cultivation, the maximum seed yield (3.00 t/ha) was recorded in case of 20% more use of fertilizer than recommended dose (RD: 90-35-85-30-3.6-1.8 kg/ha of NPKSZn and B, respectively).
- One row of bunching onion in between two normal rows of groundnut would be agronomically feasible and economically profitable for the farmers in intercropping system with higher GEY (3.21) and BCR (3.18)
- In case of newly released canola (BARI Sarisha-18) cultivation, the maximum seed yield (2.00 t/ha) was recorded when the plots were irrigated as and when necessary (5 times) which was statistically similar to those plots which were irrigated at vegetative, flowering and seed development stage (1.88 t/ha).
- In case of newly released dwarf sunflower variety (BARI Surjomukhi-3) cultivation, the maximum seed yield (1.94 t/ha) was recorded when the plots were irrigated as and when necessary (4 times) which was statistically similar to those plots which were irrigated at vegetative, flowering and seed development stage.
- Transplanting of 15 days old seedling of BARI Surjomukhi-3 gave highest seed yield (1.81 t/ha) with higher no. of seeds/head and higher seed weight at 22 November transplanting
- One row of firingi (15cm X 10cm) in between two normal rows of groundnut (40cm X 15cm) gave higher GEY: 7.97 t/ha with higher BCR: 8.40 in groundnut firingi intercropping system.
- One row of pea in between two normal rows of sunflower would be agronomically feasible and economically profitable for the farmers in intercropping system in term of SEY: 6.64 t/ha and BCR: 3.80
- 40cm x 10cm is the suitable spacing for BARI, Soybean-7 cultivation for getting high yield.
- Minimum tillage through PTOS produced the higher seed yield (1.52 t/ha) of mustard in south western saline areas sowing on 30 November.
- 20 February to 2 March sowing would be the optimum sowing time for sesame to have maximum seed yield and higher economic return in Cumilla region.

- BARI Soybean-6 and Bangladesh Soybean-4 could be cultivated under conventional tillage condition for getting higher yield and economic returns under rice based cropping systems in southern region of Bangladesh.
- Sunflower: Soybean = 1-row: 2-row and Sunflower: Soybean = 2-row: 3-row gave more Sunflower equivalent yield (SEY) and Land equivalent ratio (LER) and economic return where plant spacing for sunflower single row was row to row distance 50 cm and plant to plant distance 25 cm in southern region in Bangladesh.

C. Disease Management

- Among the thirty nine tested line of rapeseed mustard, all the lines are susceptible to Alternaria blight of mustard.
- Among the fungicides, Rovral, Amistertop, Scure, Nativo, Folicur,Tip off performed better than the other fungicides. In case of yield, the highest yield was obtained from Rovral followed by Amister top.
- Among the fungicides, Amister Top 325 SC, Score 250 EC, Nativo 75WG, Folicur 250 EC, Infinity Pro, Tip off performed better than the other fungicides in case of both the diseases. Autostin performed good for leaf spot but not for rust.
- Among the 40 tested lines, sixteen liens CHOKO-0314, ICGV-38-3, ICGV-87073, ICGV-91176, NCGV-0704, ICGV-35-1, ICGV-95090, NCGV-02096, BDGV-602-7-4-2, BDGV-14-103, ISD-2414, NCGV-0107, PK-1, ISD-0414, NCGV-0207, JALDHAKHA were selected as moderately resistance against leaf spot and rust diseases.

D. Insect Pest Management

- Among the treatments, White sticky trap + Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water) as well as Proclaim 5 SG (Emamectin benzoate) @ 2g/L of water were effective against flea beetle with higher yield and marginal benefit cost ratio.
- Nitro 505 EC @1.0 ml/L of water as well as White sticky trap + Perching+ Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water were effective against major insect pest of sesame with higher yield and marginal benefit cost ratio.
- Among the BARI release soybean varieties, BARI Soybean-7 are less susceptible, Shohag is moderately susceptible and BARI Soybean-5, BARI Soybean-6 are more susceptible.
- Among the BARI release chinabadam varieties, Basonti Badam, BARI Chinabadam-5, BARI Chinabadam-6, BARI Chinabadam-7 and BARI Chinabadam-10 are less susceptible, Dhaka-1, Tridana Badam and BARI Chinabadam-11 are more susceptible.
- Nitro 505 EC @1.0 ml/L of water as well as White sticky trap + Perching+ Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water were effective against major insect pest of sunflower with higher yield and marginal benefit cost ratio.

Executive Summary

Oilseed Research Centre of BARI has been conducting research on nine oilseed crops like rapeseed-mustard, groundnut, sesame, soybean, sunflower, linseed, niger, safflower and perilla. The area of research includes variety development, crop and soil management, disease management, insect pest management. It also includes technology transfer activities and seed production and distribution.

Variety Development

Rapeseed- mustard is a major oilseed crop in Bangladesh. Experiments were conducted to develop short duration, high yielding, commercial hybrid and double low varieties. OT, PYT and RYT of rapeseed-mustard were conducted at HQ, Gazipur and different RARS of BARI. In case of RYT, three lines were selected for adaptive trial in the next year. Observation trial of entries developed from interspecific hybridization among *B. carinata* and *B. napus* were done in which three entries produced higher seed yield compared to the check variety. Developed 15 F_6s were selfed to advance generation.From 16 parental lines, 18 single crosses, 8 three-way crosses and 2 four way crosses were made successfully. First generation produced 25 seed and second generation produced 35 allohexaploid seed successfully. Phenotyping of NAM lines under multiple stresses, 20 parental lines were used and from here 10 single crosses were made successfully.

Groundnut is an important oilseed crop in Bangladesh. Experiments were conducted to develop short duration, high yielding and bold seeded varieties. Two hundred forty one garmplasm were evaluated and maintained to rejuvenate the seeds. Six parental lines were sown and crossed in 15 different cross combinations. Total 487 buds were pollinated and produced 222 pods. Eight lines were selected for PYT based on higher yield compared to check variety BARI Chinabadam-8. Among nineteen, eight genotypes produced higher pod yield compared to BARI Chinabadam-8. Six genotypes and five genotypes were selected for adaptive trial in case of regional yield trial.

Soybeans are one of the most prevalently grown and used oilseeds in Bangladesh. Seed of soybean are high in protein and a decent source of both carbs and oil. The extraction of seed oil is not yet possible. But the crop has gained popularity as an important ingredient of poultry and fish feed as a source of protein. One hundred twenty germplasm were evaluated and eighteen germplasm would be effective to use for future breeding program. In order to develop high yielding soybean varieties for coastal areas, four entries from PYT were selected for RYT, after considering yield and other yield contributing characters.

Forty three germplasm of sunflower were maintained and evaluated. For development of dwarf inbred lines in sunflower nine genotypes were selected based on dwarf, early and high yield potential and will be grown in next year. S_6 seeds of CN001; CN001 and S_8 seeds of hysun-33 were grown and self-fertilized to find out parental lines for development of hybrid sunflower variety. To develop synthetic sunflower variety, seeds of syn-2 were grown as syn-2 and selected based on dwarf to medium dwarf height, thicker stem, bigger head. The seeds from composite-5 were grown and allowed for intermating to develop composite sunflower variety. Creating new genetic variability was done by using induced mutation such as gamma radiation and EMS. Here, mutants were grouped into tall, dwarf mutant, and medium dwarf mutant. Besides, EMS treated mutant sunflower were characterized molecularly. GA2ox1, SAD and FAD gene sequences were found to be expressed in leaf tissue of sunflower mutant.

Crop and Soil Management

To get the maximum yield of high yielding oilseed varieties, proper managenent is important. Oilseed crops are facing various problems in the farmer field. Farmers do not apply fertilizers and take less care of their oilseed crops. Therefore, there exist a big gap between yield of the research station and the farmer’s field. To minimize such losses, technologies like 20% more use of fertilizer than recommended dose followed by 30% more use of fertilizer than RD, 3 times irrigation at least at vegetative, flowering and seed development stage of BARI Sarisha-18 might be helpful to get optimum yield. For saline areas, transplanting on 22 November of 15 days old seedling of BARI Surjomukhi-3 and minimum tillage through PTOS in mustard cultivation on 30 November sowing might be some options to get optimum yield. Long durated oilseed crops like groundnut when grown as intercrop with non-leguminous crops like lalshak, spinach, indian spinach, danta, fenugreek, carrot, onion,garlic etc can contribute to their economic viability along with maintenance of fertility and organic matter contents of soils. Intercropping of one row of bunching onion and firingi in between two normal rows of groundnut would be agronomically feasible and economically profitable for the farmers in intercropping system with higher GEY and BCR. Along with this, one row of pea in between two normal rows of sunflower is also a profitable option to increase cropping intensity. Leguminous oilseed crops like soybean is a good option to incease the total oilcrop production in saline areas which also helps to improve soil fertility. BARI Soybean-6 and Bangladesh Soybean-4 could be cultivated under conventional tillage condition for getting higher yield and economic returns under rice based cropping systems in southern region of Bangladesh. Moreover spacing at 40cm x 10cm is the suitable for BARI Soybean-7 cultivation for getting optimum yield. However, by adjusting the planting time between 20 February to 2 March would be the optimum for sesame to have maximum seed yield and higher economic return in Cumilla region.

Disease Management

Around 25-30% crop can damage due to different diseases of oilseed crop in Bangladesh. To minimize this loss, the experiments were conducted to control the major diseases of different oilseed crops. Among them leaf blight, white mold of mustard, stem rot of sesame, yellow mosaic virus in soybean, tikka and rust, foot rot of groundnut, leaf blight, foot rot, white mold of sunflower are mentionable. In the varietal line screening all the thirty nine tested line of rapeseed mustard are susceptible to *Alternaria* blight of mustard and sixteen out of forty tested lines of groundnut were selected as moderately resistant for rust and leaf spot diseases. On the other hand, for efficacy testing, all the group of commercial fungicides were significantly reduced the *Alternaria* blight of mustard disease as compared to control but Rovral followed by Amister top tested plot shows the highest yield. In case of leaf spot and rust diseases of groundnut, among the group of commercial fungicides Amister Top 325 SC, Score 250 EC, Nativo 75WG, Folicur 250 EC, Infinity Pro, Tip off performed better than the other fungicides but Autostin performed good for leaf spot but not for rust.

Insect Pest Management

Insect pest can damage 20-25% of oilseed crops in Bangladesh. To minimize this loss, the experiments were conducted to control the major insect pests of different oilcrops. Among them flea beetle of mustard, hairy caterpillar, leaf roller of sesame, different sucking insects i.e, whitefly, thrips etc., hairy caterpillar and leaf roller in soybean and groundnut, common cut worm, whitefly, thrips of sunflower are mentionable. The management package of white sticky trap + Bio-chamak (*Celastras angulatas* 1% EW) @ 2.5 ml/litre of water as well as Proclaim 5 SG (Emamectin benzoate) @ 2g/L of water were effective against flea beetle with higher yield and Marginal Benefit Cost Ratio (MBCR) in mustard crop. Regarding management of insect pest of sesame, Nitro 505 EC @1.0 ml/L of water as well as white sticky trap + Perching+ Bio-chamak (*Celastras angulatas* 1% EW) @ 2.5 ml/litre of water were effective with higher MBCR. IPM package of Nitro 505 EC @1.0 ml/L of water as well as white sticky trap + Perching+ Bio-chamak (*Celastras angulatas* 1% EW) @ 2.5 ml/litre of water were effective against sunflower insect pest with higher yield and MBCR. In the varietal screening BARI Soybean-7, Basonti Badam, BARI Chinabadam-5 were found less suspectable to major insect pest during 2021-22 cropping season.

Technology Transfer Activities

Additionally matured technology transfer to the end user is another important phenomenon for strengthening sustainable agriculture. For this ORC have conducted training, pilot production programmes, adaptive trials, field day etc.over the country. We have conducted a total 05 (five) batches training programme for the scientists, DAE, BADC personnel, SA and SAAO where total participants were 120. Not only that we have also arranged training for the farmers at root level where the participants were 625. To motivate the stakeholders we have set up total 30 pilot production programmes, 15 adaptive trials throughout the country. Furthermore, ORC have arranged a total 23 field days of 20 locations of the country where 1840 participants participated along with high officials and policy makers of the country.

Seed Production and Distribution

The quality seed production and distribution play a vital role in agriculture and acts as a carrier of the genetic potential of varieties. With keep it in the mind, we have produced a total 8060 kg rapeseed and mustard seed (2940 kg breeder, 5120 kg TLS), 3000 kg groundnut seed (2000 kg breeder and 1000 kg TLS), 1978 kg soybean seed (1628 kg breeder, 350kg TLS), 650 kg sesame seed (400 kg breeder and 250 kg TLS), 1680 kg sunflower seed (468 kg breeder and 1212 kg TLS) during 2021-22 cropping season. We have also distributed seed of different oilseed crops among the stakeholders i.e., BADC, DAE, NGO, Research organization and also to the farmers of the country. We distributed 6530 kg seed of different rapeseed and mustard verities 1916 kg seed of groundnut, 1216 kg seed of soybean, 1144 kg seed of sunflower and 833 kg seed of sesame to the above mentioned stakeholders which were produced during 2020-21 cropping season.

Project I: VARIETY DEVELOPMENT

A. RAPESEED - MUSTARD (Brassica spp.)

Rapeseed- mustard is a major oilseed crop in Bangladesh. It contributes a lion share to the total edible oil production in the country. The Oilseed Research Centre of BARI has already developed 20 rapeseed and mustard varieties, which comprises 10 *Brassica rapa*, 6 *B. juncea*, and 4 *B. napus.* Most of the developed varieties take long duration to mature except a few. As a result, they do not fit well in the existing T.aman – mustard - Boro rice cropping pattern. There is a limited scope of horizontal expansion of cultivation of rapeseed-mustard. So, for increasing rapeseed-mustard production, seed yield must be increased per unit area. Hybrid variety can play an important role in this regard. Now quality of mustard oil has been considered in variety development. Short duration double low varieties have to be developed. Therefore, high yielding and short duration rapeseed and mustard varieties should be developed to fit into the existing cropping pattern. The existing varieties are also susceptible to *Alternaria* leaf blight and white mold diseases, and aphids. Thus, to develop varieties with high yield potential, early maturity, disease and insect resistance, and wider adaptability, the following experiments were conducted.

MAINTENANCE OF GERMPLASM OF *BRASSICA RAPA* L., *BRASSICA JUNCEA* L. AND *BRASSICA NAPUS* L.

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

A total 145 accessions of which 81 accessions of B. rapa L., 46 of B. juncea L.and 18 of B. napus L. were grown in rabi 2021-22 in order to maintain the existing germplasm of oliferous Brassica rapa L., B. juncea L. and B. napus L.and to use in future breeding programme.

Introduction

The genes required for crop improvement are present in different lines, varieties, strains or populations of the crop species and their relatives. The various lines, varieties, strains, populations of a crop species and its related wild species constitute the germplasm of the crop. Genetic variability is essential for selection. Germplasm of a crop is the main source of genetic variability. To develop short duration, zero erucic acid and low glucosinolate varieties, germplasm is essential. So, maintenance of existing germplasm is necessary for using in the future breeding programme.

Materials and Methods

A total 145 accessions of which 81 accessions of *B. rapa* L., 46 of *B. juncea* L. and 18 of *B. napus* L.. Each accession were grown. Unit plot size was 3 rows 3 m long and row to row distance 30 cm and plant to plant distance 5 cm after thinning. Twenty plants were selected randomly from middle row of the plot.

Results

Seeds collected from randomly selected ten plants of each germplasm were stored to maintain the germplasm of *B. rapa* L., *B. juncea* L. and *B. napus* L. and for using in the future breeding programme.

Acknowledgement

'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project

DEVELOPMENT OF SHORT DURATION INBRED LINES IN *BRASSICA RAPA*

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

The most adaptive variety Tori-7, high yielding varieties BARI Sarisha-9, BARI Sarisha-12 and Kalaynia, short duration local cultivar Din-2, short duration line BC-2193, low erucic acid lines, SBC-3593, SBC-4093, SBC-6823 and SBC-8693 were used as source populations for developing inbred lines. One hundred and nine rows were sown following plant to row. Days to flowering ranged from 28-34 days and days to maturity ranged from 77-87 days. Three hundred and eighty six plants were selected for selfing for advancing S_5 to S_6 generation from eleven source populations. Total 1710 buds were selfed from which 1075 effective siliquae and 6672 seeds were obtained. Selfed seeds were stored for maintaining as inbred lines in the next year.

Introduction

The two important features of cross pollinated species are inbreeding depression and heterosis. Heterosis is the basis for the breeding of hybrid and synthetic varieties. Hybrid varieties are the best means of utilizing heterosis and synthetic varieties utilize a part of heterosis. Hybrid and synthetic varieties have been used in many cross-pollinated crops. In *B. rapa*, as a cross-pollinated crop, hybrid and synthetic varieties have been widely used. For the development of short duration hybrid/synthetic varieties in *B. rapa*, development of short duration inbred lines having superior general combining ability is pre-requisite.

Materials and Methods

The most adaptive variety Tori-7, high yielding varieties BARI Sarisha-9, BARI Sarisha-12 and Kalaynia, short duration local cultivar Din-2, short duration line BC-2193, low erucic acid lines SBC-4093, SBC-6823 and SBC-8693 were used as source populations. Selfed seeds from individual plant of source populations obtained from previous year were sown following plant to row method. Selfed seeds were sown along with Tori-7 as check. Seeding was done on 21 November 2021. Unit plot size was 1 row 3m long. Short duration plants were selected comparing with check variety for selfing. Proper bagging was done to protect out crossing. Selfing of plants was done through bud pollination.

Results and Discussion

Advancing S_5 to S_6 generation

Results of selfing of Tori 7, BARI Sarisha 9, BARI Sarisha 12, Kalaynia, Din-2, BC-2193, S SBC-3593, BC-4093, SBC-6823 and SBC-8693 are presented in Table 1. One hundred and nine rows were sown following plant to row. Days to flowering ranged from 28-34 days and days to maturity ranged from 77-87 days. Three hundred and eighty six plants were selected for selfing for advancing S_5 to S_6 generation from eleven source populations. Total 1710 buds were selfed from which 1075 effective siliquae and 6672 seeds were obtained. Selfed seeds were stored for maintaining as inbred lines in the next year.

Acknowledgement

‘Strengthening of Oilseed and Pulses Research and Development in Bangladesh’ project

Table 1. Results of selfing of Tori-7, BARI Sarisha-9, BARI Sarisha-12, Kalaynia, Din-2, BC-2193, SBC-3593, SBC-4093, SBC-6823 and SBC-8693 under Advancing S_5 to S_6 generation in *Brassica rapa*at Gazipur during rabi 2021-22

Sl. no.	Pedigree	No. of rows sown (plant to row)	Days to flowering	Days to maturity	No. of plants selfed	No. of buds selfed	No. of effective siliqua obtained	No. of seeds obtained
1	T7-09BS$_1$-BS$_2$-BS$_3$- BS$_4$- BS$_5$-BS$_6$	26	28-33	77-84	102	504	253	1775
2	BS9-09BS$_1$- BS$_2$-BS$_3$- BS$_4$- BS$_5$-BS$_6$	25	28-34	80-87	80	443	315	2105
3	BS12-09BS$_1$-BS$_2$- BS$_3$- BS$_4$-BS$_5$- BS$_6$	16	28-33	84-85	44	183	108	901
4	Kln-09BS$_1$- BS$_2$-BS$_3$- BS$_4$- BS$_5$-BS$_6$	18	31-33	84-86	44	216	110	375
5	Din2-09BS$_1$- BS$_2$-BS$_3$- BS$_4$- BS$_5$-BS$_6$	3	30-33	85-86	15	43	33	204
6	BC2193-09BS$_1$-BS$_2$- BS$_3$- BS$_4$-BS$_5$- BS$_6$	11	30-33	84-86	56	153	137	422
7	SBC3593-09BS$_1$-BS$_2$- BS$_3$- BS$_4$-BS$_5$- BS$_6$	2	32	86	7	43	36	213
8	SBC4093-09BS$_1$-BS$_2$- BS$_3$- BS$_4$-BS$_5$- BS$_6$	3	30-31	84-85	10	28	15	122
9	SBC6823-09BS$_1$-BS$_2$- BS$_3$- BS$_4$-BS$_5$- BS$_6$	3	32-33	86	16	47	31	245
10	SBC8693(B)-09BS$_1$- BS$_2$- BS$_3$-BS$_4$- BS$_5$- BS$_6$	1	31	85	7	34	19	165
11	SBC8693(Y)-09BS$_1$- BS$_2$- BS$_3$-BS$_4$- BS$_5$- BS$_6$	1	30	84	5	16	18	145
	Total	**109**			**386**	**1710**	**1075**	**6672**

EVALUATION OF F_6 GENERATION IN *BRASSICA RAPA*

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-17 and BARI Sarisha-6 were used as female parents and S_6 generation of BARI Sarisha-9 and Tori-7 were used as male parents to develop single crosses during 2014-15. F1s were crossed with BARI Sarisha-6 and BARI Sarisha-17 to develop three-way crosses during 2015-16. F_1 –F_5 were developed through selfing during 2016-21. Days to maturity ranged from 84-86 days. Early and desirable plants were selected for selfing and 46 plants were selfed. One hundred and ninety nine siliquae were obtained from which 2314 seeds were obtained. Selfed seeds of individual plant were stored for evaluation in the next season.

Introduction

In a complex cross, more than two parents are crossed to produce the hybrid, which is then used either to produce F_2 or is used in a backcross. Such as cross is also known as convergent cross because this crossing programme aims at converging, i.e., bringing together, genes from several parents into a single hybrid. Therefore, the experiment was conducted to create genetic variability and accumulate more favorable genes from several parents into a single hybrid.

Materials and Methods

BARI Sarisha-14, BARI Sarisha-15, BARI Sarisha-17 and BARI Sarisha-6 were used as female parents and S_6 generation of BARI Sarisha-9 and Tori-7 were used as male parents to develop single crosses during rabi 2014-15. F_1s were grown during rabi 2015-16 and crossed with BARI Sarisha-6 and BARI Sarisha-17 to develop three-way crosses. F_1 –F_5 generation were developed through selfing during 2016-21. F_6 seeds of three-way crosses of eight cross combinations were sown on 18 November 2021 at Gazipurr. Unit plot size was 5 rows 3m long. Selfing was done through bud pollination to advance generation.

Results and Discussion

Results of F_6s of eight three-way cross combinations of *Brassica rapa* are presented in Table 2. Days to maturity ranged from 84-86 days. Early and desirable plants were selected for selfing. No. of selfed plants from different cross combinations ranged from 4-9 and total 46 plants were selfed. Two hundred and ninety buds were selfed to develop F_6 generation. One hundred and ninety nine siliquae were obtained from which two thousand three hundred and fourteen seeds were obtained. Selfed seeds of individual plant were stored for evaluation in the next season.

Acknowledgement

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Table 2. Results of 8 F_6s of three-way cross combinations in 'Evaluation of F_6 generation in *Brassica rapa'* during rabi 2021-22 at Gazipur

Sl. no.	F_5s of three-way crosses			Days to maturity	No. of plants selfed	No. of buds selfed	No. of effective siliquae obtained	No. of seeds obtained
1	BARI Sarisha-14 X Tori-7 (S_6)	X	BARI Sarisha-6	85	4	39	34	374
2	BARI Sarisha-14 X BARI Sarisha-9 (S_6)	X	BARI Sarisha-6	85	5	26	15	185
3	BARI Sarisha-15 X Tori-7 (S_6)	X	BARI Sarisha-6	85	6	34	25	322
4	BARI Sarisha-15 X BARI Sarisha-9 (S_6)	X	BARI Sarisha-6	85	4	21	18	277
5	BARI Sarisha-17 X Tori-7 (S_6)	X	BARI Sarisha-6	86	5	40	29	307
6	BARI Sarisha-17 X BARI Sarisha-9 (S_6)	X	BARI Sarisha-6	86	9	48	34	342
7	BARI Sarisha-6 X Tori-7 (S_6)	X	BARI Sarisha-17	84	6	40	29	322
8	BARI Sarisha-6 X BARI Sarisha-9 (S_6)	X	BARI Sarisha-17	86	7	42	15	185
			Total		**46**	**290**	**199**	**2314**

GROWING OF F_5 GENERATION ORIGINATED FROM 16 PARENTS OF *B.RAPA*

U. KULSUM, M. SHALIM UDDIN AND M. M. ALI

Abstract

A complex/multiple crosses along with the parents were used in the experiment for the accumulation of desired genes from sixteen parents into a single parent. A total of 307 single plants of which 102 were yellow seeded and 205 were brown seeded selected based on seed coat color, plant height, pod length, branches per plant, pod per plant, seeds per plant, and yield per plant. The seeds of selected single plants will be grown as F_6 next year.

Introduction

In classical plant breeding, interbreeding more than two parents is one of the best techniques for bringing together favorable genes from several parents into a single parent. Producing F_2 generation and subsequent generations, desirable genotypes can be identified. Therefore, the experiment was conducted to create genetic variability and accumulate favorable genes from 16 parents into a single parent.

Materials and Methods

Eight brown seeded and eight yellow seeded rapeseed parents were utilized to produce single crosses which are different developed varieties and advanced lines of *B. rapa*. Single crosses were made in 2013-14 following double-crosses in 2014-15. Complex crosses were done in 2015-16 and 2016-17 to accumulate desirable genes into a single parent. F_1, F_2, F_3 and F_4 generations were developed in 2017-18, 18-19, 19-20 and 20-21 respectively. The F_5 seeds along with the fourteen parents were sown on 17 November 2021. The 194 progenies (121 brown seeded & 73 yellow seeded) from F_4 selected based on seed coat color and yield per plant were allowed to grow as F_5 generation. Unite plot size was 2 rows 3m long with 30 cm row spacing. Single plant selection method was applied. Recommended fertilizer doses and intercultural operations were done as necessary.

Results and Discussion

The performance of the F_5 generation is presented in Table 1. A total of 305 single plants were selected from 194 progenies of F_5 based on seed coat color, plant height, pod length, branches per plant, pod per plant, seeds per plant, and yield per plant. Out of 307 single plants, 102 were yellow seeded and 205 were brown seeded. Days to flowering and days to maturity ranged from 27-41 days and 83-94 days for selected plants and for parents 25-40 days and 84-96 days respectively. Plant height was reduced for selected plant than the parents. For selected plant, number of siliqua per plant, seeds per siliqua, and yield per plant increase than fourteen parents. For yellow seed selected plant, brown seeded selected plant and parents yield per plant ranged from 7-42 g, 9-51 g and 7-38 g respectively.

Table 1. Performance of selected single plants during rabi 2021-2022 at BARI, Gazipur

Characters	**Range**		
	Yellow seeded plant	**Brown seeded plant**	**Parents**
Days to flowering	27-41		25-40
Days to maturity (days)	83-94		84-96
Plant height (cm)	40-166	32-162	49-170
Siliqua length (cm)	3.3-10.2	2.5-9.9	2.8-9.0
Root length (cm)	5.1-25	3-28	3.5-15.0
Siliqua per plant	25-690	15-810	20-718
Seeds per siliqua	10-70	9-77	6-49
Yield per plant (g)	7-42	9-51	7-38

Conclusion

The seeds of selected single plants with desirable characters were stored separately for next year sowing as the F_6 generation.

EVALUATION OF SEGREGATING GENERATIONS OF *Brassica rapa*

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

Families of F_6 generation of two cross combinations having both yellow and brown seed coat colour were evaluated. Families of F_6 generation of five cross combinations having both yellow and brown seed coat colour were evaluated. Single plant selection method was followed. Considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, plants were selected from each family and seeds of selected plants of individual family were bulked and stored for evaluation in the next year.

Introduction

Hybridization is one of the best techniques of incorporating desirable characters into a genotype. Development of homogenous line through conventional breeding is essential to advance the filial generations from F_1 to F_6. The present experiments were conducted to advance generation from F_4 to F_6.

Materials and Methods

F_6 generation

Families of F_6 generation of two cross combinations having both yellow and brown seed coat colour were evaluated during rabi 2021-22 at Gazipur. Families were sown following family to row method along with BARI Sarisha-14 as check in 4-rows 3m long plot with spacing 30cm and 5cm between rows and plants, respectively. Seeding was done on 18 November 2021. Single plant selection among families was done based on short duration (maturity duration upto 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

F_6 generation

Families of F_6 generation of five cross combinations having both yellow and brown seed coat colour were evaluated during rabi 2021-22 at Gazipur. Families were sown following family to row method along with BARI Sarisha-14 as check in 4-rows 3m long plot with spacing 30cm and 5cm between rows and plants, respectively. Seeding was done on 18 November 2021. Single plant selection among families was done based on short duration (maturity duration upto 85 days), erect and compact type having desirable agronomic characters, disease and insect tolerance.

Results and Discussion

F_6 generation

The results of F_6 generation of two cross combinations are presented in Table 4. Three families having yellow seed coat colour of one cross combination and three families having brown seed coat colour of two cross combinations were evaluated. Considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, families were selected for further evaluation. Seeds of selected plants of individual family were bulked and stored for evaluation in F_6 generation in the next year.

Table 4. Results of 2 cross combinations under Evaluation of F_6 generation of *Brassica rapa* at Joydebpur during rabi 2021-22

Sl. no.	Cross combinations			Maturity duration (days)	Yellow seed		Brown seed	
					No. of families evaluated	No. of families selected	No. of families evaluated	No. of families selected
1	SBC-6993	x	BARI Sar.-14	upto 85	3	2	2	2
2	SBC-5993	x	BARI Sar.-6	Do	-	-	1	1
				Total	**3**	**2**	**3**	**3**

F_6 generation

The results of F_6 generation are presented in Table 5. Twenty families having yellow seed coat colour of four cross combinations and three families having brown seed coat colour of one cross combination were evaluated. Considering earliness (maturity duration upto 85 days), erect and compact plant type, seed colour, seed size and siliqua shape, disease and insect tolerance, sixteen families were selected for further evaluation. Seeds of selected plants were bulked and stored for evaluation in the next year.

Acknowledgement

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Table 5. Results of 5 cross combinations under Evaluation of F_6 generation of *Brassica rapa* at Joydebpur during rabi 2021-22

Sl. no.	Cross combinations	Seed coat colour	Maturity duration (days)	No. of families evaluated	No. of families selected
1	BARI Sar.-14 x BARI Sar.-15	Yellow	upto 85	10	7
2	BARI Sar.-15 x SAU-1	Yellow	do	4	2
3	BARI Sar.-6 x SAU-1	Yellow	do	2	2
4	BARI Sar.-14 x SAU-1	Yellow	do	4	3
			Total	**20**	**14**
5	BARI Sar.-14 x SAU-1	Brown	do	3	2
			Grand total	**23**	**16**

OBSERVATION TRIAL OF *Brassica rapa* (SET-I)

M. SHALIM UDDIN, M A LATIF AKANDA, and A B M KHALDUN

Abstract

Twelve lines of Brassica rapa having yellow flower and yellow seed coat colour along with BARI Sarisha-14 as check were evaluated with two replications. Maturity duration ranged from 82-89 days. Four lines were matured within 87 days. The highest number of siliquae per plant recorded in BS-14x-BS-15-1 and highest number of seeds per siliqua recorded in BC-2014-Y02-1-2. Seed yield ranged from 1155-1944 kg/ha. five lines BC-2014-Y08, BS-14XBS-15-1, BC-100614(4)-14, BC-2014-Y014, BS-14XS-15-4 and BC-100614(4)-9 were selected for the next trial and other variety development activities.

Introduction

Rapeseed and mustard are very much sensitive to the environment. Most of the farmers in our country cultivate traditional variety Tori 7 to fit into existing cropping pattern. The yield of local Tori 7 is very poor compared to other improved varieties. The objective of this study was to select short duration high yielding lines with better agronomic traits like plant height, siliquae formation pattern and seed development. Better performing genotypes/lines will be included in preliminary yield trial for further evaluation.

Twelves

Materials and Methods

Twelve lines of *Brassica rapa* having yellow flower and yellow seed coat colour were selected last year from F_7 generation of different cross combinations. These lines along with check as BARI Sarisha-14 were evaluated with two replications under Observation Trial of *Brassica rapa* (Set-I) at Gazipur during 2021-22. The lines were sown on 11 November 2021 in 3 rows of 3m long with spacing of 30 cm and 5cm between rows and plants, respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid, respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of siliquae per plant, no. of seeds per siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha to measure the yield of the line.

Results and Discussion

The mean performance of twelve lines along with check as BARI Sarisha-14 are presented in Table 6. Variations were observed among the lines and significant variations recorded all the parameters except days to flowering. Maturity duration ranged from 82-85 days in case for the tested lines. Plant height ranged from 61-86 cm. Number of siliquae per plant ranged from 31-157. The highest number of siliquae per plant recorded in BS-14XBS-15-3-1. No. of seeds per siliqua ranged from 13-32. The highest number of seeds per siliqua recorded in BC-100614(4)-9. Seed yield ranged from 1055-1945 kg/ha. The highest seed yield recorded in BC-100614(4)-9 (1925 kg/ha). The seed yield was very low due to waterlogged stress at seedling stage for cyclonic storm Jawad was bringing heavy rainfall during 3-6 December 2021.

Table 6. Mean performance of 12 lines and one check as BARI Sarisha-14 in Observation Trial of *Brassica rapa* (Set-I) during rabi 2021-22 at Gazipur

Sl. no.	Lines/Variety	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
1	BC-2014-Y01	36	84	75.85	4.25	96.80	17.50	3.670	1083
2	BC-2014-Y02	36	83	80.95	4.35	58.00	21.65	3.185	1404
3	BC-2014-Y08	36	83	75.75	4.55	59.25	20.95	3.216	1541
4	BC-2014-Y014	36	85	73.40	4.90	58.90	19.75	3.438	1759
5	BS-14XBS-15-1	36	85	76.35	4.35	76.80	19.40	3.548	1644
6	BS-14XS-15-4	36	84	82.35	3.95	61.55	21.95	3.285	1789
7	BS-14XBS-15-3-1	36	85	83.80	3.65	41.40	19.25	3.103	1180
8	BC-2014-Y02-1	35	84	79.95	1.80	34.10	30.65	2.904	1500

Sl. no.	Lines/Variety	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
9	BC-2014-Y02-1-2	36	85	60.00	4.50	46.95	22.65	3.565	1376
10	BC-100614(4)-14	36	84	65.60	4.15	44.00	29.50	3.276	1646
11	BC-100614(4)-9	35	83	69.95	3.80	45.90	30.40	3.392	1926
12	BC-2014-YO11	35	83	59.90	4.65	91.95	17.80	3.484	1252
13	BARI Sarisha-14	36	82	63.10	2.75	35.35	19.85	3.349	1487
	SE	0.72	0.76	2.10	0.67	1.98	1.49	0.16	70.81
	LSD ($p \geq 0.05$)	Ns	2.34	8.05	1.07	8.47	5.66	0.49	218.19
	CV (%)	2.9	1.3	8.2	8.9	6.5	10.7	6.7	6.6

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Conclusion

Considering earliness, seed yield and other yield contributing characters, five lines BC-2014-Y08, BS-14XBS-15-1, BC-100614(4)-14, BC-2014-Y014, BS-14XS-15-4 and BC-100614(4)-9 were selected for the next trial.

OBSERVATION TRIAL OF *BRASSICA RAPA* (SET-II)

M SHALIM UDDIN, A B M KHALDUN and M A LATIF AKANDA

Abstract

Eleven lines of Brassica rapa having brown seed coat colour along with two checks as BARI Sarisha-9 and BARI Sarisha-14 were evaluated with two replications under Observation Trial of Brassica rapa (Set-II) at Gazipur. Days to flowering and maturity duration ranged from 35-38 and 82-90 days, respectively. The highest number of siliquae per plant was recorded in BS-14XBS-15-10. Seed yield ranged from 644-1282 kg/ha. Considering earliness, seed yield and other yield contributing characters, four lines BC-100614(4)-4(B), BS-14XSAU-1-4, BS-14XBS-15-6, BS-14XSAU-1-2 were selected for the next trial.

Introduction

Rapeseed and mustard are very much sensitive to the environment. Most of the farmers in our country cultivate traditional variety Tori 7 to fit into existing cropping pattern. The yield of local Tori 7 is very poor compared to other improved and modern varieties. The objective of this study was to select short duration high yielding lines with better agronomic traits. Better performing genotypes/lines will be included in preliminary yield trial further evaluation.

Materials and Methods

Eleven lines of *Brassica rapa* having yellow flower and brown seed coat colour were selected last year from F_7 generation of different cross combinations. These lines along with two checks as BARI Sarisha-9 and BARI Sarisha-14 were evaluated with two replications under Observation Trial of *Brassica rapa* (Set-II) at Gazipur during 2021-22. The lines were sown on 11 November 2021 in 3 rows of 3m long with spacing of 30 cm and 5 cm between rows and plants, respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, zinc Sulphate and Boric acid, respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of siliquae per plant, no. of seeds per siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha.

Results and Discussion

The mean performance of twelve lines along with two checks as BARI Sarisha-9 and BARI Sarisha-14 are presented in Table 7. Variation was observed in all the studied parameters, however, significant difference recorded in number of seed/siliqua and seed yield. Maturity duration ranged from 82-90 days. Plant height ranged from 44-85 cm which is almost desirable plant stature. The highest plant height was recorded in BS-14XBS-15-10. Number of siliquae per plant ranged from 23-127. The highest number of siliquae per plant was recorded in BS-14XBS-15-10. Number of seeds per siliqua ranged from 10-25. Seed yield ranged from 644-1304 kg/ha. The seed yield was very low due to waterlogged stress at seedling stage for cyclonic storm **Jawad** was bringing heavy rainfall. The highest seed yield recorded in BS-6 x-BS-1-6 (1281 kg/ha) which was significantly higher than both check varieties. Considering earliness, seed yield and other yield contributing characters, two lines BS-14XBS-15-6 and BS-14XSAU-1-2 were selected for the next trial.

Table 7. Mean performance of 11 lines and BARI Sarisha-9 and BARI Sarisha-14 as check in Observation Trial of *Brassica rapa* (Set-II) during rabi 2021-22 at Gazipur

Sl. no.	Lines/Variety	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
1	BS-14XBS-15(B)-1	35	89	68.95	4.25	58.25	15.55	2.481	794
2	BS-14XBS-15(B)-2	36	88	58.55	2.75	32.95	18.45	3.026	822
3	BS-14XBS-15(B)-3	38	89	60.75	5.85	85.50	11.25	2.235	696
4	BS-14XBS-15(B)-4	37	88	69.05	4.75	61.55	15.80	2.668	832
5	BC-100614(4)-10(B)-1	36	85	63.05	3.65	61.35	12.70	3.093	850
6	BC-100614(4)-4(B)	36	84	68.10	5.65	52.20	21.85	2.561	944
7	BC-100614(4)-10-(B)-2	36	85	68.00	4.50	52.70	18.45	3.253	656
8	BS-14XBS-15-10	38	84	80.20	4.75	115.05	16.50	2.937	924
9	BS-14XSAU-1-4	36	85	71.70	4.25	81.55	23.40	3.308	978
10	BS-14XSAU-1-2	37	86	70.75	4.40	96.90	13.65	3.345	1282
11	BS-14XBS-15-6	37	84	72.60	4.40	111.40	13.05	3.409	1272
12	BARI Sarisha-9 (Ch)	36	84	63.10	4.35	116.05	14.40	3.348	674
13	BARI Sarisha-14 (Ch)	35	82	44.30	3.55	23.20	23.35	3.354	769
	SE	0.92	1.34	5.85	0.11	2.52	2.00	0.227	33.2
	LSD (p≥0.05)	2.31	4.12	18.03	0.58	10.10	4.66	0.699	102.4
	CV (%)	5.6	2.2	12.5	6.5	8.6	6.2	8.7	5.3

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Conclusion

Considering earliness, seed yield and other yield contributing characters, four lines BC-100614(4)-4(B), BS-14XSAU-1-4, BS-14XBS-15-6, BS-14XSAU-1-2 were selected for the next trial.

PRELIMINARY YIELD TRIAL OF *Brassica rapa* (SET-I)

M SHALIM UDDIN, M A LATIF AKANDA, A B M KHALDUN, M R HUMAUAN, M H RAHMAN and M A MONIM

Abstract

Eleven lines of Brassica rapa having yellow seed coat colour along with one check as BARI Sarisha-14 were evaluated at Gazipur, Ishurdi and Jashore. Analysis of variance for the genotypes showed significant variation which revealed the presence of considerable amount of genetic variability among different genotypes. Significant genotype x environment interaction was obtained for all studied characters and those were tested against pooled error. Environment + (genotype × environment) component and genotype × environment (linear) component also showed significant variation and the genotypes performed differently in different environments. Except pooled deviation of linear components of genotype-environment interaction were significant for all the characters. So, the differences in stability for different characters were due to the linear response and not for non-linear function. Maturity duration ranged from 84-88 days and seed yield ranged from 325-1971 kg/ha at all over location. The line BC-100614(8)-7produced the highest seed yield (1382 kg/ha) at all over the location. Considering earliness, seed yield and other yield attributing characters, four lines like BC-100614(8)-7, BC-100614(8)-1, BC-100614(7)-3 and BC-100614(4)-10 were selected for RYT in the next year.

Introduction

Rapeseed and mustard are very much sensitive to the environment. Most of the farmers in our country cultivate traditional variety Tori 7 to fit into existing cropping pattern. The yield of local Tori 7 is very poor compared to other newly developed modern varieties.

For the investigation of Genotype (G)-Environment (E) interactions, several stability models (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966) have been developed. With many genotypes and environments, interactions get more complicated and are impossible to analyze in detail without a graphic approach. Multivariate, graphic-based stability models such as GGE (genotype main effect (G) plus genotype by environment interaction (GE) (Yan et al., 2000) and additive main effect and multiplicative interaction (AMMI) biplot analyses have been employed by researchers to understand the complex G × E interaction patterns and to identify stable genotypes for several economically important traits, especially grain yield. Further, these two models have been used extensively for disease resistance trait in different crops for different diseases to identify stable and durable-resistant sources and to understand G × E interactions (Pandey et al., 2021; Srivastava et al., 2021)

Complex interaction will create disagreement between realized and expected genotypic responses, hereby affecting the selection efficiency and accurate prediction models aids in enhancing selection efficiency in MET, thereby increasing the genetic gains. Through its shrinkage property, the best linear unbiased prediction (BLUP) model is reported to outperform AMMI family models in predicting genotypic means (Olivoto et al., 2019).

A recent quantitative stability index, Weighted Average of Absolute Scores (WAASB) from the singular value decomposition of the matrix of BLUPs for the GEI effects generated by a linear mixed effect model (LMM), is a graphic-based mixed-model accommodating the features of both BLUP and AMMI models (Olivoto et al., 2019) and aids in analysing MET. WAASB-based superiority index, WAASBY helps in the selection of genotypes simultaneously for superiority and stability of targeted trait (Olivoto et al., 2019). WAASB stability index has been employed for the identification of stable genotypes in different economic traits such as drought and salinity stress tolerance in soybean (Zuffo et al., 2020) and cassava mosaic disease and cassava anthracnose disease resistance (Tize et al., 2021), and grain yield and early maturity in soybean (Nataraj et al., 2021). Therefore, future studies would benefit when using WAASB, since they would integrate BLUP and AMMI proprieties into a single method (Olivoto et al., 2019). With this background, the objective of this study was to select short duration high yielding lines with better agronomic traits. Better performing genotypes/entries and understanding the G × E interaction patterns through WAASB and MTSI stability model.

Materials and Method

The experiment was conducted at Gazipur, Ishurdi, Rahamatpur, Hathazari and Jeshore during rabi 2021-22 with 11 genotypes of *Brassica rapa* having yellow seed coat colour along with one check as BARI Sarisha-14. The experiment was laid out in randomized complete block design with three replications. The plot size was 3m x 0.9m. Seeding was done on 11 November 2021 at Gazipur, 9 November 2021 at Ishurdi, 6 November 2021 at Jashore and 17 December 2021 at Rahmatpur as continuous sowing in rows of 30 cm apart. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of siliquae per plant, no. of seeds per siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into kg/hectare. The data were analyzed statistically.

Mean performance and stability of single traits

Additive main effects and multiplicative interaction (AMMI) model Analysis

The grain yield data were pooled across locations and years and subjected to the AMMI model (Gauch 1993). The AMMI analysis was performed in R software 4.0.3 (R Core Team 2020) using package 'metan' (Olivoto and Lucio 2020). Twenty-three stability statistics were calculated, and further genotypes were ranked based on each statistic. All AMMI-based stability statistics were calculated using 'metan' package in R. Moreover, several parametric and nonparametric stability statistics were calculated using R program was computed to detect interrelationships among calculated stability statistics using 'factoextra' package in R.

Genotype and genotype by environment (GGE) biplot analysis

The data were graphically analyzed for interpreting GE interaction using the GGE biplot software (Yan, 2001). This methodology uses a biplot to show the factors (G and GE) that are important in genotype evaluation and that are also the sources of variation in GE interaction analysis of MET data (Yan, 2001). The graphs were generated based on (i) The polygon view of GGE biplot to identification of winning genotypes and their mega environments by 'which-won-where' pattern, (ii) Ranking of genotypes based on yield and stability performance, (iii) Evaluation of genotypes related to an ideal genotypes, (iv) Evaluation of environments related to ideal environments, (v) Relationship among environments and (vi) Comparison between two genotypes.

Weighted average of absolute scores (WAASB) index Analysis

To account for the mean performance and stability of individual traits, the WAASBY index (Olivoto et al., 2019a) was computed as follows:

$$WAASBY_i = \frac{\left(rY_i \times \theta_Y\right) + \left(rW_i \times \theta_W\right)}{\theta_Y + \theta_W}$$

where $WAASBY_i$ is the superiority index for the *i*th hybrid; rY_i and rW_i are the rescaled values (0-100) for the response trait (Y) and the stability (WAASB), respectively, where WAASB is the Weighted Average of Absolute Scores from the singular value decomposition of the matrix of BLUPs for the genotype-environment interaction effect ($\mathbf{u}_{ge}$), described in Eq. [1]; θ_Y and θ_W are the weights for MPE, respectively. The goal of selection (increase or decrease) and the weights assumed for the mean performance (θ_Y) are described in (Fig. 1). The values of (θ_W) are assumed to be $100-\theta_Y$. To compute these indexes we used the function *waasb()* of the R package metan (Olivoto and Lúcio, 2020).

Mean performance and stability of multiple traits

To account for the MPE of multiple traits simultaneously, we used the multi-trait stability index, MTSI, as follows (Olivoto et al., 2019b).

$$MTSI_i = \left[\sum_{j=1}^{f} \left(\gamma_{ij} - \gamma_j \right)^2 \right]^{0.5}$$

where $MTSI_i$ is the multi-trait stability index for the *i*th hybrid; γ_{ij} is the score of the *i*th hybrid in the *j*th factor (i = 1, 2, ..., g; j = 1, 2, ..., f); being g and f the number of hybrids and factors, respectively; and γ_j is the *j*th score of the ideotype. The scores were obtained in a factor analysis performed in the two-way table containing the WAASBY values for hybrids and traits. The function *mtsi()* of the R package metan (Olivoto and Lúcio, 2020) was used to compute the index.

Results and Discussion

Eleven lines of *Brassica rapa* having yellow seed coat colour along with BARI Sarisha-14 as check were evaluated at Gazipur, Ishurdi, Rahamatpur, Hathazari and Jeshore for seed yield and yield contributing characters. But, due to waterlogged stress at seedling stage for cyclonic storm **Jawad** was bringing heavy rainfall during 3-6 December 2021 the experiment were completely damage at Rahamatpur and Hathazari.

Pooled analysis of variance (ANOVA) and likelihood ratio test (LRT)

Results of combined analysis of variance for eight characters of 11 genotypes along with one check at three environments are presented in Table 1. Highly significant MS for both genotypes and environments revealed the presence of genetic variability where highly significant for days to flowering (DF), days to maturity (DM), plant height (PH), number of branches per plant (NBPP), No. of number siliquae per plant (NSPP), number of seeds per siliqua (NSPS), 1000 seeds weight (TSW), yield (kg/ha). MS due to environments (linear) indicated the difference between the environments. Highly significant mean squares due to environments (linear) indicated the difference between the environments. Significant genotypes x environment interactions were observed when tested against pooled error. Environment + (genotype x environment) component and genotype ^ environment (linear) component also showed significant variation and the genotypes performed differently in different environments. Except pooled deviation linear components of genotype- environment interaction were significant for all the characters (Table 2). So, the differences in stability for different characters were due to the linear response and not for non-linear function. The significant E + (G x E) component indicated variable response of the genotypes to different environments. Amin et al. (2005) also found that there was genetic and environmental variability among the genotypes due to variance in pooled analysis of variance.

The regression coefficient (bi) value close to zero indicates the better performance of genotypes in the for the poor environment and when the value is significantly more than unity means the genotypes are better for the favorable environments. When a genotype shows higher mean value for a character, higher phenotypic index (Pi) with one unit bi and S2di approaching to zero, then the genotype will be stable for the character (Eberhart, 1966). Higher environmental index (Ij) is the indication of favorable environment for a distinct character that needs to increase to improve the yield and vice-versa.

Eberhart and Russel (1966) emphasized the need of both linear (bi) and nonlinear (s^2di) components of genotype environment interactions in judging the phenotypic stability of a genotype. In this model, regression coefficient (bi) is considered as parameter of response and deviation from regression (s^2di) as the parameter of stability. Relatively lower value of bi, say around 1 will mean less responsive to the environmental change and therefore, more adaptive. However, bi is negative, the genotype may be grown only in poor environment.

Mean performance of genotypes and environments

Mean performance of different lines over the location is presented in Table 8. Significant variations were observed for days to maturity, number of siliquae per plant at Gazipur location. Maturity duration ranged from 84-88 days. Plant height ranged from 45-95 cm. Number of siliquae per plant ranged from 42-75. The highest number of siliquae per plant was recorded was found 88 in line BC-100614(8)-2 and BC-100614(4)-11. Number of seeds per siliqua ranged from 14-37. Seed yield ranged from 325-1971 kg/ha all over the location. Variability for seed yield among genotypes and environments is evident through heat map (Fig. 2).

Table 1. Combined ANOVA for yield components and yield of *B. rapa* L. across environments

Source of variation	**df**	**Mean Square (MS)**							
		DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
Total	38	6.9	33.7	1.12e+3	1.3	4.67e+3	120.0	0.44	385601
GEN	12	2.5*	12.4*	162.0	0.7	920	93.4	0.21	120469**
ENV + (GEN x ENV)	26	8.9	48.2	1.56e+3	1.5	6.40e+3	132.0	0.54	507120
ENV (linear)	1	185.0	1170	3.85e+4	11.0	1.28e+5	928.0	7.79	10447229
GEN x ENV (linear)	12	2.2	2.4	83.4*	1.3	2.94e+3	98.7	0.12	18241
Pooled deviation	13	0.6	4.0	25.0	0.9	222	102.0	0.38	117749
BARI-Sarisha-14	1	0.5	0.2	89.7*	0.1	14	4.4	0.63	274748**
BC-100614(4)-10	1	0.4	3.4	18.5	0.0	498*	10.9	0.27	69068**
BC-100614(4)-11	1	0.0	2.3	10.1	0.0	322	3.0	1.40**	5296**
BC-100614(4)-19	1	1.4	6.6*	1.2	0.1	42	0.8	0.02	18065**
BC-100614(4)-2	1	1.2	2.2	503.0*	0.0	1	187.0	0.68	157444
BC-100614(4)-4	1	1.6	1.3	57.7*	0.2	459*	90.1	0.52	83728
BC-100614(4)-5	1	1.2	2.9	78.3*	0.6	195	241.0**	0.75**	14704
BC-100614(7)-3	1	3.6	3.6	3.9	5.1**	205	440.0**	0.24	16445
BC-100614(8)-1	1	0.0	22.2**	102.0*	2.1	417*	12.1	0.13	508376
BC-100614(8)-2	1	2.0	1.0	110.0*	3.5**	7	22.3	0.14	2069
BC-100614(8)-7	1	1.3	2.0	84.0*	0.0	10	0.1	0.01	253068
BC-110714(7)-8	1	7.5*	1.8	16.4	0.2	489*	226.0**	0.00	9978
Pooled error	72	0.8	1.3	6.0	0.3	88	23.7	0.09	993

*,**denotes significance level at p<0.05&0.01; LSD- least significant difference; CV- coefficient of variation; G/GGE Genotype and Genotype by environment interaction, DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant, NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g), YIELD= Seed yield (kg/ha)

Table 2. Mean performances of *B. rapa* genotypes in Preliminary Yield Trial over the locations during rabi 2021-22

Sl. no.	Lines/Variety	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
1	BC-100614(8)-1	35	87	78.20	4.33	55.92	29.62	2.86	1407
2	BC-100614(4)-2	36	88	68.93	4.31	75.00	24.29	2.99	1137
3	BC-100614(4)-4	35	87	82.00	5.13	85.38	23.37	2.75	1202
4	BC-100614(4)-5	36	88	78.40	4.78	63.34	34.37	2.88	1312
5	BC-100614(4)-11	35	88	81.27	4.74	88.31	24.80	2.96	1134
6	BC-100614(4)-19	36	88	77.91	4.32	75.33	25.90	2.75	1197
7	BC-110714(7)-8	36	87	78.76	4.96	79.52	22.67	2.96	1197
8	BC-100614(8)-2	36	87	76.92	4.89	88.24	27.24	2.86	1223
9	BC-100614(4)-10	37	88	84.77	4.32	73.18	24.36	2.68	1353
10	BC-100614(8)-7	36	87	76.51	4.28	73.00	25.44	2.90	1510
11	BC-100614(7)-3	35	88	82.92	4.57	65.82	25.21	3.09	1352
12	BARI-Sarisha-14	36	88	83.68	4.64	84.02	29.74	3.07	1318
	SE	0.43	0.44	0.88	0.22	3.48	1.69	0.11	10.35
	LSD ($p \geq 0.05$)	1.22	1.25	2.48	0.62	9.81	4.78	0.30	29.20
	CV (%)	3.6	1.5	3.3	4.3	3.8	9.2	11.1	5.4

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Regarding maturity duration over the locations, days to maturity ranged from 82-85 days (Table 8a) and seed yield over locations ranged from 977-1382 kg/ha (Table 8b). The line BC-100614(8)-7 produced the highest seed yield (1382.7 kg/ha) over the locations (Table 8b). The seed yield was very low due to waterlogged stress at seedling stage for cyclonic storm Jawad was bringing heavy rainfall during 3-6 December 2021.

Table 8a. Mean data for maturity duration of *Brassica rapa* lines in Preliminary Yield Trial over three locations during rabi 2021-22

SL. No.	Line/Variety	Days to Maturity (day)			Over all mean	P. Index (Pi)	bi	S^2di	R^2
		Gazipur	Ishurdi	Jashore					
1	BC-100614(8)-1	82	87	91	87	-1	0.7	-0.4	1.00
2	BC-100614(4)-2	83	90	91	88	0	1.0	0.6	0.96
3	BC-100614(4)-4	82	90	90	87	0	0.9	0.3	0.97
4	BC-100614(4)-5	83	92	90	88	1	1.2	1.7*	0.95
5	BC-100614(4)-11	84	91	89	88	0	1.1	0.2	0.98
6	BC-100614(4)-19	83	92	89	88	0	1.2	-0.1	0.99
7	BC-110714(7)-8	83	88	89	87	-1	1.2	0.5	0.98
8	BC-100614(8)-2	83	90	89	87	0	1.1	0.7	0.97
9	BC-100614(4)-10	83	91	89	88	0	1.0	6.9**	0.81
10	BC-100614(8)-7	83	90	89	87	0	1.0	-0.1	0.99
11	BC-100614(7)-3	84	90	89	88	0	1.0	0.2	0.98
12	BARI-Sarisha-14	85	90	90	88		0.8	0.1	0.97
	E. Mean	83	90	89	83				
	E. Index	-4	3	2	-4				

Table 8b. Mean data for seed yield of *Brassica rapa* lines in Preliminary Yield Trial over three locations during rabi 202-122

SL. No.	Line/Variety	Seed yield (kg/ha)			Over all mean	P. Index (Pi)	bi	S^2di	R^2
		Gazipur	Ishurdi	Jashore					
1	BC-100614(8)-1	1586	1749	887	1407	129	0.93	1.74E+05	0.58
2	BC-100614(4)-2	781	1698	934	1138	-141	1.24	4.87E+04	0.9
3	BC-100614(4)-4	898	1738	970	1202	-77	1.2	2.52E+04	0.94
4	BC-100614(4)-5	1210	1756	970	1312	33	1.06	5.50E+03	0.98
5	BC-100614(4)-11	917	1677	807	1134	-145	1.26	838	1
6	BC-100614(4)-19	979	1670	942	1197	-82	1.08	4.70E+03	0.99
7	BC-110714(7)-8	997	1660	934	1197	-82	0.95	684	1
8	BC-100614(8)-2	1104	1625	940	1223	-56	0.89	3.68E+03	0.98
9	BC-100614(4)-10	1329	1741	989	1353	74	0.96	2.45E+04	0.91
10	BC-100614(8)-7	1596	1871	1065	1511	232	0.94	8.74E+04	0.74
11	BC-100614(7)-3	1167	1736	1152	1352	73	0.86	5.93E+03	0.97
12	BARI-Sarisha-14	999	1615	1341	1318	40	0.6	8.91E+04	0.53
	Mean	1130	1711	994	**1279**				
	E. Index	-148	433	-284					

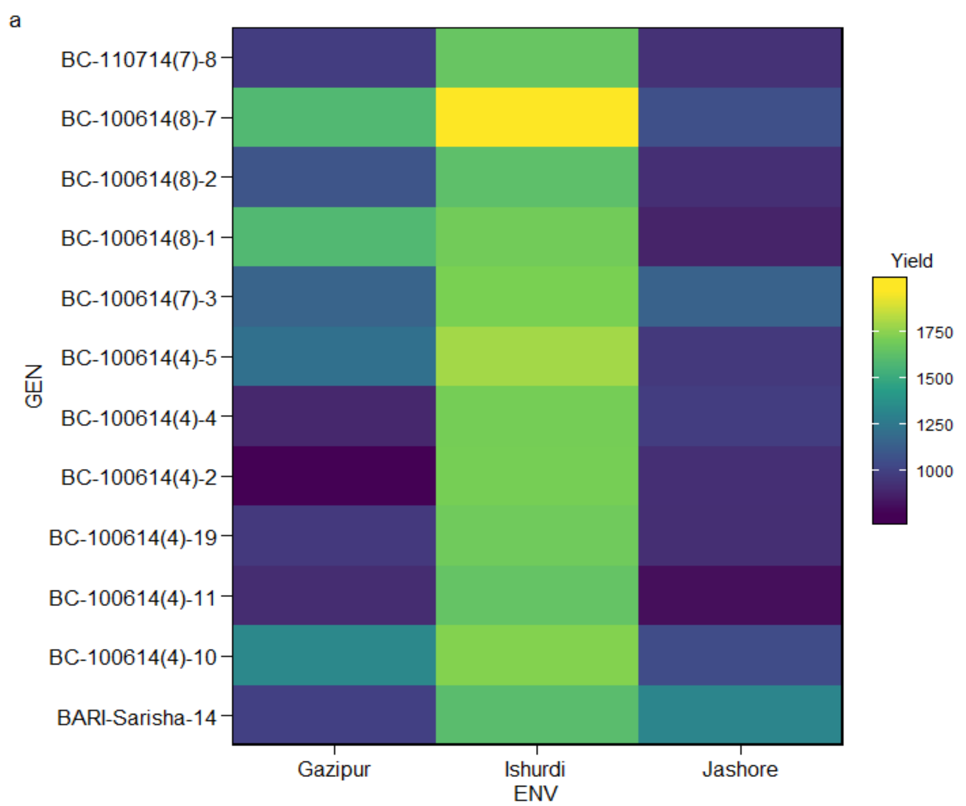

Fig.1. Heatmap showing genotype performance and stability in three environments, with 12 lines ranked according to how seed yield performance and stability are weighted in each environment. The y-axis shows the genotypes and the related mean seed yield, while the x-axis shows the environment (kg ha-1).

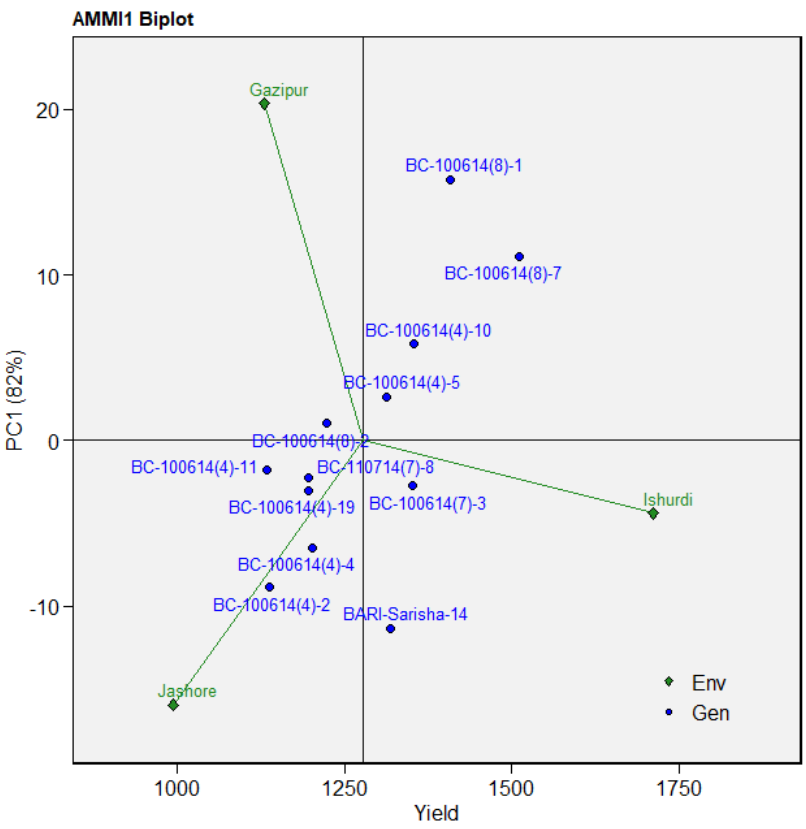

Fig.2 AMMI1 biplot for seed yield (kg per ha) of the 12 *B. rapa* genotypes evaluated in three locations

The AMMI1 model

The AMMI1 biplot represents the relationship between the eigenvectors for IPCA1 and the mean yield of environments and genotypes. The AMMI1 biplot gave a model fit of 82.0%. Genotypes and environments that had IPCA1 values close to zero were characterized with a low interaction effect (Fig. 2), being considered stable or wide adaptation. Environments responded differently regarding seed yield (Fig 2). Jashore location had a high negative IPCA1 value, with environmental mean being > the grand mean. In addition, Furthermore, Gazipur had a high positive IPCA1 value, with environmental mean being close to the grand mean. On the other hand, Ishurdi had an IPCA1 score of just above zero and an environmental mean close to zero, which indicated that it had a low interaction effect. It can be concluded that two out of the tree tested locations, i.e., Jeshore and Gazipur had, high IPCA1 scores, indicating high G×E interactions. Similarly, genotypes can be characterized based on their interactions with the environments. The genotypes BC-100614(7)-3, BC-110714(7)-8, BC-100614(4)-5 and BC-100614(8)-2 had IPCA1 score close to the zero line, which indicated that they had stable performance across the testing environments (Carbonell et al 2004). On the contrary, large deviations from zero on the ordinate indicated specific adaptation to the environments with the same IPCA1 sign. Therefore, genotypes BC-100614(8)-7, BC-100614(4)-10 and BC-100614(8)-1 had higher mean yield than other genotypes and were significantly adapted to the best productive site (Ishurdi). However, genotype BC-100614(4)-2 and BC-100614(4)-11 had the lowest mean seed yield. Moreover, it was more adapted to the poorest site (Jeshore) than other genotypes. In addition, the right side of the biplot shows the higher yielding genotypes and vice-versa. Genotypes BC-100614(8)-7 and BC-100614(8)-1 were the highest yielding but responded variably across environments. Therefore, we suggest testing these genotypes under a wider range of environmental conditions to ensure yield stability.

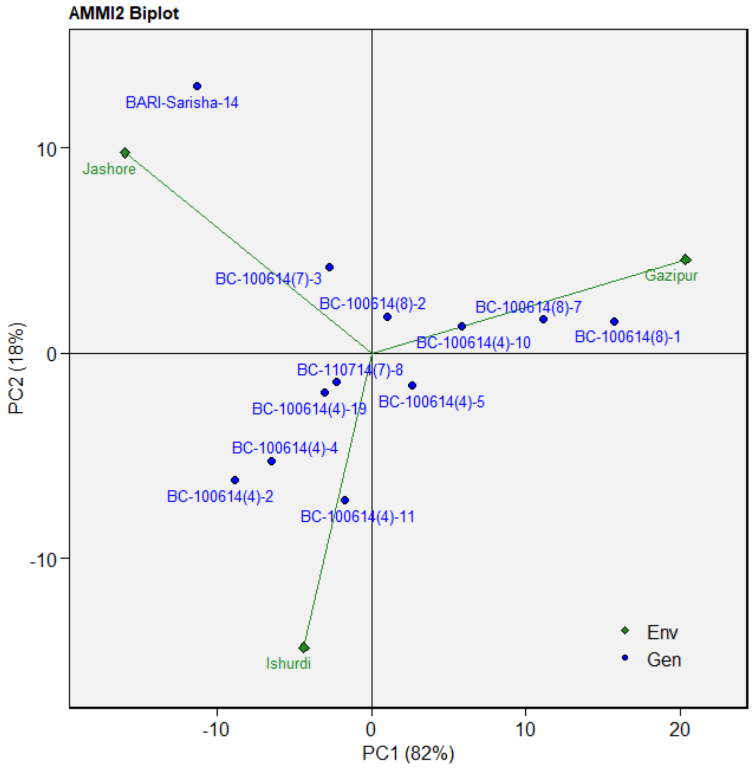

Fig. 3 AMMI2 biplot for seed yield (kg per ha) of the 12 *B. rapa* genotypes evaluated in three locations

The AMMI2 model

The vector length in the AMMI model can be used to determine the discriminative ability of environments for genotypes. The environments Ishurdi and Jeshore had longer vector than vector for Gazipur (Fig. 3). Thus, they were the best discriminative environments for investigated genotypes. On the other hand, environments with shorter vectors (Gazipur) are not discriminative ones for the genotypes. The obtuse angle between vectors of Ishurdi, Jeshore and Gazipur environments indicated that these three environments were different for yield determination.

The biplot analyses visualize the best genotype for each environment (Fig. 4), which is known as which-won-where pattern. Genotypes BC-100614(8)-1, BC-100614(8)-7 and BC-100614(4)-10 showed a degree of positive relationship to Gazipur with a negative G×E relation with other environments. On the other hand, genotype BC-100614(4)-2 and BC-100614(4)-11 yielded the lowest across all environments. Furthermore, genotypes BC-100614(7)-3 and BARI-Sarisha-14 were adapted to Jeshore environment but had a negative G×E relationship with other environments. A positive G×E interaction was noticeable between genotype BC-110714(7)-8 and Ishurdi, and a negative interaction with other environments. Genotype BC-100614(8)-1 had a positive G×E relationship with Gazipur and a negative interaction with other environments.

Some environments were discriminative of genotypes for all or some of the studied traits. However, locations were distinctly different, e.g., Ishurdi was considered a favorable location (environment); nevertheless, Jeshore and Gzaipur showed a variable degree of stresses. The genotypes grown in these three locations were exposed to moderate waterlogged stress in Gazipur, extreme waterlogged stress in Jeshore (Fig. 4).

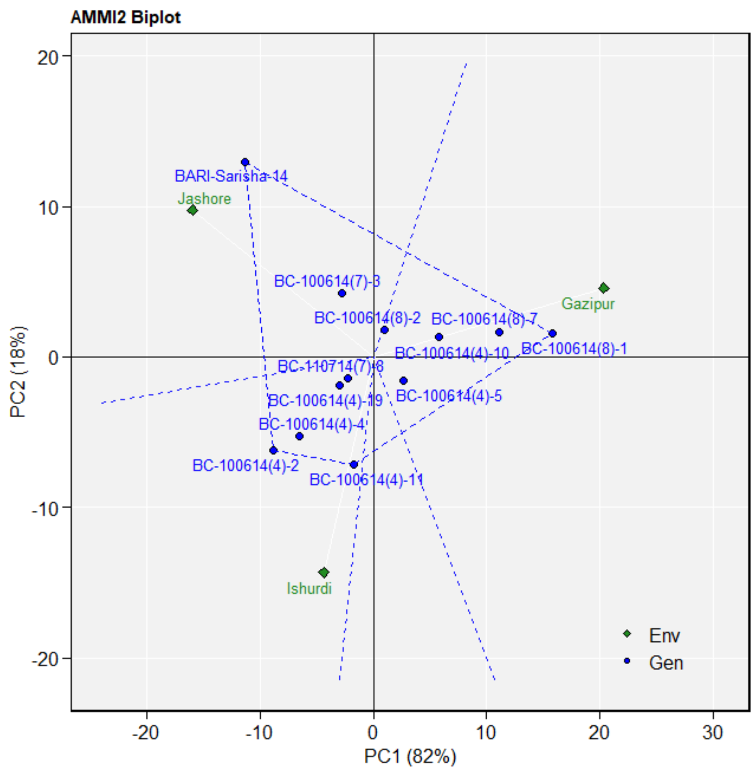

Fig.4 AMMI2 biplot for seed yield (kg per ha) of the 12 *B. rapa* genotypes evaluated in three locations

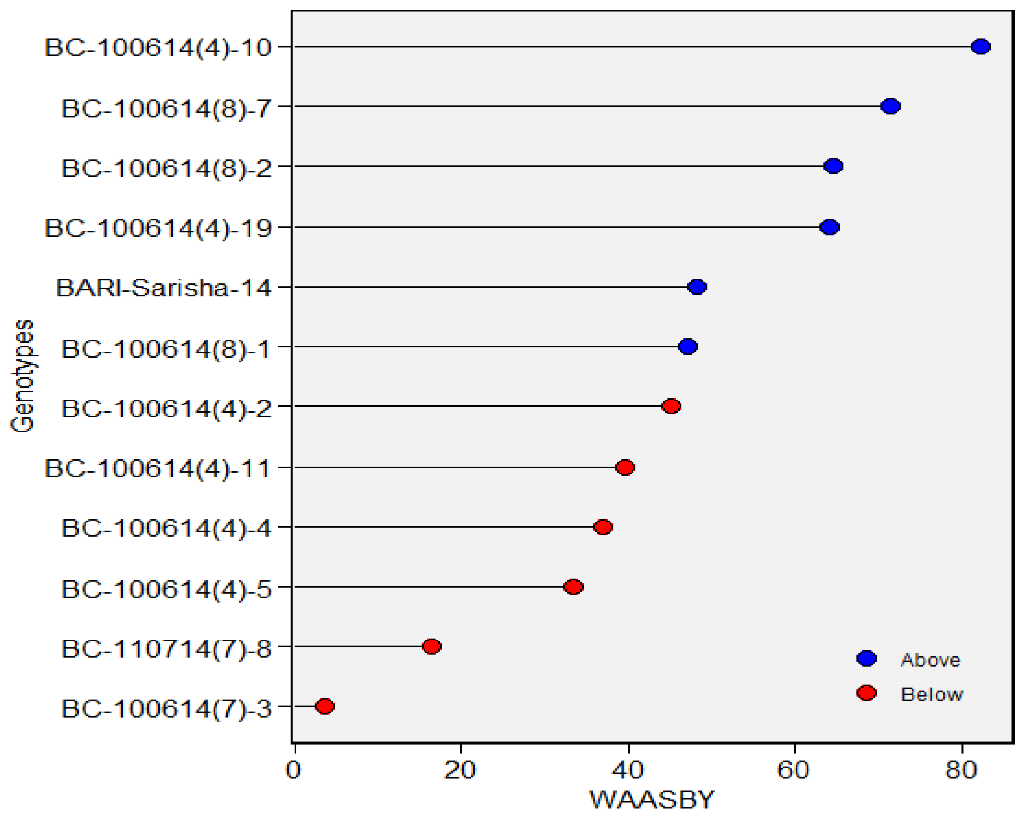

Fig. 5. WAASBY scores of genotypes for yield and yield contributing traits.

WAASBY index-based ranking of genotypes

Simultaneous selection for high yield and stability has been carried out through WAASBY index (Fig. 5). BC-100614(4)-10 was found to have the highest WAASBY score (>75) followed by BC-100614(8)-2 (<75), BC-100614(8)-7 (73) and BARI-Sarisha-14 (65). Genotype BC-100614(7)-3 was found to have the least WAASBY score (12) followed by BC-100614(7)-3 (35).

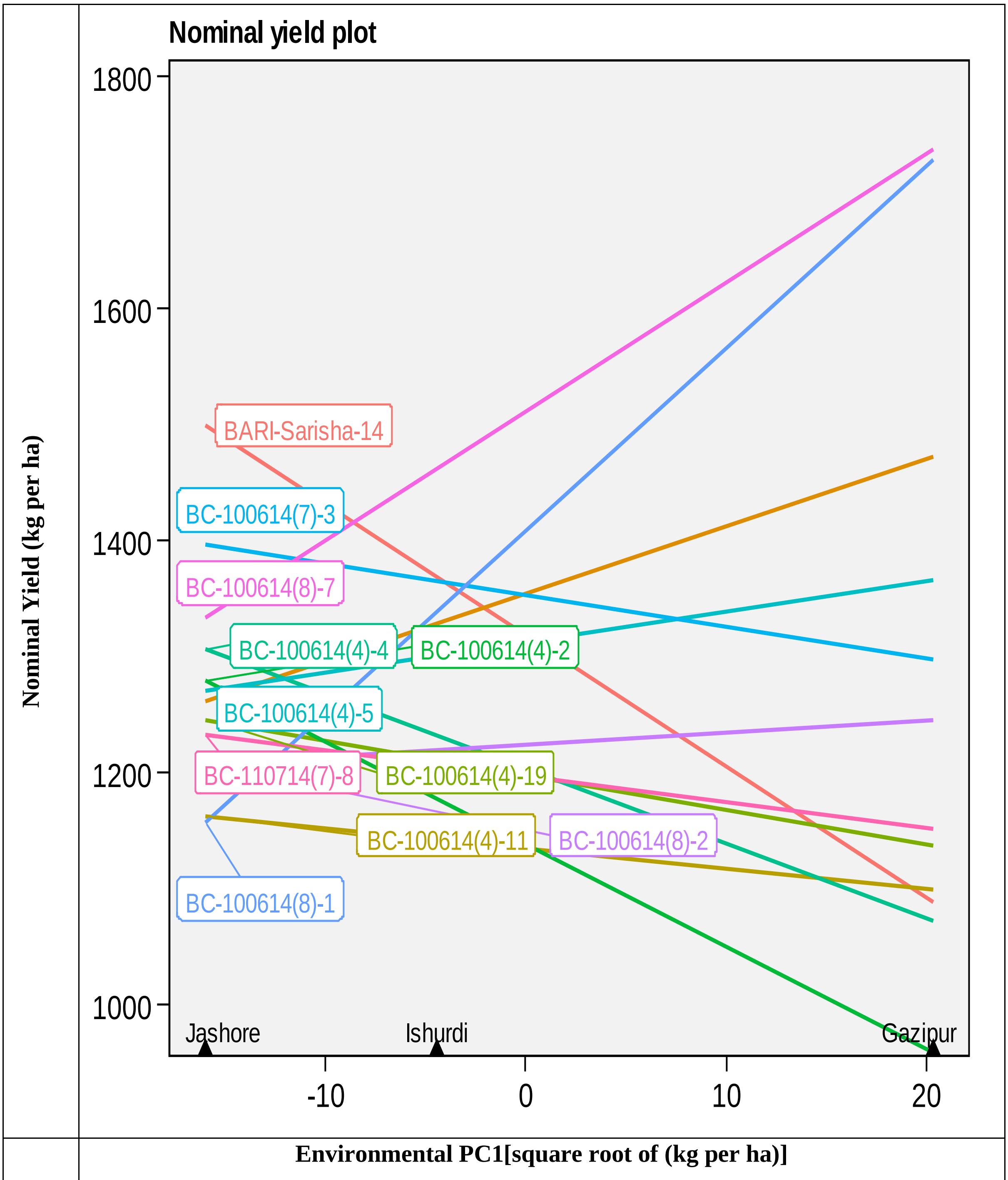

Figure 6. Nominal yield plots based on predicted yields in all over environments

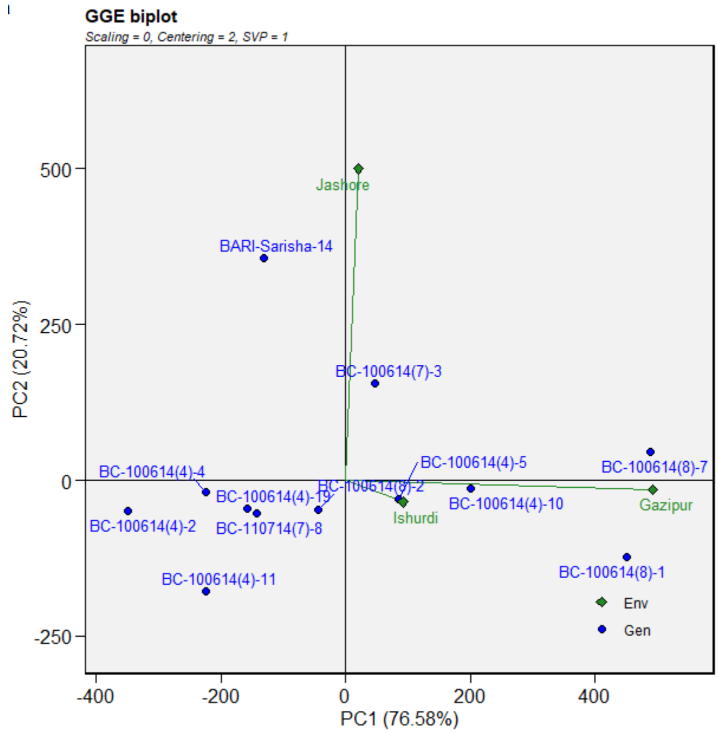

Figure 7. GGE biplot analysis among the test locations and genotypes interaction

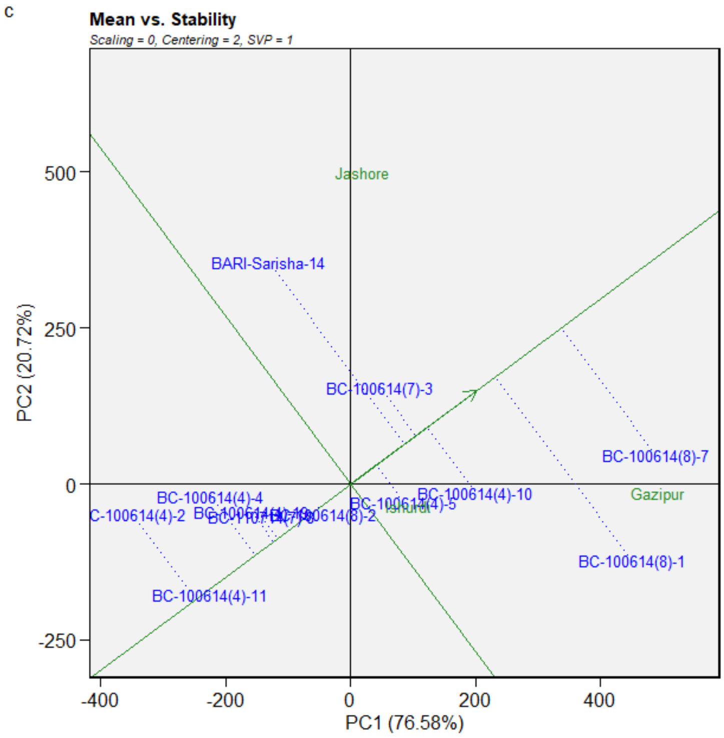

Figure 8. GGE biplot showing mean vs. stability of the test environments for seed yield

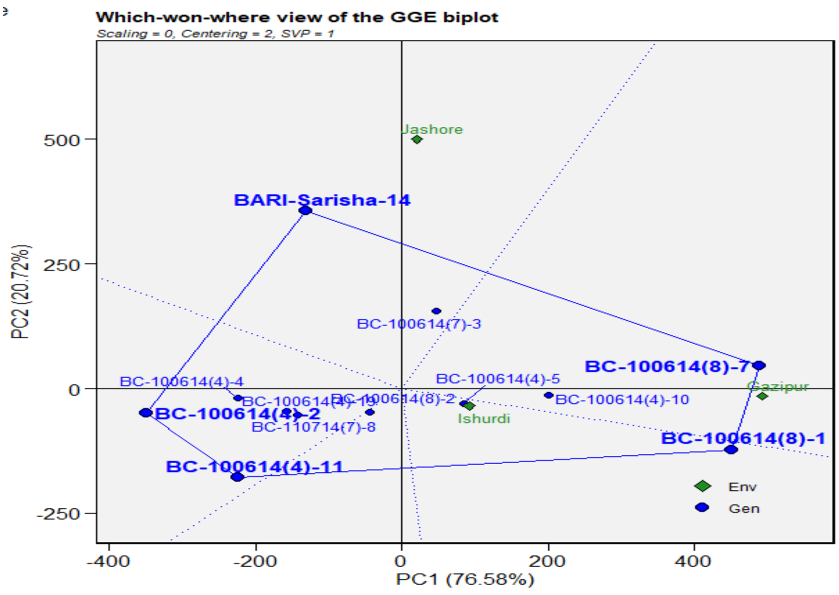

Figure 9. Rapeseed seed yield and Environments (GGE) biplot polygon view based on symmetrical scaling for the which-won-where pattern

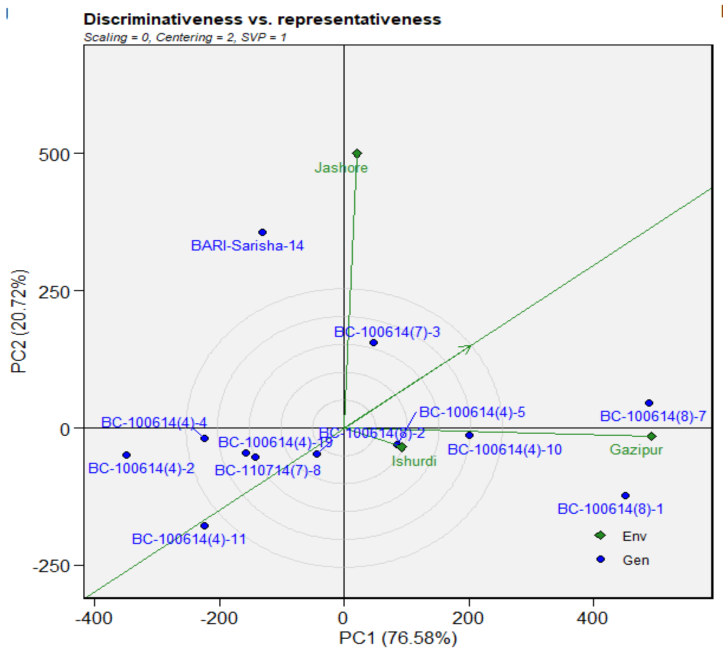

Figure 10. Discriminativeness vs. representativeness

GGE Biplot analysis of the testcross hybrids for GY

Identification of best hybrids

Overall yield variance was explained by a GGE biplot model, which explained97.30 % variation in yield (PC1: 76.58 %, PC2: 20.72 %). (Fig. 7–10).

Performance and stability of genotypes

Among the lines/genotypes 6 (BC-100614(4)-5, BARI-Sarisha-14, BC-100614(7)-3, BC-100614(4)-10, BC-100614(8)-1, BC-100614(8)-7) rapeseed showed above average yield as revealed in Fig. 7 including check. The genotypes located on the left Fig. 7 of the perpendicular line showed higher than average yield. The best selected genotypes sequences were BC-100614(7)-3> BC-110714(7)-8> BC-100614(4)-5 and BC-100614(8)-2 across the locations.

Winning genotypes and mega-environment

The polygon was created by linking the genotypes' scores (BC-100614(8)-1, BC-100614(8)-7, BARI-Sarisha-14, BC-100614(4)-2 and BC-100614(4)-11) that are the furthest from the place of origin, thereby containing all other genotypes. Five vertical lines were pinched from the origin and stretched beyond the polygon, dividing the biplot into Five sectors, three of which included three environments. For each sector, the winning genotype is the one found at the vertex. As illustrated in Fig. 8, the Gazipur location a sector dominated by genotypes BC-100614(8)-7, BC-100614(4)-10 and BC-100614(4)-5. Though two one vertex genotype existed, BC-100614(4)-5 and BC-100614(8)-1 were the genotypes that were uniquely adapted to the Ishurdi. Jeshore located the sector where genotypes BC-100614(7)-3 and BARI-Sarisha-14 were vertex genotypes, suggesting that they were the genotypes with the highest predicted seed yield for this location.

Conclusion

Considering earliness, seed yield and other yield attributing characters, four lines like BC-100614(8)-7, BC-100614(8)-1, BC-100614(7)-3 and BC-100614(4)-10 were selected for RYT in the next year.

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REGIONAL YIELD TRIAL OF *Brassica rapa* L.

M SHALIM UDDIN, A B M KHALDUN, M A LATIF AKANDA, M KHORSHED ALAM, M R HUMAUAN, M H RAHMAN and M A MONIM

Abstract

Eight lines of Brassica rapa L. along with BARI Sarisha-14 as check were evaluated at Gazipur, Jamalpur, Ishurdi and Jashore for seed yield and yield contributing characters. Maturity duration ranged from 76-99 days. Plant height ranged from 60-120 cm. Number of siliquae/plant and number of seeds per siliqua ranged from 27-115 and 11-45, respectively. 1000-seed weight recorded in a range of 2.28-4.01 g. The variation of seed weight was highly significant which is desirable from the entries used for the trial of advanced lines. Seed yield ranged from 800-2156 kg/ha. The additive main effects multiplicative interaction (AMMI) analysis showed that environments (E), genotypes (G) and GE interaction (GGE) effects were significant for seed yield and yield contributing traits. Using Multi-trait genotype-ideotype distance index (MGIDI) and stability statistics and clustering, which allowed identifying three main groups based on their stability concepts. The biplot rendered using the weighted average of absolute scores (WAASB) and mean seed yield and yield contributing traits identified superior genotypes in terms of performance and stability. Hence, these regions are suggested as discriminative sites for the selection of high-yielding and stable rapeseed genotypes. The highest seed yield was recorded in BC-100614 (4)-7 all over the location. Considering stability parameter, MGIDI, earliness, seed yield and other yield attributing characters, three lines like BC-100614 (8)-4, BC-100614 (4)-7and BC-20-GS-1 ware selected for adaptive trials in the next year.

Introduction

Rapeseed and mustard are very much sensitive to the environment. Most of the farmers in our country cultivate traditional variety Tori 7 to fit into existing cropping pattern. The yield of local Tori 7 is very poor compared to other developed varieties. The objective of this study was to select short duration high yielding lines with better agronomic traits and wider adaptability. Better performing genotypes/entries will be included in adaptive trials at farmer's field towards recommend for variety release.

Materials and Method

The experiment was conducted at Gazipur, Jamalpur, Ishurdi and Jashore rabi 2021-22. It consisted of eight advanced lines of *Brassica rapa* along with one check as BARI Sarisha-14. The experiment was laid out in randomized complete block design with three replications. The plot size was 3m x 1.2m. Seeding was sown on 10 November 2021 at Gazipur, 13 November 2021 at Jamalpur, 11 November 2021 at Ishurdi, 12 November 2021 at Jashore in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to 50% flowering (DF), days to 80% maturity (DM), plant height (PH), No. branch /plant (NBPP), No. of siliquae/Plant (NSPP), No. of seeds/Siliqua (NSPS), 1000 seed weight (TSW), Seed yield (kg/ha). The data were analyzed statistically.

Measures of stability used in the study

The AMMI based stability parameters (ASTABs) such as AMMI stability value (ASV) as per Purchase (2020), sums of the absolute value of the IPC Scores (SIPC) and averages of the squared eigen value (EV) as proposed by Sneller et al. (1997), absolute value of the relative contribution of IPCs to the interaction (ZA) as per the procedure of Zali et al. (2012) and Weighted Average of Absolute Scores (WAAS) according to Olivoto et al. (2019) were calculated.

Multi-trait genotype-ideotype distance index (MGIDI)

The multi-trait genotype-ideotype distance index (MGIDI) was used to rank the genotypes based on information of multiple traits as proposed by Olivoto and Nardino (2020). Initially, the rescaling of data was carried out within a range between 0 and 100, followed by factor analysis to generate an ideotype matrix as given by Olivoto and Nardino (2020). Later, MGIDI index was computed as the Euclidean distance between the scores of accessions and the ideal genotype. The genotype with the lowest MGIDI is closer to the ideal genotype and thus indicates desired values for all the measured traits. The selection differential for all traits was performed considering approximately 10% selection intensity.

The proportion of MGIDI index of the i_{th} treatment explained by the j^{th} factor (ω_{ij}) was used to show the strengths and weaknesses of the treatments and was computed as:

$$\omega_{ij} = \frac{\sqrt{D_{ij}^2}}{\sum_{j=1}^{f} \sqrt{D_{ij}^2}}$$

where D_{ij} is the distance between the i_{th} treatment and ideal treatment for the j_{th} factor. Low contributions of a factor indicating that the traits within such a factor are close to the ideal treatment.

Statistical analysis for all the stability-related parameters was performed by functions available in the 'metan' package (v. 1.16.0) (Olivoto and Lucio 2020) in R (http:// www.r-project.org/).

Results and Discussion

Eight advanced lines of *Brassica rapa* along with BARI Sarisha-14 as check were evaluated at Gazipur, Jamalpur, Ishurdi and Jashore for seed yield and yield contributing characters in order to select line (s) for development of short duration and high performing variety of rapeseed. The joint combined ANOVA and mean performance of different lines over location is presented in Table 10 and Table 11, respectively.

Results of joint combined analysis of variance for eight characters of nine advanced lines at four environments are presented in Table-10. The mean sum of squares for the genotypes was highly significant for all the traits which revealed the presence of genetic variability in the material under investigation for all the characters studied. Environments mean sum of squares were highly significant for days to 50% flowering (DF), days to 80% maturity (DM), plant height (PH), No. branch /plant (NBPP), No. of siliquae/Plant (NSPP), No. of seeds/Siliqua (NSPS), 1000 seed weight (TSW), Seed yield (kg/ha).

The highly significant effects of environment indicate high differential genotypic response across the different environments. The variation in soil structure and moisture across the different environments were considered as a major underlying causal factor for the GXE interaction. Environment relative magnitude was much higher than the genotypic effect, suggesting that performance of each genotype is influenced more by environmental factors.

Results of stability and response of the genotypes for yield under different environments according to Eberhart and Russell are discussed character-wise as follows; Stability parameter i.e. regression coefficient (bi) and deviation from regression (S2di) for days to tasseling, days to silking and yield of the individual genotypes are presented in Table 11, 12 and 13 respectively.

Significant variations were observed for number of siliquae per plant and seed yield. Maturity duration ranged from 76-99 days (Fig. 1). Plant height ranged from 60-120 cm. Number of siliquae/plant and number of seeds/siliqua ranged from 27-115 and 11-45, respectively. 1000-seed weight recorded in a range of 2.28-4.01 g. The variation of seed weight was highly significant which is desirable from the entries used for the trial of advanced lines. Seed yield ranged from 800-2156 kg/ha. The highest seed yield was recorded in BC-100614 (4)-7 all over the location.

The environment x location interaction analysis related to days to flowering, days to maturity, plant height and yield revealed that (Table 12, 13, 14 and Table 15) the days to maturity exhibited significant variation among the locations. Location Ishurdi required little longer than other locations to get maturity (Fig. 2). However, combined result shows the entries took from 84 to 86 days for physiological maturity. Yield performance over the tested locations also shown a significant variation among the entries. The highest mean yield recorded in BC-100614 (4)-7 (1293 kg/ha) and lowest found in BC-110714 (7)-2 (1032 kg/ha). The seed yield was very low due to waterlogged stress at seedling stage for cyclonic storm

Jawad was bringing heavy rainfall. Yield of some promising entries shown quite higher than check variety which is desired for further steps of variety development process.

Results of stability and response of the genotypes under different environments according to Eberhart and Russell are discussed character-wise as follows; Stability parameter i.e. regression coefficient (bi) and deviation from regression (S^2di) for days to 50% flowering, days to 80% maturity, plant height, and seed yield of the individual genotypes are presented in Table 12, 13, 14 and 15.

The seed yield along with the value of phenotypic indices (Pi), environmental index (Ei) regression coefficient (bi) stability (S^2di) and are presented in Table 15. The environmental mean and genotypic mean ranged from 812 kg/ha to 1793 kg/ha and 1157 to 1442 kg/ha respectively (Fig. 8). Five lines showed positive phenotypic index while the other genotypes had negative phenotypic index for yield. Thus, positive phenotypic index represents the higher yield and negative represents the lower yield among the genotypes. Again, positive and negative environmental index (Ij) reflects the rich or favourable and poor or unfavourable environments for this character, respectively. The environmental index (Ij) directly reflects the poor or rich environment in terms of negative and positive Ij, respectively. Thus, the environment Gazipur and Jashore were poor environment on the other hand Jamalpur and Ishurdi were rich environments for rape seed production.

The regression coefficient (bi) values for yield of these genotypes ranged from 0.82 to 1.23 (Table 15). These differences in bi values indicated that all the genotypes responded differently to different environments. Considering the mean, bi and S^2di three parameters, it was evident that all the genotypes showed different response of adaptability under different environmental conditions. Among the advanced lines BC-100614 (8)-4, BC-20-GS-1, BC-100614 (3)-1, BARI-Sarisa-14 and BC-100614 (4)-7 exhibited the higher seed yield, bi~1, S2di~0. The lines BC-100614 (1)-6, BC-120114, BC-15-YF-01 and BC-110714 (7)-2 had bi value significantly different from the unity with non-significant S^2di value indicating high responsiveness of the lines but suitable for favourable environments.

The AMMI biplot provide a visual expression of the relationship between the first interaction principal component axis (AMMI component 1) and mean of genotypes and environment (Fig. 3) with the biplot according for up to 78.6% of the treatment sum of squares. The first interaction principal component axis (AMMI component 1) was highly significant and explained the interaction pattern better than other interaction axis.

Table 10. Combined ANOVA for yield components and yield of *B. rapa* L. across environments

Source of variation	Df	Mean Square (MS)							
		DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
Total	35	15.9	89.1	1134.0	5.43	1547.0	102.0	0.58	719926
GEN	8	14.6**	24.4**	467.0**	0.98ns	174.0**	75.3**	0.07**	89197**
ENV + (GEN x ENV)	27	16.3**	108.0**	1331.0**	6.75**	1954.0**	110.0**	0.73**	906809**
ENV (linear)	1	286**	2569.0**	32882**	146.00**	48010**	2111.0**	18**	22996740**
GEN x ENV (linear)	8	4.04**	4.7**	241.0**	2.13**	141.0**	31.0**	0.04ns	66283**
Pooled deviation	18	3.78	11.6	63.6	0.48	101.0	33.9	0.03	53158
BC-100614 (1)-6	2	1.62	7.2	30.1	0.93	112.0	63.3	0.00	10054**
BC-100614 (3)-1	2	5.96	5.5	87.0	2.56	129.0	34.6	0.12	49986**
BC-100614 (4)-7	2	0.896	10.9	83.3	0.25	25.7	22.2	0.04	54233
BC-100614 (8)-4	2	1.98	9.8	86.2	0.91	191.0	7.4	0.01	49742
BC-110714 (7)-2	2	7.5	3.5	10.9	1.72	343.0	3.1	0.32	33968
BC-120114	2	6.05	7.4	57.4	0.35	10.2	25.9	0.08	26680
BC-15-YF-01	2	3.88	10.1	8.7	0.01	115.0	32.9	0.06	8426ns
BC-20-GS-1	2	32	99.5	203.0	1.85	142.0	11.0	0.02	88007
BARI-Sarisa-14	2	1.19	4.3	5.5	1.10	642.0	105.0	0.02	57323**
Pooled error	64	2.81	3.7	9.6	0.61	82.5	10.3	0.02	6474
AMMI component 1	10	-0.89	-0.90	-0.94	0.35	0.76	0.07	0.15	0.29
AMMI component 2	8	-0.32	0.07	0.07	-0.02	-0.01	0.89	-0.87	-0.25

Source of variation	Df	Mean Square (MS)							
		DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
AMMI component 3	6	-0.29	-0.33	-0.22	-0.87	-0.36	-0.23	0.03	-0.61
AMMI component 4	**4**	0.13	0.00	0.18	0.13	0.47	0.26	0.41	-0.66
CV(%)		4.8	2.4	8.8	16.8	15.3	10.2	8.4	4.8
Mean		35.53	86.01	86.33	4.958	60.25	31.09	2.964	1137

** denotes significance level at $p<0.01$; LSD- least significant difference; CV- coefficient of variation; G/GGE Genotype and Genotype by environment interaction, DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Table 11. Mean performances of *Brassica rapa* genotypes in Regional Yield Trial during rabi 2021-22 over the 4 locations

Sl. no.	Lines/varieties	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
1	BC-100614 (1)-6	36	86	90.0	5.3	66.0	32.7	2.919	1165
2	BC-100614 (3)-1	36	87	84.7	4.7	60.8	31.9	3.018	1189
3	BC-100614 (4)-7	36	86	85.7	5.1	56.1	34.4	3.046	1293
4	BC-100614 (8)-4	36	86	85.4	5.0	59.2	33.0	2.841	1182
5	BC-110714 (7)-2	35	85	80.5	4.4	54.2	29.6	2.885	1032
6	BC-120114	34	86	80.0	4.9	58.9	30.1	2.916	1034
7	BC-15-YF-01	35	86	92.0	4.8	65.0	26.0	2.974	1174
8	BC-20-GS-1	37	89	98.5	5.0	60.2	32.3	3.031	1094
9	BARI-Sarisa-14	34	84	80.1	5.4	62.0	29.8	3.044	1070
	SE	0.5	0.6	0.9	0.2	2.7	0.9	0.046	26.0
	LSD (p≥0.05)	1.4	1.7	2.6	0.7	7.5	2.6	0.130	73.4
	CV (%)	4.8	2.4	3.7	16.8	15.3	10.2	5.4	7.9

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant, NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g), YIELD= Seed yield (kg/ha)

Table 13. Genotype by environment interaction of maturity duration of *Brassica rapa* lines in Regional Yield Trial over four locations during rabi 2021-2022

SL. No.	Line/Variety	Days to Maturity (day)				Over all mean	P. Index (Pi)	Bi	S^2di
		Gazipur	Jamalpur	Ishurdi	Jashore				
1	BC-100614 (1)-6	87	81	100	89	89	3.28	0.79	0.32
2	BC-100614 (3)-1	83	79	89	91	86	-0.47	0.95	0.15
3	BC-100614 (4)-7	86	79	90	92	87	0.78	1.04	0.24
4	BC-100614 (8)-4	82	80	91	91	86	0.03	1.02	0.06
5	BC-110714 (7)-2	82	79	90	92	86	-0.22	1.09	0.08
6	BC-120114	83	77	89	91	85	-0.97	1.12	0.39
7	BC-15-YF-01	86	78	88	90	86	-0.47	0.96	0.15
8	BC-20-GS-1	87	78	89	89	86	-0.22	0.85	0.07
9	BARI-Sarisa-14	84	78	87	88	84	-1.72	1.19	0.00
Mean		84	79	90	90	**86**			
E. Index		-1.53	-7.19	4.36	4.36				
SE		1.8	0.4	0.8	0.9	0.6			
LSD (p≥0.05)		5.5	1.1	2.3	2.8	1.7			
CV (%)		4.0	1.4	1.0	2.0	2.4			

Table 15. Genotype by environment interaction of seed yield of *Brassica rapa* lines in Regional Yield Trial over four locations during rabi 2021-2022

SL. No.	Line/Variety	Seed yield (kg ha^{-1})				Over all mean	P. Index (Pi)	Bi	S^2di
		Gazipur	Jamalpur	Ishurdi	Jashore				
1	BC-100614 (1)-6	1022	1254	1570	945	1198	-80	0.82	0.00
2	BC-100614 (3)-1	1141	1608	1780	703	1308	31	1.12	0.00
3	BC-100614 (4)-7	1074	1581	1919	720	1324	46	1.23	0.00
4	BC-100614 (8)-4	1484	1443	1997	842	1442	164	1.00	0.00
5	BC-110714 (7)-2	1380	1281	1813	795	1317	40	0.87	0.00
6	BC-120114	1001	1163	1587	876	1157	-121	0.85	0.01
7	BC-15-YF-01	1165	1093	1644	817	1180	-98	0.85	0.02
8	BC-20-GS-1	1165	1451	1852	812	1320	43	1.09	0.28
9	BARI-Sarisa-14	1104	1127	1975	798	1251	-26	1.18	0.00
Mean		1171	1333	1793	812	**1277**			
E. Index (Ij)		-107	56	516	-465				
SE		25.1	52.4	63.7	34.7	26.0			
LSD (p≥0.05)		75.2	157.0	190.9	104.1	73.4			
CV (%)		6.5	7.3	6.0	7.0	7.9			

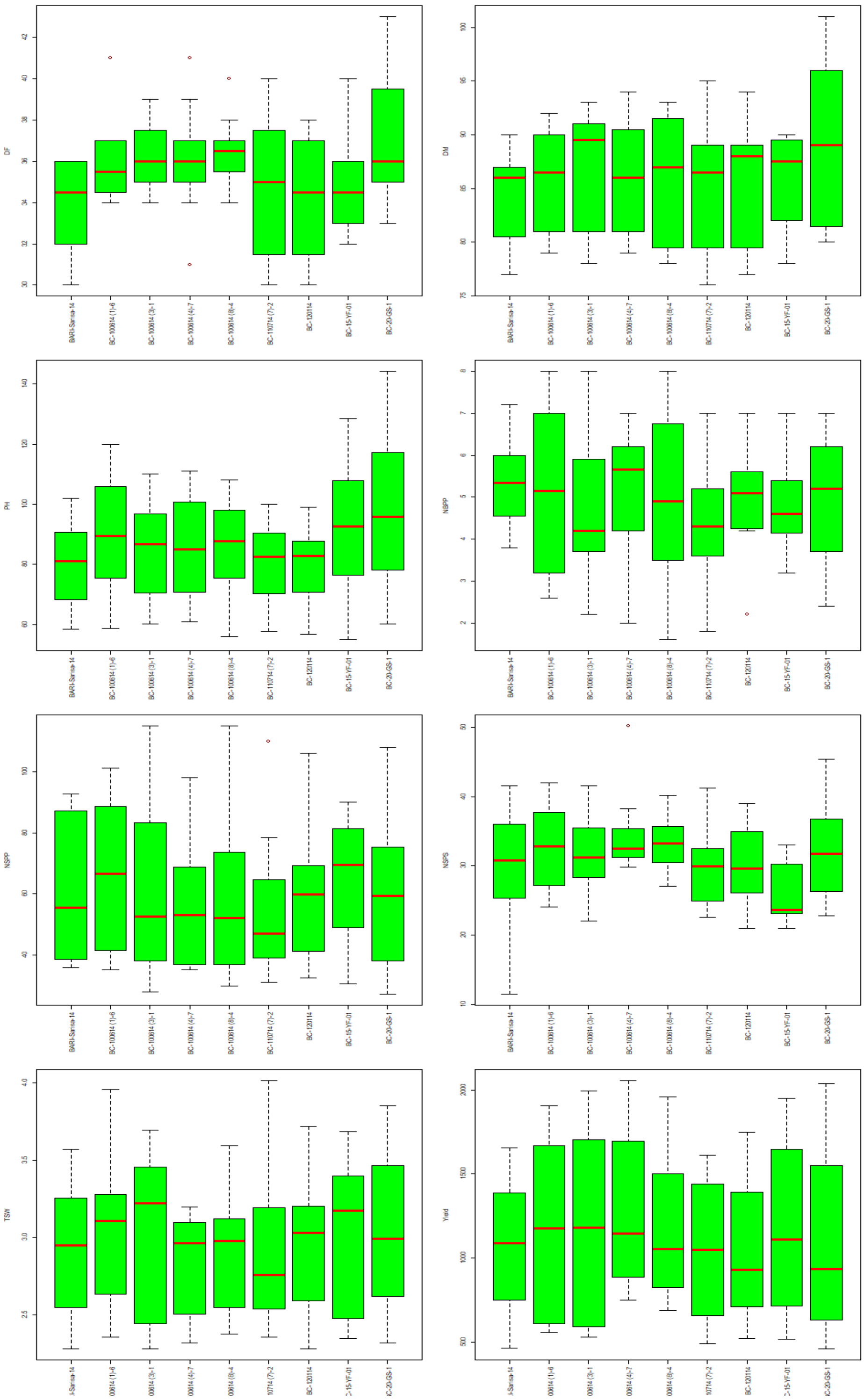

Fig.1. Performances of *Brassica rapa* genotypes in Regional Yield Trial during rabi 2021-22 at 4 locations of Bangladesh. Box plots showing the pattern of the measured traits of lines. Box edges show upper and lower quantile and the median as shown in the middle of the box. Individuals falling outside of the rank of whisker are shown as circles.

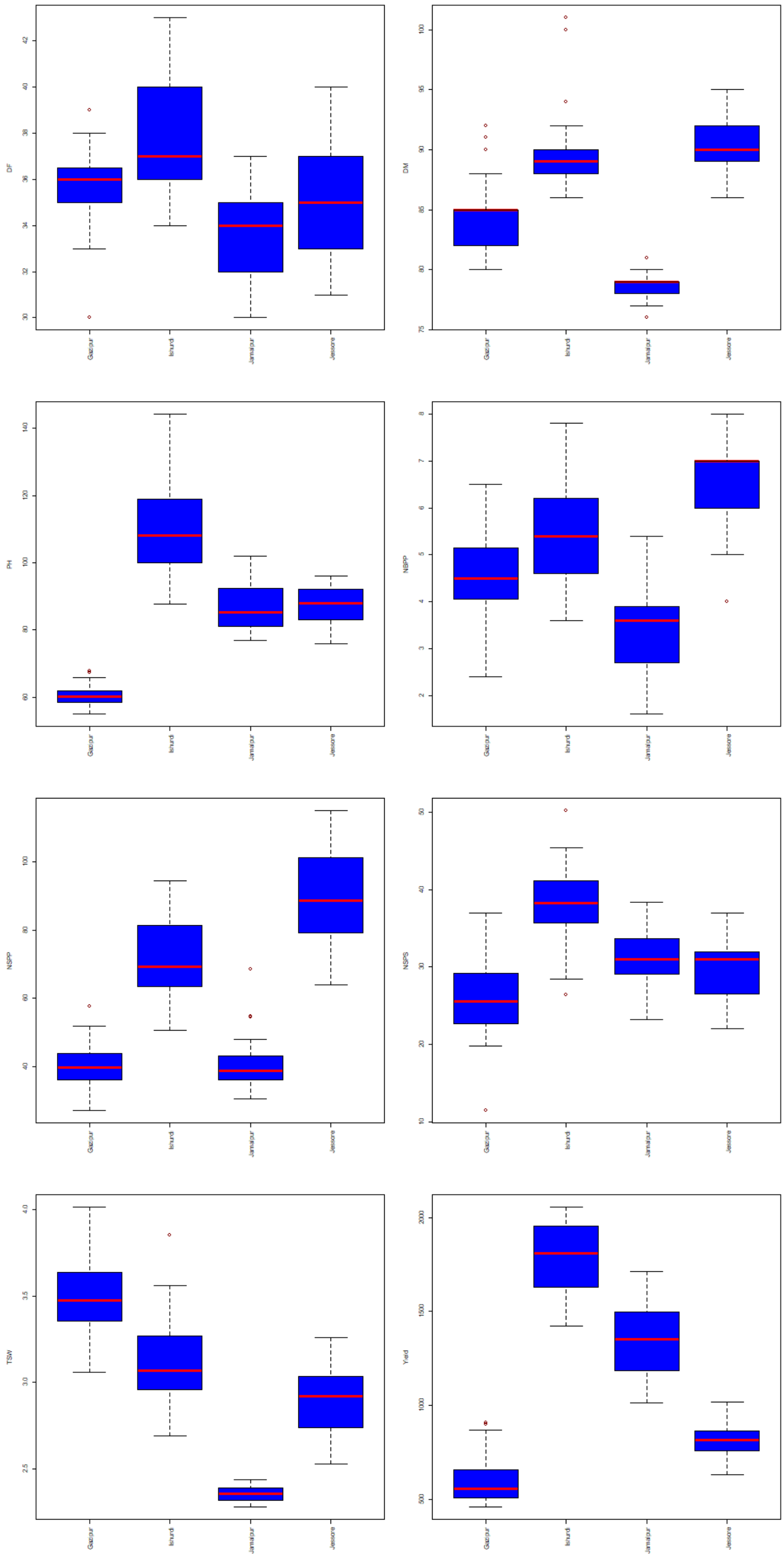

Fig. 2. Yield and yield contributing traits of *Brassica rapa* lines in Regional Yield Trial over four locations during rabi 2021-22. Box plots showing the pattern of the measured traits of lines. Box edges show upper and lower quantile and the median as shown in the middle of the box. Individuals falling outside of the rank of whisker are shown as circles.

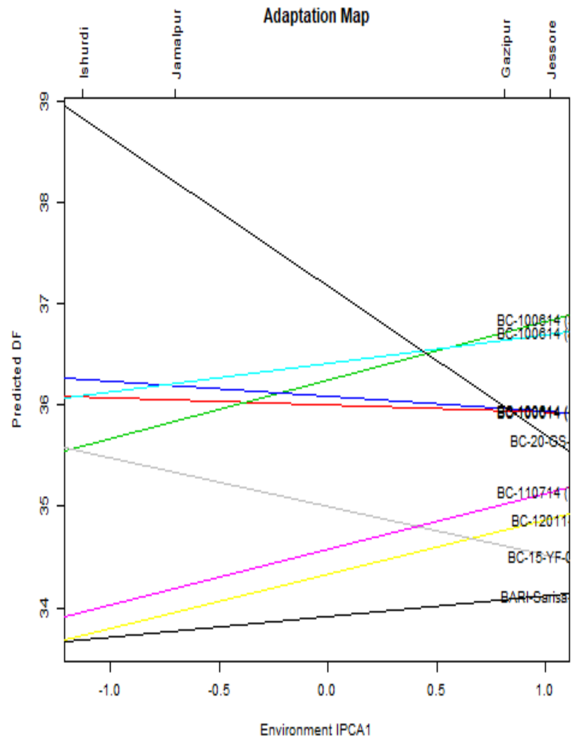

Fig. 3a. Nominal DF plots based on predicted DF in all over environments

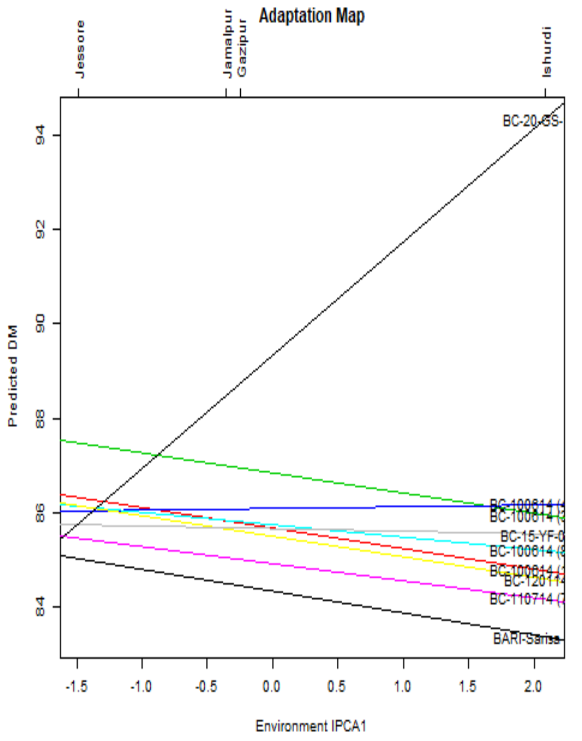

Fig. 3b. Nominal DM plots based on predicted DM in all over environments

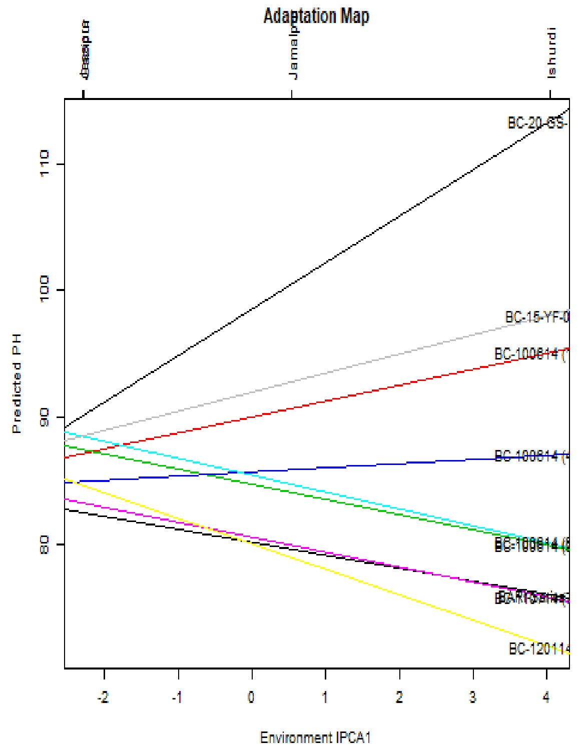

Fig. 3c. Nominal PH plots based on predicted PH in all over environments

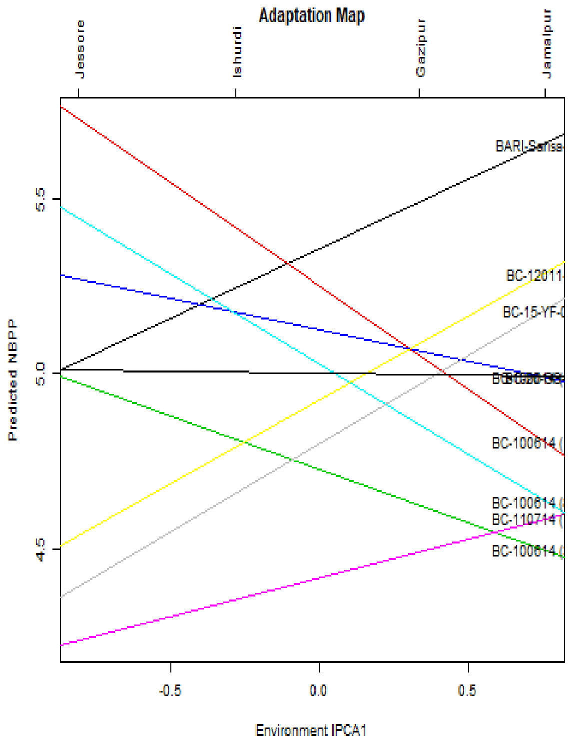

Fig. 3d. Nominal NBPP plots based on predicted NBPP in all over environments

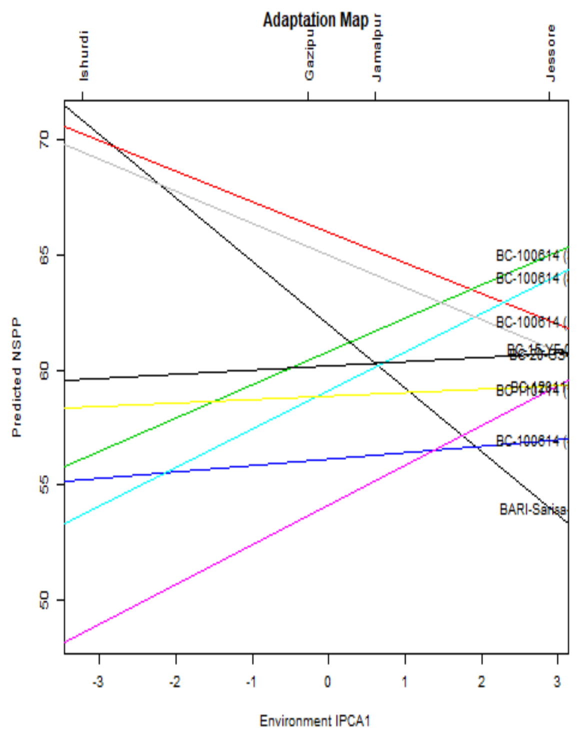

Fig. 3e. Nominal NSPP plots based on predicted NSPP in all over environments

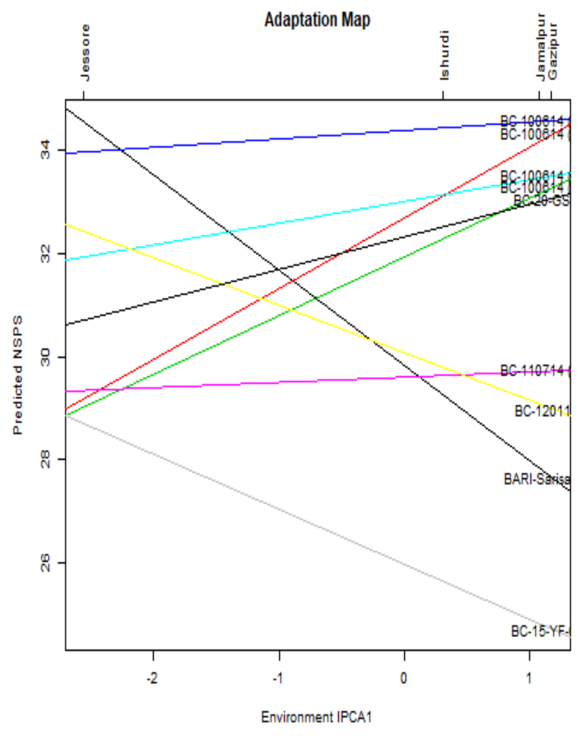

Fig. 3f. Nominal NSPS plots based on predicted NSPS in all over environments

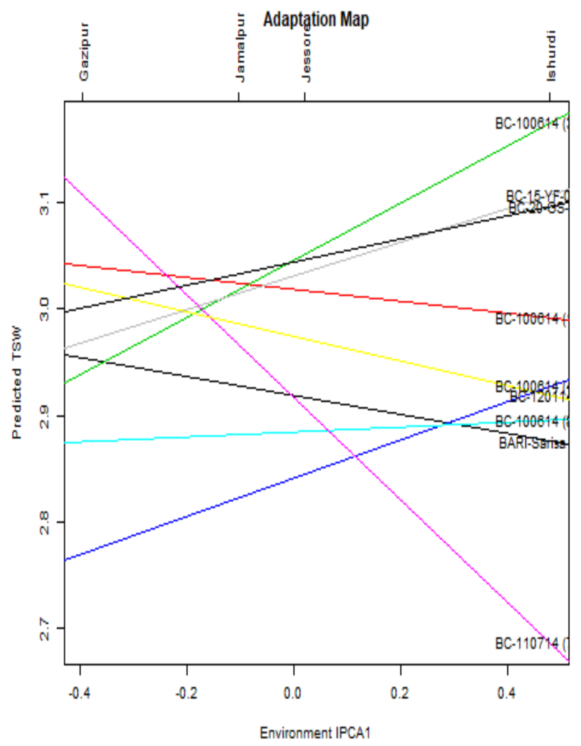

Fig. 3g. Nominal TSW plots based on predicted TSW in all over environments

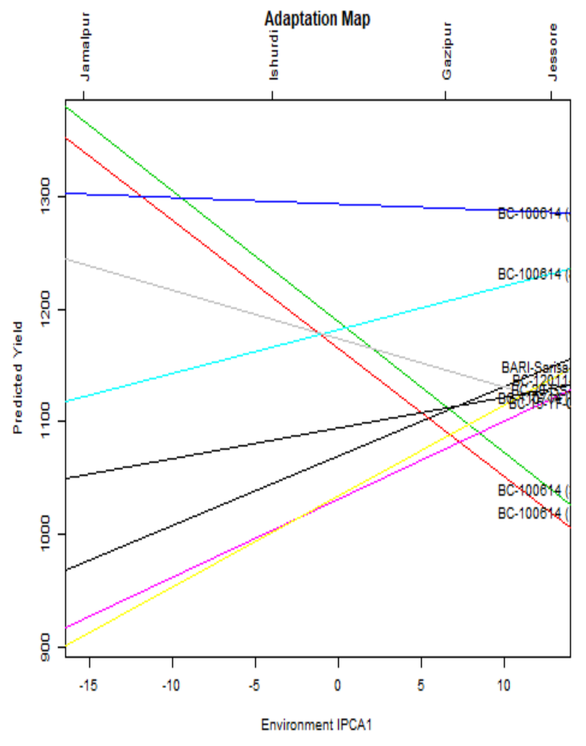

Fig. 3h. Nominal yield plots based on predicted yields in all over environments

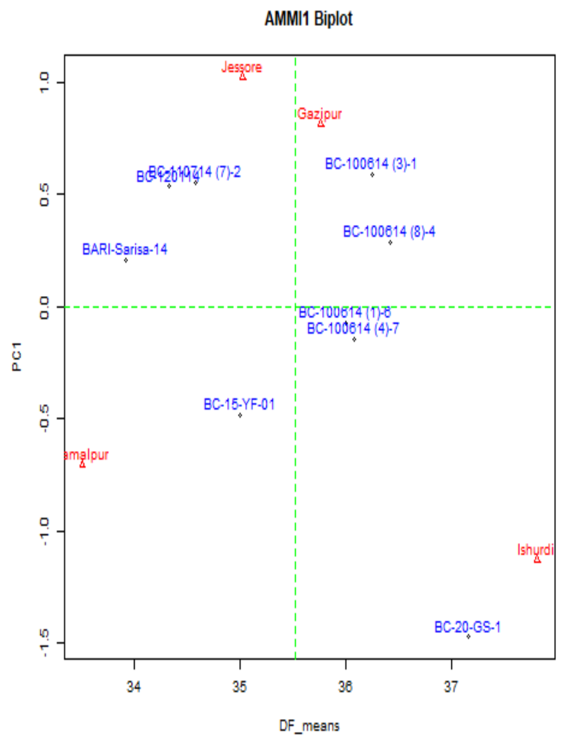

Fig.4a. AMMI1 biplot of days to 50% flowering environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

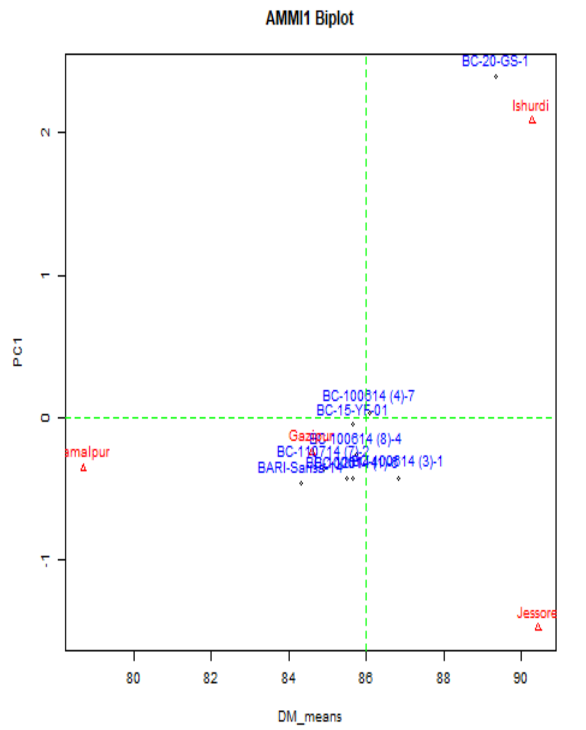

Fig.4b. AMMI1 biplot of days to 80% maturity environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

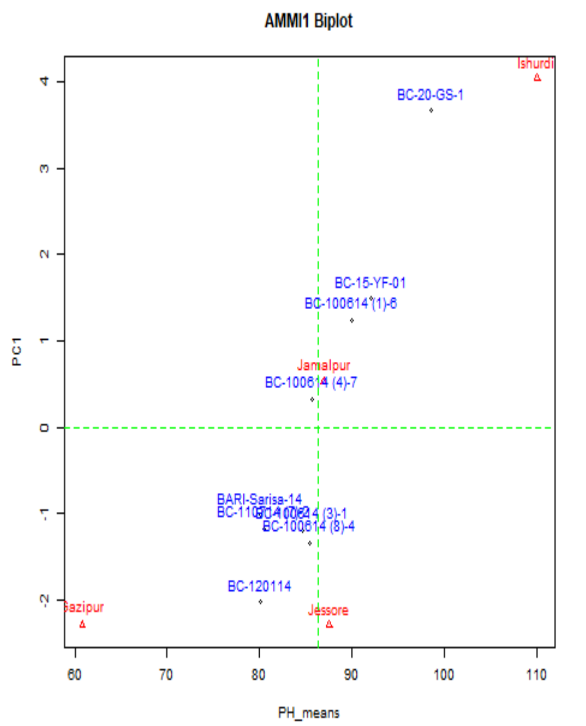

Fig.4c. AMMI1 biplot of plant height (cm) environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

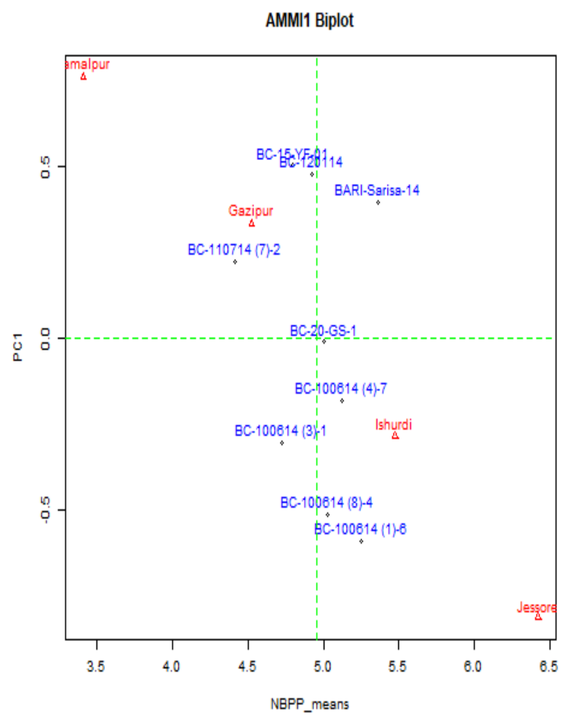

Fig.4d. AMMI1 biplot of number of branches per plant environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

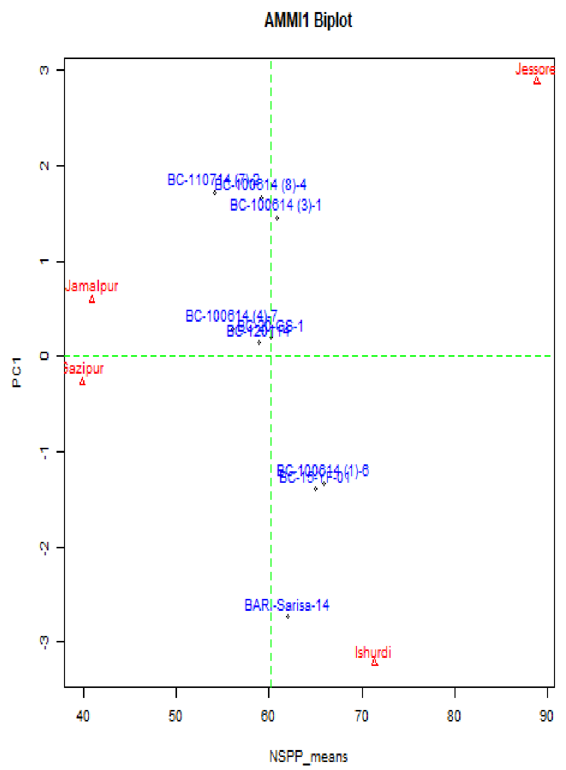

Fig.4e. AMMI1 biplot of no. of siliqua per plant environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

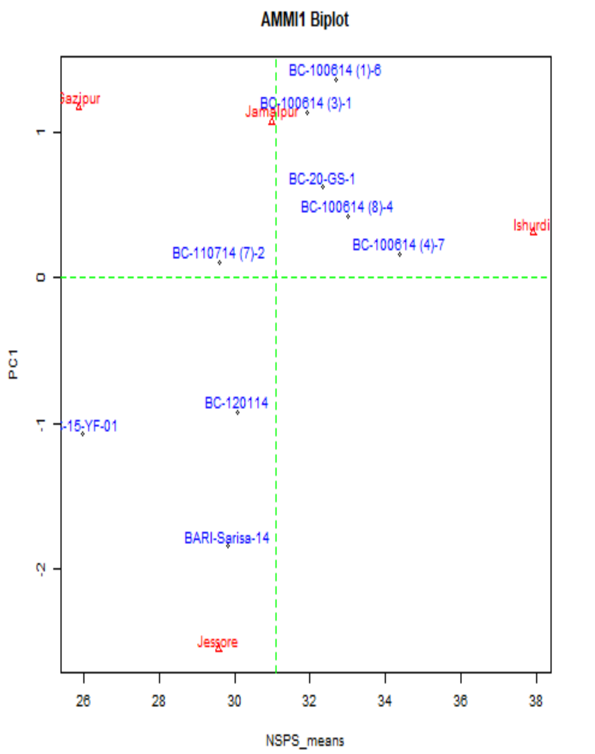

Fig.4f. AMMI1 biplot of no. of seed per siliqua environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

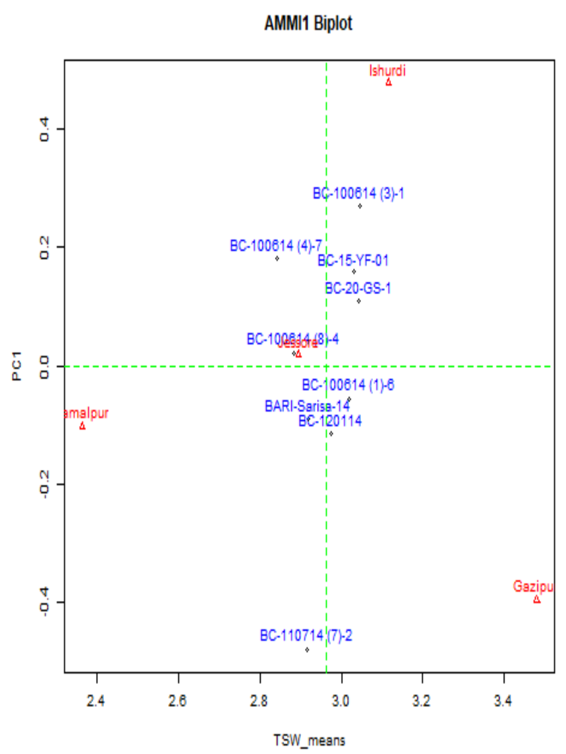

Fig.4g. AMMI1 biplot of TSW(g) environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

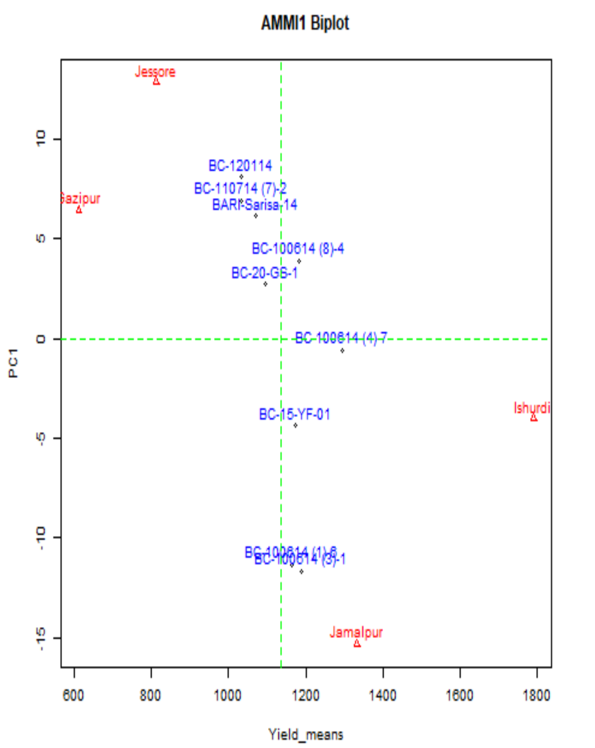

Fig.4h. AMMI1 biplot of seed yield (kg ha^{-1}) environmental means vs IPCA1 for 8 *B. rapa* advanced lines and one check in the four environments.

AMMI1 biplot analysis

AMMI biplots are a powerful interpretative tool to understand the role of main effects and interaction effects on yield and yield associated traits (Fig.4a-4h). In AMMI1 biplot, the main effects (genotype mean and environment mean) are plotted against IPCA1 scores for both genotypes and environments. The inference from the analysis is that the genotypes displacement along the abscissa indicates differences in the main (additive) effects, and displacement along the ordinate indicates differences in interaction effects. Genotypes that group together have similar adaptation, while environments that group together influences the genotypes in the same way. Genotypes and environments on the right side of the midpoint of this axis has higher yields than those on left hand side and a genotype or environment on the same parallel line, relative, or ordinate have similar yields. The analysis showed that genotype BC-100614 (8)-4 lying on the right side of the perpendicular are less influenced by the G×E interaction for seed yield (Fig. 4h). Genotypes viz., BC-15-YF-01, BC-20-GS-1 and BC-100614 (4)-7 were found stable across the locations for seed yield as they lie closer to the centre point in the biplot. Combined analysis of variance carried out by several workers earlier suggested the genotypic effect as a predominant source of variation followed by GEI and environment effect. AMMI and biplot analysis were used to analyze the effects of GEI on grain yield and compute the AMMI stability value and yield stability index, which identified the above listed genotypes that are highly adapted, stable, and high yielding. proximity

AMMI2 biplot analysis

This is based on a plot of IPCA1 vs IPCA2 and elucidates the magnitude of interaction of each genotype with the environment (Fig.5a-5h). Genotypes clustering in close proximity on the plot will have similar yields across all the locations and genotypes that are drifted apart have variation in yields or shows a different pattern of response to environments. Genotypes and environments that fall into the same sector interact positively and negatively if they fall into opposite sectors (Osiru et al. 2009). Genotypes viz., BARI-Sarisa-14, BC-110714 (7)-2 and BC-120114 occurring close together on the biplot have similar yields across the three locations and G16, G17 and G29 showed difference in mean yield across the locations (Fig.5h). Genotypes near the origin are indicative of the stable performance in all the locations. BC-15-YF-01, BC-120114 and BC-100614(8)-4 were found stable and showed less interaction with the environmental-interactive forces. Genotypes BARI-Sarisa-14 and BC-20-GS-1 were away from the origin, indicating their responsiveness to different environmental factors for seed yield.

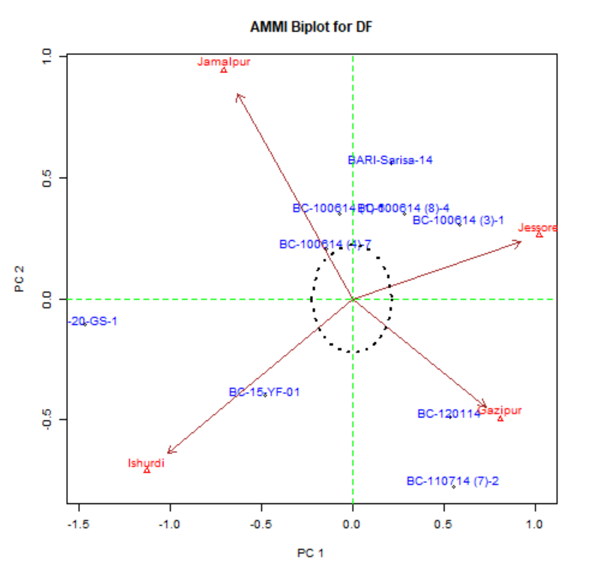

Fig. 5a. AMMI1 and AMMI2 biplots indicating GE interaction for days 50% flower of 9 *B. rapa* lines across 4 environments of Bangladesh

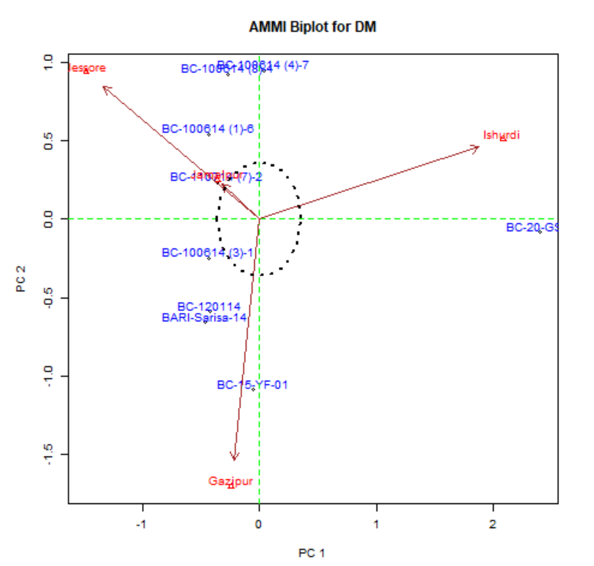

Fig. 5b. AMMI1 and AMMI2 biplots indicating GE interaction for days to 80% maturity of 9 *B. rapa* lines across 4 environments of Bangladesh

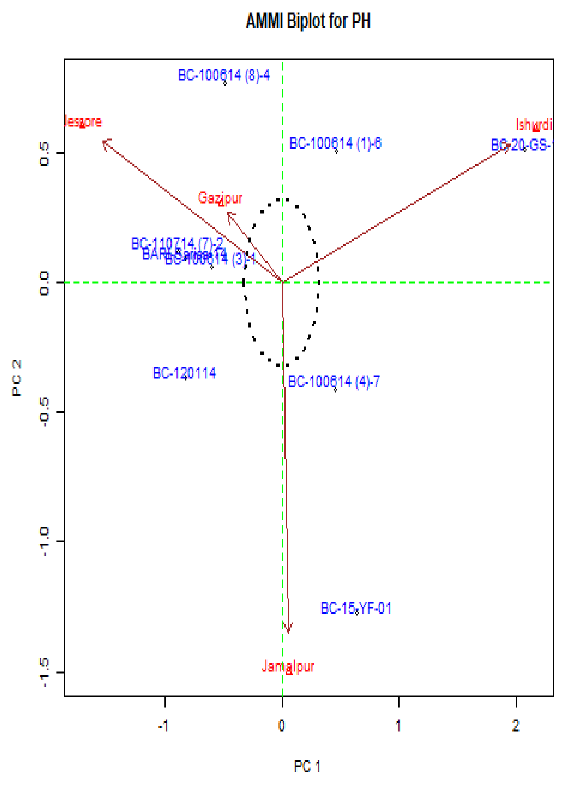

Fig. 5c. AMMI1 and AMMI2 biplots indicating GE interaction for plant height (cm) of 9 *B. rapa* lines across 4 environments of Bangladesh

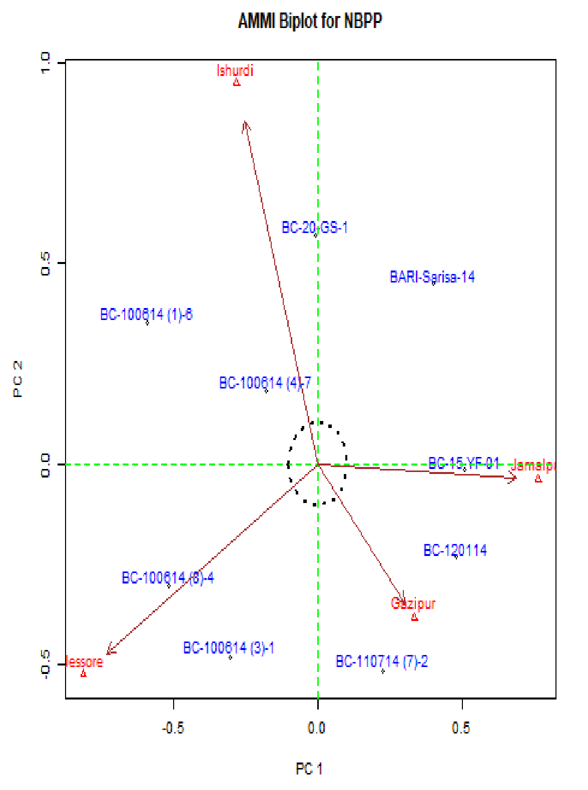

Fig. 5d. AMMI1 and AMMI2 biplots indicating GE interaction for NBPP of 9 *B. rapa* lines across 4 environments of Bangladesh

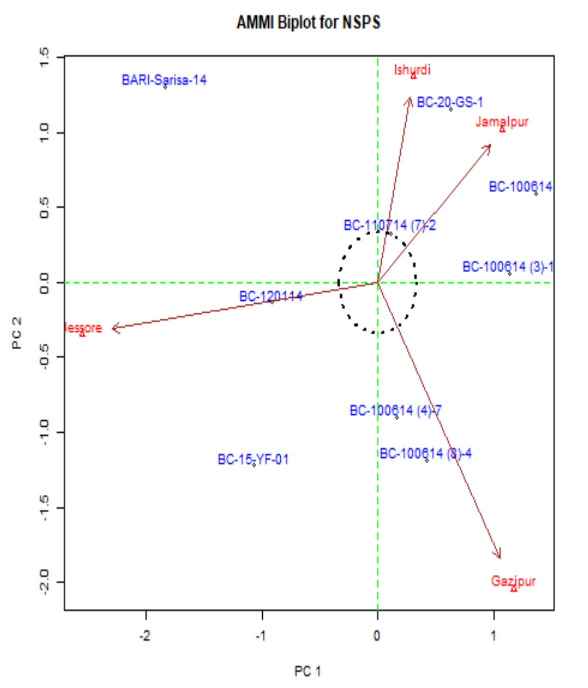

Fig. 5e. AMMI1 and AMMI2 biplots indicating GE interaction for NSPS of 9 *B. rapa* lines across 4 environments of Bangladesh

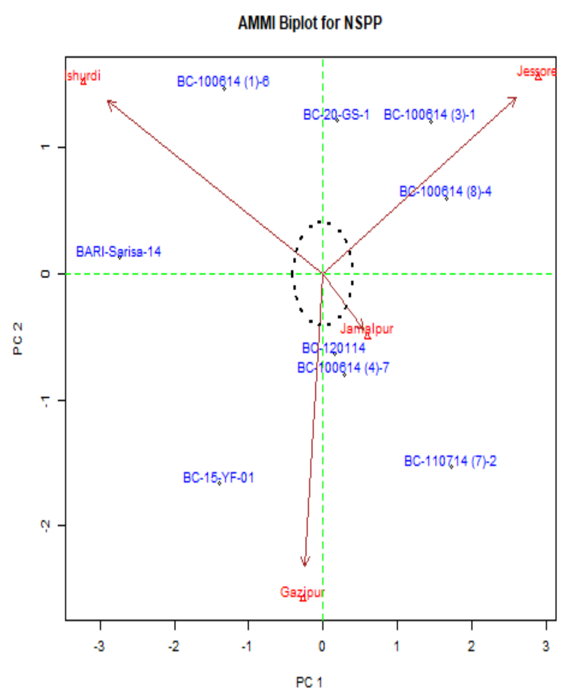

Fig. 5f. AMMI1 and AMMI2 biplots indicating GE interaction for NSPP of 9 *B. rapa* lines across 4 environments of Bangladesh

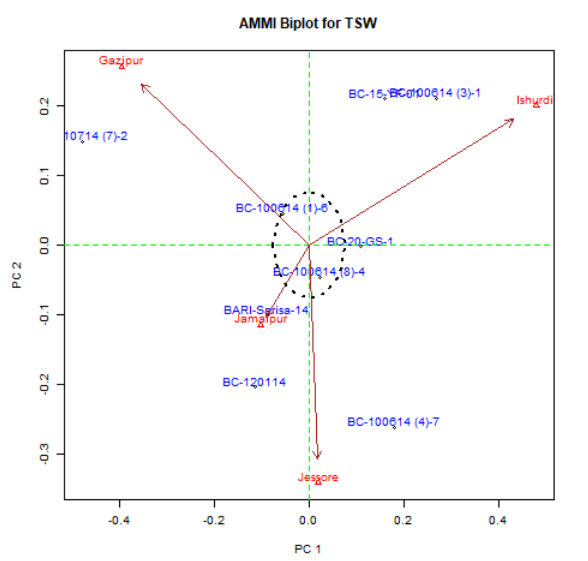

Fig. 5g. AMMI1 and AMMI2 biplots indicating GE interaction for TSW of 9 *B. rapa* lines across 4 environments of Bangladesh

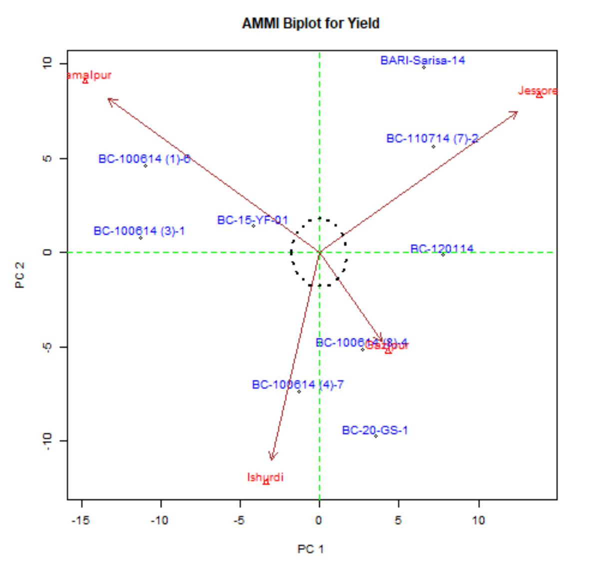

Fig. 5h. AMMI1 and AMMI2 biplots indicating GE interaction for seed yield (kg ha^{-1}) of 9 *B. rapa* lines across 4 environments of Bangladesh

GGE biplot analysis

GGE biplot is a data visualization tool, which graphically displays a G×E interaction in a two-way table (Yan, 2011). It is an effective tool for mega-environment analysis (e.g. "which-won-where" pattern), whereby specific genotypes can be recommended to specific mega-environments (Mattos et al., 2013; Yan & Kang, 2003; Yan, Kang, Ma, Wood, & Cornelius, 2007; Yan & Tinker, 2006). In this method, genotypes are evaluated for their mean performance and stability and also environmental evaluation, the power to discriminate among genotypes in target environments.

The polygon view of a GGE-biplot based on symmetric scaling unambiguously displays the which-won where pattern providing a comprehensible summary of the GEI pattern of a multi Environmental Trail (MET) data set (Fig.7a to 7h). The polygon is formed by connecting vertex genotypes (BC-100614 (1)-6, BC-120114, BC-110714 (7)-2, BC-100614 (8)-4, BC-100614 (3)-1, BARI-Sarisa-14 and BC-100614 (4)-7) for seed yield (Fig.6g)). These genotypes have the largest vectors in their respective directions; the vector length and direction represent the extent of the response of the genotypes to the tested environments. All other genotypes are contained within the polygon and have smaller vectors, i.e., they are less responsive in relation to the interaction with the environments within that location. A set of lines drawn from the biplot origin and intersecting the sides of the polygon at right angles. Thus, the lines divide the biplot into four sectors and thereby the biplot subdivide the target environment into subregions (mega-environments). Mega-environments are those sectors which comprise one or more environments. This way the environment markers were grouped into two sectors (i.e. two mega-environments) where sector 1 contained environments Jamalpur and sector 4 had two environment Gazipur and Ishurdi (Fig. 7h). In agreement with the results reported by Yan (2002), the genotype(s) vertex in these sectors may have higher or the highest yield compared to other parts in all environments

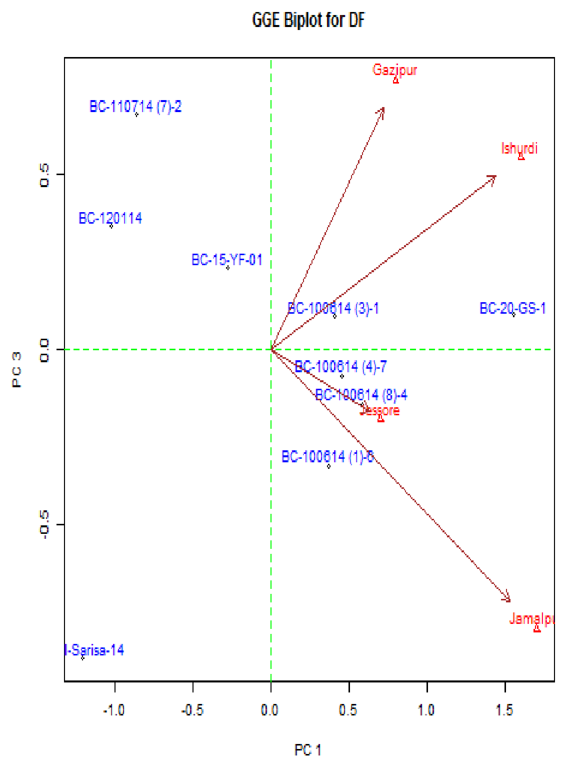

Fig. 6a. GGE biplot showing of the test environments for days to 50% flowering

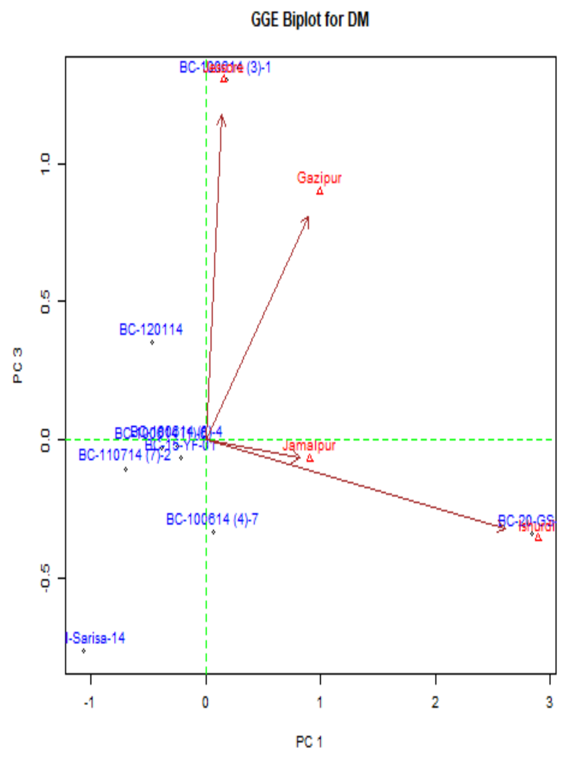

Fig. 6b. GGE biplot showing of the test environments for days to 80% maturity

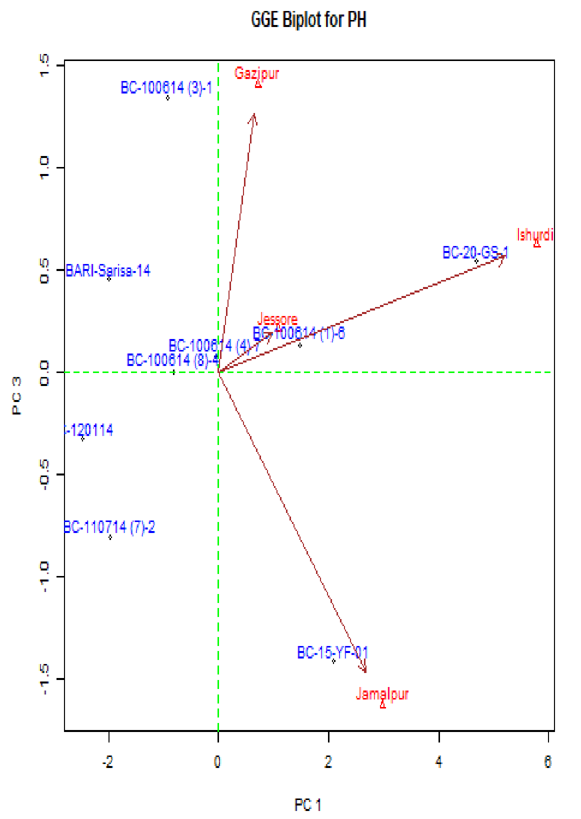

Fig. 6c. GGE biplot showing of the test environments for plant height

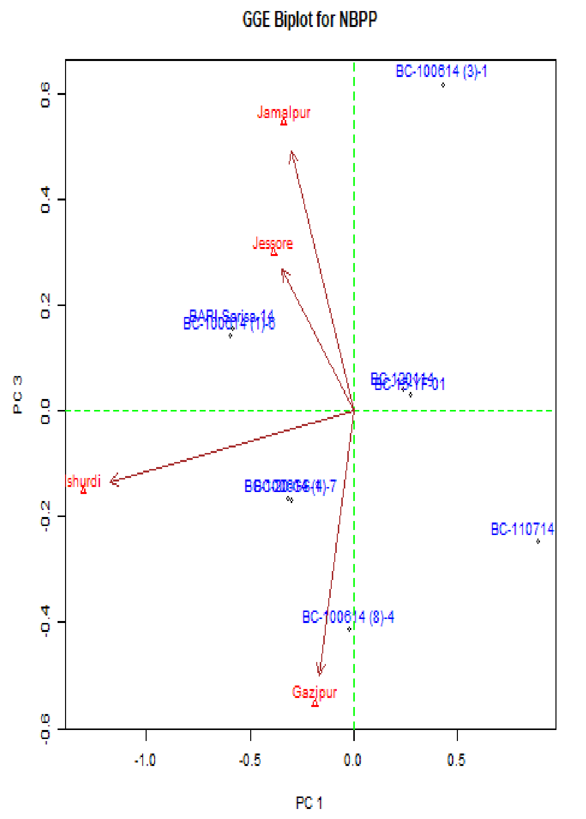

Fig. 6d. GGE biplot showing of the test environments for no. of branches per plant

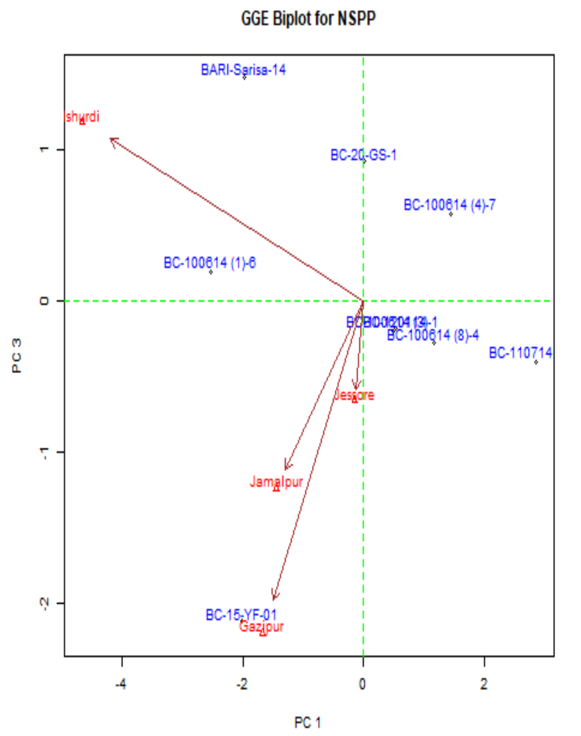

Fig. 6a. GGE biplot showing of the test environments for no. of siliquae per plant

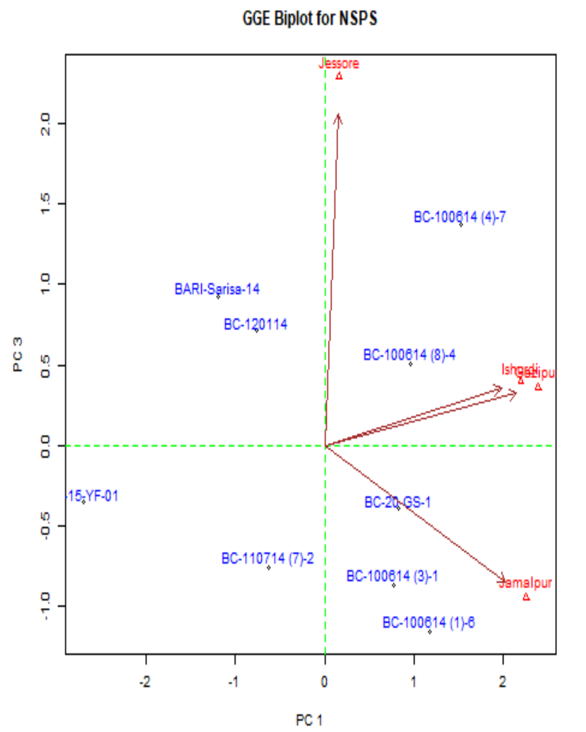

Fig. 6a. GGE biplot showing of the test environments for no. seed per siliqua

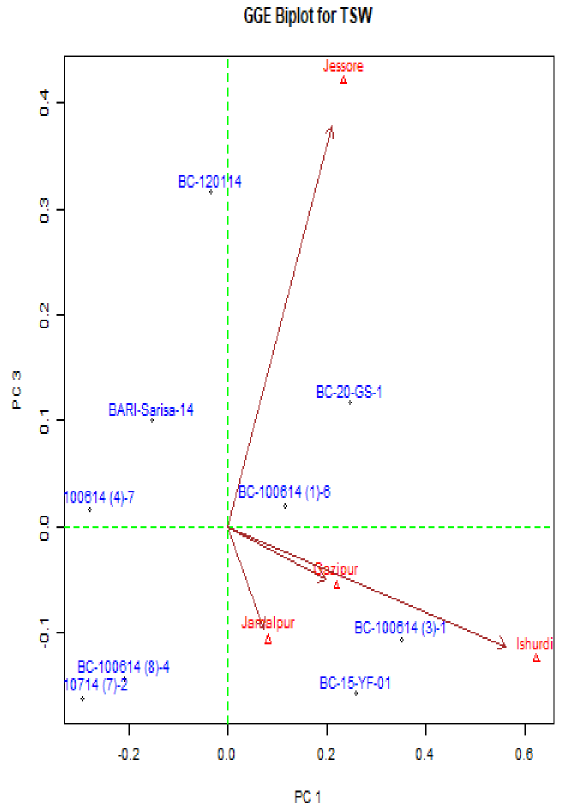

Fig. 6a. GGE biplot showing of the test environments for 1000 seed weight (g)

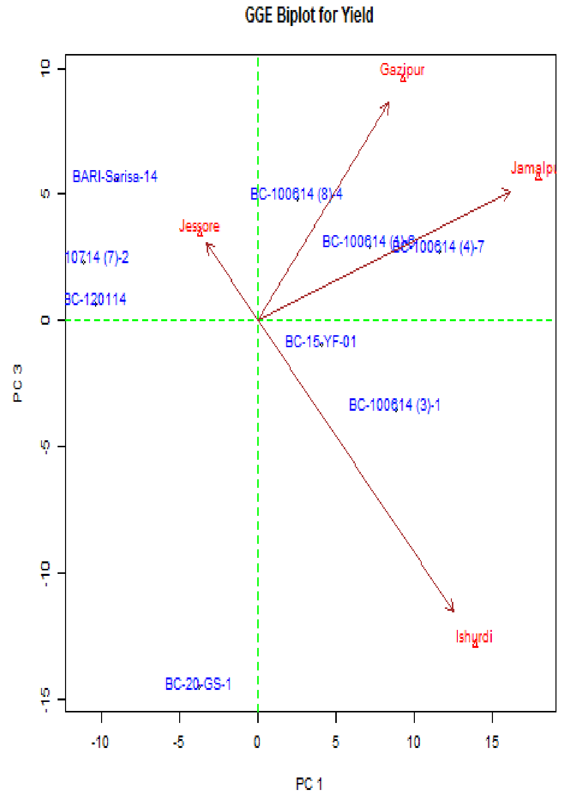

Fig. 6a. GGE biplot showing of the test environments for seed yield (kg ha^{-1})

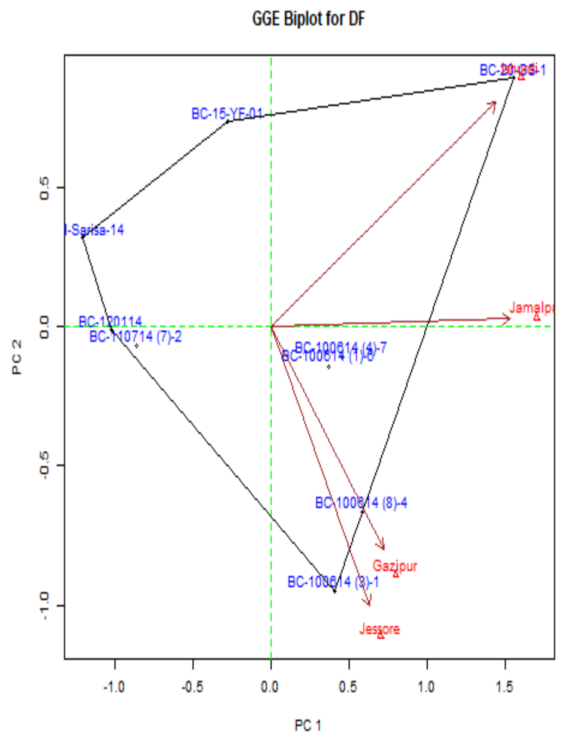

Fig.7a. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for days to 50% flowering in rapeseed lines and environments

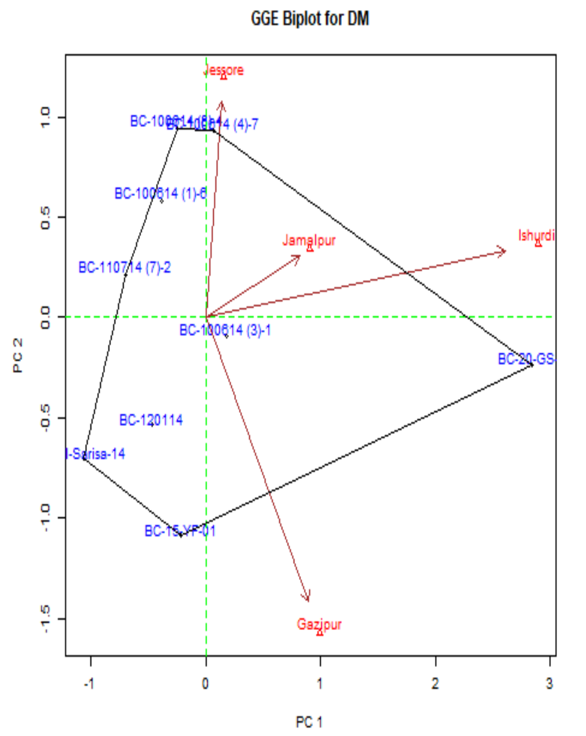

Fig.7b. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for days to 80% maturity in rapeseed lines and environments

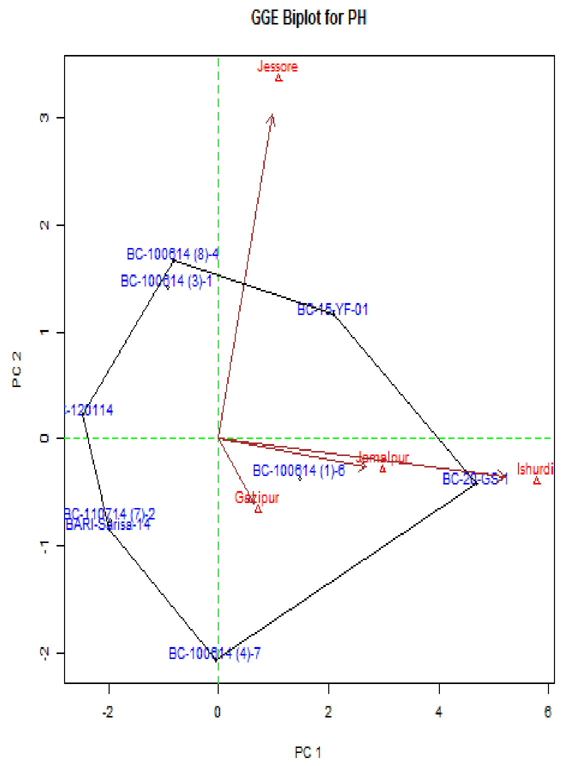

Fig.7c. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for plant height in rapeseed lines and environments

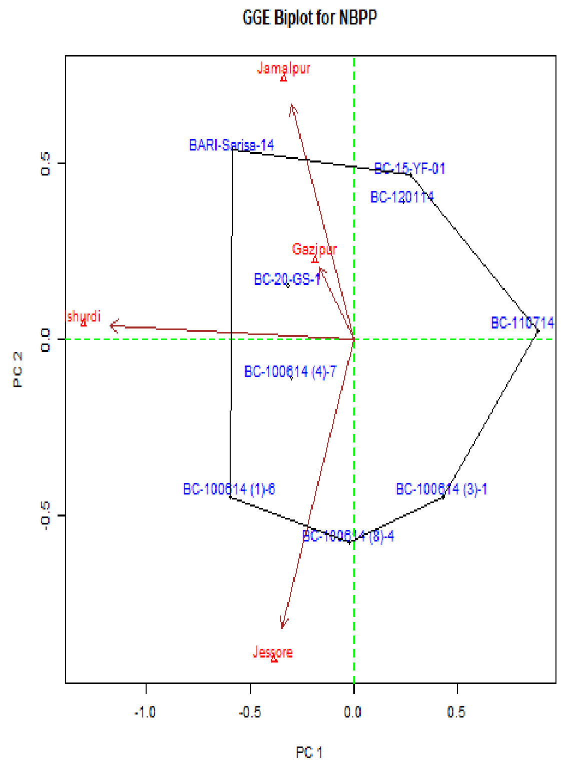

Fig.7d. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for NBPP in rapeseed lines and environments

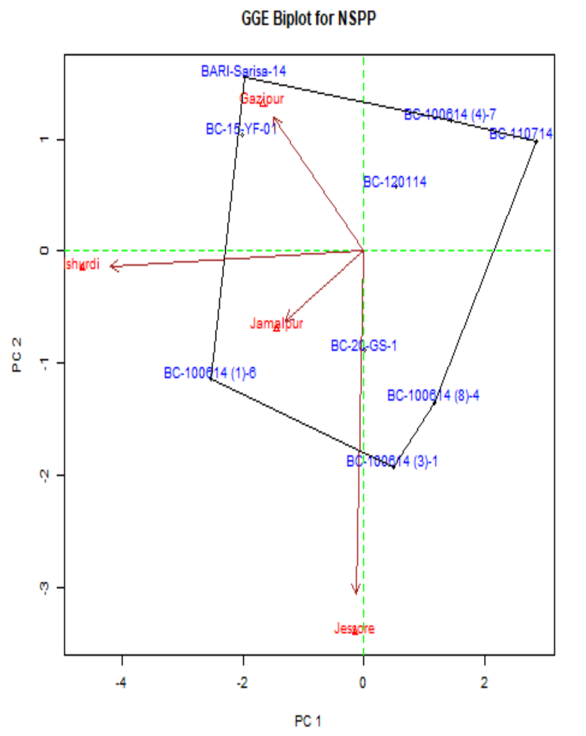

Fig.7e. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for NSPP in rapeseed lines and environments

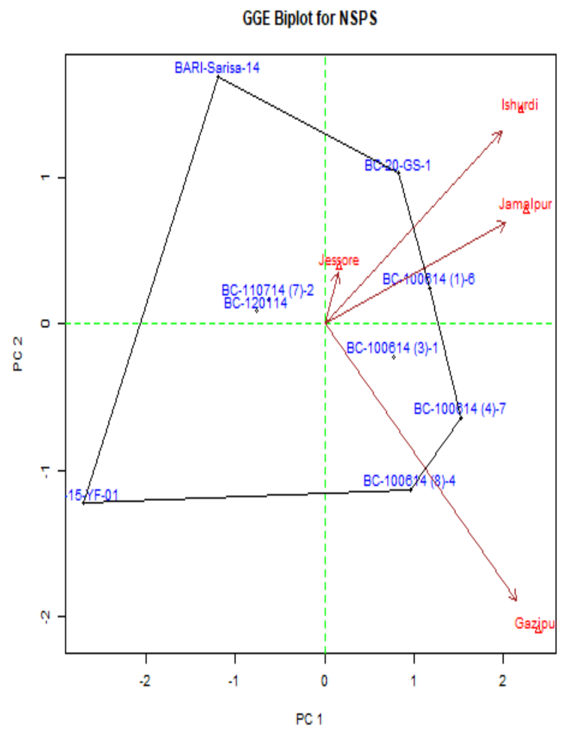

Fig.7f. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for NSPS in rapeseed lines and environments

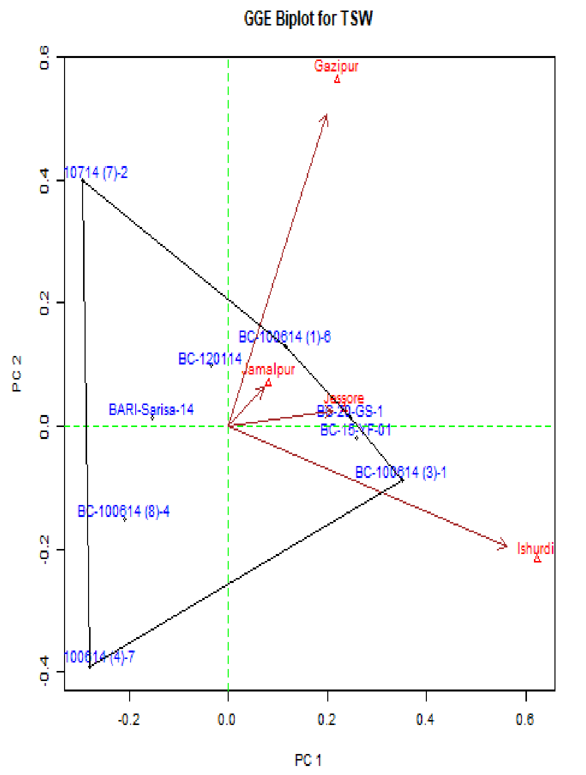

Fig.7g. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for TSW in rapeseed lines and environments

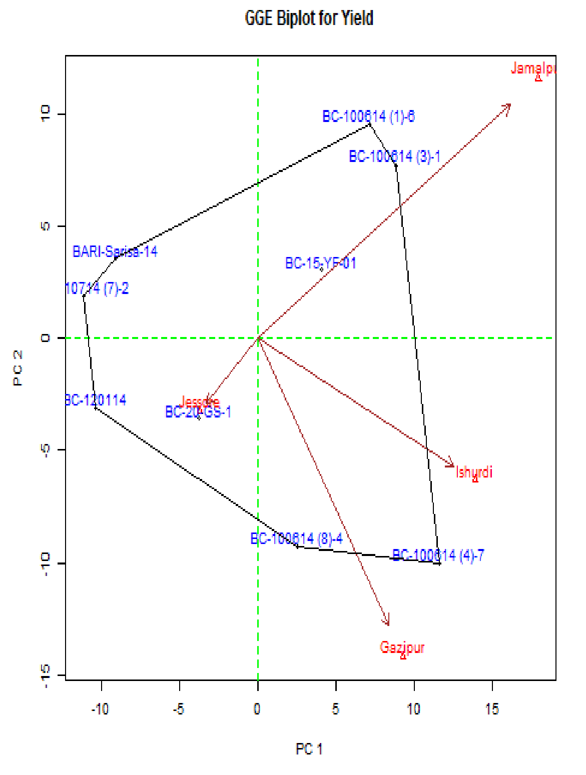

Fig.7h. The GGE biplot polygon view is based on symmetrical scaling for the which-won-where pattern for seed yield in rapeseed lines and environments

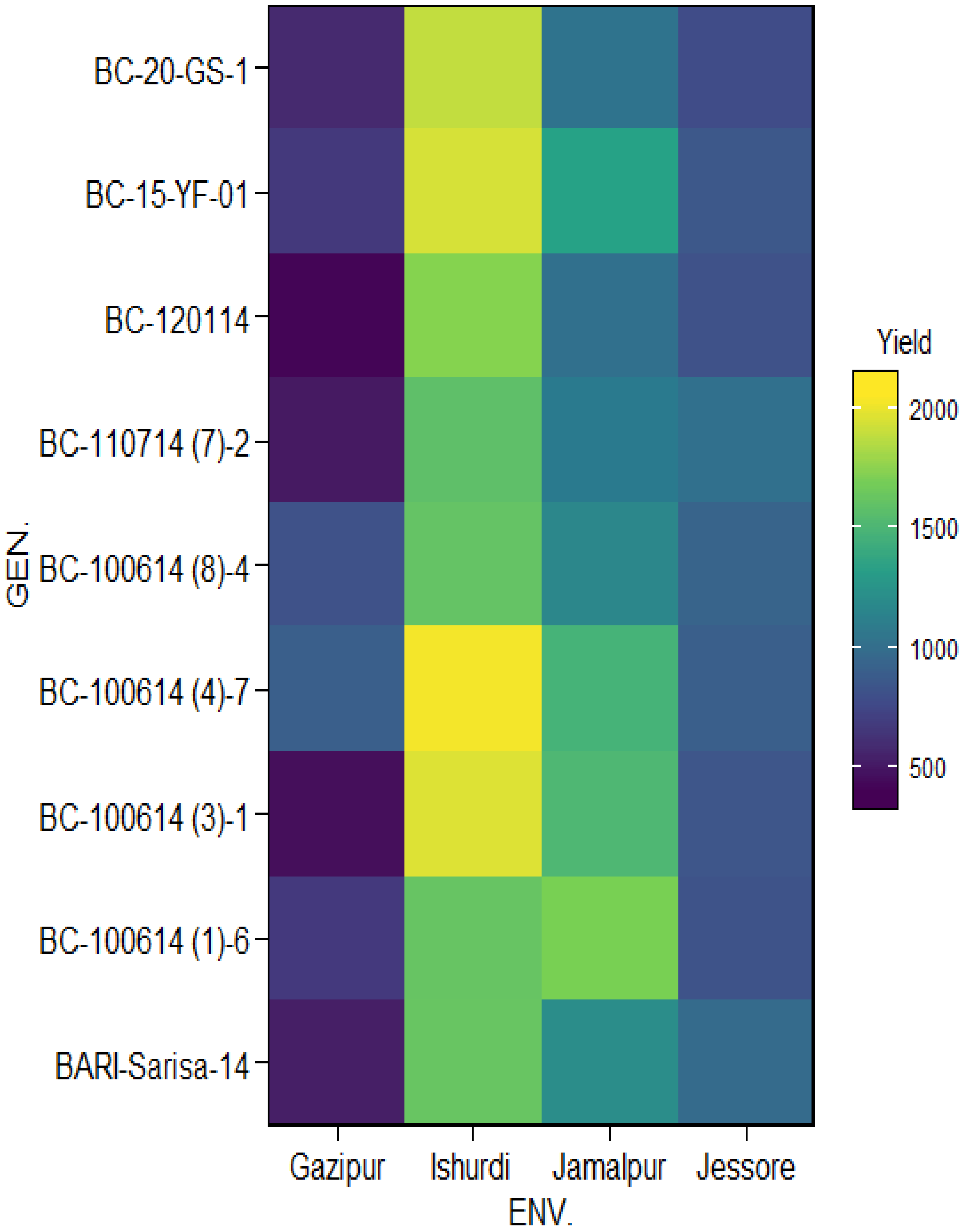

Fig.8. Heatmap displaying genotype performance and stability across all environments, with a ranking of nine lines based on different weightings of stability and seed yield performance in individual environments. The x-axis depicts the environment, while the y-axis depicts the genotypes and the corresponding mean seed yield (kg ha^{-1}) recorded.

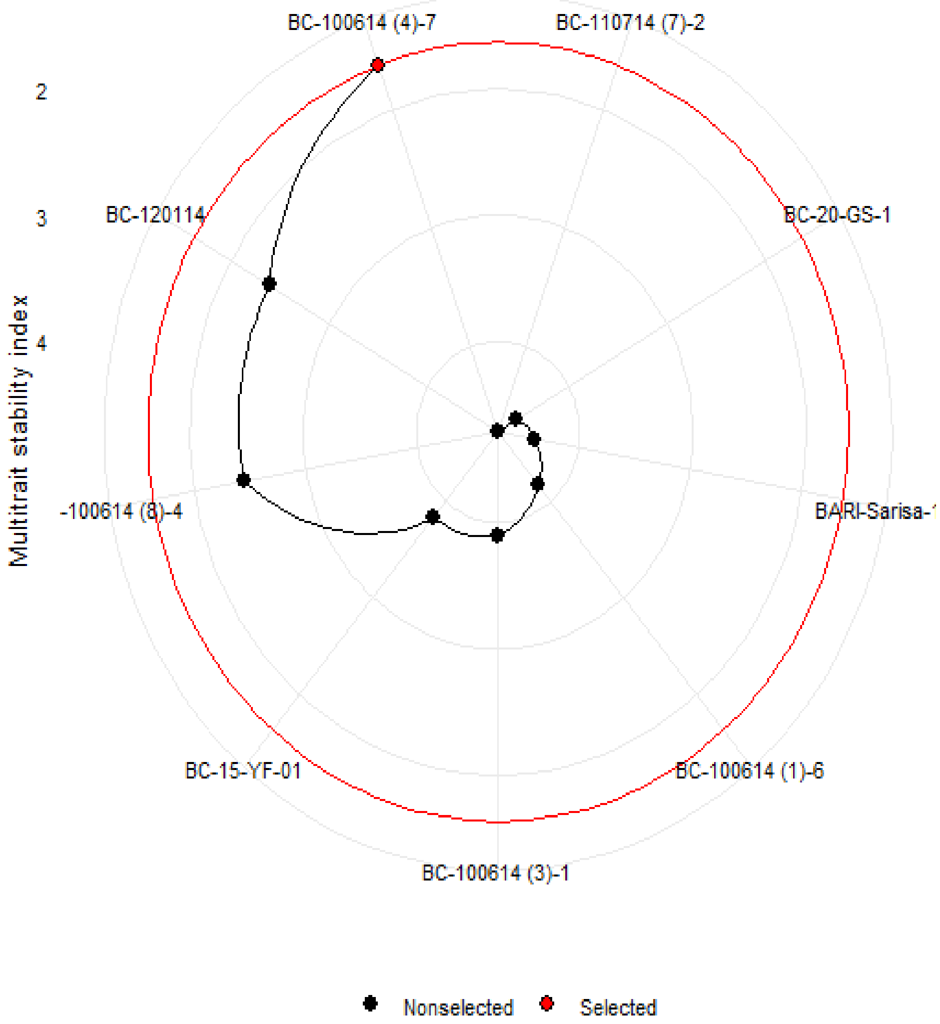

Fig.9. Genotype ranking based on the MTSI considering a selection intensity of 5% (red circle). Selected genotypes are highlighted in red.

Weighted Average of Absolute Scores (WAAS)

Olivoto et al. (2019) developed WAAS model, an integrated stability statistic combining the AMMI and BLUP models based on the singular value decomposition of the matrix of the best linear unbiased predictions for the genotype × environment interaction effects generated by a linear mixed-effect model. The genotypes with the lowest WAAS score is considered as best stable genotype. WAAS measure selected BC-100614 (4)-7 for their stable behaviour with high mean yield (Fig. 9), whereas BC-100614 (1)-6, BC-120114 and BC-15-YF-01 were considered the least stable.

Multi-trait stability index and genotype selection

The multi-trait stability index (Olivoto et al. 2021) has been proven useful for selecting genotypes for multiple traits based on mean performance and stability. Stable genotypes of soybean were also identified for stress conditions by Zuffo et al. (2020). Benakanahalli et al. (2021) made a suitable genotypic selection to identify stable guar genotypes with productive traits under differential environmental conditions through Multi-Trait Stability Index (MTSI) and Multi-Trait Genotype-Ideotype Distance Index (MGIDI). In the present study, the genotypes selected by the MGIDI index were BC-100614 (4)-7 as indicated by the red line that suggests the number of genotypes selected based on the selection pressure (Fig. 9).

Table 16. Factors linked to correlated traits, selection differential, heritability, and indicators for rape seed traits

Trait	Factor	indicator	Xo	Xs	SD	SDperc	h2	SG
DF	FA 1	decrease	35.53	36.08	0.56	1.56	0.56	0.31
DM	FA 1	decrease	86.01	86.08	0.07	0.09	0.40	0.03
PH	FA 1	decrease	86.33	85.65	-0.68	-0.79	0.73	-0.49
NSPS	FA 2	Increase	31.09	34.37	3.28	10.55	0.53	1.72
TSW	FA 2	Increase	2.96	2.84	-0.12	-4.13	0.00	0.00
NBPP	FA 3	Increase	4.96	5.13	0.17	3.36	0.00	0.00
NSPP	FA 3	Increase	60.25	56.12	-4.13	-6.86	0.00	0.00
Yield	FA 4	Increase	1137.0	1293.00	156.20	13.74	0.31	47.70

Xo = The mean value for the trait in base population; Xs = The mean value for the trait in a population with selected genotypes and SDperc: The selection differential expressed in percentage.

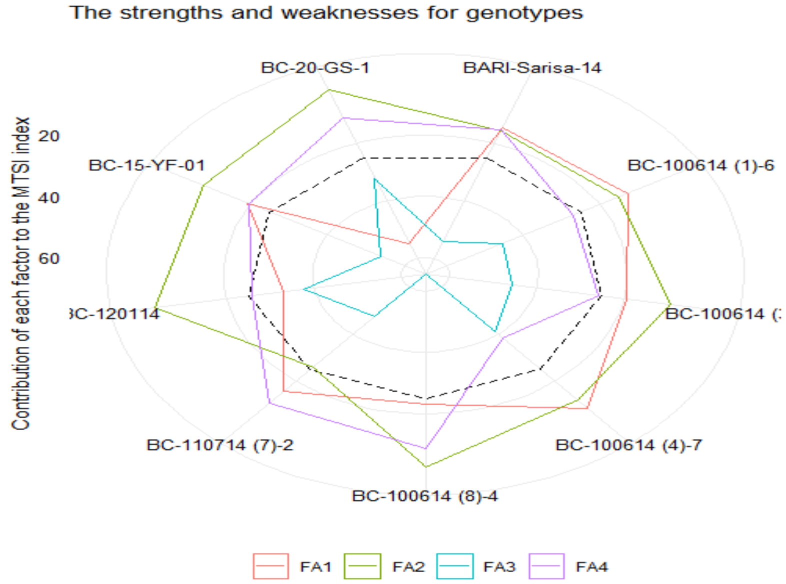

Fig. 10. Strengths and weaknesses view of the stable genotypes identified across three consecutive locations, shown as the proportion of each factor on the computed MTSI index. Smaller proportions explained by a factor (closer to the external edge) indicate that the trait within that factor is closer to the ideotype. The dashed line shows the theoretical value if all the factors contributed equally.

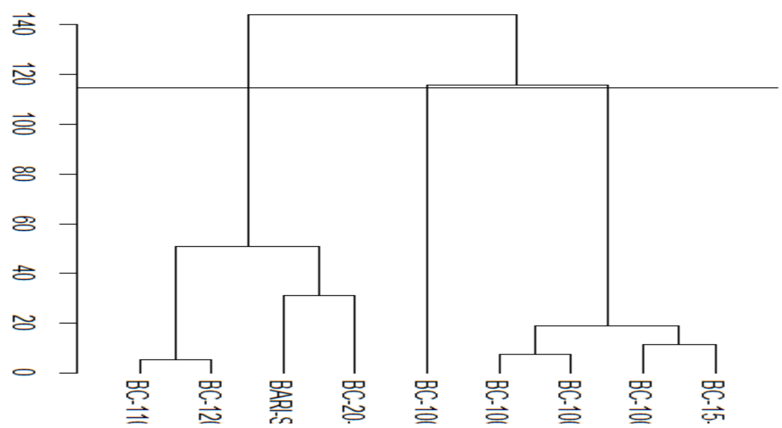

Fig. 11 Hierarchical cluster analysis of dissimilarities across rapeseed lines on their Euclidean distances.

Hierarchical cluster analysis

In the case of investigated genotypes, a hierarchical cluster analysis was computed based on squared Euclidean distance using Ward's method. The grouping pattern obtained from this analysis showed that all rapeseed genotypes were separated into three main clusters (Fig. 4). The first cluster (CI) further was divided into two sub-clusters (SCI-I and SCI-II).

Conclusion

Considering earliness, seed yield, yield attributing traits and all stability statistics together identify three lines like BC-100614 (8)-4, BC-100614 (4)-7and BC-20-GS-1 ware selected for adaptive trials in the next year.

Acknowledgement

'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project

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HYBRIDIZATION IN *BRASSICA NAPUS*

M K ALAM AND M M KADIR

Crop production can be improved by breeding new varieties of crops having higher yield. The main aim of plant breeding is to produce new crop superior to the existing ones. The most frequently employed plant breeding technique is hybridization. The aim of hybridization is to bring together desired traits found in different plant lines into one plant line via crossing.

Table 02. Cross combination and pollinated flower

Sl. No	Cross combination	Pollinated bud	Success bud	Seed obtained
1	Nap-15029 X Nap-16013	15	12	108
2	Nap-15029X Nap-0876	26	21	145
3	Nap-15029X Nap-15027	24	18	120
4	Nap-15029X Nap-15037	28	22	123
5	Nap-15029X Nap-0865	20	16	101
6	Nap-15029X BARI Sarisha-8	21	18	98
7	Nap-16013X Nap-0876	36	30	190
8	Nap-16013X Nap-15027	25	18	108
9	Nap-16013X Nap-15037	22	16	148
10	Nap-16013X Nap-0865	22	18	154
11	Nap-16013X BARI Sarisha-8	23	18	145
12	Nap-0876X Nap-15027	18	15	187
13	Nap-0876X Nap-15037	25	20	96
14	Nap-0876X Nap-0865	22	17	145
15	Nap-0876X BARI Sarisha-8	30	21	100
16	Nap-15027X Nap-15037	30	26	144
17	Nap-15027X Nap-0865	28	26	126
18	Nap-15027X BARI Sarisha-8	26	24	174
19	Nap-15037 X Nap-0865	30	27	187
20	Nap-15037 X BARI Sarisha-8	23	18	133
21	Nap-0865X BARI Sarisha-8	24	19	78

CONFIRMATION OF F_1 GENERATION OF *BRASSICA NAPUS*

M K ALAM AND M M KADIR

Seeds from 21 cross combinations from *Brassica napus* were separately harvested and were bulked cross wise for growing F2 generation.

Introduction

The F_1 generation refers to the first filial generation. Filial generations are the nomenclature given to subsequent sets of offspring from controlled or observed reproduction. The initial generation is given the letter “P” for parental generation. The first set of offspring from these parents is the known as the F_1 generation. The F_1 generation can reproduce to create the F_2 generation, and so forth. Scientists use this designation to track groups of offspring as they observe the genetics of various generations.

Development of homogenous line through conventional breeding, it is essential to advance the filial generations from F_1 through F_6. The present investigation was therefore to know the hybrid performance of the crosses involving 6 parents and to advance F_1 to F_2 generation.

Materials and Methods

F_1 seeds were obtained from 21 cross combinations from *Brassica napus*. It was made during 2020-21and was included in this trial. The seeds were sown on the 8.11.2021 each entry was grown in a single row of 2 m long plot with spacing 40 cm and 10 cm between row and plant respectively along with their parents as check. Five competitive plants were randomly selected from each parents and F_1 plots for data collection.

Results

Twenty-one F_1s were confirmed and selected for growing as F_2 in the next generation. F_1 progenies were harvested, bulked and seeds were preserved to grow F_2 population in next generation.

OBSERVATION YIELD TRIAL OF *BRASSICA NAPUS*

M K ALAM, M I RIAD AND M KADIR

Abstract

An observational yield trial of Brassica napus was conducted with 30 genotypes including two check varieties BARI Sarisha-8 and BARI Sarisha-13 at RARS Jamalpur during Rabi, 2021-2022 to evaluate the yield and yield contributing characters. Nap-20021 produced the highest yield among the genotypes included in this trial. It was produced13 % and 23 % higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-13 respectively. The second highest yield was found from Nap-5002, which was 7% and 17% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-13, respectively. The third highest yield was obtained from Nap-32021. They also took 82-84 days to mature.

Introduction

Brassica napus L is an important oil-producing crop. Mostly it is being cultivated in the colder region. Oil seed Research Centre Scientists have developed genotypes, which would be suitable for cultivation in Bangladesh. Three varieties have been released for cultivation till to date. The researchers are looking forward for more yield producing genotypes of *Brassica napus*. The experiment was conducted with 30 genotypes to find out the high yield potential genotypes of this species.

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station, Jamalpur during rabi 2021-2022 with 30 promising genotypes of *Brassica napus* including two checks BARI Sarisha-8 and BARI Sarisha-13. It was laid out in RCBD design with two replications. The plot size was 3.0 m x2.0 m. Seeds were sown on the 4th November, 2021 in continuous and row was 30 cm apart from each. The seedlings were thinned after 11 days of germination 5 cm apart. Fertilizer were applied @ 120:80:60:40:4:1 kg/ha of N: P: K: S: Zn: and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of flowering. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to flowering, plant height, pod/plant, seeds/pod, days to mature and yield per plot. The plot yield was converted into hectare.

Results and Discussion

Thirty genotypes of *Brassica napus* were evaluated for yield and yield contributing characters. The performance of different lines is expressed in table 1. Significant differences were observed for the traits of days to maturity, plant height, seeds/pod, and yield per hectare. The table revealed that the highest yield was recorded from the genotype Nap-20021. It produced 1388 kg/ha yields which was 13% and 23% higher than check varieties BARI Sarisha-8 and BARI Sarisha-13, respectively. It took 84 days to mature. It produced moderate higher no. pods/plant and seeds/pod. The second highest yield was recorded from Nap-50021. It was recorded 1322 kg/ha seed yield. It was 7% and 17% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-13 and also took 86 days to mature. The third highest yield obtained from Nap-33021. It produced 1308 kg/ha seed yield which was 6% and 16% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-13, respectively. It took 82 days to mature and also moderate higher number of pods/plant and pod length. These three lines produced higher yield and took 82-86 days to mature. These lines are suitable for growing in between

T.aman and Boro rice. There are some other lines which produced higher yield than check varieties and they became mature below 82 days. These lines may simultaneously be selected with the high yielding lines with early maturity for evaluation in preliminary yield in next year.

Table 1. Observation Trial of *Brassica napus*

Name of entries	Days to maturity	Plant height (cm)	Primary branch	Pods/ plant	Pod length (cm)	Seeds/ pod	Yield (kg/ha)	Yield over increase BARI-8(%)	Yield over increase BARI-13(%)
1.NAP-20021	**84**	**83**	**3.9**	**110**	**7.01**	**28**	**1388**	**13**	**23**
2.NAP-30021	87	96	2.8	82	6.93	27	1230	0	9
3.NAP-50021	**86**	**91**	**2.6**	**79**	**7.04**	**21**	**1322**	**7**	**17**
4.NAP-60021	85	94	3.5	115	7.19	31	1080	-12	-4
5.NAP-80021	86	97	2.9	104	7.34	30	1291	5	15
6.NAP-10021	86	96	4	110	7.43	31	1022	-17	-9
7.NAP-12021	86	90	3.8	72	6.67	27	1137	-8	1
8.NAP-13021	86	92	3.4	55	7.05	28	1079	-12	-4
9.NAP-14021	85	94	3.4	98	6.61	26	1177	-4	5
10.NAP-15021	85	86	3.7	93	6.01	23	1092	-11	-3
11.NAP-16021	82	81	4	91	6.82	24	1123	-9	0
12.NAP-19021	82	86	3.3	76	6.44	28	1279	4	14
13.NAP-21021	86	95	3.2	88	6.56	25	1040	-16	-8
14.NAP-22021	85	86	3.5	103	6.5	24	1219	-1	8
15.NAP-25021	88	82	3.4	114	6.88	25	1067	-13	-5
16.NAP-26021	86	88	3.6	92	6.68	25	1024	-17	-9
17.NAP-27021	82	99	2.8	76	6.73	27	1032	-16	-8
18.NAP-31021	80	96	2.6	70	6.22	23	1177	-4	5
19.NAP-32021	82	87	3.7	87	6.64	25	1157	-6	3
20.NAP-33021	**83**	**85**	**3.3**	**90**	**7.18**	**27**	**1308**	**6**	**16**
21.NAP-35021	81	85	3.5	104	6.76	25	1094	-11	-3
22.NAP-37021	78	90	3.9	95	6.49	28	1157	-6	3
23.NAP-38021	80	92	3.6	85	7.12	29	1185	-4	5
24.NAP-42021	88	95	3.6	95	6.89	29	1146	-7	2
25.NAP-44021	81	103	2.8	90	7.17	31	1264	3	12
26.NAP-47021	88	93	3.4	101	7.48	28	1095	-11	-3
27.NAP-49021	84	94	3.6	106	6.83	25	1189	-3	6
28.NAP-51021	81	89	3.8	107	6.54	26	1194	-3	6
29.BARI Sarisha-8	83	91	2.7	86	6.97	27	1231	0	9
30.BARI Sarisha-13	82	92	3.6	99	7.09	29	1125	-9	0
CV%	**0.95**	**4.74**	**15.63**	**18.62**	**6.10**	**9.01**	**8.32**	-	-
Level of Sig.	**	**	ns	ns	ns	*	**	-	-
LSD	3.29	17.82	-	-	-	9.93	334.17	-	-

Conclusion

Nap-20021, Nap-50021 and Nap-33021 these three lines took just 82-86 days to mature and produced more than 1300 kg/ha yield maybe used in preliminary yield trial in next season.

RELIMINARY YIELD TRIAL OF *BRASSICA NAPUS*

M K ALAM, M R HUMAUN, M A MONIM, M A LATIF AKANDA AND M M KADIR

Abstract

Preliminary yield trial of Brassica napus was conducted with 14 genotypes at RARS Jamalpur Ishurdi, Jessore and Joydevpur during rabi, 2021-2022 to evaluate the yield and yield contributing characters. Maturity duration ranged from 82-87 days at Jamalpur location. Seed yield ranged from 1716 to 1353 kg/ha at Jamalpur location. Maturity duration over locations ranged from 88-90 days. Seed yield ranged from 1701-1836 kg/ha over the locations. Nap-18009 produced the highest seed yield among the genotypes included in this trial. It produced 10% and 28% higher seed yield than check variety BARI Sarisha-8 and BARI Sarisha-13. Nap-21010 produced the second highest yield which was 3 % and 20% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-13, respectively. The third highest grain yield was recorded from Nap-20002 among the entries. Nap-18009, Nap-21010 and Nap-20002 these three entries took 84 to 87 days to maturity. Considering location wise seed yield and other yield contributing characters, four lines Nap-18009, Nap-20002, Nap-16021and Nap-21010 were selected for regional yield trial in the next year.

Introduction

Brassica napus L is an important oil-producing crop. Mostly it is being cultivated in the colder region. Now a day's farmers of the different parts of Bangladesh started cultivation of *Brassica napus* for its high yield potentiality. Oil seed Research Centre Scientists are interested to develop genotypes, which would be suitable for cultivation in Bangladesh. Three varieties have been released for cultivation till to date. The researchers are looking forward for more yield producing genotypes of *Brassica napus*. The experiment was conducted with fourteen genotypes to find out the high yield potential genotypes of this species.

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station, Jamalpur, Jessore, Ishurdi and Joydevpur during rabi 2021-2022 with 14 promising genotypes of *Brassica napus*. It was laid out in randomized compete block design with three replications. BARI Sarisha-8 and BARI Sarisha-13 released variety of *Brassica napus* were used as check. The plot size was 3.0 m x2.0 m. Seeds were sown on the 4th November, 2021 in continuous and row was 30 cm apart from each. The seedlings were thinned after 11 days of germination 5 cm apart. Fertilizer were applied @ 120:80:60:40:4:1 kg/ha of N: P: K: S: Zn: and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of flowering. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to flowering, plant height, primary branches/plant, secondary branches/ plant, pod/plant, pod length, seed/pod, days to mature and yield per plot. The plot yield was converted into hectare. The data were analyzed statistically.

Results and Discussion

Fourteen genotypes of *Brassica napus* including two check varieties BARI Sarisha-8 and BARI Sarisha-13 were evaluated for yield and yield contributing characters. The mean performance of different lines is expressed in table 2. Significant differences were observed for the traits of days to maturity, plant height, pods/plant, and yield per hectare at Jamalpur location. Maturity duration ranged from 82-87 days. Plant height ranged from 77-96 cm. No. of pods per plant ranged from 158-91. The highest grain yield was recorded from Nap-18009. It produced 1716 kg/ha grain yield which was 10% and 28% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-13. It took 87 days to mature. The highest number of pods/plant was recorded in Nap-18009 and produced moderately higher in primary branches, pod length and seeds/pod. The 2nd highest yield was obtained from Nap-21010. It produced 1618 kg/ha which was 3 % and 20 % higher yield than existing *napus* variety BARI Sarisha-8 and BARI Sarisha-13 and also gave moderately higher in pods/plant, primary branches, pod length and seeds/pod. The 3rd highest yield obtained from Nap-20002, and it was produced 1603 kg/ha which was 2% and 19% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-13 respectively. It was also recorded highest number of secondary branches and moderately higher in pods/plant. They took 84-87 days to mature. These lines may easily be fitted in between T-Aman and Boro rice.

Table 2. Mean performance of *Brassica napus* genotypes in Preliminary Yield Trial during rabi 2021-2022 at Jamalpur

Sl no.	Genotypes	Days to flowering	Days to maturity	Plant height	Primary Branch	Pods/ Plant	Seeds /pod	1000 seed weight	Yield (Kg/ha)	YOC BARI-8 (%)	YOC BARI-13 (%)
1	Nap-20002	31 B	85 BC	96 A	4.1	120 BC	27.8 A-C	3.17 A-C	1,603 AB	2	19
2	Nap-20008	30 C	86 B	92 A-C	3.8	101 CD	29.0 A-C	3.13 A-D	1,441 B-D	-8	7
3	Nap-20009	28 D	83 EF	79 EF	3.5	113 C	27.3 A-C	2.87 B-D	1,464 B-D	-6	9
4	Nap-18002	30 BC	85 BC	87 B-D	3.3	114 C	31.1 A	2.97 A-D	1,562 A-C	0	16
5	Nap-18009	31 B	87 A	94 AB	3.5	140 AB	30.5 AB	3.27 AB	1,716 A	10	28
6	Nap-18010	30 BC	83 EF	86 C-E	3.4	91 D	26.8 BC	2.80 CD	1,465 B-D	-6	9
7	Nap-18013	30 BC	85 B-D	83 D-F	4.0	113 C	28.0 A-C	3.10 A-D	1,353 D	-14	1
8	Nap-16004	32 A	85 B-D	95 AB	3.5	108 CD	28.1 A-C	2.97 A-D	1,358 D	-13	1
9	Nap-16021	30 C	84 C-E	77 F	3.4	108 CD	30.5 AB	3.03 A-D	1,493 B-D	-5	11
10	Nap-16036	28 D	84 C-E	93 A-C	4.1	158 A	26.3 C	2.87 B-D	1,445 B-D	-8	7
11	Nap-21010	31 B	84 DE	87 B-D	3.3	100 CD	29.1 A-C	2.83 CD	1,618 AB	3	20
12	Nap-21011	30 BC	82 F	91 A-C	3.7	110 CD	28.0 A-C	2.73 D	1,397 CD	-11	4
13	BARI Sarisha-8	31 B	87 A	92 A-C	4.1	102 CD	29.9 A-C	3.37 A	1,565 A-C	0	16
14	BARI Sarisha-13	30 BC	87 A	90 A-D	4.1	115 C	31.2 A	2.87 B-D	1,345 D	-14	0
	CV%	1.8	0.7	5.17	15.17	11.11	8.03	8.21	7.08	-	-
	Level of Sig.	**	**	**	ns	**	ns	ns	**	-	-
	Lsd	0.9114	1.003	7.6927	0.941	21.208	3.8848	0.4133	176.73	-	-

Significant variation of genotypes x locations interactions for days to maturity but non-significant variations for seed yield were observed over locations (Table 2a and 2b). Regarding maturity duration over locations, days to maturity ranged from 88-90days. Seed yield ranged from 1702-1836 kg/ha over locations. The line Nap-20002 produced the highest seed yield (1836 kg/ha) followed by Nap-16021 (1829 kg/ha) over locations.

Table 2a. Genotype x Location interaction for maturity duration of *Brassica napus* genotypes in PYT at 4 locations during rabi 2021-2022

Sl No.	Line/varieties	Days to maturity				
		Ishurdi	Jessore	Jamalpur	Joydevpur	Average
1	Nap-20002	94	96	85	84	90
2	Nap-20008	93	95	86	84	89
3	Nap-20009	92	95	83	83	88
4	Nap-18002	94	96	85	84	90
5	Nap-18009	93	96	87	83	90
6	Nap-18010	94	95	83	81	88
7	Nap-18013	93	94	85	82	89
8	Nap-16004	93	95	85	82	89
9	Nap-16021	94	95	84	81	89
10	Nap-16036	93	96	84	82	89
11	Nap-21010	95	96	84	82	89
12	Nap-21011	94	95	82	83	88
13	BARI Sarisha-8	94	95	87	84	90
14	BARI Sarisha-13	94	94	87	83	90
	CV%	1.44				
	Level of Sig.	**				
	Lsd	1.0325				

Table 2b. Genotype x Location interaction for seed yield of *Brassica napus* genotypes in PYT at 4 locations during rabi 2021-2022

Sl No.	Line/variety	Yield (kg/ha)				
		Ishurdi	Jessore	Jamalpur	Joydevpur	Average
1	Nap-20002	2210	1847.7	1636.0	1651	1836
2	Nap-20008	2230	1553.3	1441.3	1851	1769
3	Nap-20009	2323	1643.7	1530.7	1650	1787
4	Nap-18002	2126	1606.3	1461.7	1870	1766
5	Nap-18009	2410	1504.7	1749.3	1458	1781
6	Nap-18010	2258	1449.3	1432.0	1874	1753
7	Nap-18013	2258	1453.0	1320.0	1773	1701
8	Nap-16004	2417	1447.0	1324.7	1764	1738
9	Nap-16021	2366	1545.3	1460.0	1944	1829
10	Nap-16036	1932	1537.3	1478.7	1858	1702
11	Nap-21010	2256	1496.3	1651.3	1837	1810
12	Nap-21011	2051	1500.3	1430.0	1828	1702
13	BARI Sarisha-8	2341	1448.3	1532.0	1742	1766
14	BARI Sarisha-13	2197	1592.3	1545.3	1747	1771
	CV%	7.03				
	Level of Sig.	ns				
	Lsd	100.09				

Conclusion

Considering location wise seed yield and other yield contributing characters, four lines Nap-18009, Nap-20002, Nap-16021 and Nap-21010 were selected for regional yield trial in the next year.

REGIONAL YIELD TRIAL OF *Brassica napus*

M K ALAM, M R HUMAUN, M A MONIM, M A LATIF AKANDA AND M M KADIR

Abstract

A regional yield trial of Brassica napus L was conducted with 12 genotypes at RARS Jamalpur Jessore, Ishurdi and Joydevpur during rabi 2021-2022 to evaluate for yield and yield contributing characters. Maturity duration ranged from 82-86 days at Jamalpur location. Seed yield ranged from 2558 -1764 kg/ha at Jamalpur location and Nap-18005 has produced the highest yield among the genotypes included in this trial. It produced 23% and 24% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-9, respectively. The second highest yield was recorded from Nap-16013. It produced 19% and 20% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-9, respectively. The third highest yield was recorded from Nap-16006. It gave 13% higher yield than check variety BARI Sarisha-8.

Introduction

*Brassica napus*L is mainly grown in the summer season of the cold countries under long day condition. As mustard and rapeseed are grown in the winter season of Bangladesh under short day's condition; it was not possible to introduce this species directly in this country. *Brassica napus,* which would be suitable to cultivate in Bangladesh was developed by artificially and through introgressive hybridization. It is an important species for producing oil. Twelve lines including two check varieties were chosen, among the developed genotypes of *Brassica napus* in Bangladesh; on the basis of their previous performance for conducting regional yield trial. It was done to find out the high yield potential genotypes of rapeseed.

Materials and Methods

The experiment was conducted at RARS Jamalpur during rabi 2021-2022with 12 promising genotypes of *Brassica napus*. It was laid out in randomized compete block design with three replications. BARI Sarisha-8 and BARI Sarisha-9 the released varieties of *Brassica napus* were used as checks. The plot size was 3.0 m x 2.0 m. Seeds were sown on the 4th November, 2021 in continuous and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizer were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn: and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of flowering. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to flowering, plant height, primary branches/plant, secondary branches/ plant, pods/plant, length of pod, seed/pod, days to mature and yield per hectare. The data were analyzed statistically.

Results and Discussion

Twelve genotypes of *Brassica napus* including two check varieties BARI Sarisha-8 and BARI Sarisha-9 were evaluated for yield and yield contributing characters. The mean performances of different genotypes are expressed in table-3. Significant differences were observed for the traits of days to flowering, days to maturity, plant height, pods/plant, seeds per pod, thousand seed weight and seed yield (kg/ha) per hectare. Maturity duration ranged from 82-86 days at Jamalpur location. Plant height ranged from 76-100 cm. Pods per plant ranged from 97-162 and seeds per pod ranged from 23-30.7 at Jamalpur location. Seed yield ranged from 2558 -1764 kg/ha at Jamalpur location. Thousand seed weight ranged from 2.6-2.8. The highest seed yield was obtained from the genotype Nap-18005(2558 kg/ha), which was 23% higher yield than existing *Brassica napus* variety BARI Sarisha-8 and 24% higher yield than check variety BARI Sarisha-9. It took 84 days to mature. This line also showed moderately higher number of primary branches, pod length, and pods/plant. The second highest yield (2480 kg/ha) was recorded fromNap-16013 which was 19% and 20% higher yield than check varieties BARI Sarisha-8 and BARI Sarisha-9, respectively. It took 83 days to mature. Maturity duration and seed yield ranged from 89-91 days and 1774-2245 kg/ha, respectively over the location. Maximum seed yield (2245 kg/ha) was recorded from Nap-16013 and took 89 days over the locations followed by Nap-18005(2068 kg/ha).

Table 3. Mean performance of *Brassica napus* genotypes in Regional Yield Trial during rabi 2021-2022 at Jamalpur

Sl no.	Genotypes	Days to flowering	Days to maturity	Plant height	Primary Branch	Pods/ Plant	Seeds /pod	1000 seed weight	Yield (Kg/ha)	YOC BARI-8	YOC BARI-9
1	Napus-15027	29 EF	86 A	81 DE	3.5 BC	97 C	23.4 C	2.6 DE	2,262 BC	9	9
2	Napus-15029	30 DE	84 DE	76 E	4.5 A	108 BC	26.7 A-C	2.6 CD	1,857 EF	-11	-10
3	Napus-15037	29 F	83 EF	85 C-E	4.2 AB	115 BC	23.1 C	2.7 B	1,938 D-F	-7	-6
4	Napus-16006	32 B	85 BC	89 B-D	4.1 AB	162 A	29.3 AB	2.6 DE	2,344 AB	13	13
5	Napus-16009	31 C	83 E	88 B-D	3.8 A-C	122 BC	26.2 BC	2.6 DE	1,900 D-F	-9	-8
6	Napus-16013	31 CD	83 EF	92 A-C	3.3 C	98 C	28.1 AB	2.6 DE	2,480 AB	19	20
7	Napus-18005	32 B	84 CD	88 B-D	4.1 AB	109 BC	30.1 AB	2.7 C	2,558 A	23	24
8	Napus-18025	32 B	83 EF	90 B-D	3.9 A-C	106 C	29.2 AB	2.4 H	1,937 D-F	-7	-6
9	Napus-18033	31 C	82 F	92 A-C	4.0 A-C	114 BC	29.7 AB	2.6 FG	1,764 F	-15	-15
10	Napus-19080	33 A	84 DE	90 A-D	3.9 A-C	146 AB	27.9 AB	2.5 G	1,877 D-F	-10	-9
11	BARI Sarisha-8	31 C	85 AB	100 A	3.9 A-C	125 A-C	30.7 A	2.8 A	2,083 CD	0	1
12	BARI Sarisha-9	33 A	85 AB	95 AB	3.7 BC	103 C	30.0 AB	2.6 EF	2,067 C-E	-1	0
	CV%	1.83	0.68	6.51	11.2	19.49	9.08	0.68	6.19	-	-
	Level of Sig.	**	**	**	ns	*	**	**	**	-	-
	Lsd	0.973	0.962	9.787	0.742	38.627	4.282	0.030	219.07	-	-

Significant variations of genotypes x locations interactions for days to maturity and seed yield were observed over locations (Table 3a and 3b). Regarding maturity duration over locations, days to maturity ranged from 89-91days. Seed yield ranged from 1784-2245 kg/ha over locations. The line Nap-16013 produced the highest seed yield (2245 kg/ha) followed by Napus-18005 (2068 kg/ha) over locations.

Table 3a. Genotype x Location interaction for maturity duration of *Brassica napus* genotypes in RYT at 4 locations during rabi 2021-2022

Line/Varieties	Days to maturity				Average
	Jamalpur	Jessore	Ishurdi	Joydevpur	
Napus-15027	86	96	92	86	90 B-E
Napus-15029	84	97	93	86	90 C-E
Napus-15037	83	96	92	86	89 DE
Napus-16006	85	96	93	83	89 DE
Napus-16009	83	96	93	85	89 DE
Napus-16013	83	96	94	82	89 E
Napus-18005	84	96	94	83	89 DE
Napus-18025	83	97	93	86	90 C-E
Napus-18033	82	97	94	87	90 A-D
Napus-19080	84	97	95	87	91 A-C
BARI Sarisha-8	85	97	94	88	91 AB
BARI Sarisha-9	85	97	96	87	91 A
CV%	1.74				
Level of Sig.	**				
Lsd	1.2628				

Table 3b. Genotype x Location interaction for seed yield of *Brassica napus* genotypes in RYT at 4 locations during rabi 2021-2022

Genotypes	Jamalpur	Jessore	Ishurdi	Joydevpur	Average
Napus-15027	2262	1795	2219	1816	2023 B
Napus-15029	1857	1865	2317	1727	1941 BC
Napus-15037	1938	1710	2616	1457	1930 BC
Napus-16006	2344	1962	1871	1704	1970 BC
Napus-16009	1900	2088	1992	1839	1955 BC
Napus-16013	2480	1988	2926	1587	2245 A
Napus-18005	2558	2018	2404	1293	2068 AB
Napus-18025	1937	1905	1859	1547	1812 C
Napus-18033	1763	1936	2394	1728	1955 BC
Napus-19080	1877	1881	2138	1377	1818 C
BARI Sarisha-8	2083	2008	2039	1673	1951 BC
BARI Sarisha-9	2067	1957	1898	1214	1784 C
CV%	12.72				
Level of Sig.	**				
Lsd	200.95				

Conclusion

Considering location wise seed yield and other yield contributing characters, four lines Napus-16013, Napus-18005 and Napus-15027 were selected for adaptive yield trial in the next year.

EVALUATION OF SEGREGATING GENERATION OF *Brassica juncea*

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

A total of 96 plants from thirteen cross combinations having brown seed coat colour and 15 plants from two cross combinations having yellow seed coat colour were selected in F_6 generation (Set-I). A total of 13 families from three cross combinations having black/brown seed coat colour were selected and 10 families from three cross combinations having yellow seed coat colour were selected in F_6 generation (Set-II). Plants were selected considering erect, seed colour, seed size and siliqua shape. Harvested seeds from selected plants and progenies were stored for further evaluation in the next year.

Introduction

Hybridization is one of the best techniques of incorporating desirable characters into a genotype. Development of homozygous line through conventional breeding, it is essential to advance the filial generations from F_1 to F_6. The present experiments were conducted to advance generation from F_5 to F_6 for selection of desirable type.

Materials and Methods

F_6 generation (Set-I)

Families of fifteen cross combinations having both brown and yellow seed coat colour were evaluated in F_6 generation (Set-I) during 2021-22 at Gazipur. Families were sown following family to row method along with BARI Sarisha-11 as check. Seeding of fifteen crosses was done on 18 November 2021 in 3m long of 5-rows-plot with spacing 30cm and 5cm between rows and plants, respectively. Single plant selection among the families was done based on erect and compact type having desirable agronomic characters, disease and insect tolerance.

F_6 generation (Set-II)

Families of six cross combinations having both and yellow black/brown seed coat colour were evaluated during 2021-22 at Gazipur. Families were sown following family to row method along with BARI Sarisha-11 as check. Seeding of families of different cross combinations was done on 18 November 2021 in 3m long of 3-rows-plot with spacing 30cm and 5cm between rows and plants, respectively. Single plant selection among families was done based on erect and compact type having desirable agronomic characters, disease and insect tolerance.

Results and Discussion

F_6 generation (Set-I)

The results of F_6 generation (Set-I) are presented in Table 14. Single plant selection method was followed. A total of 96 plants from eleven cross combinations having black/brown seed coat colour and 15 plants from two cross combinations having yellow seed coat colour were selected considering erect and compact plant type, seed colour, seed size and siliqua shape. Two cross combinations were discarded. Seeds from selected plants of individual cross combinations were harvested in bulk. Seeds were stored for evaluation in Observation Trial in the next year.

Table 14. Results of 15 cross combinations under Evaluation of F_6 generation (Set-I) of *Brassica juncea* at Gazipur during rabi 2021-22

Sl. no.	Cross combinations	Seed colour	No. of plants selected	Remarks
1	BARI Sar.-11 x Rajat-6(2)	blackish	8	
2	BARI Sar.-11 x Rajat-15	black	7	
3	Rajat x BJDH-18-7(1)	black	9	
4	Rajat x BJDH-18-14(2)	brownish	7	
5	Bj-17 x BJDH-18-11(1)	black	10	
6	Bj-17 x BARI Sar.-11-2	black	9	
7	Bj-17 x BARI Sar.-11-6	brown	7	
8	BARI Sar.-10 x Bj-17-15	brown	10	
9	Rajat x BJDH-18-7(1)	brown	9	
10	BARI Sar.-17 x BARI Sar.-11	brown	-	discarded
11	BS-10xBJ-17-15	brown	11	
12	Rajat x BJDH-18-9(1)	brown	-	discarded
13	Bj-17 x BS-11-6(1)	brown	9	
		Total	**96**	
14	Bj-17 x BARI Sar.-11-2-Y	Yellow	7	
15	BARI Sar.-10 x Bj-17 -15-Y	Yellow	8	
		Total	**15**	
		Grand total	**111**	

F_6 generation (Set-II)

The results of F_6 generation (Set-II) are presented in Table 15. A total of eighteen families from three cross combinations having black/brown seed coat colour were evaluated and thirteen families were selected for further evaluation. Twelve families from three cross combinations having yellow seed coat colour were evaluated and ten families were selected for further evaluation. Considering erect and compact plant type, seed colour, seed size and siliqua shape, single plant selection method was followed. Harvested seeds from selected plants of individual family were bulked. Seeds were stored for evaluation in the next year.

Acknowledgement

'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project

Table 15. Results of 6 cross combinations under Evaluation of F_6 generation (Set-II) of *Brassica juncea* at Joydebpur during rabi 2021-22

Sl. no.	Cross combinations	Seed colour	No. of families evaluated	No. of families selected
1	BJDH-18 x BARI Sar.-10	black/brown	8	6
2	BJDH-18 x BARI Sar.-11	black	8	5
3	Bj-66 x BARI Sar.-11	black	2	2
		Total	**18**	**13**
4	BJDH-18 x BARI Sar.-10	yellow	6	5
5	BJDH-18 x BARI Sar.-11	yellow	2	2
6	Bj-66 x BARI Sar.-11	yellow	4	3
		Total	**12**	**10**

OBSERVATION TRIAL OF *Brassica juncea*

M SHALIM UDDIN, M A LATIF AKANDA and A B M KHALDUN

Abstract

Thirteen lines of Brassica juncea along with BARI Sarisha-11 as check were evaluated at Gazipur with two replications in 2021-22 season. Maturity duration ranged from 100-109 days. Seed yield ranged from 678-1507 kg/ha. The highest seed yield recorded in BJ-2014-B06(Y) (2235 kg/ha) followed by BJ-2014-B04 (1507 kg/ha). Considering earliness, seed yield and other yield contributing characters, four lines BJ-2014-B14, BJ-2014-B10, BJ-2014-B07 and BJ-2014-B04 were selected for the next trial.

Introduction

Mustard is an important oil producing crop. Mostly it is being cultivated in the colder region. Oilseed Research Center of BARI has recently released BARI Sarisha-16 for cultivation in Bangladesh. The researchers are looking forward for more yield producing genotypes of *Brassica juncea* with bold seed. The experiment has been conducted with a view to find out the high yield potential genotypes of this species.

Materials and Methods

Thirteen lines of *Brassica juncea* along with BARI Sarisha-11 as check were evaluated with two replications under Observation Trial of *Brassica juncea* at Gazipur during 2021-22. The lines were sown on 17 November 2021 in 3 rows of 3m long with spacing of 30 cm and 5 cm between rows and plants respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, zinc Sulphate and Boric acid, respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height (cm), no. of primary branches/plant, no. of siliquae per plant, no. of seeds per siliqua, 1000-seed weight (g) and seed yield/plot. The plot yield was converted into kg/ha.

Results and Discussion

The mean performance of thirteen lines of *Brassica juncea* along with BARI Sarisha-11 as check are presented in Table 17. Maturity duration ranged from 103-108 days. Plant height ranged from 101-131 cm. Number of siliquae per plant ranged from 106-154. Number of seeds per siliqua ranged from 11-15. Seed yield ranged from 630-1574 kg/ha. The highest seed yield recorded in BJ-2014-B06(Y) (2235 kg/ha) followed by BJ-2014-B09 (2209 kg/ha). Considering earliness, seed yield and other yield contributing characters, four lines BJ-2014-B14, BJ-2014-B10, BJ-2014-B07 and BJ-2014-B04 were selected for the next trial.

Table 17. Mean performance of 13 lines and check as BARI Sarisha-11 in Observation Trial of *Brassica juncea* during rabi 202-22 at Gazipur

Sl. no.	Lines/Variety	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
1	BJ-2014-Y04	56	105	111.3	4.65	153.65	12.30	2.649	834
2	BJ-2014-B06 (Y)	55	104	111.2	4.65	176.40	13.50	2.739	1053
3	BJ-2014-B07	56	105	116.5	3.95	129.35	13.95	2.828	1462
4	BJ-2014-B08	57	105	114.0	4.20	141.70	13.95	2.578	1026
5	BJ-2014-B09	58	107	113.0	4.20	147.55	12.20	2.658	1000
6	BJ-2014-B10	57	107	117.8	4.15	162.60	13.65	2.471	1404
7	BJ-2014-B11	58	106	122.4	4.00	147.60	13.95	2.811	1059
8	BJ-2014-B12	57	105	129.9	3.90	132.90	14.50	2.624	967
9	BJ-2014-B13	56	108	117.8	3.85	138.75	13.10	3.036	1117
10	BJ-2014-B14	55	108	122.5	4.15	130.60	14.40	2.833	1391
11	BJ-2014-B15	57	107	119.2	3.55	134.45	13.70	2.543	1070
12	BJ-2014-B16	58	106	116.3	4.50	141.35	13.70	2.479	1074
13	BJ-2014-B04	57	109	120.5	4.75	160.55	13.75	2.753	1507
14	BARI SARI-11	55	108	114.6	5.95	224.10	12.60	3.142	678
	SE	1.65	0.90	2.79	0.50	6.55	0.65	0.22	74.65
	LSD ($p \geq 0.05$)	5.06	2.76	8.53	1.54	20.01	1.99	0.66	228.08
	CV (%)	4.1	1.2	3.4	16.5	6.1	6.8	11.2	9.4

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Conclusion

Considering earliness, seed yield and other yield contributing characters, four lines BJ-2014-B06(Y), BJ-2014-B09 and BJ-2014-Y04 were selected for the next trial.

PRELIMINARY YIELD TRIAL OF *Brassica juncea* L.

M SHALIM UDDIN, M A LATIF AKANDA, A B M KHALDUN, M R HUMAUAN and M H RAHMAN

Abstract

Eleven lines of Brassica juncea having yellow seed coat colour along with BARI Sarisha-11 as check were evaluated at Gazipur, Ishurdi and Jashore. Significant differences among the genotypes over the years were observed for all the traits studied. The first two principal components axis (IPCA1, 76.1% and IPCA2, 23.9%) could explain 100% of the total of the interaction variation. Days to maturity ranged from 103-110 days. Plant height ranged from 93-175 cm. Number of siliquae per plant ranged from 87-350. Number of seeds per siliqua ranged from 11-20. Seed yield ranged from 860-2300 kg/ha. The highest seed yield was recorded in BJ-11536(9)-2. Considering seed yield and other yield contributing characters, three lines like BJ-10.10411, BJ-11536(9)-6 and BJ-11536(12)-3 were selected for evaluation in RYT.

Introduction

Mustard is an important oil producing crop. Mostly it is being cultivated in the colder region. Oilseed Research Center of BARI has recently released BARI Sarisha 16 for cultivation in Bangladesh. The researchers are looking forward for more yield producing genotypes of *Brassica juncea* with bold seed. The experiment has been conducted with a view to find out the high yield potential genotypes of this species.

Materials and Method

The experiment was conducted at Gazipur, Ishurdi and Jashore during Rabi 202122. The experiment consisted of 11 lines of *Brassica juncea* having yellow seed coat colour. The experiment was laid out in randomized complete block design with three replications. The plot size was 3m x 1.2m. Seeding was done on 29 November 2021 at Gazipur, 09 November 2021 at Ishurdi and 06 November 2021 at Jashore in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of flowering. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height in cm, no. of primary branches/plant, no. of siliquae per plant, no. of seeds per siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into seed yield/hectare.

Measures of stability used in the study

The AMMI based stability parameters (ASTABs) such as AMMI stability value (ASV) as per Purchase (2020), sums of the absolute value of the IPC Scores (SIPC) and averages of the squared eigen value (EV) as proposed by Sneller et al. (1997), absolute value of the relative contribution of IPCs to the interaction (ZA) as per the procedure of Zali et al. (2012) and Weighted Average of Absolute Scores (WAAS) according to Olivoto et al. (2019) were calculated.

Multi-trait genotype-ideotype distance index (MGIDI)

The multi-trait genotype-ideotype distance index (MGIDI) was used to rank the genotypes based on information of multiple traits as proposed by Olivoto and Nardino (2020). Statistical analysis for all the stability-related parameters was performed by functions available in the 'metan' package (v. 1.16.0) (Olivoto and Lucio 2020) in R version 4.2.0 (http:// www.r-project.org/).

Results and Discussion

AMMI analysis of variance

The performances with respect to yield and yield-related traits viz., for days to flowering (DF), days to maturity (DM), plant height (PH), number of branches per plant (NBPP), No. of number siliquae per plant (NSPP), number of seeds per siliqua (NSPS), 1000 seeds weight (TSW), yield (kg/ha) is presented in Table 1. Combined ANOVA for all the traits across the locations were analyzed, taking the location as random effects and genotypes as fixed effects. The results show that the genotypes (G), environmental (E) and interaction (GEI) effects being highly significant ($p<0.01$) for all the traits studied, indicating the prominence of all the three types of effects which is merely not random or due to chance.

The AMMI analysis of variance for seed yield per plant (g) of 12 genotypes tested across three environments showed significant variances for ($p<0.01$) due to environments, genotypes and G×E interactions. A higher value of sum of squares for genotypes designated that the genotypes were diverse, causing variation in seed yield due to large differences among the genotypic means. The G×E interaction component was partitioned into first two interaction principal components (IPCA), which was found non-significant. The IPCA1 explained 76.1% and IPCA2 explained 23.9% of the G x E interaction, thus the first two principal components could explain 100% of the G×E variation (Fig. 2). The mean sum of squares due to environment is the largest, indicating the greater control of environmental conditions on seed yield, which supports the fact that yield is a complex trait and, therefore, strongly relies on the environment to express the trait.

Regarding maturity duration over locations, days to maturity ranged from 103-105 days (Table 17a) and seed yield over locations ranged from kg/ha (Table 3). The line BJ-10-10104 Y produced the highest seed yield over locations.

Eleven genotypes of *Brassica juncea* including BARI Sarisha-11 check were evaluated at Gazipur, Ishurdi and Jashore for yield and yield contributing characters. The mean performance of different lines over the locations is presented in Table 2. Days to maturity ranged from 105-107 days. Plant height ranged from 93-175 cm. Number of siliquae per plant ranged from 87-350. Number of seeds per siliqua ranged from 11-20. Seed yield ranged from 860-2300 kg/ha. The highest seed yield was recorded in BJ-11536(9)-2.

Table 2. Additive Main effects and Multiplicative interaction (AMMI) analysis of variance for seed yield and yield contributing traits across three locations

Source of variation	**Df**	**Mean Square (MS)**							
		DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
ENV	2	899.2**	2.01	67500**	74.35**	398829**	54.8**	4.01**	10960960**
REP(ENV)	6	22.6**	2.56	227.1*	1.09	5881**	5.3*	0.06	3141
GEN	11	12.0**	6.09**	212.9**	42.30*	5457**	6.4*	0.19**	124760**
GEN:ENV	22	7.5**	5.15**	167.4*	0.52	3355**	2.3	0.18**	173178**
PC1	12	10.6**	7.18**	215.5*	0.64	5137**	3.3	0.11*	259368**
PC2	10	3.7*	2.71	109.8	0.38	1216**	1.1	0.05	69750**
Residuals	66	1.7	1.78	85.0	0.56	1273	2.1	0.05	2483
Total	129	19.4	3.34	1167.3	1.69	8718	3.2	0.13	241061

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Table 2. Mean performances of *Brassica juncea* genotypes in Preliminary Yield Trial during rabi 2021-22

Sl. no.	Line/Variety	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
1	BJ-10-10104	52	107	162	5.26	280	15.2	2.71	1549
2	BJ-10-10104Y	51	106	150	4.98	242	14.1	2.51	1721
3	BJ-10.10411	53	107	162	5.19	260	13.9	2.42	1312
4	BJ-11536(11)-1	53	109	161	5.04	316	15.2	2.54	1511
5	BJ-11536(7)-2	50	106	154	4.9	234	16.2	2.57	1611
6	BJ-11536(9)-6	53	108	152	4.87	276	15	2.46	1483
7	BJ-1153612)-3	53	108	154	5.87	271	13.6	2.76	1556
8	BJ-115369)-2	53	108	159	4.59	293	15.4	2.64	1333
9	BJ-2014-Y03	52	107	161	4.67	296	15.3	2.79	1405
10	BJ-2014-Y04	50	106	153	5.8	223	14	2.77	1574
11	BJ-2014-Y05	52	106	153	4.79	217	15.1	2.67	1682
12	BARI Sarisha-11	51	107	148	4.9	249	14.1	2.89	1647
	SE	0.61	0.45	3.30	0.26	12.66	0.51	0.08	37.39
	LSD (p≥0.05)	1.72	1.27	9.31	0.74	35.70	1.43	0.21	146.48
	CV (%)	3.5	1.3	6.4	15.6	14.4	10.3	8.6	9.7

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant, NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g), YIELD= Seed yield (kg/ha)

Table 3. Mean data for seed yield of *Brassica juncea* lines in Preliminary Yield Trial over three locations during rabi 2021-22

SL. No.	Line/Variety	Seed Yield (kg/ha)			Over all mean	P. Index (Pi)	bi	S^2di	R^2
		Gazipur	Ishurdi	Jashore					
1	BJ-10-10104	1642	1676	1328	1549	17	0.36	5.59E+04	0.20
2	BJ-10.10411	1420	2042	1702	1721	189	0.08	5.41E+03	0.09
3	BJ-10-10104Y	1240	1324	1371	1312	-220	1.23	1.70E+04	0.90
4	BJ-2014-Y04	1822	1271	1442	1512	-20	1.40	-2.67E+03	1.00
5	BJ-2014-Y03	1316	2092	1043	1484	-48	1.71	2.44E+04	0.93
6	BJ-2014-Y05	1527	1450	1690	1556	24	1.57	-2.33E+03	1.00
7	BJ-11536(7)-2	1006	1856	1355	1406	-126	2.15	3.18E+04	0.94
8	BJ-11536(9)-2	954	1669	1375	1333	-199	1.33	5.27E+04	0.79
9	BJ-11536(9)-6	1400	2110	1535	1682	150	2.09	8.64E+04	0.85
10	BJ-11536(11)-1	1336	1959	1428	1574	42	-0.97	4.72E+04	0.69
11	BJ-11536(12)-3	1361	2221	1250	1611	79	-0.33	1.49E+04	0.42
12	BARI Sarisha-11	1301	2004	1636	1647	115	1.38	2.68E+04	0.88
	E. Mean	1360	1806	1430	**1532**				
	E. Index (Ei)	-172	274	-102					
	SE		51.37						
	LSD (p≥0.05)		226.91						
	CV (%)								

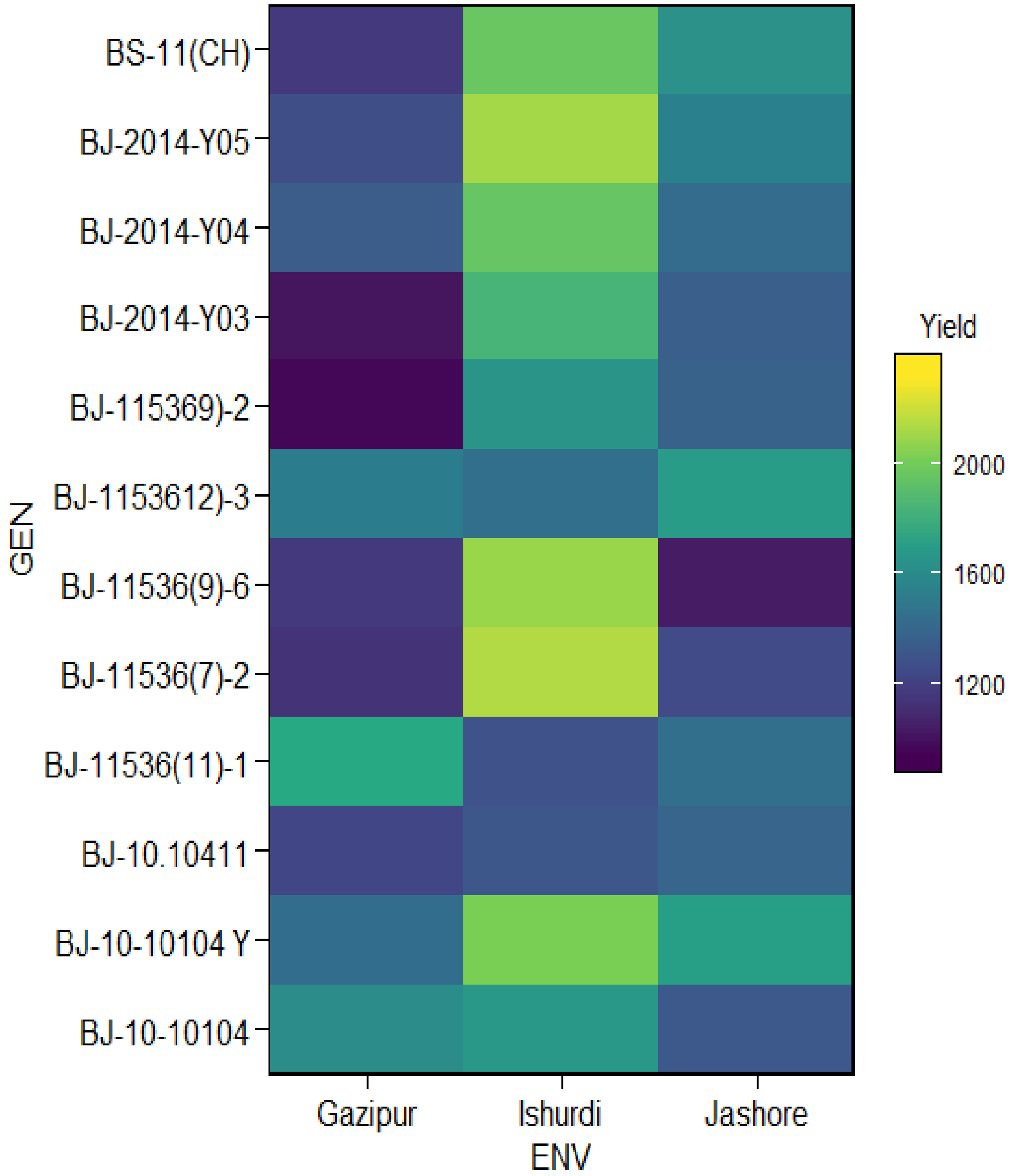

Fig.8. Heatmap showing genotype performance and stability in three environments, with 12 lines ranked according to how seed yield performance and stability are weighted in each environment. The y-axis shows the genotypes and the related mean seed yield, while the x-axis shows the environment (kg ha-1).

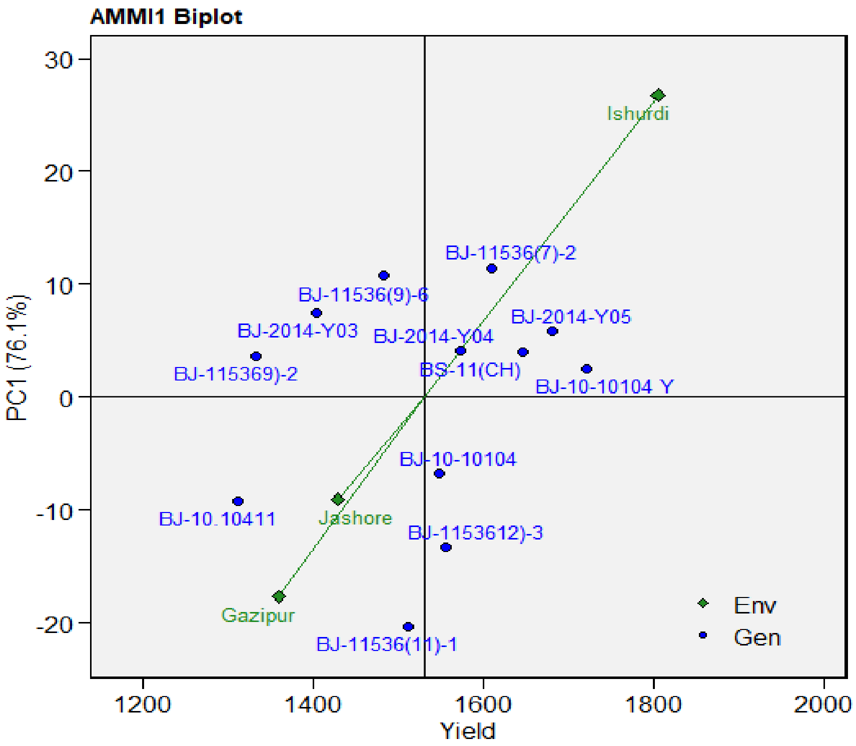

Fig.2 AMMI1 biplot for seed yield (kg per ha) of the 12 *B. rapa* genotypes evaluated in three locations

The AMMI1 model

The AMMI1 biplot represents the relationship between the eigenvectors for IPCA1 and the mean yield of environments and genotypes. The AMMI1 biplot gave a model fit of 76.1%. Genotypes and environments that had IPCA1 values close to zero were characterized with a low interaction effect (Fig. 2), being considered stable or wide adaptation. Environments responded differently regarding seed yield (Fig 2). Jashore and Gazipur locations had a high negative IPCA1 value, with environmental mean being > the grand mean. In addition, Furthermore, Gazipur had a high positive IPCA1 value, with environmental mean being close to the grand mean. On the other hand, Ishurdi had an IPCA1 score of just above zero and an environmental mean close to zero, which indicated that it had a low interaction effect. It can be concluded that one out of the tree tested locations, i.e., Ishurdi had, high IPCA1 scores, indicating high G×E interactions. Similarly, Genotypes and environments on the right side of the midpoint of this axis has higher yields than those on left hand side and a genotype or environment on the same parallel line, relative, or ordinate have similar yields (Akter et al. 2014). The analysis showed that genotypes viz., BJ-2014-Y04, BS-11 (CH), BJ-10-10104Y and BJ-2014-Y05 lying on the right side of the perpendicular are less influenced by the G×E interaction for seed yield. Genotypes viz., BJ-2014-Y04, BS-11 (CH) were found stable across the locations for seed yield as they lie more close to the centre point in the biplot.

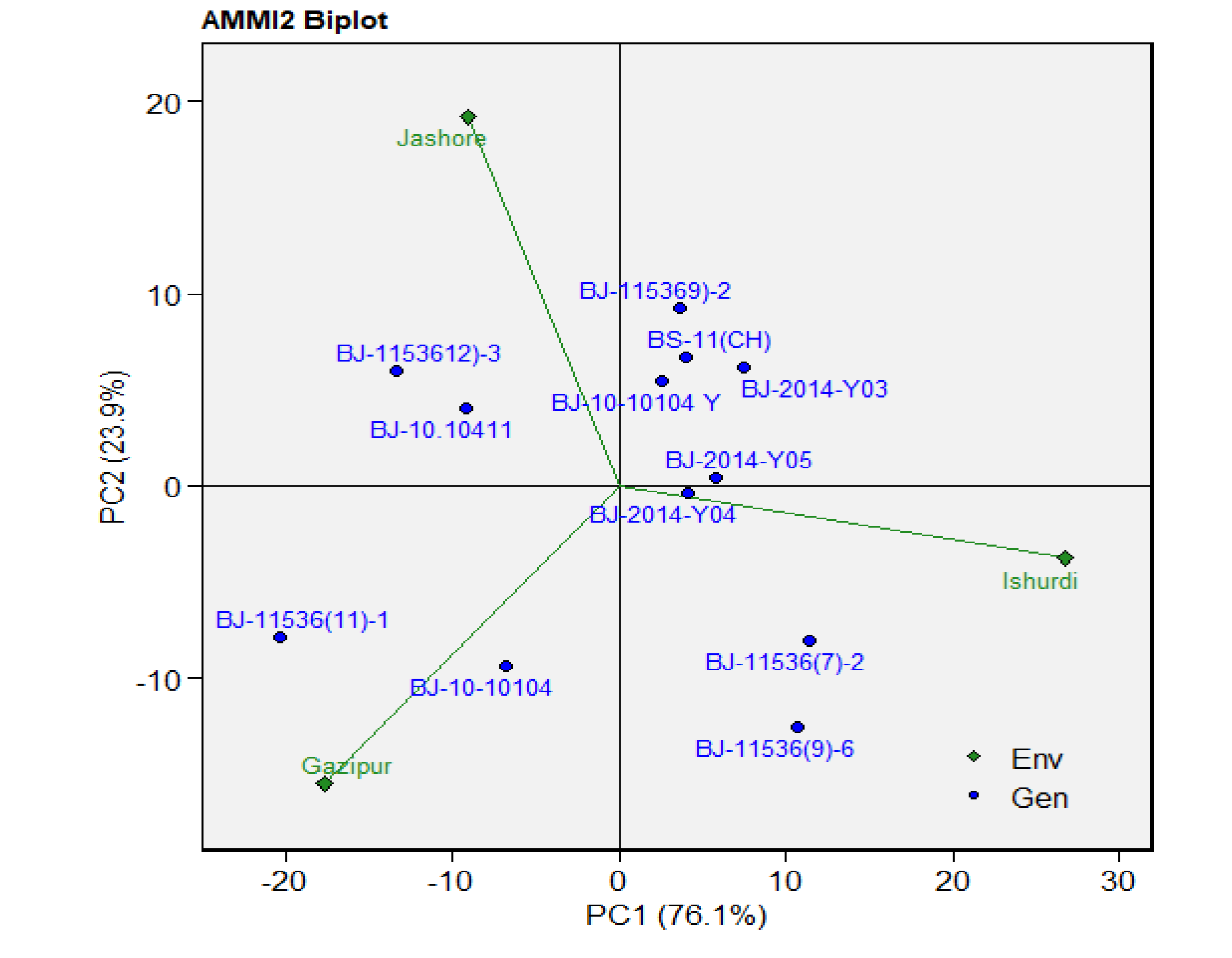

Fig. 3 AMMI2 biplot for seed yield (kg per ha) of the 12 *B. rapa* genotypes evaluated in three locations

The AMMI2 model

The vector length in the AMMI model can be used to determine the discriminative ability of environments for genotypes (Li et al 2003). The environments Gazipu had longer vector than vector for Ishurdi and Jeshore (Fig. 3). Thus, they were the best discriminative environments for investigated genotypes (Yan and Hunt 2001). On the other hand, environments with shorter vectors (Gazipur) are not discriminative ones for the genotypes. The obtuse angle between vectors of Ishurdi, Jeshore and Gazipur environments indicated that these three environments were different for yield determination.

The biplot analyses visualize the best genotype for each environment (Fig. 4), which is known as which-won-where pattern. Genotypes BJ-11536(11)-1 and BJ-10-10104 showed a degree of positive relationship to Gazipur with a negative G×E relation with other environments. On the other hand, genotype BC-100614(4)-2 and BC-100614(4)-11 yielded the lowest across all environments. Furthermore, genotypes BC-100614(7)-3 and BARI-Sarisha-14 were adapted to Jeshore environment but had a negative G×E relationship with other environments. A positive G×E interaction was noticeable between genotype BC-110714(7)-8 and Ishurdi, and a negative interaction with other environments. Genotype BC-100614(8)-1 had a positive G×E relationship with Gazipur and a negative interaction with other environments.

Some environments were discriminative of genotypes for all or some of the studied traits. However, locations were distinctly different, e.g., Ishurdi was considered a favorable location (environment); nevertheless, Jeshore and Gzaipur showed a variable degree of stresses. The genotypes grown in these three locations were exposed to moderate waterlogged stress in Gazipur, extreme waterlogged stress in Jeshore (Fig. 4).

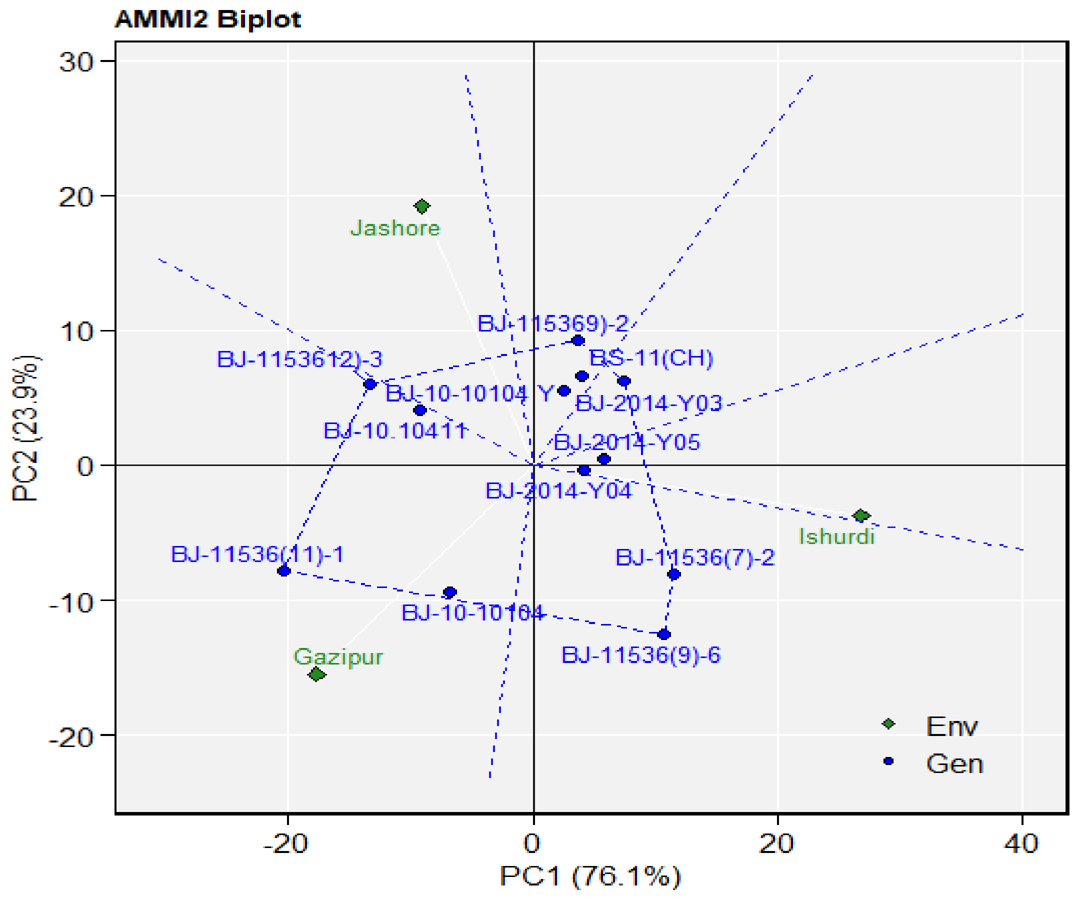

Fig.4 AMMI2 biplot for seed yield (kg per ha) of the 12 *B. rapa* genotypes evaluated in three locations

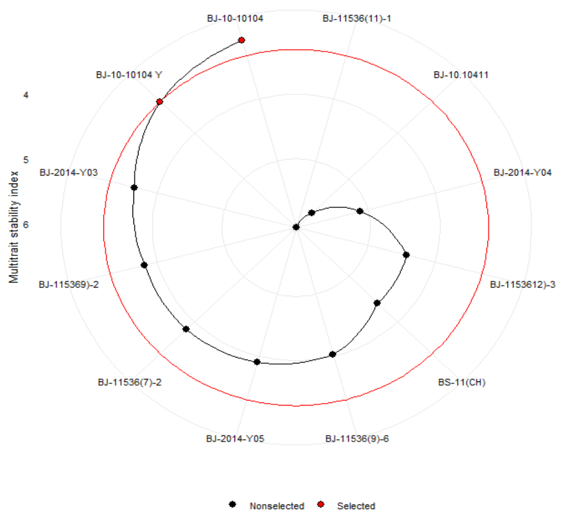

Fig.9. Genotype ranking based on the MTSI considering a selection intensity of 5% (red circle). Selected genotypes are highlighted in red.

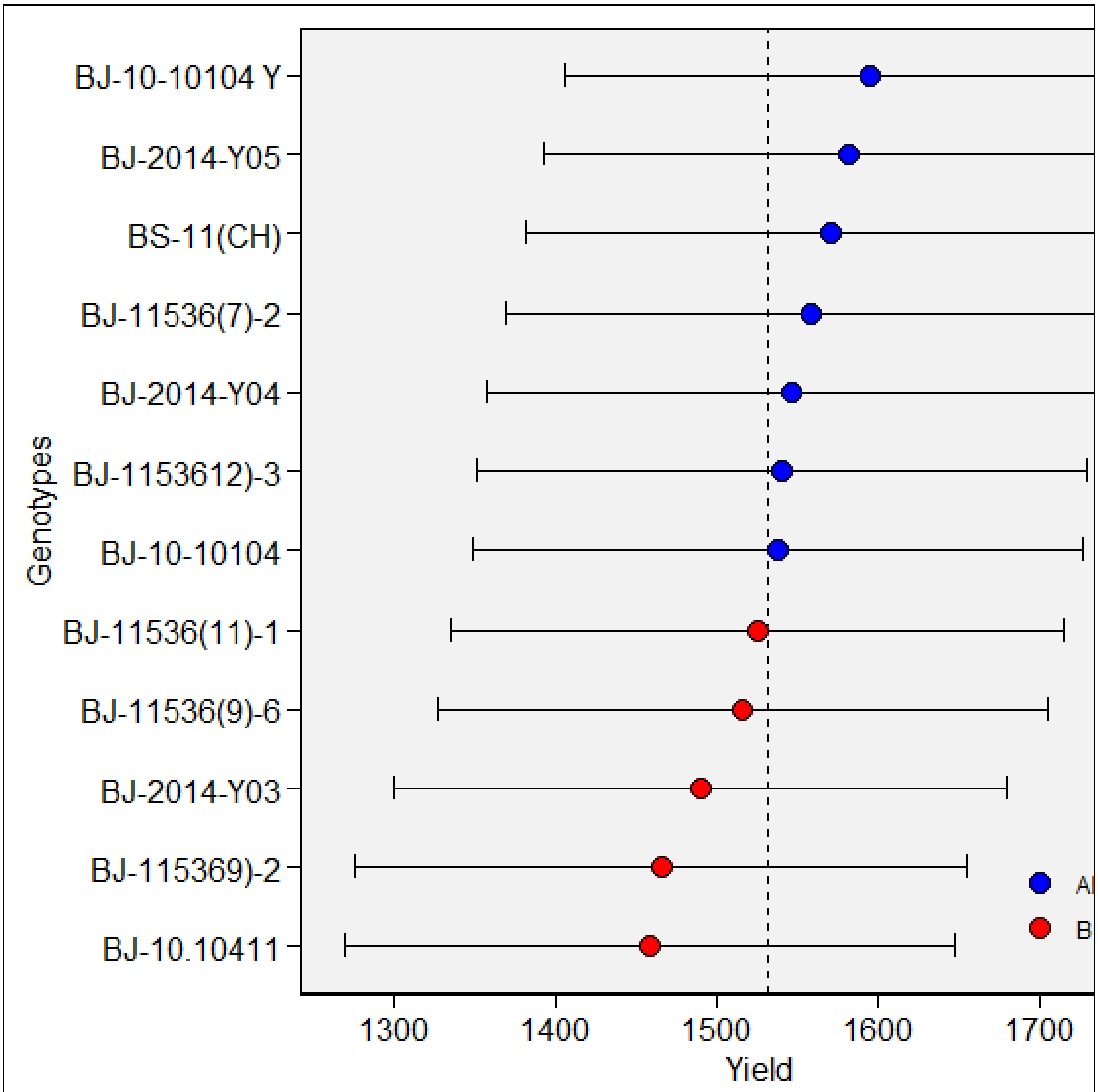

Fig.5. WAASBY scores of genotypes for yield and yield contributing traits.

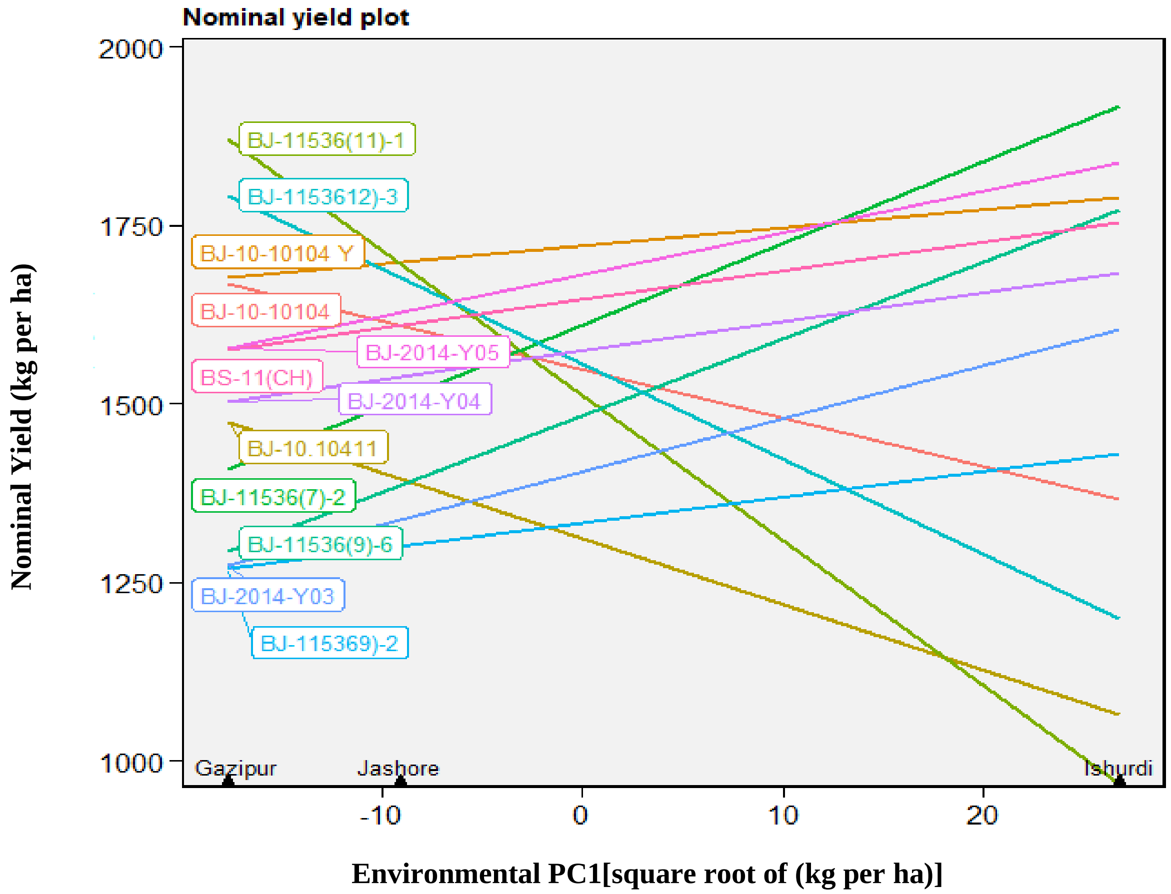

Fig. 6. Nominal yield plots based on predicted yields in all over environments

Conclusion

Considering seed yield and other yield contributing characters, three lines like BJ-10.10411, BJ-11536(9)-6 and BJ-11536(12)-3 were selected for evaluation in RYT.

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REGIONAL YIELD TRIAL OF *BRASSICA JUNCEA* L.

M SHALIM UDDIN, M A LATIF AKANDA, M R HUMAUAN, M H RAHMAN AND M A MONIM

Abstract

Eight advanced lines of Brassica juncea along with BARI Sarisha-11 as check were evaluated at Gazipur, Jamalpur, Ishurdi and Jashore for yield and yield contributing characters. Plant height ranged from 122-170 cm. Number of siliquae per plant ranged from 90-243. The highest number of siliquae per plant was recorded in BJ 1110 (12)-1. Number of seeds per siliqua ranged from 13-16. Seed yield ranged from 940-2450 kg/ha. The line BJ 1110 (12)-1 (1664 kg/ha) produced the highest seed yield all over the location. Considering seed yield and other yield contributing characters, three lines BJ 11536 (12)-1, BJ DH -20 and BJ DH -05 were selected for Adaptive Trial in the next year.

Introduction

Mustard is an important oil producing crop. Mostly it is being cultivated in the colder region. Oilseed Research Center of BARI has recently released BARI Sarisha-16 for cultivation in Bangladesh. The researchers are looking forward for more yield producing genotypes of *Brassica juncea* with bold seed. The experiment has been conducted with a view to find out the high yield potential genotypes of this species.

Materials and Method

The experiment was conducted at Gazipur, Jamalpur, Ishurdi, Jashore and Rahmatpur during rabi 202122. It consisted of 8 advanced lines of *Brassica juncea* along with one check as BARI Sarisha-11. The experiment was laid out in randomized complete block design with three replications. The plot size was 3mx1.8m. Seeding was done on 29 November 2021 at Gazipur, 17 November 2021 at Jamalpur, 9 November 2021 at Jashore and 17 December 2021 at Rahamatpur in continuous sowing and row was 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Data were taken on days to flowering, days to maturity, plant height, no. of primary branches/plant, number of siliquae per plant, number of seeds per siliqua, 1000 seed weight (g) and seed yield/plot. The plot yield was converted into seed yield/hectare. The data were analyzed statistically.

Results and Discussion

Combined analysis of variance

Combined analysis of variance for seed yield of nine mustard genotypes. Genotype (G), environment (E) and genotype × environment interaction (GEI) were highly significant ($P>0.05$). The highly significant G × E effects suggest that genotypes may be selected for adaptation to specific environments, which is in harmony with the findings of Aina et al. (2009) and Xu Fei-fei et al. (2014) in G × E interaction effects of cassava genotypes. Hence, the genotype × environment interaction effects demonstrated that genotypes responded differently to the variation in environmental conditions of locations, which indicated the necessity of testing rice varieties at multiple locations. This also shows the difficulties encountered by breeders in selecting new varieties for release. The factors explained (%) showed that rice grain yield was affected by genotype (76.51%), environment (12.49%) and their interaction (10.21%).

Table 1. Combined analysis of variance of seed yield and yield contributing traits for 9 mustard genotypes evaluated at four environments.

Source of variation	**df**	**Mean Square (MS)**							
		DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
ENV	3	2.02e+3**	40.7**	2.42e+4**	21.2**	1.48e+5**	14.6**	0.84**	5.05e+6**
REP(ENV)	8	3.38**	5.32**	192**	0.386	2.13e+3	3.75	0.10**	382.00**
GEN	8	6.53**	3.87*	321**	1.34**	3.88e+3	2.75**	0.16**	1.14e+5**
GEN:ENV	24	8.39**	4.73**	250**	1.05**	2.24e+3	4.93**	0.13**	6.03e+4**
Residuals	64	1.08	.11	89.7	0.231	1.10e+3	2.46	0.06	570.00
CV(%)		2.5	3.00	6.12	9.94	16.2	10.9	9.26	4.53
MSR+/MSR-		4	4.27	8.07	3.87	2.20	2.73	234.00	6.30
OVmean		47	105	155	4.84	205	14.4	2.68	1.56e+3

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Eight advanced lines of *Brassica juncea* along with BARI Sarisha-11 as check were evaluated at Gazipur, Jamalpur, Ishurdi, Jashore and Rahmatpur for seed yield and yield contributing characters. The mean performance of different lines at Gazipur location is presented in Table 18. Maturity duration ranged from 99-110 days. Plant height ranged from 122-170 cm. Number of siliquae per plant ranged from 90-243. The highest number of siliquae per plant was recorded in BJ 1110 (12)-1. Number of seeds per siliqua ranged from 13-16. Seed yield ranged from 940-2450 kg/ha. The line BJ 1110 (12)-1 (1664 kg/ha) produced the highest seed yield all over the location.

Table 18. Mean performances of *Brassica juncea* genotypes in Regional Yield Trial during rabi 2021-22 over the location

Sl. no.	Lines/varieties	DF	DM	PH	NBPP	NSPP	NSPS	TSW	YIELD
1	BJ 11536 (12)-1	45	105	143.7	4.4	195.6	13.9	2.70	1664
2	BJ 11536 (12)-5	47	105	156.5	4.8	217.3	14.8	2.66	1495
3	BJ 11536 (12)-6	47	105	156.6	4.7	181.7	15.1	2.64	1573
4	BJ 1110 (12)-1	47	105	160.7	5.2	236.9	14.7	2.63	1371
5	BJ 53611 (12)-8	47	105	160.3	5.4	201.7	14.1	2.71	1543
6	BJ 1111 (7)-7	46	105	150.8	4.7	178.8	14.7	2.60	1523
7	BJ DH -05	48	105	153.3	4.6	211.0	14.0	2.72	1635
8	BJ DH -20	47	106	156.3	5.2	210.5	14.3	2.81	1631
9	BARI Sarisah-11	47	105	155.6	4.6	209.7	13.8	2.60	1618
	SE	0.32	0.36	2.7	0.1	9.9	0.5	0.08	19.8
	LSD (p≥0.05)	0.91	1.01	7.7	0.4	27.9	1.3	0.21	55.9
	CV (%)	2.4	1.2	6.1	10.2	16.8	11	9.8	4.8

DF=Days to flowering, DM=Days to maturity, PH=Plant height (cm), NBPP=No. branch /plant,NSPP= No. of siliquae/Plant, NSPS=No. of seeds/siliqua, TSW=1000 seed weight (g),YIELD= Seed yield (kg/ha)

Table 18b. Mean data for seed yield of *Brassica juncea* lines in Regional Yield Trial over the locations during rabi 2021-22

SL. No.	Line/Variety	Seed yield (kg ha^{-1})				Over all mean	P. Index (Pi)
		Gazipur	Jamalpur	Ishurdi	Jashore		
1	BJ 11536 (12)-1	1491	1587	2218	1361	1664	103
2	BJ 11536 (12)-5	1247	1559	2107	1068	1495	-66
3	BJ 11536 (12)-6	1072	1659	2241	1321	1573	12
4	BJ 1110 (12)-1	1091	1473	1932	989	1371	-190
5	BJ 53611 (12)-8	1378	1647	1998	1148	1543	-18
6	BJ 1111 (7)-7	1449	1598	1985	1061	1523	-38
7	BJ DH -05	1350	1726	2394	1069	1635	74
8	BJ DH -20	1368	1430	2471	1255	1631	70
9	BARI Sarisah-11	1044	1607	2246	1576	1618	57
E. Mean		1277	1587	2177	1205	**1561**	
E. Index (Ei)		-285	26	615	-356	0	
SE		39.6					
LSD (p≥0.05)		111.8					
CV (%)		10					

Conclusion

Considering seed yield and other yield contributing characters, three lines BJ 11536 (12)-1, BJ DH -20 and BJ DH -05 were selected for Adaptive Trial in the next year.

OBSERVATION TRIAL OF ENTRIES DEVELOPED FROM INTERSPECIFIC HYBRIDIZATION AMONG *B. CARINATA* AND *B. NAPUS*

U. KULSUM, M SHALIM UDDIN AND M. M. ALI

Abstract

An attempt of interspecific hybridization has been taken to incorporate desirable characters from B. carinata species into the existing variety BARI Sarisha-13 of B. napus. In B. napus, three entries produced higher seed yield compared to the check variety BARI Sarisha-13. The highest yield obtained from 13CA92014 and 13CA52014 which were 21% and 16% higher than check variety. The B. napus lines were almost determinate types.

Introduction

Interspecific hybridization is one of the best techniques for incorporating desirable characters from different species of the same genus into a genotype/variety well adapted. The African mustard *B.carinata* species is stress-tolerant specially drought and diseases. Most of the high yielding rapeseed-mustard varieties of ORC is susceptible to drought and diseases. The experiment was conducted to create genetic variability and incorporate stress tolerance genes from *B.carinata* into the varieties developed by ORC, BARI of different *Brassica* species. Hybridization and back cross was done 2011-12 and 2012-13 respectively. Six lines have been selected from the back cross-population based on disease appearance and yield. These lines were used in this experiment to observe the performance.

Materials and Methods

The experiment was conducted with seven accessions including one check variety BARI Sarisha-13. The entries were developed crossing between the BARI Sarisha -13 with *B. carinata*. The seed was sawn on 18 November, 2021. The experiment was laid out in RCB design having three replications. Each entry was grown in 3m long 3 rows. Recommended doses of fertilizer and other cultural operations were done when necessary. Data were collected from 5 randomly selected plants.

Results and Discussion

The results of the observation trial have been shown in **Table-2**. A significant difference was observed among the entries tested in the experiment for all the characters. Days to maturity were reduced for all the entries than check variety BARI Sarisha-13. Root length and siliqua per plant were higher for all the entries than check variety BARI Sarisha-13. Out of six entries, three entries 13CA92014, 13CA52014 and 13CA12014 produced a higher seed yield than the check variety (1798.9kg/ha). The BARI Sarisha-13 was an indeterminate type while the selected materials were the almost determinate type. The determinate type can reduce the shattering loss of *B. napus.*

Table 2. Performance of the entries developed from interspecific crosses with *B. napus* with *B. carinata* during rabi 2021-2022 at Gazipur

Entries	**D/F (days)**	**D/M (days)**	**Plant height (cm)**	**Root length (cm)**	**Siliqua length (cm)**	**Siliqua per plant**	**Seed per siliqua**	**1000-seed weight (gm)**	**Seed Yield (kg/ha)**	**Over yield (%)**
13CA12014	30	96	103.6	10.22	7.38	304.4	33.4	4.2	2018	**12**
13CA32014	32	97	102.2	7.28	6.92	270.8	27.2	3.7	1590	-12
13CA42014	31	97	99.8	6.96	7.56	283	22.2	4.1	911	-49
13CA52014	33	95	104	7.92	7.9	309.2	28.2	4.3	2094	**16**
13CA72014	30	98	104.2	7.3	7.38	268.6	28.8	3.9	1202	-33
13CA92014	33	96	102.2	8.04	7.76	327.6	29	4.2	2182	**21**
BARI Sar.-13(Ch.)	31	99	100	6.7	7.4	239.4	28	4.3	1798.9	0
Std. Error	0.6	0.5	0.7	0.4	0.1	11.3	1.2	0.1	181.3	--
Significance	**	**	**	*	**	**	**	**	**	--
CV(%)	4.8	1.3	1.8	15.2	4.2	10.4	11.7	5.1	28.5	--

***D/F=days to flower, *D/M= days to maturity, ** Significant at 1% level**

MAINTENANCE OF CMS, MAINTAINER AND RESTORER LINES OF *B. NAPUS*

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

The experiment consisted of two CMS lines like CMSZ$_1$ (248) and CMSZ$_2$ (279), two maintainer lines like Nap-248M and Nap-279M and one restorer line, Nap-14-01R. Days to flowering and maturity for CMS lines ranged from 24-25 days and 95 days, respectively. In total 401 buds of 55 plants of two CMS lines were crossed with two maintainer lines. Three thousand nine hundred and seventy eight seeds were obtained from 315 siliquae. Days to flowering and maturity for restorer and maintainer lines were 24-25 days and 95 days, respectively. Seven hundred and twenty five buds were selfed from 99 plants. In total 9099 seeds were obtained from 619 siliquae. Seeds were stored for future breeding programme.

Introduction

For development of hybrid variety, three parental lines are pre-requisite. They are cytoplasmic male sterility (CMS) line (A line), maintainer line (B line) and restorer line (R line). Maintainer or B-line is self-fertile, it is multiplied through selfing or open-pollination in an isolation. Restorer or R-line carries male fertility restorer genes and is self-fertile. It is maintained just like B-line by selfing or open-pollination in an isolation. The experiment has been undertaken to maintain and increase seed of CMS, maintainer and restorer lines for utilizing in future breeding programme.

Materials and Methods

The experiment consisted of two CMS lines like CMSZ$_1$ (248) and CMSZ$_2$ (279), two maintainer lines like Nap-248M and Nap-279M and one restorer line like Nap-14-01R. It was conducted at Gazipur during rabi 2021-22. Unit plot size was four rows three meter long. Seeding was done on 21 November 2021. CMS lines were crossed with maintainer lines. Maintainer lines and restorer line were selfed. Bagging was done to protect out crossing. Crossing and selfing were done by hand pollination.

Results and Discussion

Results on crossing (CMS x maintainer line) for maintenance of CMS lines are presented in Table 19. Days to flowering and maturity for CMS lines ranged from 24-25 days and 95 days, respectively. In total 401 buds of 55 plants of two CMS lines were crossed with two maintainer lines. Three thousand nine hundred and seventy eight seeds were obtained from 315 siliquae. Seeds were stored for future breeding programme.

Table 19. Results on crossing (CMS x maintainer line) for maintenance of CMS lines during rabi 2021-22 at Gazipur

Sl. no.	Crosses (CMS x ML)	Days to flowering (CMS)	Days to maturity (CMS)	No. of plants crossed	No. of buds crossed	No. of siliquae obtained	No. of seeds obtained
1	$CMSZ_1$ (248) x Nap-248M	25	95	20	136	109	1506
2	$CMSZ_2$ (279) x Nap-279M	24	95	35	265	206	2472
			Total	**55**	**401**	**315**	**3978**

Results on selfing for maintenance of maintainer and restorer lines are presented in Table 20. Days to flowering and maturity for Nap-248M, Nap-279M and Nap-14-01R were 24-25 days and 95 days, respectively. Seven hundred and twenty five buds were selfed from 99 plants. In total 9099 seeds were obtained from 619 siliquae. Seeds were stored for future breeding programme.

Acknowledgement

'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project

Table 20: Results on selfing for maintenance of Maintainer and Restorer lines during rabi 2021-22

Sl. no.	Selfing	Days to flowering	Days to maturity	No. of plants selfed	No. of buds selfed	No. of siliquae obtained	No. of seeds obtained
1	Nap-248M	24	95	22	161	115	1840
2	Nap-279M	25	95	33	252	222	3307
3	Nap-14-01R	24	95	44	312	282	3952
	Total			**99**	**725**	**619**	**9099**

DEVELOPMENT OF HYBRID VARIETY IN RAPESEED

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

Long duration CMS and restorer lines were back crossed with short duration Brassica napus lines, and BARI Sarisha-8 and BARI Sarisha-13 to develop short duration patental lines. CMS lines were crossed with selected Restorer line (Nap-2014-01R) to develop test cross hybrid seed and previously developed test cross hybrids were evaluated. Seeds were stored for the next year evaluation.

Introduction

There is a limited scope of horizontal expansion of cultivation of rapeseed in Bangladesh. So, for increasing rapeseed-mustard production, seed yield must be increased per unit area. Hybrid variety can play an important role in this regard. Hybrid varieties of rapeseed are being cultivated in some countries. Hybrid varieties of rapeseed have already been cultivated in India and China. Exploitation of heterosis utilizing pollination mechanisms like cytoplasmic-genetic male sterility (CMS) and self-incompatibility (SI) for development of hybrid variety is the usual practice in many crops including oilseeds in China and other countries of the world. Ogura and Polima CMS systems are being used for development of hybrid variety of rapeseed. For development of hybrids, three parental lines like CMS, maintainer and restorer lines, are pre-requisite. The following experiments have been under taken to develop short duration parental lines, to develop and evaluate test cross hybrids and maintenance of selected parental lines for hybrid variety in rapeseed.

I. DEVELOPMENT OF SHORT DURATION PARENTAL LINES IN *BRASSICA NAPUS* L.

Materials and Methods

Two CMS lines [CMSZ$_1$ (248) and CMSZ$_2$ (279)], one Restorer line (Nap-14-01R), three short duration (87-88 days) of *Brassica napus* lines (Nap-0876, Nap-0869 and Nap-205), two varieties (BARI Sarisha-8 and BARI Sarisha-13) and one *Brassica napus* line (Nap-14-015) were used as experimental materials. The experiment was conducted during rabi 2021-22 at Gazipur. Seeds were sown on 21 November 2021. CMS lines were crossed with three short duration *Brassica napus* lines and BARI Sarisha-8 and BARI Sarisha-13. Bagging was done to protect out crossing. Crossing was done by hand pollination.

Results and Discussion

Results on crossing between CMS lines and short duration *Brassica napus* lines/varieties are presented in Table 21. Days to maturity for CMS lines ranged from 90-92 days and for *Brassica napus* lines/varieties ranged from 87-95 days. Seven hundred and eighty five buds of 109 CMS plants were crossed with short duration *Brassica napus* lines/varieties. Five hundred and thirty five siliquae was obtained from which 5401 seeds were obtained. Seeds were stored for back crossing in the next year.

Table 21: Results on crossing between CMS lines and short duration *Brassica napus* lines/varieties during rabi 2020-21 at Gazipur

Sl. no.	Crosses (CMS x *B. napus* lines/varieties)	Days to maturity (CMS lines)	Days to maturity (*B. napus* lines)	Crossing (CMS x *B. napus* lines/varieties)			
				CMS plants crossed	No. of buds crossed	No. of siliquae obtained	No. of seeds obtained
1	CMSZ$_1$ (248) x Nap-0876	91	88	14	144	102	820
2	CMSZ$_2$ (279) x Nap-0876	92	88	13	101	76	755
3	CMSZ$_1$ (248) x Nap-0869	90	87	17	114	64	699
4	CMSZ$_2$ (279) x Nap-0869	91	87	14	96	57	733
5	CMSZ$_1$ (248) x Nap-205	92	88	14	118	93	923
6	CMSZ$_2$ (279) x Nap-205	90	88	13	81	48	567
7	CMSZ$_1$ (248) x BARI Sarisha-8	91	93	13	76	57	528
8	CMSZ$_1$ (248) x BARI Sarisha-13	92	95	11	55	38	376
			Total	**109**	**785**	**535**	**5401**

II. DEVELOPMENT OF TEST CROSS HYBRID IN *BRASSICA NAPUS* L.

Materials and Methods

CMS line [CMSZ$_1$ (248) was crossed with Restorer line (Nap-2014-01R-P$_6$) and CMS line [CMSZ$_2$ (279) was crossed with Restorer line (Nap-2014-01R-P$_{10}$ to develop test cross hybrid seed. Seeds of female and male parent were sown on 21 November 2021 following 4:2 ratio. Unit plot size was twenty rows of 3m long. Netting was done to protect out crossing. Hand pollination was done for proper seed setting. The experiment was conducted at Gazipur.

Results and Discussion

Results on hybrid seeds of test crosses between CMSZ$_1$ (248) x Nap-2014-01R-P$_6$ and CMSZ$_2$ (2798) x Nap-2014-01R-P$_{10}$ are presented in Table 23. Days to maturity of CMSZ$_1$ (248) and CMSZ$_2$ (279) lines was 91 and 92 days and restorer Nap-2014-01R-P$_6$ and Nap-2014-01R-P$_{10}$ lines was 103 and 104 days, respectively. Three hundred and five gram seeds of CMSZ$_1$ (248) x Nap-2014-01R-P$_6$ and 202 gram seeds of CMSZ$_2$ (279) x Nap-2014-01R-P$_{10}$ were obtained. Hybrid seeds of test crosses was stored for evaluation in the next year.

Table 23. Results on production of hybrid seed of test crosses during rabi 2021-22 at Gazipur

Test cross hybrids	Days to maturity (CMS lines)	Days to maturity (Restorer line)	Amount of hybrid seed obtained (g)
$CMSZ_1$ (248) x Nap-2014-01R-P_6	91	103	305
$CMSZ_2$ (279) x Nap-2014-01R-P_{10}	92	104	202

III. EVALUATION OF TEST CROSS HYBRIDS IN BRASSICA NAPUS L.

Materials and Methods

Two CMS lines, $CMSZ_1$(248) and $CMSZ_2$ (279) were crossed with Restorer lines, Nap-2014-01R-P_6 and Nap-2014-01R-P_{10} during last rabi 2020-21 to develop test cross hybrids. Developed two hybrids were evaluated during rabi 2021-22. Hybrid seeds were sown on 21 November 2021. Unit plot size was 20 rows of 3m long with 3 replications. The experiment was conducted at Gazipur.

Results and Discussion

Results on test cross hybrids, $CMSZ_1$ (248) x Nap-2014-01R-P_6 and $CMSZ_2$ (279) x Nap-2014-01R-P_{10} are presented in Table 24. Days to flower was 23 and 25 days and days to maturity was 106 and 107 days, respectively for test crosses. Seed yield for hybrid $CMSZ_1$ (248) x Nap-2014-01R-P_6 was 1856 kg/ha and for hybrid $CMSZ_2$ (279) x Nap-2014-01R-P_{10} was 2276 kg/ha.

Acknowledgement

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Table 24: Results on test cross hybrids between CMS line x Restorer line (Nap-2014-01R) during rabi 2021-22 at Gazipur

Test cross hybrids	Days to flower	Days to maturity	Seed yield/ plot (g)	Seed yield/ ha (kg)
$CMSZ_1$ (248) xNap-2014-01R-P_6	23	106	1680	1856
$CMSZ_2$ (279) xNap-2014-01R-P_{10}	25	107	1908	2276

HETEROSIS STUDY OF HYBRIDS DEVELOPED THROUGH SELECTED RESTORERS

U. KULSUM, M. M. ALI AND M A LATIF AKANDA

Abstract

An attempt has been taken to develop hybrid through selected restorer. Most of the hybrids were over yielded compared to check variety BARI Sarisha-13. Out of fifteen hybrids, thirteen have been shown positive standard heterosis in seed yield. Maximum heterosis was observed in the hybrid-18 (44.6%) followed by Hybrid-8 (34.1%) in seed yield (kg/ha).

Introduction

The exploitation of heterosis utilizing pollination mechanisms like cytoplasmic-genetic male sterility (CMS) and self-incompatibility (SI) for the development of hybrid has been proved in *Brassica* widely been used in China and other countries of the world. But Ogura and Polima CMS systems are being used for the development of a hybrid variety of *Brassica napus.* BSMRAU, Salna provided Oilseed Research Centre, BARI two male sterile lines, and one Restorer. The Centre highly acknowledges BSMRAU, Salna for proving Restorer and CMS lines. The supplied restorer was very late and did not synchronize with the developed CMS lines. To create the appropriate restorer gene sources and to develop the hybrid, the experiment was conducted with the new developing restorer and CMS lines.

Materials and Methods

Twenty-four restorer lines have been developed through backcrossing by incorporating early genes in the supplied restorer. Using developed restorers twenty-four test cross hybrid was produced in 2017-2018 and fifteen restorers with good heterosis were selected in 2018-2019. Again in 2019-20 test cross hybrid was developed with the selected restorer and considering the fertility status of restorer and seed yield of test hybrid nine hybrids were selected. And in 2020-2021 these nine hybrid was evaluated and fifteen hybrid was developed in isolated condition. This year's experiment was conducted using those fifteen hybrids along with check variety BARI Sarisha-13. Unite plot size was 3 m long 5 lines with 30 cm spacing. The hybrids were sown on 17 November 2021 at Gazipur. Recommended doses of fertilizer and other cultural operations were done when necessary. Half seeds of each restorer line were kept for future use. Data have been taken from randomly taken 10 plants from each accession. Standard heterosis was calculated.

Results and Discussion

The performance of the fifteen hybrids along with check variety BARI Sarisha-13 have been presented in Table 2. Most of the hybrids were over yielded compared to check variety BARI Sarisha-13. The hybrids namely, Hybrid-18, Hybrid-8, Hybrid-16, Hybrid-4, and Hybrid-1 showed around 20% to 44% higher seed yield compared to the standard variety BARI Sarisha-13. In the case of maturity, all the hybrids took less time to mature than BARI Sharisha-13.

Table 3: Yield and yield contributing characters of different hybrids during robi, 2021-22 at Gazipur

Entries	D/F (days)	D/M (days)	Plant height (cm)	Root length (cm)	Siliqua length (cm)	Siliqua per plant	Seed per siliqua	1000-seed weight (gm)	Seed Yield (kg/ha)	Over yield (%)
Hybrid-1	30	98	110.9	9.81	7.8	136	30	3.9	1809	**20.5**
Hybrid-2	30	97	108.6	10.14	7.7	173	25	3.9	1408	-6.2
Hybrid-3	30	96	105.2	10.37	7.6	211	28	4.0	1521	1.3
Hybrid-4	31	97	97.0	9.20	7.7	174	29	3.7	1835	**22.2**
Hybrid-5	31	97	98.6	9.84	7.8	139	29	3.9	1474	-1.9
Hybrid-6	32	98	119.8	9.88	7.8	223	28	3.9	1571	4.6
Hybrid-7	32	98	109.1	9.45	7.5	197	26	4.6	1614	7.5
Hybrid-8	30	97	116.9	9.20	8.2	275	30	3.7	2014	**34.1**
Hybrid-10	31	97	110.2	7.45	7.8	183	25	3.9	1583	5.5
Hybrid-14	32	96	107.2	8.41	8.3	191	29	3.9	1683	**12.1**
Hybrid-15	31	96	111.3	9.27	8.4	157	28	4.2	1732	**15.4**
Hybrid-16	31	97	109.5	11.66	8.3	254	25	3.7	1938	**29.0**
Hybrid-17	31	99	113.3	10.26	8.0	234	25	4.2	1628	8.4
Hybrid-18	31	96	108.1	11.50	8.3	248	30	4.1	2171	**44.6**
Hybrid-23	31	98	105.7	11.47	6.8	195	25	3.7	1646	9.6
BARI Sar.-13 (Ch.)	31	100	105.3	12.65	7.9	133	31	3.7	1501	0.0
Significance	**	**	**	ns	**	**	**	**	**	
Std. error	0.2	0.2	1.3	0.3	0.1	12.3	0.5	0.1	58.2	
CV(%)	3.7	1.3	6.7	19.3	6.7	35.7	10.6	7.4	19.4	-

***D/F = Days to Flowering   *D/M= Days to maturity**

Standard heterosis study of different hybrids shown in Table-4. Out of fifteen hybrids, thirteen have been shown positive heterosis in seed yield. Maximum heterosis was observed in the hybrid-18 (44.6%) followed by Hybrid-8 (34.1%) in seed yield (kg/ha). All the hybrid shown positive and high heterosis for siliqua per plant.

Table 4: Standard heterosis of the different developed hybrids during robi 2021-22 at Gazipur

Entries	*D/F (days)	*D/M (days)	Plant height (cm)	Root length (cm)	Siliqua length (cm)	Siliqua per plant	Seed per Siliqua	1000-seed weight (gm)	Seed Yield (kg/ha)
Hybrid-1	-4.84	-1.51	5.32	-22.45	-1.39	2.57	-2.59	3.20	**20.51**
Hybrid-2	-3.23	-2.51	3.13	-19.84	-3.15	30.79	-17.80	3.95	-6.20
Hybrid-3	-3.23	-4.02	-0.09	-18.02	-4.54	58.94	-10.36	6.18	1.30
Hybrid-4	-1.61	-2.51	-7.88	-27.27	-2.52	31.02	-7.12	-1.45	**22.20**
Hybrid-5	-1.61	-2.51	-6.36	-22.21	-1.89	4.75	-6.15	3.12	-1.85
Hybrid-6	1.61	-1.51	13.77	-21.90	-2.14	68.53	-8.41	4.02	4.63
Hybrid-7	1.61	-1.51	3.61	-25.30	-5.80	48.38	-17.48	21.63	7.49
Hybrid-8	**-3.23**	**-2.51**	**11.02**	-27.27	**3.91**	**107.17**	**-2.59**	**-0.69**	**34.14**
Hybrid-10	-1.61	-2.51	4.65	-41.11	-2.14	37.81	-18.12	3.75	5.46
Hybrid-14	1.61	-3.52	1.80	-33.52	4.67	44.38	-6.47	4.11	**12.12**
Hybrid-15	0.00	-3.52	5.70	-26.72	5.93	18.11	-11.00	11.56	**15.36**
Hybrid-16	0.00	-2.51	3.99	-7.83	5.17	91.77	-20.06	-0.52	**29.05**
Hybrid-17	0.00	-1.01	7.60	-18.89	1.26	76.91	-20.71	12.77	8.42
Hybrid-18	**-1.61**	**-3.52**	**2.66**	-9.09	**4.04**	**87.17**	**-2.27**	**9.12**	**44.59**
Hybrid-23	0.00	-2.01	0.38	-9.33	-13.87	46.79	-20.06	-0.61	9.62

D/F = Days to Flowering   *D/M= Days to maturity

Conclusion

The hybrids with good heterosis will be planted in large area and evaluated.

HYBRID SEED PRODUCTION OF *B. NAPUS*

M SHALIM UDDIN, U. KULSUM AND M A LATIF AKANDA

Abstract

The experiment was conducted at field PGRC, Bangladesh Agricultural Research Institute, Joydebpur to increase the seed stock of the selected hybrid for conduct RYT and adaptive trails and future use. The produced 12.0 kg rapeseed hybrid seed will be grown in for conduct RYT and adaptive trails and future use.

Introduction

Exploitation of heterosis utilizing pollination mechanisms like cytoplasmic-genetic male sterility (CMS) and self-incompatibility (SI) for development of hybrid variety is the usual practice in many crops including oilseeds in China and other countries of the world. Ogura and Polima CMS systems are being used for development of hybrid variety of *Brassica napus*. So, this experiment was undertaken to increase the seed stock of the selected hybrid for conduct RYT and adaptive trails and future use.

Materials and Methods

The experiment was conducted at PGRC, BARI, Gazipur during rabi 2021-22. Parental lines of hybrid (CMS-248 × R-23) was sown in isolation (time/space) maintaining a ratio of four female rows alternate with two male rows. Male rows were sown in two different dates for synchronization. continuous sowing and row were 30 cm apart from each. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of flowering. All intercultural operations were done timely to raise a good crop. Undesirable plants of both male and female parents were rouged out. At physical maturity ears were harvested from the female and male rows separately and dried for 4-5days. A final selection was done based on seed color and texture. 4-5 days dried and preserved for future use.

Results and Discussion

The amount of quality seed of hybrids produced at Gazipur are given below.

Table 1. hybrid Seed produced of rapeseed during rabi 2021-22

Hybrid	Location	Quantity of seed produced (kg)
CMS-248 × R-23	Gazipur	12.0

Conclusion

The produced 12.0 kg rapeseed hybrid seed will be grown in for conduct RYT, adaptive trails and future use.

DEVELOPMENT OF DOUBLE LOW SHORT DURATION GENOTYPES THROUGH INTERSPECIFIC HYBRIDIZATION EVALUATION OF F_6 GENERATION

M A LATIF AKANDA, M S UDDIN AND A B M KHALDUN

Abstract

BARI Sarisha-17 of Brassica rapa, Nap-0876 and Nap-0569 of Brassica napus having high erucic acid but short duration were crossed with Nap-14-001, Nap-14-004, Nap-14-007, Nap-14-010 and Nap-14-011of Brassica napus having low erucic acid, high yielding but long duration. Developed 15F_6s were selfed to advance generation. Maturity duration for 15 cross combinations ranged from 83-96 days. Seven hundred and sixteenr buds from 118 plants were selfed to advance generation. Four hundred and sixty three siliqua were obtained from which 6374 seeds were obtained. Selfed seeds were stored for evaluation in the next season.

Introduction

In its original form, *Brassica* oil, was harmful to humans due to its relatively high level of erucic acid. Erucic acid is commonly present in native cultivars in concentrations of 30-50% by weight based upon the total fatty acid content. “Double-low" varieties (low in erucic acid in the oil as well as low in glucosinolates in the solid meal after oil extraction) were developed in many countries, which have an erucic acid content of less than 2% by weight based upon the total fatty acid content, and a glucosinolate content of less than 40 µmol/gram of the oil-free meal. These high quality forms of rape, first developed in Canada, are known as ‘Canola’. Existing varieties of rapeseed-mustard have high quantity of erucic acid (25-30%). The experiment has been undertaken to develop double low genotypes through crossing between *Brassica rapa* and *Brassica napus*.

Materials and Methods

Parent materials of the experiment consisted of two species (*Brassica rapa* and *Brassica napus*). BARI Sarisha-17 of *Brassica rapa*, Nap-0876 and Nap-0569 of *Brassica napus* [high erucic acid (30-45%) but short duration (80-85 days)]. Nap-14-001, Nap-14-004, Nap-14-007, Nap-14-010 and Nap-14-011of *Brassica napus* [low erucic acid (less than 2%), high yielding (2.0-2.5 t/ha) but long duration (100-105 days)]. BARI Sarisha-17, Nap-0876 and Nap-0569 were crossed with Nap-14-001, Nap-14-004, Nap-14-007, Nap-14-010 and Nap-14-011 during last rabi 2015-16. Developed 15F_1s were selfed during 2016-2021 to develop F_6 generation. Developed 15F_6s were sown on 18 November 2021. Selfing was done through bud pollination for evaluation in the next season.

Results and Discussion

Results of F_6s of 15 cross combinations of inter- and intra-spesific hybridization (*Brassica rapa* x *Brassica napus* and *Brassica napus* x *Brassica napus)* are presented in Table 28. Maturity duration for cross combinations ranged from 83-96 days. A total of 716 buds were selfed from 118 plants to advance generation. Four hundred and sixty three siliquae were obtained from which 6374 seeds were obtained. Selfed seeds were stored for evaluation in the next season.

Acknowledgement

'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project

Table 28: Results of 15 F_6s in 'Evaluation of F_6 generation' during rabi 2021-22 at Gazipur

Sl. no.	Cross combinations			Days to maturity	No. of plants selfed	No. of buds selfed	No. of effective siliquae obtained	No. of seeds obtained
1	BARI Sarisha-17	X	Nap-14-001	84	3	17	14	224
2	BARI Sarisha-17	X	Nap-14-004	84	12	62	45	620
3	BARI Sarisha-17	X	Nap-14-007	84	11	81	54	723
4	BARI Sarisha-17	X	Nap-14-010	83	9	63	63	845
5	BARI Sarisha-17	X	Nap-14-011	84	6	34	32	445
6	Nap-0876	X	Nap-14-001	95	5	49	28	375
7	Nap-0876	X	Nap-14-004	95	10	76	49	585
8	Nap-0876	X	Nap-14-007	95	11	62	47	655
9	Nap-0876	X	Nap-14-010	95	7	35	14	214
10	Nap-0876	X	Nap-14-011	95	7	39	11	175
11	Nap-0869	X	Nap-14-001	96	9	50	22	309
12	Nap-0869	X	Nap-14-004	96	11	60	38	495
13	Nap-0869	X	Nap-14-007	95	8	46	30	399
14	Nap-0869	X	Nap-14-010	94	4	20	4	89
15	Nap-0869	X	Nap-14-011	96	5	22	12	221
			Total		**118**	**716**	**463**	**6374**

DEVELOPMENT OF MULTI-PARENT ADVANCED GENERATION INTER-CROSS (MAGIC) POPULATIONS

M SHALIM UDDIN AND M A LATIF AKANDA

Abstract

The experiment was conducted at green house of Plant Breeding Division, Bangladesh Agricultural Research Institute, Joydebpur to develop 16-way MAGIC population to accumulate all favorable genes from multi-parents into a single parent and to create genetic variability. Sixteen parental lines were used and 18 single crosses, 8 three-way crosses and 2 four way crosses were made successfully.

Introduction

The multi-parent advanced generation inter-cross (MAGIC) population represents a new and powerful tool allowing the high-resolution mapping of quantitative traits (Mackay, et al., 2009; Cavanagh, et al., 2008). Crop improvement against abiotic stresses such as salinity, waterlogged, drought requires large germplasm diversity screening (Cavanagh, et al., 2008), and the combination of multiple founders provides a higher genetic and phenotypic diversity within a single mapping population. In recent years, various mapping populations that involve crossing of more than two parental lines such as multi-parent advanced generation inter-cross (MAGIC) (Cavanagh et al. 2008) and nested association mapping (NAM) populations (Yu et al. 2008) are being developed in different crops (see Scott et al. 2020). The incorporation of multiple parents ensures the population is segregating for multiple genes for multiple traits and cytoplasm effects can be normalized. Further, MAGIC populations provide a platform for community-based approach for gene discovery, characterization and deployment of genes for under-standing complex traits (Glaszmann et al. 2010). Thus, the MAGIC population is a useful tool to develop strategies to cope with abiotic stress. Therefore, keeping in view the above points, present investigation was undertaken to develop MAGIC population to accumulate all favorable genes from multi-parents into a single parent and to create genetic variability.

Materials and Methods

Sixteen selected diverse founder varieties/lines, with a heterogeneous background (Table1) were used in this program. Seeds of the parents were sown at green house of Plant Breeding Division by customize the green house environment with enhanced lighting to create intense day-long regimes to speed up the search for better performing crops to make crosses. The plot size was one row of 1.5 m long for each line. Row to row distance was 25 cm and seeds were sown continuously. Fertilizers were applied at per recommended doses. Intercultural operations were done as and when necessary. Rouging was done before flowering. At flowering time 8-way, 4-way and 2-way crosses were made. Matured siliquae of all the crosses were harvested, dried and after threshing seeds were preserved properly for next use.

Results and Discussion

The results of the crosses are shown in Table 2. Seeds were harvested from the different crosses.

Table 2. Number of crosses made and number of seed produced in hybridization

Sl.no.	Cross combination	No. of seed harvested
1.	BS-15xBS-9	45
2.	BS-14XBS-9	74
3.	BS-9XBS-11	65
4.	BS-17XBS-11	23
5.	BS-17XRai-5	1
6.	Line 248xBS-18	23
7.	BS-13XBS-9	23
8.	Line-248xBS-16	29
9.	BS-16XBS-11	16
10.	BS-17 x rai-5	43
11.	BS-7XBS-18	50
12.	Line-248Xcarinata	1
13.	BS-7X0876	65

Table 3. Number of 3-way and 4-way crosses made, and number of seed produced in hybridization

Sl.no.	Cross combination	No. of seed harvested
1.	line248xBS-18XBS-16	7
2.	BS-17XBS-11XBS-18	282
3.	BS-18XWildXBS-7	216
4.	BS-17XRai-5 X0876	2
5.	BS-9XB Line-248xBS-7	526
6.	BS-18XWildx0876	1606
7.	BS-11XBS-18X0876	570
8.	BS-17XBS-11X0876	7
9.	BS-14XBS-9(B)XBS-14XBS-9(Y)	600
10.	B Line-248xBS-18xBS-13XBS-9	6

Conclusion

The produced 13 single crosses, 8 three-way crosses and 2 four-way crosses will be grown in the next rabi season along with their parents for confirmation and make 4-way cross and 8-way crosses.

DEVELOPMENT OF HEXAPLOIDY *Brassica spp.*

M SHALIM UDDIN AND M A LATIF AKANDA

Abstract

The experiment was conducted at green house of Plant Breeding Division, Bangladesh Agricultural Research Institute, Joydebpur to incorporation of sufficient genetic diversity to form a basis for breeding and improvement of this potential crop species and to improvement of agronomic traits to the level of "elite" breeding material in the diploid and allotetraploid crop species. First generation produced 25 seed and second generation produced 35 allohexaploid seeds successfully will be grown in the next season along with their parents for confirmation and the subsequent generations.

Introduction

The production of allohexaploid Brassica crop (2n = AABBCC) is increasingly attracting international interest: allohexaploid crop could benefit from several major advantages over the existing Brassica diploid and allotetraploid species, combining genetic diversity and traits from all six crop species with additional allelic heterosis from the extra genome. Although early attempts to produce allohexaploids showed mixed results, recent technological and conceptual advances have provided promising leads to follow. Therefore, keeping in view the above points, present investigation was undertaken to incorporation of sufficient genetic diversity to form a basis for breeding and improvement of this potential crop species and to improvement of agronomic traits to the level of "elite" breeding material in the diploid and allotetraploid crop species.

Materials and Methods

Crosses were done in the fashion between two of the three allotetraploids, following which will be produce hybrid crossed to the third species (e.g. AACC × BBCC → CCAB × AABB → AABBCC). The allohexaploids produce by crosses between the allotetraploid species, referring to the names of the species in the cross combination (*B. napus, B. carinata and B. juncea*; NCJ model). Crosses between allotetraploids rely on production of unreduced gametes (gametes with the somatic chromosome number, or all chromosomes present in the somatic tissue of the interspecific hybrid) in the cross to restore balanced ploidy level, while crosses between diploids rely on colchicine treatment to double the chromosome number. Both of these two methods have only ever been successfully carried out using one order of crossing. Crosses will be grown in one row 1 m long plot in greenhouse.

Parents:

1st Generation: BARI Sarisha-13 ;*B. napus* x *B. carinata*

AACC x BBCC

$\downarrow$

2nd Generation F$_1$ Hybrid × *B. juncea (*BARI Sarisha-11*)*

CCAB × AABB

$\downarrow$

3rd Generation Allohexaploids

(2n=AABBCC)

$\downarrow$

Selection for desirable plant types has to be done in F$_2$ and the subsequent generations.

Results and Discussion

The results of the crosses between *B. napus* (BARI Sarisha-13) × *B. carinata* in first generation were produced 25 seed in green house by using 1% GA_3 spraying after emasculation in the stigma and second generation crossing between F_1 Hybrid (CCAB) × *B. juncea (*BARI Sarisha-11; AABB*)* produced 35 Allohexaploids seeds.

Table 1. Number of crosses made, and number of seed produced in hybridization

Sl.no.	Cross combination	No. of seed harvested
1.	*B. napus* (BARI Sarisha-13) × *B. carinata*	25
2.	F_1 Hybrid (CCAB) × *B. juncea (*BARI Sarisha-11; AABB*)*	35

Conclusion

First generation produced 25 seed and second generation produced 35 allohexaploid seeds successfully will be grown in the next season along with their parents for confirmation and the subsequent generations.

DEVELOPMENT OF NESTED ASSOCIATION MAPPING (NAM) POPULATIONS

M SHALIM UDDIN and M A LATIF AKANDA

Abstract

The experiment was conducted at green house of Plant Breeding Division, Bangladesh Agricultural Research Institute, Joydebpur to develop NAM population to create genetic variability and to phenotyping of NAM lines under multiple stresses. Twenty parental lines were used, and 10 single crosses were made successfully.

Introduction

Nested association mapping (NAM) is a technique designed for identifying and dissecting the genetic architecture of complex traits. It is important to note that nested association mapping is a specific technique that cannot be performed outside of a specifically designed population. The novel allele rearrangements and greater genetic diversity in these NAM populations will be identified. The highly recombined NAM lines may be used directly as source materials for the extraction and development of varieties adapted to different environments. Therefore, keeping in view the above points, present investigation was undertaken to develop NAM population to create genetic variability and to phenotyping of NAM lines under multiple stresses.

Materials and Methods

Twenty selected diverse founder varieties/lines, with a heterogeneous background were used in this program. Seeds of the parents were sown at green house of Plant Breeding Division by customize the green house environment with enhanced lighting to create intense day-long regimes to speed up the search for better performing crops to make crosses. The plot size was one row of 1.5 m long for each line. Row to row distance was 25 cm and seeds were sown continuously. Fertilizers were applied at per recommended doses. Intercultural operations were done as and when necessary. Rouging was done before heading. At flowering time single crosses were made. Matured siliquae of all the crosses were harvested, dried and after threshing seeds were preserved properly for next use.

Results and Discussion

The results of the crosses are shown in Table 1. Seeds were harvested from the different crosses.

Table 1. F1 plant selfing and number of F2 seed harvested

Sl.no.	F1 selfing for F2	No. of F2 seed harvested
1.	BS-15xBS-9	342
2.	BS-14XBS-9	164
3.	BS-9XBS-11	120
4.	BS-17XBS-11	30
5.	BS-18XWild	575
6.	BS-17XRai-5	1
7.	Line 248xBS-18	253
8.	BS-13XBS-9	353
9.	Line-248xBS-16	799
10.	BS-13XBS-9	690
11.	BS-9XLine -248	500
12.	BS-16XBS-11	216
13.	BS-17 x rai-5	758
14.	BS-14XBS-9 (Y)	204
15.	BS-7XBS-18	1300
16.	BS-7X0876	1214

Conclusion

Sixteen parental lines were used and 18 single crosses, 8 three-way crosses and 2 four-way crosses were made successfully will be grown in the next rabi season along with their parents for confirmation and make 4-way cross and 8-way crosses.

INTROGRESSION OF HEAT TOLERANCE GENE IN RAPESEED-MUSTARD FROM WILD RELATIVES

M SHALIM UDDIN and M A LATIF AKANDA

Abstract

The experiment was conducted at green house of Plant Breeding Division, Bangladesh Agricultural Research Institute, Joydebpur to introgression of heat and aphid tolerance gene and to broadening of genetic diversity. From 9 F_1 plants 150 F_2 seeds were harvested and after proper drying the seeds were stored in the cool room for the rapid generation advancing in green house.

Introduction

Crop wild relatives (CWR) are widely recognized as an invaluable genetic resource for breeding, in particular for broadening the genetic base of crops with narrow genetic diversity, and as sources of variation for traits of interest in breeding crops, including adapting them to the challenges posed by climate change (Dempewolf et al., 2014). Modern varieties of many important crops carry introgressions from wild species resulting from breeding programs performed in the last 100 years (Hajjar and Hodgkin, 2007).

Rorippa indica (L.) Hiern, an ocassional shade loving weed shows resistance against the mustard aphid and heat tolarance. *R. indica* is a wild crucifer found in the Bangladesh, Indian and Asia. It remains in the rosette form throughout the winter. Then it bolts out and grows into highly branched bush throughout the summer. It survives many nonspecialist herbivores including the crucifer specialist aphid L. erysimi

Therefore, keeping in view the above points, present investigation was undertaken to introgression of heat and aphid tolerance gene and to broadening of genetic diversity.

Materials and Methods

BARI sarisha-18 (*B. napus*; 2n=34) and *Rorippa indica***,** *(*2n = 16, 32*)* one of the CWR of *Brassica spp*. were used in this program. Seeds of the parents were sown at green house of Plant Breeding Division by customize the green house environment with enhanced lighting to create intense day-long regimes to speed up the search for better performing crops to make crosses. The plot size was one row of 1.5 m long for each line. Row to row distance was 25 cm and seeds were sown continuously. Fertilizers were applied at per recommended doses. Intercultural operations were done as and when necessary. Rouging was done before flowering. Emasculation and pollination were followed by bagging with the thin brown paper bags and labelled with tags. To overcome the interspecific pre-fertilization barrier, 0.1% gibberellic acid was sprayed after emasculation by using a hand sprayer. Achieving the proper maturation of siliqua F_1 hybrids were harvested and after proper drying the seeds were stored in the refrigerator for the use of next winter season. At flowering time single crosses were made. Matured siliquae of all the crosses were harvested, dried and after threshing seeds were preserved properly for next use.

Results and Discussion

The results of the crosses are shown in Table 1. Seeds were harvested from the different crosses.

Table 1. Number of crosses made, and number of seed produced in hybridization

Sl.no.	Cross combination	No. of seed harvested
1.	BS-18XWild; F_1	16
2.	BS-18XWild (Selfing); F_2	150

5 interspecific cross was success, and 16 seeds were found in the green house. Interspecific F_1 seeds were sowing in the field during 2021-22. From 9 F_1 plants 150 F_2 seeds were harvested and after proper drying the seeds were stored in the cool room for the rapid generation advancing in green house.

Conclusion

From 9 F_1 plants 150 F_2 seeds were harvested and after proper drying the seeds were stored in the cool room for the rapid generation advancing in green house.

IDENTIFICATION OF CLIMATE SMART RAPESEED-MUSTARD

M SHALIN UDDIN, M K SHAHADAT, U KULSUM, M H RASHID AND M A LATIF AKANDA

Abstract

One hundred ninety-nine (199) multi-parent advanced generation inter-cross (MAGIC) population RIL lines of rapeseed (B. rapa) was evaluated at OFRD, BARI, Khulna in saline soil to select diverse saline tolerance parents based on multiple traits selection index for the future breeding program. This selection was done focusing on a total of seventeen qualitative and quantitative traits variation and genetic parameters namely, phenotypic and genotypic variance (PV and GV) and genotypic and phenotypic coefficients of variation (GCV and PCV), broad-sense heritability (hBS), genetic advance, traits association, Genotype by trait biplot (G×T), Heatmap analysis and Multi-trait index based on factor analysis and genotype-ideotype distance (MGIDI). Descriptive statistics and analysis of variance revealed a wide range of variability for morpho-physiological traits. Estimated hBS for all the measured traits ranged from 10.6% to 93%, indicating that all the traits were highly inheritable. Genetic variances were low to high for most morpho-physiological traits, indicating complex genetic architecture. Yield per plant was significantly correlated with Fruit diameter, fruits per plant, percent fruits infestation by rapeseed shoot and fruit borer, and fruit weight traits indicating that direct selection based on fruit number and fruit weight might be sufficient for improvement of other traits. The first two principal components (PCs) explained about 81.27% of the total variation among lines for thirty-eight rapeseed morpho-physiological traits. Genotype by trait (G×T) biplot revealed superior genotypes with combinations of favorable traits. The average genetic distance was 3.53, ranging from 0.25 to 20.01, indicating high levels of variability among the germplasm. The heat map was also used to know the relationship matrix among all the rapeseed genotypes. MGIDI is an appropriate method of selection based on multiple trait information. Based on the fourteen qualitative and ten quantitative traits and evaluation of various genetic parameters, the germplasm M-26, M-1, M-127, M-171, M-106, M-160, M-58, M-65, M-38 and M-28 might be considered as best parents as a saline tolerance for the future breeding program for rapeseed in improvement.

Introduction

Abiotic and biotic stresses are major regulating factor that inhabit plant growth and rigorously decrease crop productivity Abiotic stresses such as drought, water logging, high temperature, cold, low-phosphorus, and salinity have an over whelming impacts on growth and yield of crops. In the field, crop simultaneously exposed to multiple abiotic stresses, like combination of drought and heat, drought and cold, salinity and heat, salinity and water logging or any of the major abiotic stresses. The response of crop to multiple stress conditions is unique and cannot be directly extrapolated from the response to each of the different stresses applied individually. Moreover, the simultaneous occurrence of different stresses results in a high degree of complexity in plant responses, as the responses to the multiple stresses are largely controlled by different metabolic pathways, signal transduction, microRNA, transcriptional regulation, genotype environment interaction (envirotyping) and many processes related to growth and development. On the other hand, sometimes opposing signaling pathways that may interact and inhibit each other. It is necessary to select saline, drought, water-logged and low-P tolerant rapeseed-mustard genotypes.

Salinity is the major abiotic stress that extremely affects plant growth and development that has appeared as an important constraint for agricultural productivity in the present days. About 1.5 million hectares of land are being unsuitable every year due to high salinity levels for agricultural production throughout the world. If this process continues in such a way, by the year 2050 nearly 50% of the cultivable area of the world will be lost.

The greater pressure to produce more food for growing populations, is especially in the developing world, because marginal lands are now being brought into cultivation, which was previously not used due to their high degree of natural salinity (Khan et al. 2003). In Bangladesh around 3.1 million hectares of cultivable land are directly and indirectly exposed to salinity. Till now 17 districts of the coastal region of Bangladesh are affected by salinity which will be turned into 30 in next 10 years. In some saline areas, desalinization can be possible. But the use of crops that have some degree of salt tolerance can also be a scope to overcome the constraints caused by salinity. Among the crops of economic interest, there are large variations from highly sensitive species such as bean and citrus, over tolerant species such as wheat, maize and sunflower, to highly tolerant ones like cotton and barley (Khan et al. 2003; Giaveno et al. 2007). Therefore, improvement of salt tolerance in plants has gained importance because of the need to provide sufficient food for the world's increasing population (Bita and Gerats 2013; Yumurtaci, 2015), which has been proposed as the most cost-effective strategy to deal with the problem (Epstein and Rains, 1987).

The multi-parent advanced generation inter-cross (MAGIC) population represents a new and powerful tool allowing the high-resolution mapping of quantitative traits (Mackay, et al., 2009; Cavanagh, et al., 2008). Crop improvement against abiotic stresses such as salinity, waterlogged, drought requires large germplasm diversity screening (Cavanagh, et al., 2008), and the combination of multiple founders provides a higher genetic and phenotypic diversity within a single mapping population. In recent years, various mapping populations that involve crossing of more than two parental lines such as multi-parent advanced generation inter-cross (MAGIC) (Cavanagh et al. 2008) and nested association mapping (NAM) populations (Yu et al. 2008) are being developed in different crops (see Scott et al. 2020). The incorporation of multiple parents ensures the population is segregating for multiple genes for multiple traits and cytoplasm effects can be normalized. Further, MAGIC populations provide a platform for community-based approach for gene discovery, characterization, and deployment of genes for under-standing complex traits (Glaszmann et al. 2010). Thus, the MAGIC population is a useful tool to develop strategies to cope with salinity stress.

Therefore, keeping in view the above points, present investigation was undertaken to evaluate the MAGIC population RIL lines on the basis of qualitative and quantitative traits at Salian area.

Materials and Methods

2.1. Experimental Site

The experiment was executed at OFRD, BARI at Khulna, Bangladesh during winter (Rabi season) 2021-2022 at Uttar Bedkashi, Koyra, 22.323100N latitude, 89.311430 E longitudes and 1.40 m above sea level of the saline condition in the coastal area.

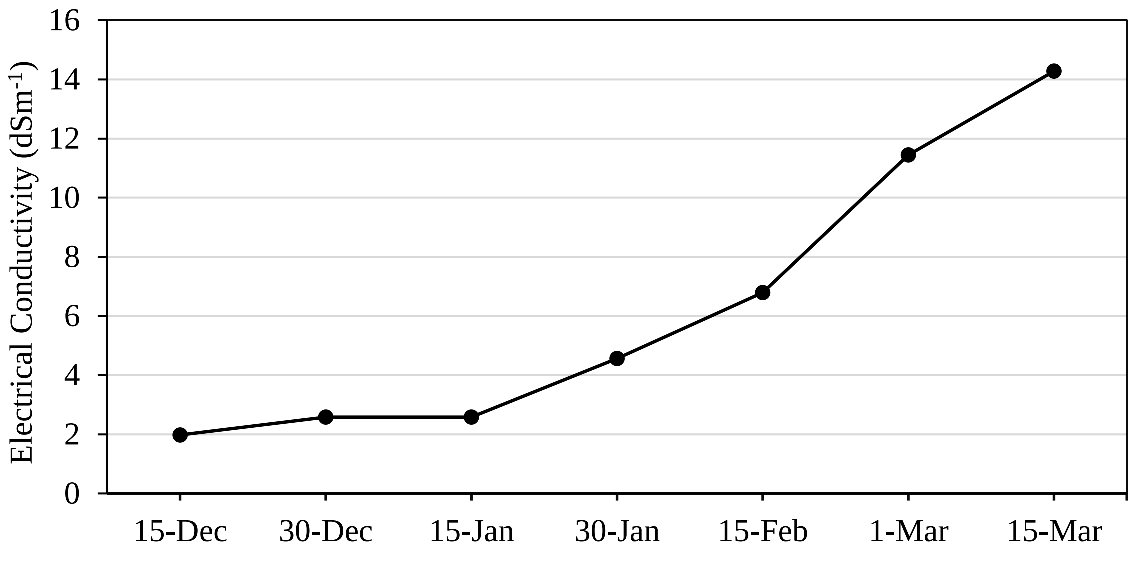

Fig.1. Soil salinity level during MAGIC populations of *B. rapa* growing period

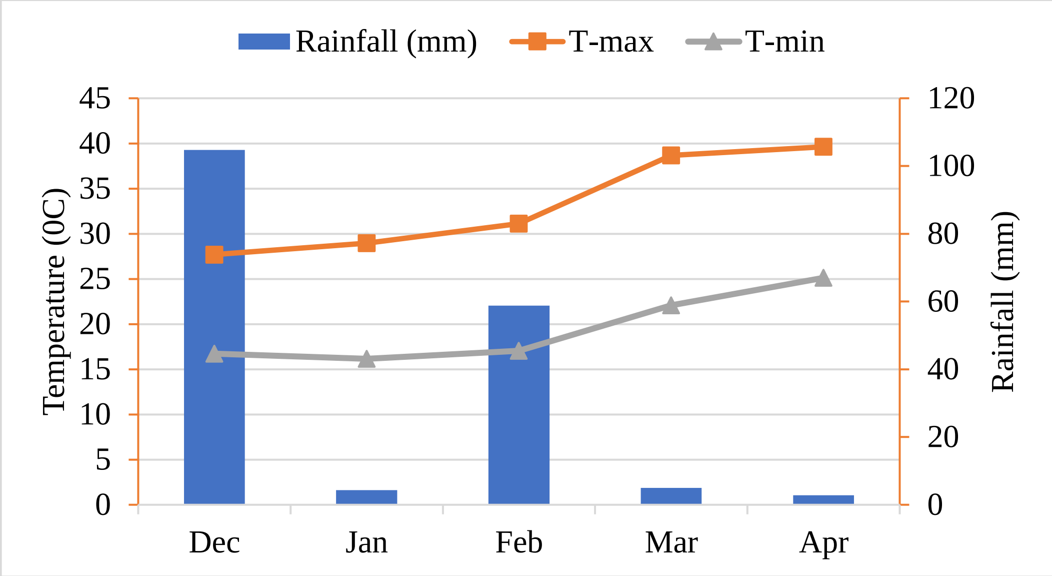

Fig.2. Rainfall and temperatures during MAGIC populations of *B. rapa* growing period

2.2. Experimental Materials, Treatments, Design and Procedures

The *B. rapa* multi-parent advanced generation inter-cross (MAGIC) population used in this study was established by the Oilseed Research Centre (ORC), BARI, Gazipur-1701, with 16 diverse founder varieties/lines, with a heterogeneous background. A total of 185 recombinant inbred lines (RILS) of the MAGIC population together with the 14 parents, among the parents 6 were used as check variety for saline tolerance.

All 185+14 genotypes were arranged in an augmented Randomized Complete Block Design (Augmented RCBD) with four check varieties and 5 blocks was followed in this study. All check varieties received 5 replications, giving a total of 255 experimental plots.

The lines were sown on 15 December 2021 in 1 rows of 3m long with spacing of 30 cm and 5cm between rows and plants, respectively. The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid, respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop.

2.3. Data Recorded

Fourteen qualitative traits and ten quantitative traits (Table 1) were considered during the morphological characterization based on short descriptor (Srivastava *et al*., 2001).

Table 1. Descriptors and descriptor states of characterization

Descriptors status

1	**Early plant vigour**		**PLT_VGR**	
	To be recorded after 25 days of sowing.			
		Poor		1
		Good		2
		Very Good		3
2	**Growth habit**		**GRW_HAB**	
	To be recorded at full foliage stage.			
		Semi erect		1
		Erect		2
		Lodging		3
		Other (Specify in the “REMARKS” descriptor)		99

3	**Branching position**		**BRN_POS**	
	To be recorded at full foliage stage.			
		Top		1
		Middle		2
		Basal		3
		Other (Specify in the "REMARKS" descriptor)		99
4	**Branching pattern**		**BRN_PAT**	
	To be recorded at full foliage stage.			
		Unbranched		0
		Sparsely branched		3
		Moderately branched		5
		Densely branched		7
		Other (Specify in the "REMARKS" descriptor)		99
5	**Number of primary branches per plant**		**PRI_BRN**	
	To be recorded at full foliage stage.			
		Quantitative		
6	**Leaf pubescence**		**LF_PUB**	
	To be recorded at full foliage stage.			
		Glabrous		
		Sparsely pubescent		
		Moderately pubescent		5
		Densely pubescent		7
		Other (Specify in the "REMARKS" descriptor)		99
7	**Leaf division**		**LF_DIVI**	
	To be recorded at full foliage stage.			
		Lyrate		
		Entire		
		Divided/ Pinnatified		
		Sinuate		4
		Lacerate		5
		Other (Specify in the "REMARKS" descriptor)		99
8	**Days to 50% flowering**		**DAY_FLW**	
	To be recorded from the date of sowing to the day when 50% of the plant in a row flowered.			
		Quantitative		
9	**Plant height (cm)**		**PLT_HGT**	
	To be measured form the base of the plant (at ground level) to the tip of the main stem shoot (average of 5 random plants).			
		Quantitative		
10	**Total number of silique per plant**		**SILI_PLT**	
	To be recorded at near maturity stage			
		Quantitative		
11	**Number of siliquea on basal primary branch**		**SILI_BRN**	
	To be recorded at near maturity stage			
		Quantitative		
12	**Number of silique on main stem**		**SILI_STM**	
	To be recorded at near maturity stage			
		Quantitative		
13	**Silique length (cm)**		**SILIQ_LT**	
	To be recorded at near maturity stage			
		Quantitative		

14	**Days to 80$ maturity**		**DAY_MAT**	
	To be recorded as the number of days from sowing to the day when 80% of silique turned brown and attained near maturity.			
		Quantitative		
15	**Number of seeds per siliqua**		**SED_SILI**	
	To be recorded at near maturity stage (average of 20 silique)			
		Quantitative		
16	**Silique shattering**		**SILIQ_ST**	
	To be recorded at visually at near maturity stage.			
		Absent		
		Present		
17	**Seed yield per plant (g)**		**SED_YLD**	
	To be recorded at maturity (average of 5 random plants).			
		Quantitative		
18	**100 seed weight (g)**		**SED_WT**	
	To be recorded at maturity stage			
		Quantitative		
19	**Seed colour**		**SED_CLR**	
	To be recorded at maturity stage			
		Yellow		
		Yellow brown		
		Light brown		
		Brown		
		Dark brown		
		Red brown		
		Red		
		Bluish black		
		Grey black		
		Others (specify in the “REMARKS” descriptor		
20	**Oil content (%)**		**OIL%**	
	Estivation of oil content (%) through NMR technique. of matured and harvested seeds			
		Quantitative		
21	**Erucic acid (%)**		**ERUCIC%**	
	Estimation of erucic acid (%), of matured and harvested seeds.			
		Quantitative		
22	**Glucosinolate (%)**		**GLUCOSI%**	
		Quantitative		
23	**Protein content (%)**		**PROTEIN%**	
	To be estimated on matured rape seeds			
		Quantitative		
24	**Blotic Stress Susceptibility**		**BSS**	
	Specify the indestation or infection using any 1-9 scale.			
	Note: For Additional information as common name9s) of disease(s)/ pest(s) and casual organism(s) may be appended in the BIOTIC NOTE descriptor.			
		Very low or no visible sign of susceptibility		1
		Low		3
		Intermediate		5
		High		7
		Very high		9
25	**Blotic notes**		**BIO_NOTE**	
		Text		
26	**Remarks**		**REMARKS**	
		Text		

Data analysis

The normalized difference vegetation index (NDVI) was measured by hand green seeker (Trimble) and green seeker RT100 (Agri Optics). Quantification of two natural light sources (near infrared-NIR and red light) is measured by NDVI. These two natural lights have individual mechanisms on vegetation. For example, NIR is reflected by the vegetation, whereas red light is absorbed by the vegetation.

The formula NDVI formula is:

NDVI = "NIR-Red" /"NIR+Red"

The multi-trait index based on factor analysis and genotype-ideotype distance (MGIDI) proposed by (Olivoto, and Nardino; 2021) was used to select the novel donors with high performing under optimum and low nitrogen conditions. We also compared the result of the MGIDI index with the result of the Smith–-Hazel (SH) index proposed by Smith (1936) and Hazel (1943) multiple trait index based on factor analysis and ideotype-design (FAI-BLUP) index proposed by (Olivoto, and Nardino; 2021). The MGIDI was computed as follows:

$$\boldsymbol{MGIDI_i = \left[\sum_{j=1}^{f}(\gamma_{ij} - \gamma_j)^2\right]^{0.5}}$$ **(Olivoto, and Nardino; 2021)**

where MGIDIi is the distance index of multi-trait genotype-ideotype for the ith genotype, γij is the score of the ith genotype in the jth factor I = 1, 2,..., g; j = 1, 2,..., f), g and f are the number of genotypes and factors, respectively, and Fj is the ideotype's jth score. This means that the genotype with the lowest MGIDI is closest to the ideotype, and as a result, it has the ideal values for all the analyzed features.

Statistical analyses were performed using R-statistics software Version 4.0.2 for Windows (R Development Core Team, 2020). Analyses of variance (ANOVA) for each trait were estimated by using R package 'augmentedRCBD' (Aravind et al., 2019). The genotypic and phenotypic coefficients of variation were calculated according to the formula given by Falconer (1981). Heritability (h^2) in the broad sense was calculated according to the formula given by Allard (1960). From the heritability estimates the genetic advance was estimated by the following formula given by Burton (1952). For each trait, components of phenotypic variance were estimated from analysis of variance using restricted maximum likelihood methods. The linear mixed effect ''lmer'' command in the lme4 package was used to estimate variance components. R package ggplot2, scales and GGally used for heatmap analysis.

The hierarchical clustering was performed using the Spearman's rank correlation algorithm. Principal component analysis (PCA) was performed using R package ggplot2, ggfortify, usethis, devtools, plyr, scales and grid.

G×T biplot was constructed from a two-way matrix of 17 traits and 199 genotypes. The first two PCs were plotted. Genotypes were plotted according to scores on each PC, and traits were plotted on the basis of the eigenvectors on each PC. The genotypic, phenotypic variance and broad-sense heritability were estimated using agricolae R-package.

Results and Discussion

Analysis of variance and frequency distribution of traits

The MAGIC population panel consisted of 185 RILs with 14 parents, among them 6 used as a check variety was tested for characterized through different morphological traits including 17 qualitative and quantitative characters. Analysis of variance (ANOVA) revealed high significant variation among the accessions with check for all the investigated traits. ANOVA for all the traits also revealed highly significant differences among the check, accession by check interaction as well as among the accession (Table 1).

Table 1. Analysis of variance of the tested morpho-physiological traits

Source	**Df**	DAYFLW	DAYMAT	BRNPAT	BRNPOS	BSS	NDVI
Genotype (G) with C	198	20.36 **	18.36**	1.78 **	0.53 **	3.22 **	0.18 **
Check (C)	5	103.74 **	25.93 **	8 **	4.83 **	30 **	0.06**
Genotype (G) vs. C	1	7.44 ns	16.96**	0.06 **	1.49 **	0.03 **	0.03 ns
Genotype (G)	192	18.26 **	17.97 **	1.63 **	0.41 **	2.54 **	0.13**
Adj.Block (B)	4	3.88 ns	6.95ns	5.6e-32 ns	4.6e-32 ns	1.9e-32 ns	0.01 ns
Residuals	20	1.92	7.75	6.3e-32	3.1e-32	5.8e-32	0.02

ns P > 0.05; * P <= 0.05; ** P <= 0.01

Table 1. Analysis of variance of the tested morpho-physiological traits (contd.)

Source	**Df**	PLTHGT	PLTVGR	PRIBRN	SEEDCLR	SEEDSILI
Genotype (G) with C	198	198.82 **	0.51 **	51.36 **	5.5 **	36.15 **
Check (C)	5	1558.85 **	1.5 **	11.07 **	10.83 **	300.29 **
Genotype (G) vs. C	1	519.3 **	2.39 **	91.93 **	1.9e-05 **	321.81 **
Genotype (G)	192	161.73 **	0.47 **	52.19 **	5.39 **	27.78 **
Adj.Block (B)	4	17.72 ns	7.6e-33 ns	0.42 ns	7e-32 ns	10.55 ns
Residuals	20	8.54	3.4e-32	0.46	3.6e-31	5.91

ns P > 0.05; * P <= 0.05; ** P <= 0.01

Table 1. Analysis of variance of the tested morpho-physiological traits (contd.)

Source	**Df**	SILIBRN	SILIPLT	SILIQLT	SILISTM	TSW	SEEDYLD
Genotype (G) with C	198	152.01 **	21969 **	26.08 **	180.86 **	0.26 **	16.26 **
Check (C)	5	519.5 **	37062**	28 **	324 **	1.13 **	26.86 **
Genotype (G) vs. C	1	1275.07 **	224703 **	148.14 **	301.79 **	0.3 **	61.94 **
Genotype (G)	192	136.59 **	20520 **	25.4 **	176.5 **	0.24 **	15.75 **
Adj.Block (B)	4	1.8e-29 ns	479. ns	2.2e-30 ns	2.5e-29 ns	0.04 ns	0.06 ns
Residuals	20	1.6e-29	489.17	4e-30	1.2e-29	0.09	0.02

ns P > 0.05; * P <= 0.05; ** P <= 0.01

Table 2. Descriptive statistics of measured traits

Trait	**Mean**	**Std.Error**	**Std.Deviation**	**Min**	**Max**	**Skewness**	**Kurtosis**
PLTVGR	1.79	0.05	0.68	1	3	0.28 ns	2.13 **
NDVI	0.65	0.004	0.06	0.52	0.97	1.11 **	7.03 **
BRNPOS	2.07	0.05	0.65	1	3	-0.06 ns	2.35 *
BRNPAT	4.95	0.09	1.27	3	7	0.03 ns	2.48 ns
PRIBRN	10.66	0.5	7.12	3.67	71	6.68 **	54.82 **
DAYFLW	36.38	0.31	4.4	28.57	46.23	0.28 ns	2.08 **
PLTHGT	102.37	0.93	13.11	68.57	136.07	0.0023 ns	2.79 ns
SILIPLT	307.65	10.06	141.87	47.8	748.8	1.16 **	4.31 **
SILIBRN	21.7	0.83	11.68	4	60	0.98 **	3.63 ns
SILISTM	44.31	0.93	13.16	13	72	0.16 ns	2.65 ns
SILIQLT	23.32	0.35	4.99	0	39	-0.1 ns	5.04 **
SEEDSILI	19.84	0.38	5.4	8.77	37.27	0.66 **	3.66 ns
DAYMAT	77.06	0.23	3.18	68.53	84.53	-0.07 ns	2.72 ns
TSW	3.4	0.03	0.49	2.11	4.64	-0.03 ns	2.41 *
SEEDCLR	4.17	0.16	2.3	1	9	0.12 ns	1.77 **
BSS	4.03	0.11	1.62	1	7	-0.11 ns	2.53 ns
SEEDYLD	8.87	0.28	3.94	2.14	24.53	1.15 **	4.83 **

ns P > 0.05; * P <= 0.05; ** P <= 0.01

Descriptive statistic of the traits

For morpho-physiological traits evaluated in this study, their descriptive statistics including means and standard error (std.Error), standard deviations (std.Dev), minimum (Min), maximum (Max), skewness and kurtosis are summarized in Table 2. Wide ranges of phenotypic values were observed for all traits.

Skewness is a measure of the asymmetry and kurtosis is a measure of 'peakedness' of a distribution (Fig.3-13). The skewness and kurtosis both were non-significant for the traits of BRNPAT, PLTHGT, SILISTM, and DAYMAT indicating all the traits fitted with normal distribution. The traits PLTVGR, NDVI, PRIBRN, DAYFLW, SILIPLT, SEEDSILI, SEEDCLR and SEEDYLD were significant, and the distribution is positively skewed, which means that more accessions below the mean than expected in a normal distribution. The trait BRNPOS, SILIQLT, BSS and TSW were non-significant, and the distribution is negatively skewed, which means that more accessions above the mean than expected in a normal distribution. The traits PLTVGR, NDVI, BRNPAT, DAYFLW, SILIPLT, SILIQLT, TSW SEEDCLR and SEEDYLD were significant and positive for kurtosis which means heavily leptokurtic distributions.

The results pertaining to genetic parameters viz., phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), broad sense heritability (h^2 bs) and genetic advance as percent of mean (GAM) for all the 17 characters are furnished in Table 3. The Highest magnitude of both PCV (67.78%) and GCV (67.49%) were observed for SILIPLT followed by SEEDCLR, SILIBRN, SILIPLT and SEEDYLD. For High PCV and high GCV suggesting that these characters were under the influence of genetic control. The characters DAYFLW, PLTHGT and TSW recorded for medium magnitudes of both PCV and GCV, respectively. The traits NDVI and DAYMAT recorded for low magnitudes of both PCV and GCV respectively.

Table 3. Genetic Variability Analysis of different traits

Trait	Mean	PV	GV	EV	GCV	PCV	ECV	hBS	GA	GAM
PLTVGR	1.79	0.47	0.47	3.4e-32	38.27	38.27	1e-14	80	1.42	78.96
NDVI	0.65	0.0013		0.02		5.63	19.17	76		
BRNPOS	2.07	0.41	0.41	3.1e-32	31.05	31.05	8.5e-15	74	1.32	64.07
BRNPAT	4.95	1.63	1.63	6.3e-32	25.75	25.75	5.1e-15	68	2.63	53.13
PRIBRN	10.66	52.19	51.74	0.46	67.49	67.78	6.34	90.13	14.77	138.61
DAYFLW	36.38	18.26	16.33	1.92	11.11	11.74	3.81	89.47	7.89	21.68
PLTHGT	102.37	161.73	153.19	8.54	12.09	12.42	2.85	94.72	24.85	24.28
SILIPLT	307.65	20520.97	20031.79	489.17	46.01	46.56	7.19	97.62	288.48	93.77
SILIBRN	21.7	136.59	136.59	1.6e-29	53.85	53.85	1.8e-14	89.0	24.11	111.09
SILISTM	44.31	176.5	176.5	1.2e-29	29.99	29.99	7.9e-15	91.0	27.41	61.86
SILIQLT	23.32	25.4	25.4	4e-30	21.61	21.61	8.6e-15	93.0	10.4	44.59
SEEDSILI	19.84	27.78	21.87	5.91	23.57	26.56	12.25	78.73	8.56	43.14
DAYMAT	77.06	7.97	5.37	12.75	2.45	3.66	4.63	72.0	2.00	10.00
TSW	3.4	0.24	0.22	0.02	13.7	14.41	4.47	90.39	0.91	26.86
SEEDCLR	4.17	5.39	5.39	3.6e-31	55.73	55.73	1.4e-14	89.8	4.79	114.96
BSS	4.03	2.54	2.54	5.8e-32	39.55	39.55	6e-15	90.2	3.29	81.59
SEEDYLD	8.87	15.75	15.66	0.09	44.6	44.72	3.31	9.45	8.14	91.76

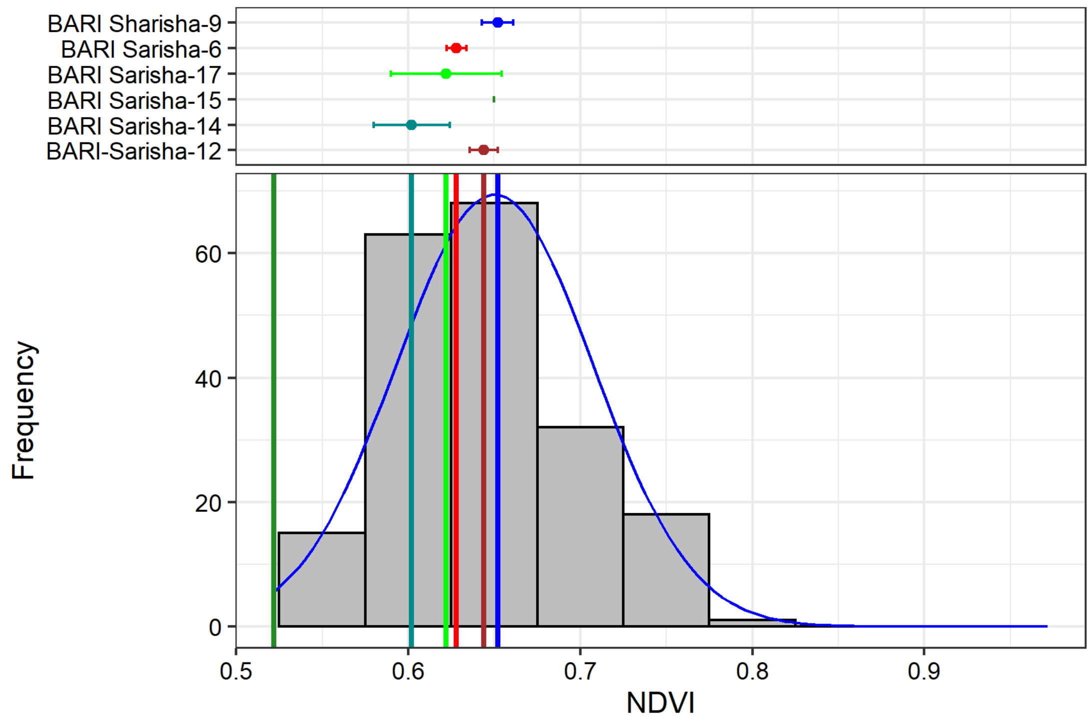

Fig. 3. Frequency distribution of NDVI with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

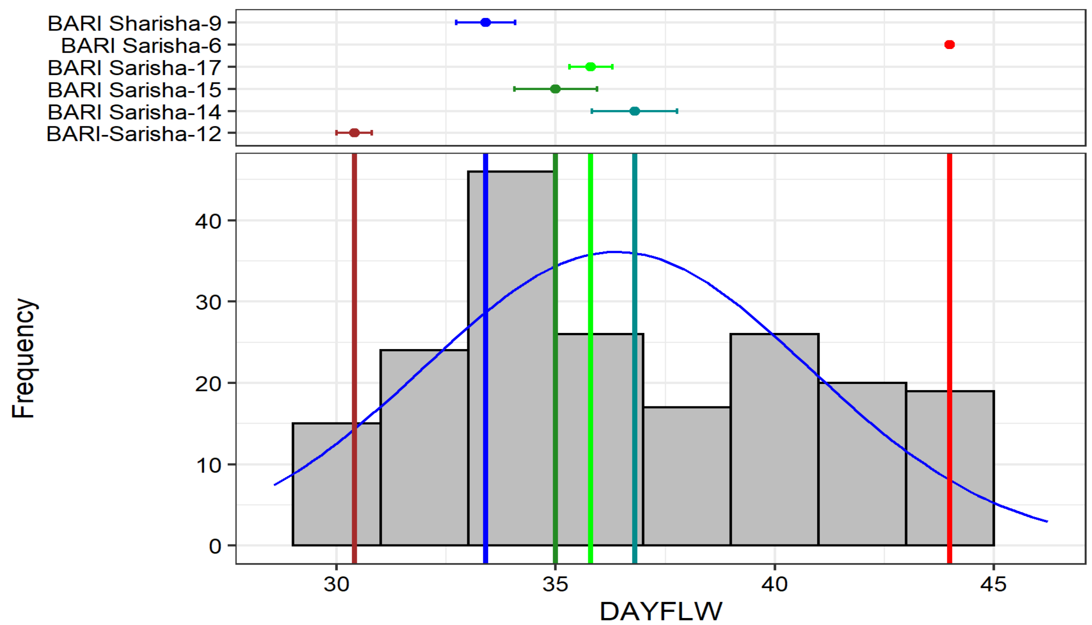

Fig. 4. Frequency distribution of days to 50% flowering (DYFLW) with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

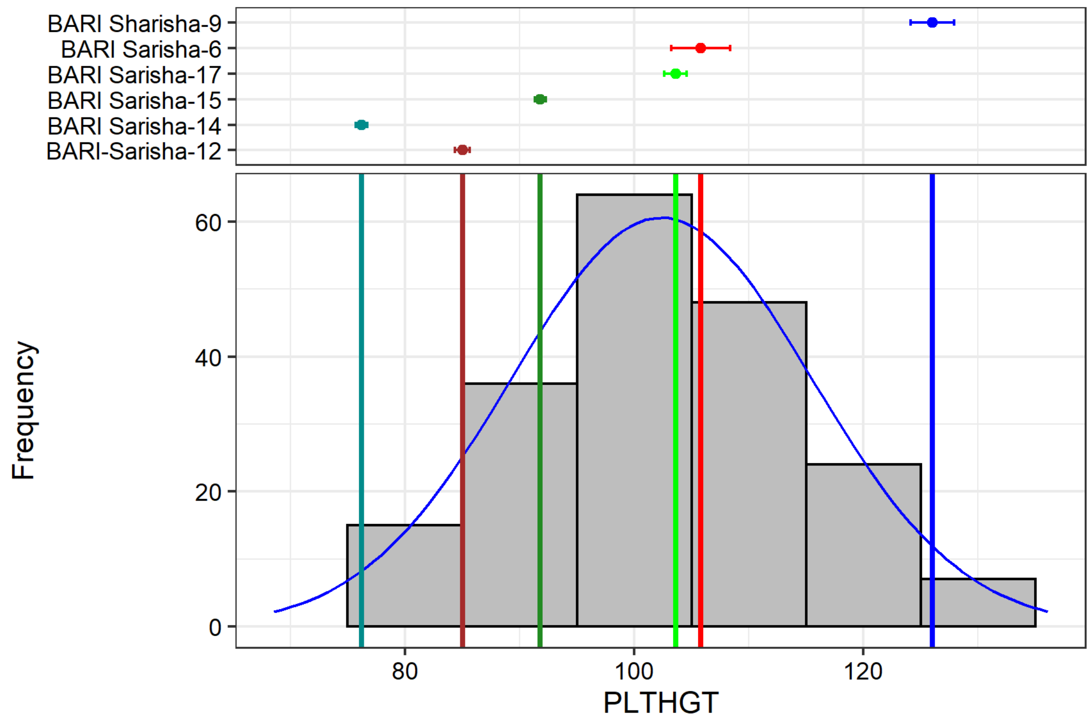

Fig.5. Frequency distribution of plant height (PLTHGT) with a normal probability curve and check varieties of B. *rapa* MAGIC population RIL lines at salinity stress

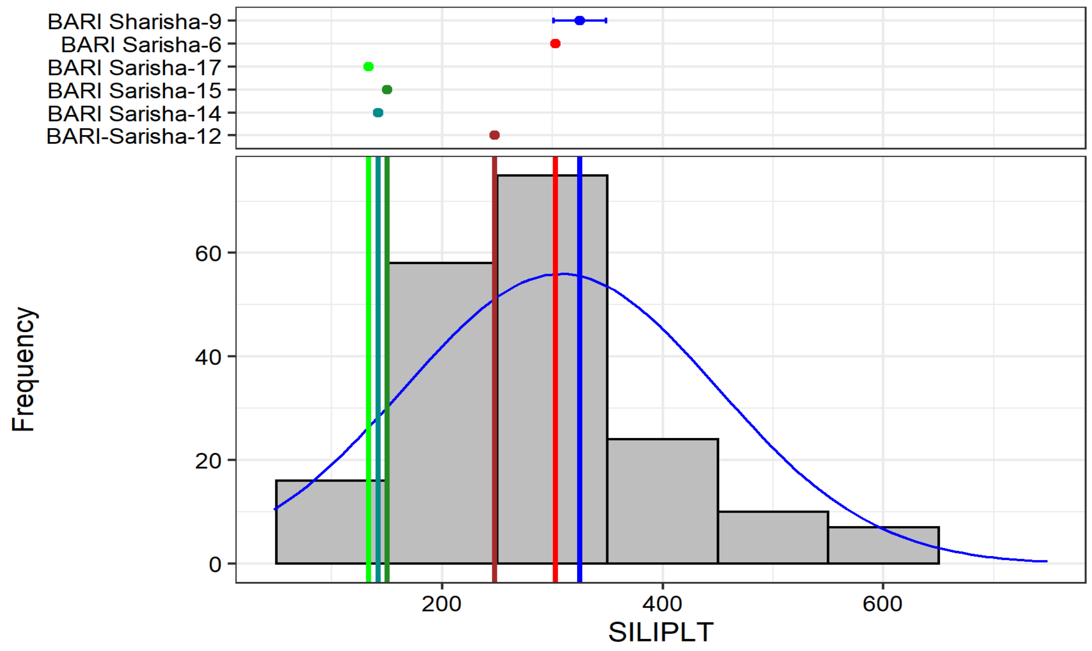

Fig.6. Frequency distribution of Total number of silique per plant (SILIPLT) with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

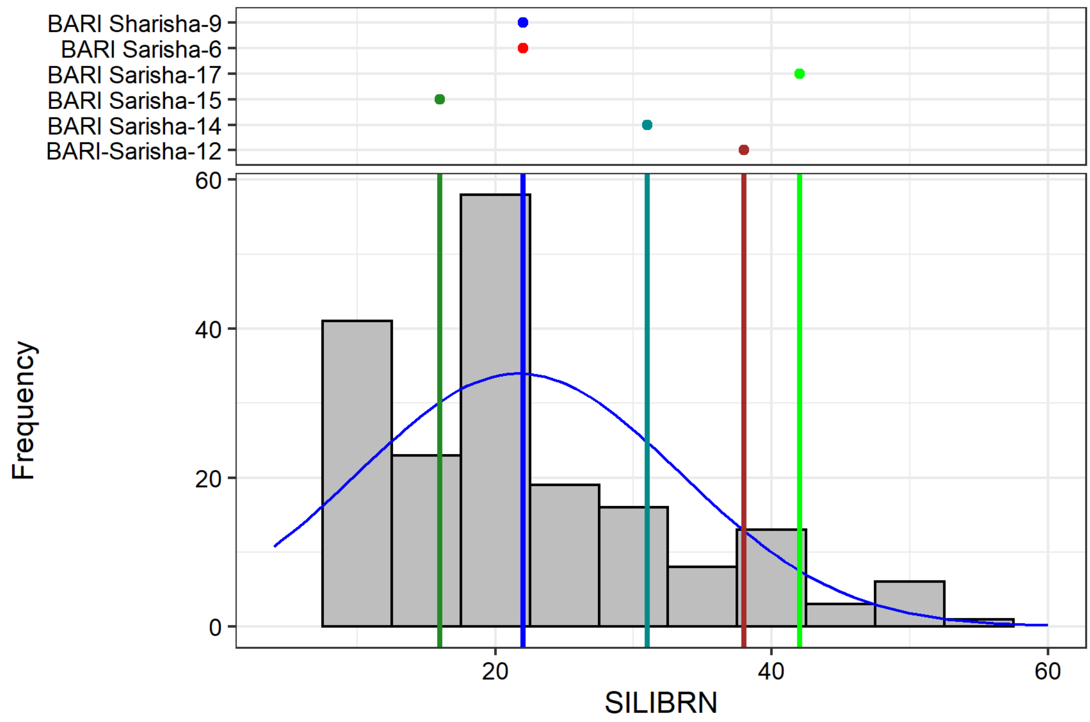

Fig.7. Frequency distribution of Number of siliquea on basal primary branch (SILIBRN) with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

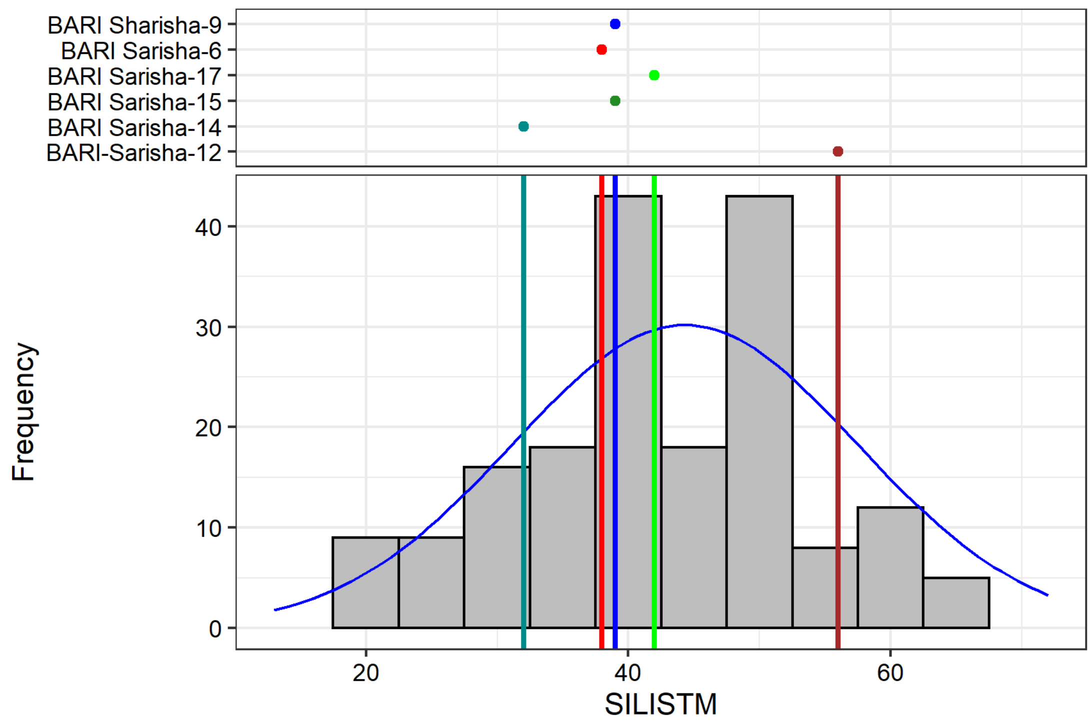

Fig.8. Frequency distribution of Number of silique on main stem (SILISTM) with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

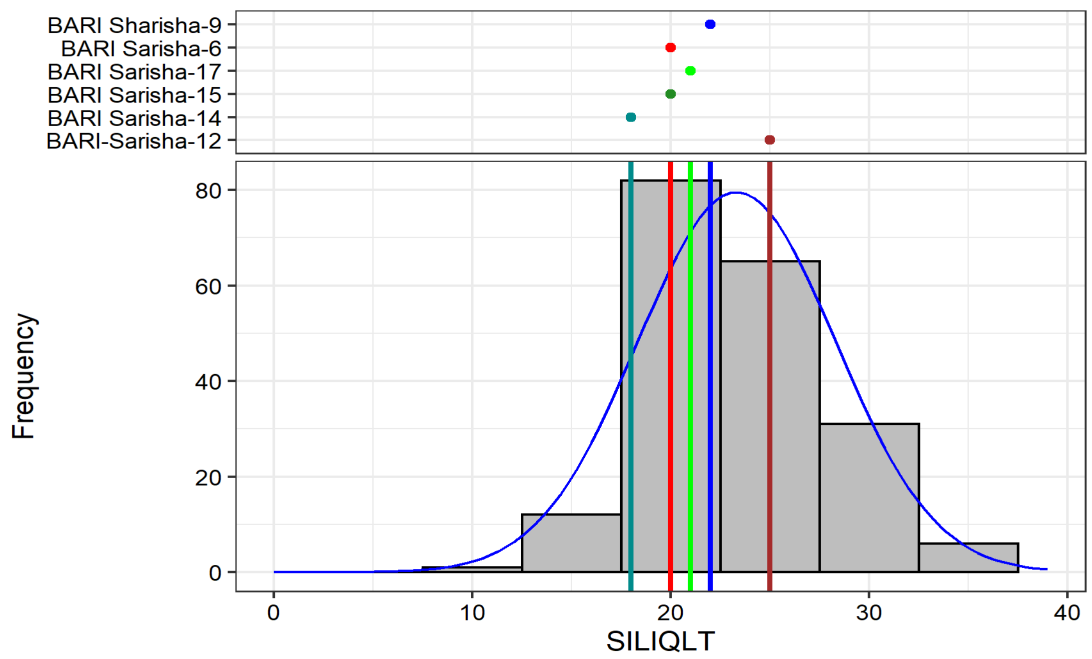

Fig.9. Frequency distribution of Silique length (cm) (SILIQLT) with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

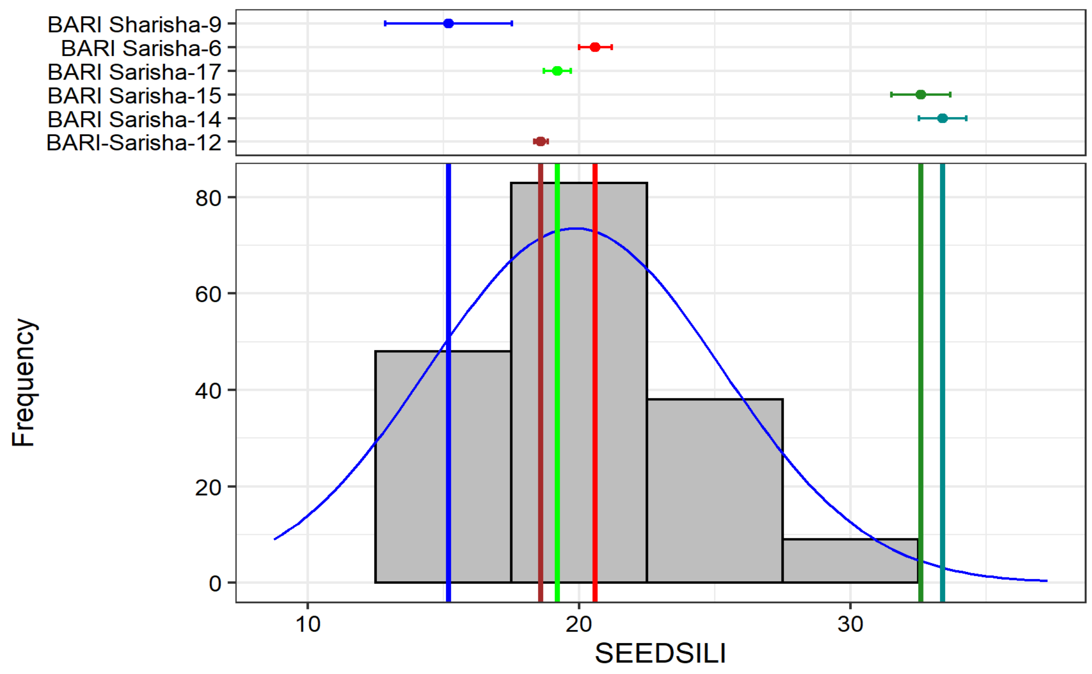

Fig. 10. Frequency distribution of Number of seeds per siliqua (SEEDSILI) with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

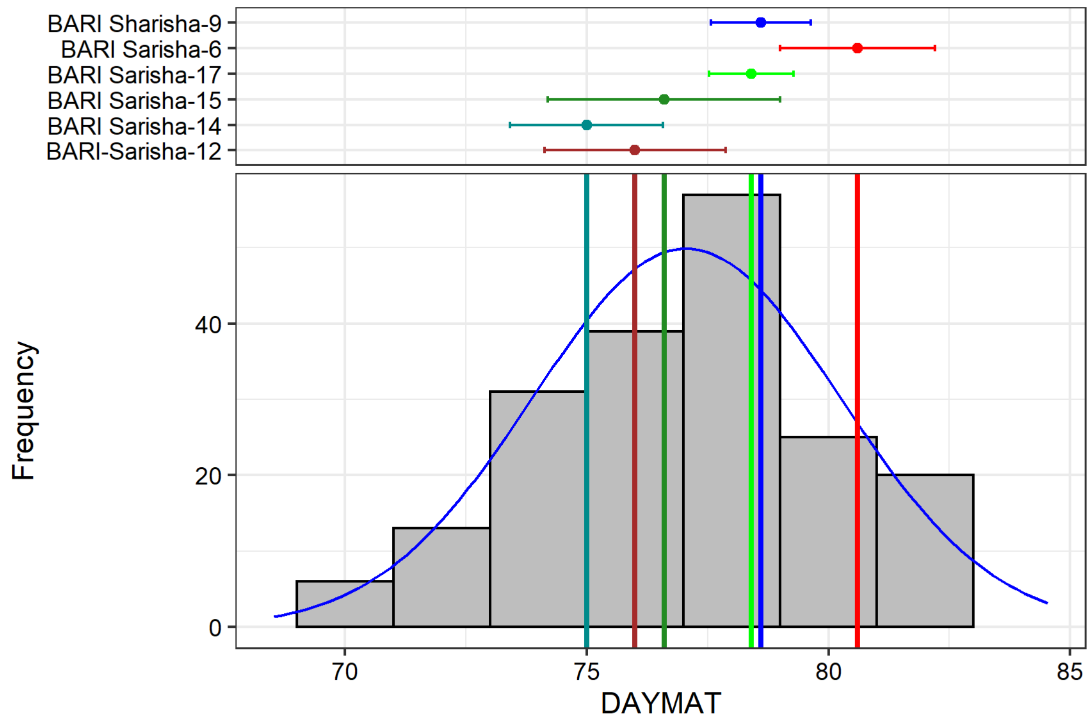

Fig. 11. Frequency distribution of Days to 80% maturity (DAYMAT) with a normal probability curve and check varieties of *B. rapa* MAGIC population RIL lines at salinity stress

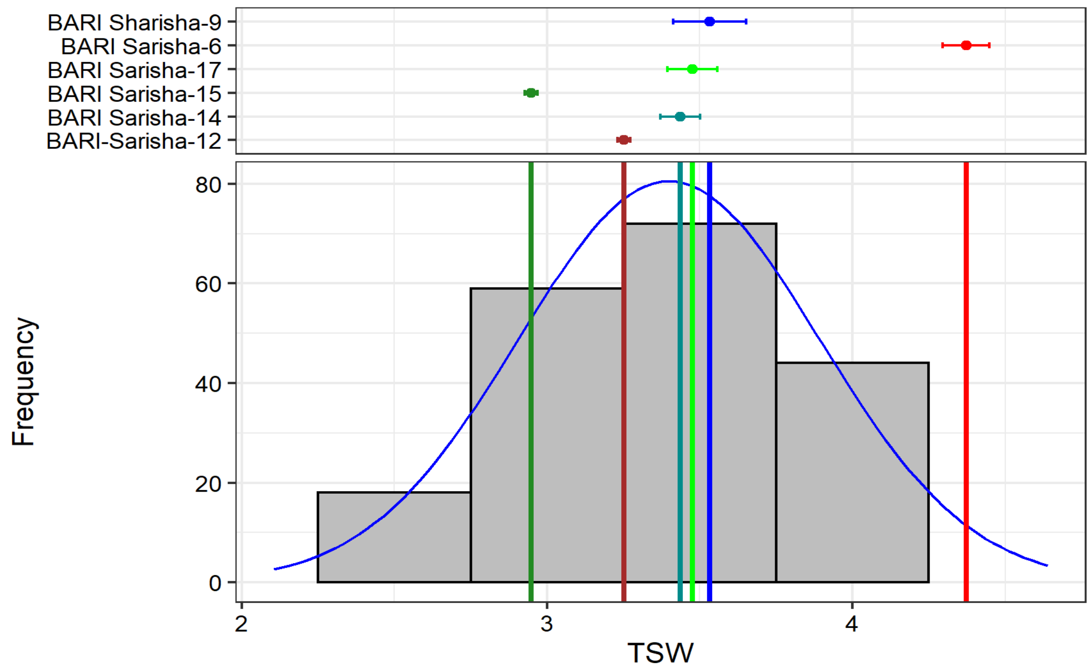

Fig. 12. Frequency distribution of 1000 seed weight (g) (TSW) with a normal probability curve and check varieties of B. *rapa* MAGIC population RIL lines at salinity stress

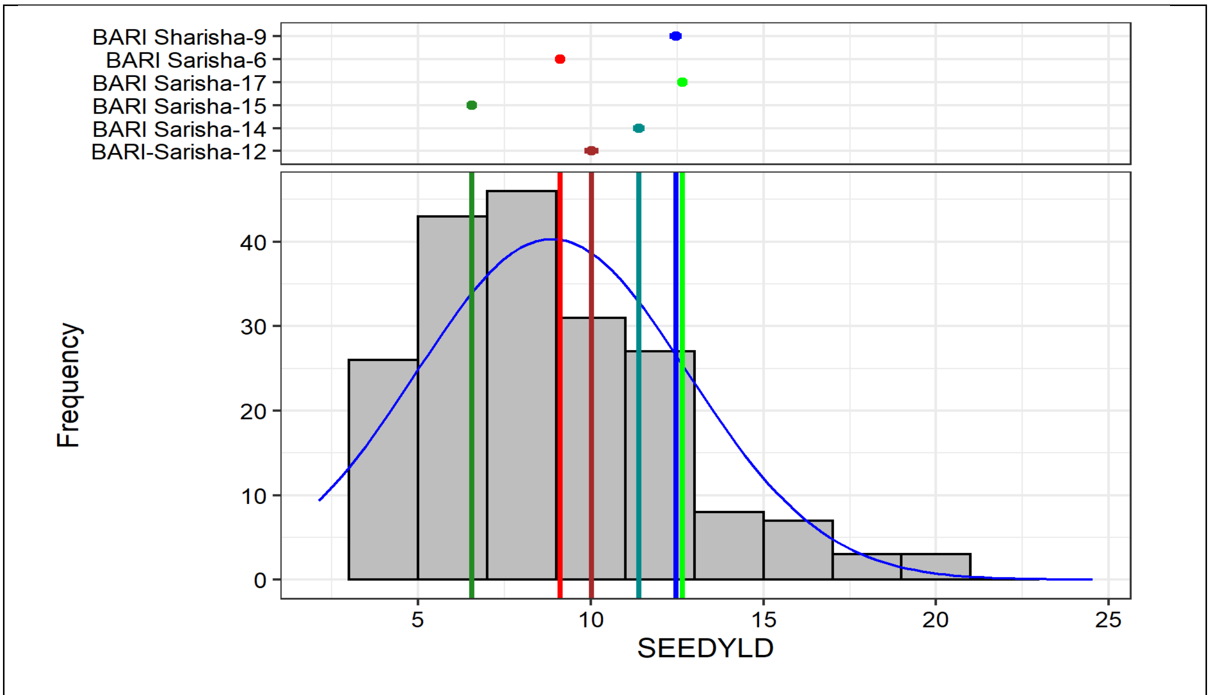

Fig.13. Frequency distribution of Seed yield per plant (g) (SEEDYLD) with a normal probability curve and check varieties of B. *rapa* MAGIC population RIL lines at salinity stress

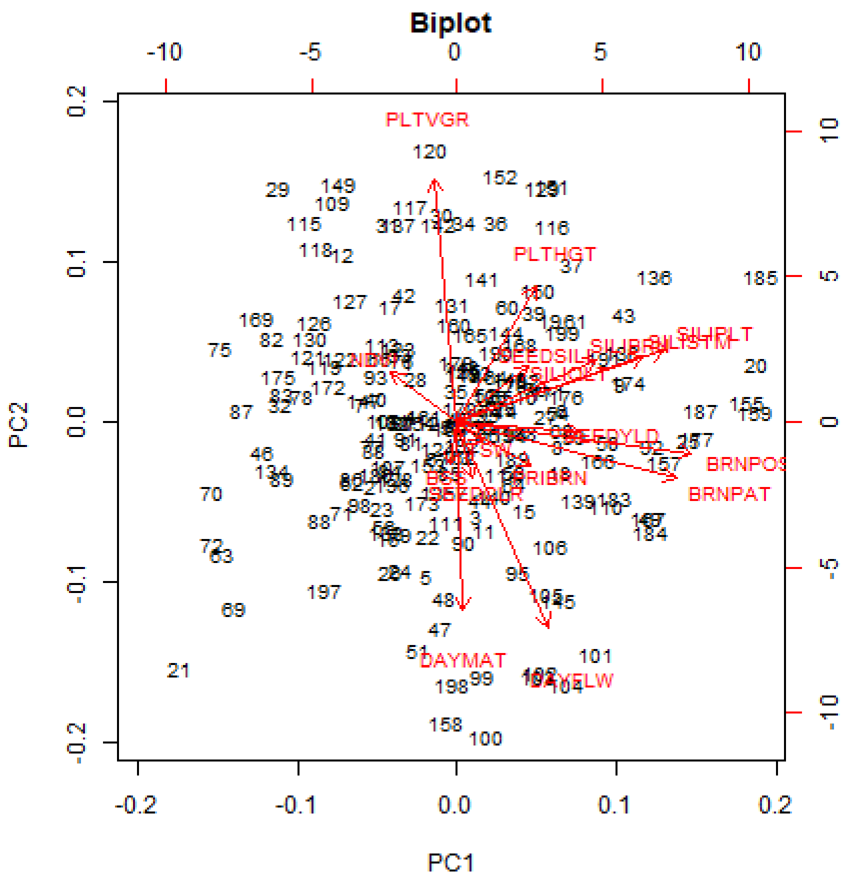

Fig.14. A G×T biplot based on 199 MAGIC population RILs and 17 morpho-physiological traits of *B. rapa*.

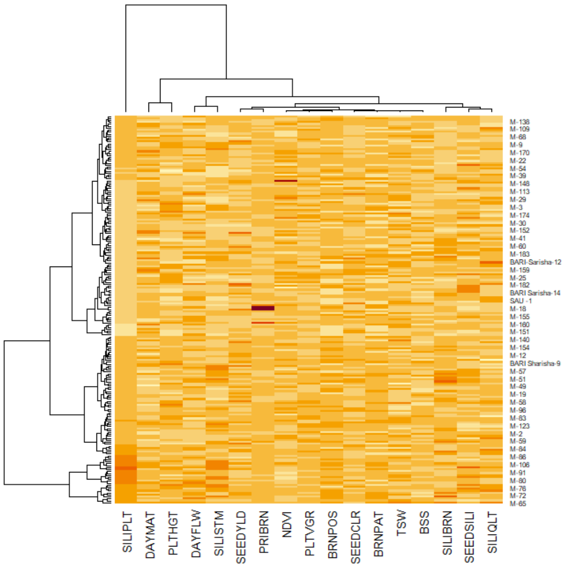

Fig.15. Heatmap showing the clustering pattern of 199 *B. rapa* MAGIC lines with 17 morpho-physiological traits. Heat map displaying the relationship matrix among *B. rapa* genotypes. The red diagonal represents a perfect relationship of each accession with itself. The symmetric off-diagonal elements represent the relationship measures for pairs of genotypes. The white of warmer colors on the diagonal show clusters of closely related genotypes

Multivariate analysis

Multivariate analysis is a tool to find patterns and relationships between several variables simultaneously. Unlike univariate and bivariate statistical methods, multivariate statistical methods are capable of analyzing more than one relationship at a time. There are a number of multivariate data analysis methods, each with its own purpose like Regression Analysis, Factor analysis, Cluster analysis, Variance analysis, Discriminant analysis etc. In order to study the relationship among 199 *B. rapa* genotypes with various morpho-physiological traits. Principal component analysis biplot, heatmap analysis were done which revealed different clusters of genotypes that performed better in different aspects.

Biplot analysis

Biplot analysis mostly used to determine the components which effect is more to create the genotypic variation. The highest values indicate the highest influence of the trait to the total variation. Biplot analysis determine varietal stability in the multi-environmental trial (Farshadfaret al. 2013). It describes the association among the traits across different genotypes (Yan and Reid, 2008). Biplot can also be used to determine gene expression of plants (Chapman et al. 2002). The Principal Component Analysis (PCA) identified a total of 10 Principal Components (PCs) for the morpho-physiological traits. Among them three PC with an eigenvalue greater than 1 explaining 82.36% of the entire morpho-physiological variation (Fig. 14).

The association between morpho-physiological traits among the 199 genotypes were observed by the biplot analysis. Again, biplot analysis showed the trait profiles of the genotypes, especially, those genotypes positioned far away from the origin and the results indicated correlation between traits with genotypes. The acute angle between two traits represented positive correlation while the obtuse angle between two traits represented negative correlation (Yan and Reid, 2008).

Heatmap analysis

Heatmap explored the performances of the observed hybrids encountering salinity as well as in controlled condition regarding their biochemical traits. It shows the highest and lowest values of each genotypes in different colors against all the traits comparing. The intensity of the color indicates the degree of high or low of the traits. Grey color indicates higher value while cyan color indicates lower value as showed in the scale. Hierarchical clustering based on the morpho-physiological traits of the studied germplasm revealed five clusters (Fig. 15).

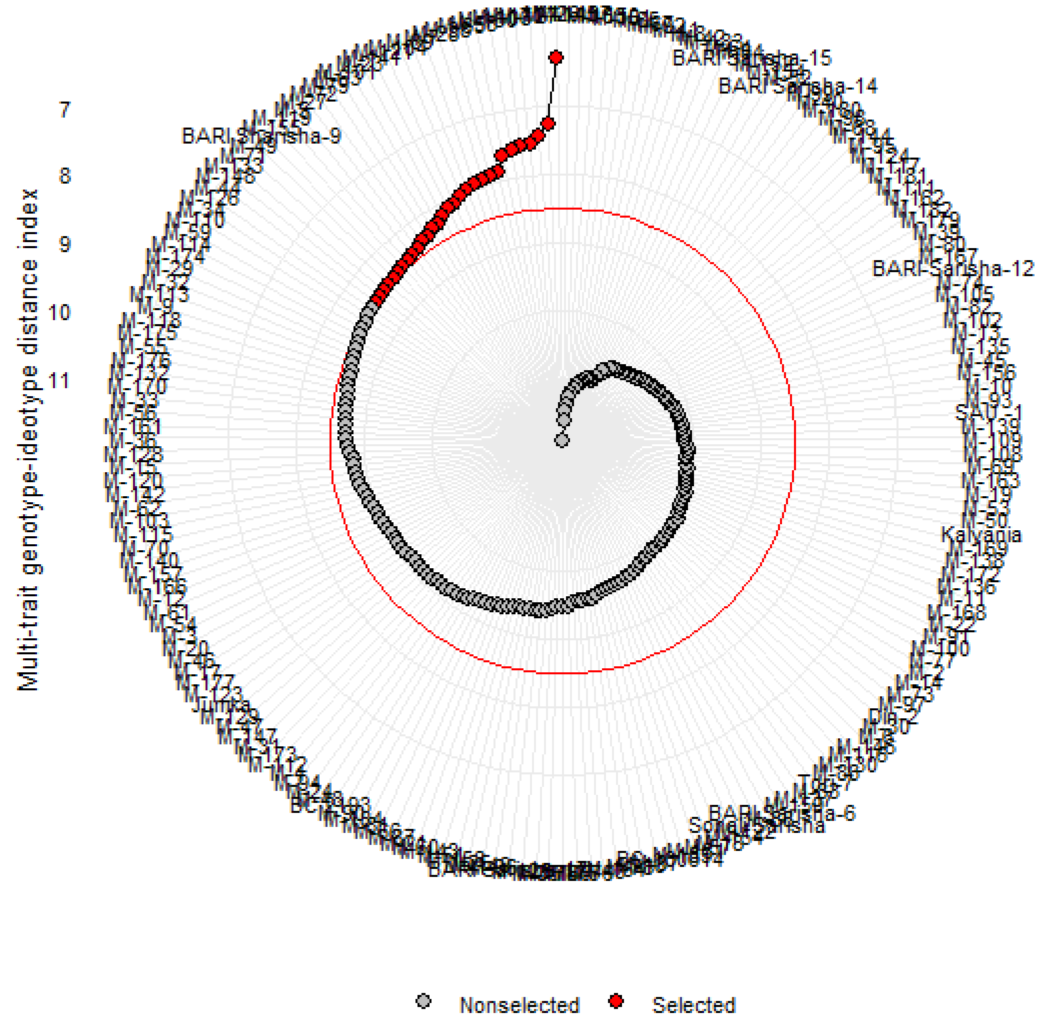

Fig.16. Genotype ranking based on the MTSI considering a selection intensity of 5% (red circle). Selected genotypes are highlighted in red.

Multi-trait index and genotype selection

The multi-trait stability index (Olivoto et al. 2021) has been proven useful for selecting genotypes for multiple traits based on mean performance and stability. Stable genotypes of soybean were also identified for stress conditions by Zuffo et al. (2020). Benakanahalli et al. (2021) made a suitable genotypic selection to identify stable guar genotypes with productive traits under differential environmental conditions through Multi-Trait Stability Index (MTSI) and Multi-Trait Genotype-Ideotype Distance Index (MGIDI). In the present study, the genotypes selected by the MGIDI index were M-26, M-1, M-127, M-171, M-106, M-160, M-58, M-65, M-38, M-28, M-7, M-89, M-104, M-121, M-141, M-23, M-101, M-63, M-79 and M-72 as indicated by the red line that suggests the number of genotypes selected based on the selection pressure (Fig. 16 and 17).

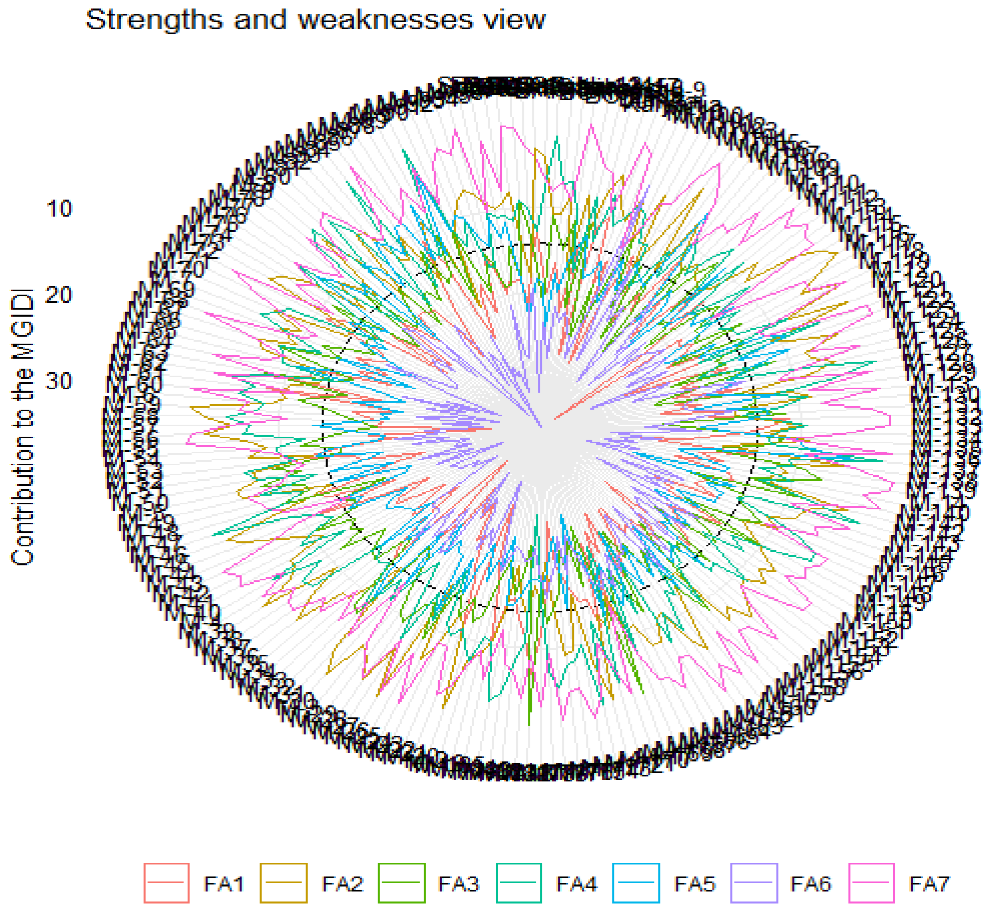

Fig. 17. Strengths and weaknesses view of the stable genotypes identified across three consecutives locations, shown as the proportion of each factor on the computed MTSI index. Smaller proportions explained by a factor (closer to the external edge) indicate that the trait within that factor is closer to the ideotype. The dashed line shows the theoretical value if all the factors contributed equally.

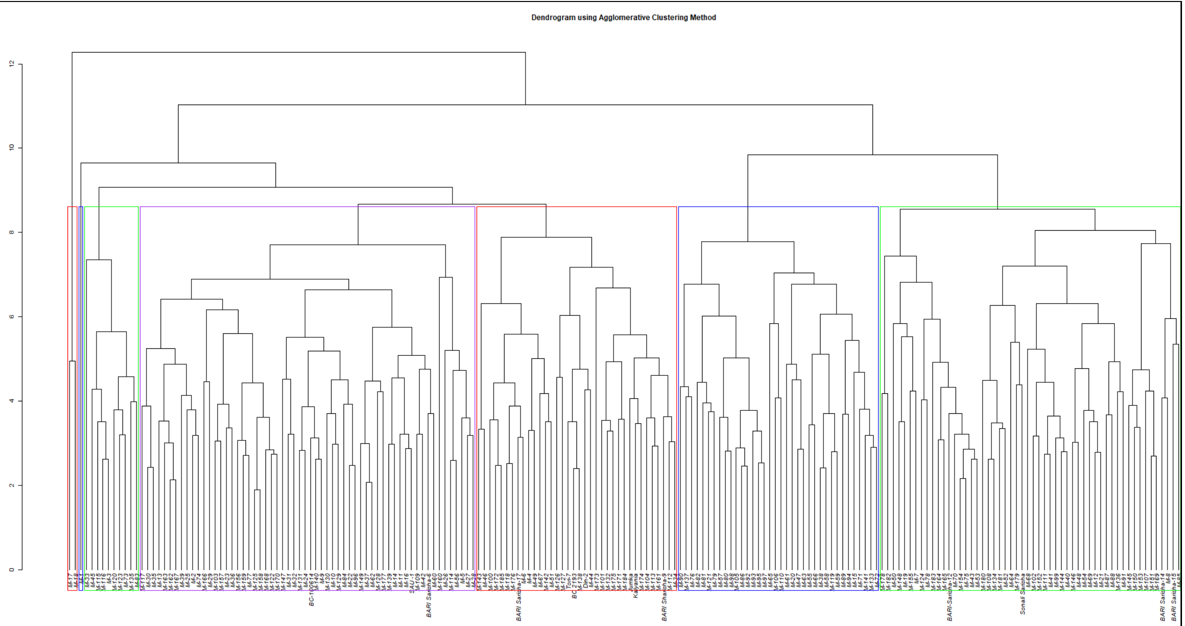

Fig. 18. Hierarchical cluster analysis of dissimilarities across rapeseed lines on their Euclidean distances.

Hierarchical cluster analysis

In the case of investigated genotypes, a hierarchical cluster analysis was computed based on squared Euclidean distance using Ward's method. The grouping pattern obtained from this analysis showed that 199 MAGIC population RILs of rapeseed with 17 traits were separated into seven main clusters (Fig.18). Cluster III contain the maximum number of RILs (60) followed by cluster I (54). Cluster IV content one RILs and cluster seven contain two RILs. The cophenetic correlation coefficient was found 0.326.

Conclusion

The present study has shown that selection with the evaluation of various analyzes of genetic parameters such as GCV, PCV, hBS and GA can achieve an improved *B. rapa* MAGIC population yield and related traits at saline soil. It can be observed that practically all of the agronomic traits tested in this study exhibit significant variability based on the recorded data and additional analyses (heatmap analysis, correlation matrix, PCA, MGIDI analysis). Therefore, the germplasm M-26, M-1, M-127, M-171, M-106, M-160, M-58, M-65, M-38, M-28, M-7, M-89, M-104, M-121, M-141, M-23, M-101, M-63, M-79 and M-72 might be selected for next year PYT.

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B. GROUNDNUT (*Arachis hypogaea* L.)

The **groundnut** or **peanut** (*Arachis hypogaea*) is a species in the family Fabaceae (commonly known as the bean, pea or legume family). The peanut was probably first domesticated and cultivated in the valleys of Paraguay. The domesticated peanut is an amphidiploid or allotetraploid, meaning that it has two sets of chromosomes from two different species, thought to be *A. duranensis* and *A. ipaensis*. These probably combined in the wild to form the tetraploid species *A. monticola*, which gave rise to the domesticated peanut. This domestication might have taken place in Paraguay or Bolivia, where the wildest strains grow today.

Groundnut is the most important oil legume crop cultivated in the world. Among the oil crops grown in Bangladesh, groundnut stands third position both in area and production. Groundnut can be grown in 'Char' areas during the winter season (September-March) under rainfed condition. July–August sowing of groundnut is done only for seed production and used in the September sowing. But in the northern region of Bangladesh groundnut is sown after the cultivation of potato in February to March. Being a photo insensitive crop, it can be grown round the year. It is well suited as intercrop with other short duration crops and fits well in various crop rotations. It is easy to handle in maintaining seed purity due to its self pollination nature. Groundnut as a legume crop enriches the soil by fixing nitrogen from the atmosphere. In spite of having great advantages for growing groundnut in Bangladesh, its yield is lower compared to other developed countries. Groundnut being a multipurpose crop can help in reducing the shortage of edible oil, food and fodder in the country. Apart from its rich sources of oil content (48-52%), groundnut seed is a good source of protein (22-25%), carbohydrate (20%) and vitamin B and E. Being highly digestible, the children's food made from groundnut can help in meeting part of the nutritional needs. The Oilseed Research Centre of BARI has developed 11 groundnut varieties, which comprises 7 Spanish, 3 Valencia and 1 Virginia type of groundnut. Most of the cultivars (bold seeded) take long duration for maturity particularly in the winter season and highly susceptible to leaf spot, rust and root/foot rot diseases, which reduce the yield substantially. It has another major constraint that the varieties developed do not have dormancy in seed and seed viability is lost very quickly. Therefore, the objective of groundnut breeding programme is to develop high yielding, early maturing, determinate type, widely adapted, disease and insect resistant/tolerant, dwarf varieties suitable for kharif season as well as suitable for the existing cropping pattern.

MAINTENANCE AND EVALUATION OF GROUNDNUT GERMPLASM

K C SAHA AND M S UDDIN

Abstract

A total of 241 genotypes were evaluated and maintained just to rejuvenate the seeds of germplasm. The highest CV% was observed from the character plot yield (kg/ha) followed by mature pods per plant. Minimum variation was observed in the character days to maturity. The character100 kernel weight (g) and plant height (cm) showed moderate variation. The seeds of the germplasm were stored for using in the future breeding programme.

Introduction

Groundnut contributes in total oilseed production in Bangladesh and the production can be increased only by cultivating superior high yielding cultivars and varieties. For development of new varieties and creating variability in the crop, it is necessary to maintain and evaluates groundnut germplasm. Lack of high yielding groundnut genotypes with diseases and pest resistance are major constraints in groundnut cultivation. Therefore, the experiment was conducted with a view to find out the desired potential genotypes and maintain the accessions of the collected germplasm.

Materials and methods

A total of 241 genotypes were grown in a non replicated trial at Gazipur to evaluate the collected materials for future use in the breeding program. The sowing date was 30 December, 2021. Seeds were sown in two rows of 4 m long plot with the spacing of line to line 30 cm and plant to plant 15 cm. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of NPKSZnB respectively.

Intercultural operations were done properly as and when necessary to obtain optimum plant growth. Data on days to 1st flowering, days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like no. of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot.

Results and discussion

A total of 241 groundnut germplasm accessions were evaluated at Joydebpur, Gazipur. The ranges for days to 1st flowering, days to maturity, plant height, mature pods/plant, 100 kernel weight (g), shelling % and plot yield were 53-67 days, 138-163 days, 24-63 cm, 15-53, 32-66, 55-78 and 910-3680 kg/ha respectively. The highest coefficient of variation (CV %) was recorded for the character plot yield (42.69%). Minimum variation was observed in the character days to maturity. The seeds of the germplasm will be grown in the next year and stored for using in the future breeding program. Higher cv% indicated higher variation in the characters and thus there were higher variations among the genotypes for plot yield and mature pods per plant, medium variation in plant height, 100 kernel weight and least variations in days to flower, days to maturity and shelling %.

Table1. Variation in different characters of groundnut germplasm evaluated at Joydebpur 2021-22

Characters	Range	Mean	Stand. dev.	CV%
Days to 1st flowering(days)	53-67	58	± 3.27	5.64
Days to maturity (days)	138-163	148	± 4.45	3.01
Plant height(cm)	24-63	38	± 6.38	16.79
Mature pods/plant	15-53	25	± 6.00	24.00
100 kernel weight(g)	32-66	46	± 7.80	16.95
Shelling %	55-78	60	± 6.20	10.33
Plot yield(kg/ha)	910-3680	1890	± 807	42.69

Acknowledgement

‘Enhance Production of Oil crops (BARI Part)’ project.

CREATION OF GENETIC VARIABILITY IN GROUNDNUT THROUGH HYBRIDIZATION

K C SAHA AND M S UDDIN

Abstract

Six parental lines were sown in two batches were crossed in 15 different cross combinations. A total of 487 buds were pollinated at Joydebpur. Average cross success was 45% and produced 222 pods.

Introduction

High yielding varieties of groundnut developed by ORC, BARI like BARI Chinabadam-6, BARI Chinabadam-7, BARI Chinabadam-8, BARI Chinabadam-9 and BARI Chinabadam-10 are tolerant to diseases and pest but take longer time to mature than the local cultivar Golachipa. ICGV-06285 and ICGV-07219 are disease and pest tolerant advanced groundnut lines those take less time than BARI Chinabadam-8 and BARI Chinabadam-9 to mature. Therefore, a hybridization program was undertaken to incorporate earliness and cluster bearing character from Golachipa, ICGV-06285 and ICGV-07219 to modern variety.

Materials and Methods

Two batches of six parental lines were sown on ten days interval in 02 January, 2022 and 11 January, 2022 at Joydebpur. The seeds of individual parents were planted in raised bed of 2 rows x 4 m long with the spacing of 50 cm and 20 cm between rows and plants respectively. After the flower initiation, the crosses have been attempted. The unopened matured buds were emasculated at afternoon (12.00 pm to 3.00 pm) and the emasculated buds were pollinated in the following morning (6.00 am to 8.00 am.).

Results and Discussion

A total of 222 pods were harvested from 487 pollinated buds out of fifteen crosses (Table 2). On an average 45% crosses were successful. The pollinated pods will be grown in the next Rabi season for F_1 confirmation.

Table 2. Different cross combinations and success at Joydebpur during Rabi, 2021-22

Sl. No.	Cross combination	ID	No. of pollinated buds	No. of pods harvested	Percent success
1.	ICGV-06285 × ICGV-07219	06285-07219-22	32	14	43
2.	ICGV-06285 × Golachipa	06285-Golachipa-22	28	12	42
3.	ICGV-06285 × Tridana Badam	06285-03-22	35	18	51
4.	ICGV-06285 × BARI Chinabadam 8	06285-8-22	42	14	33
5.	ICGV-06285 × BARI Chinabadam 9	06285-9-22	38	18	47
6.	ICGV-07219 × Golachipa	07219-Golachipa-22	28	16	57
7.	ICGV-07219 × Tridana Badam	07219-03-22	38	18	47
8.	ICGV-07219 × BARI Chinabadam 8	07219-8-22	36	14	38
9.	ICGV-07219 × BARI Chinabadam 9	07219-9-22	28	12	42
10.	Golachipa × Tridana Badam	Golachipa-03-22	28	17	60
11.	Golachipa × BARI Chinabadam 8	Golachipa-8-22	30	14	46
12	Golachipa × BARI Chinabadam 9	Golachipa-9-22	29	13	44
13.	Tridana Badam × BARI Chinabadam 8	03-8-22	30	16	53
14.	Tridana Badam × BARI Chinabadam 9	03-9-22	35	14	40
15.	BARI Chinabadam 8 × BARI Chinabadam 9	8-9-22	30	12	40
Total			**487**	**222**	**45**

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

EVALUATION OF SEGREGATING GENERATIONS OF GROUNDNUT

K C SAHA AND M S UDDIN

Abstract

On the basis of no. of mature pods, pod bearing nature, diseases and insect resistant 23, 37, 90, 56 and 35 single plants were selected from F_2, F_3, F_4, F_5 and F_6 generations, respectively.

Introduction

The yield of groundnut in Bangladesh is low compared to other developed countries. The existing varieties take long duration to mature particularly grown in the winter season. Groundnut is mainly grown in the char areas. During the harvesting time flash flood is occurred in the char areas and the crop is damaged. Therefore, farmers need short duration varieties which can be harvested before the flash flood come. Genetic variability in groundnut is scanty as a self pollinated crop. But variability is the prerequisite for obtaining desirable characters. High yielding superior genotype with short duration can be achieved by combining desirable traits in to a genotype. Hybridization is one of the best techniques to incorporate desirable traits in to a genotype. Evaluation and selection in the subsequent generation after hybridization would provide the superior high yielding variety. Therefore, the present study was taken to advance the generation from F_2, F_3, F_4, F_5 and F_6 for evaluating and selecting the progenies having desirable combinations of traits.

Materials and methods

Seeds of five cross combinations from F_2, 8 entries from F_3, 20 entries from F_4, 12 entries from F_5 and 7 entries from F_6 respectively were sown on December 30, 2021 at Joydebpur. Unit plot size was 4m long with required number of rows. Recommended doses of fertilizers were applied and necessary steps were taken to grow the crop uniformly.

Results and discussion

The results of different segregating generations are presented in Table 3a, 3b, 3c, 3d and 3e. On the basis of number of mature pods per plant, cluster pod formation, dwarf canopy of the plant, pod surface and diseases and insect reaction a number of single plants as well as bulk populations from different cross combinations of different segregating generations were selected. A total of 23, 37, 90, 56 and 35 single plants were selected from F_2, F_3, F_4, F_5 and F_6 generations respectively. The seeds from selected single plants of F_2 were collected and stored for advancing the generation as F_3 in the next season. On the other hand, the seeds from selected plants of F_3 were collected and stored according to the cross and generation will be advanced as F_4 generation. From the F_4 generation 90 plants were selected from 20 accessions and will be tested their performance as F_4 generation in the next season. From the F_5 generation 56 plants were selected from 12 accessions and will be tested their performance as F_6 generation in the next season. From the F_6 generation 35 plants were selected from 7 accessions and will be tested their performance as observation trial in the next season.

Table 3a. Performance of F_2 generation of groundnut at Joydebpur during Rabi, 2021-22

Sl. No.	Pedigree	No. of plants selected	No. of pods/ plant (range)	Remarks
1.	Dh1x IC 07219-20	5	18-36	Seeds from selected plants were collected and stored according to the cross
2.	IC00338x BC8-20	4	19-40	"
3.	Dh1x BC8-20	5	18-42	"
4.	IC07219xIC00338-20	5	19-35	"
5.	IC07219x BC8-20	4	21-36	"
Total plants selected		23	-	
Entries selected		05	-	

Table 3b. Performance of F_3 generation of groundnut at Joydebpur during Rabi, 2021-22

Sl. No.	Pedigree	No. of plants selected	No. of pods/ plant (range)	Remarks
1.	TG51xBC10-19	5	22-38	Seeds from selected plants were collected and stored according to the cross
2.	IC91114xIC00338-19	3	19-40	"
3.	IC91114xBC10-19	5	22-38	"
4.	Dh1xTG51-19	5	22-39	"
5.	Dh1xIC91114-19	4	21-38	"
6.	TG51xIC91114-19	5	21-42	"
7.	Dh1xIC00338-19	5	22-40	"
8.	Dh1xBC10-19	5	21-41	"
Total plants selected		37	-	
Entries selected		08	-	

Table 3c. Performance of F_4 generation of groundnut at Joydebpur during Rabi, 2021-22

Sl. No.	Pedigree	No. of plants selected	No. of pods/ plant (range)
1.	Dh1xTG37-18	5	22-42
2.	Dh1xIC07217-18	5	21-38
3.	Dh1xIC01080-18	5	20-36
4.	Dh1xBC10-18	4	25-44
5.	BINA4xBC93471-18	5	20-38
6.	BINA4xTG-51-18	5	25-45
7.	BINA4xIC07217-18	4	20-55
8.	BINA4xIC01080-18	4	22-36
9.	IC93471xTG37-18	4	19-43
10.	IC93471xIC07217-18	5	18-43
11.	IC93471xTG-51-18	4	18-35
12.	TG-5107217-18	4	21-38
13.	IC07217xBC10-18	5	22-35
14.	TG37xIC01080-18	3	23-58
15.	TG-51xBC10-18	4	22-50
16.	TG37xIC07217-18	5	25-43
17.	TG37xBC10-18	4	26-38
18.	IC93471xIC01080-18	5	25-44
19.	IC93471xBC10-18	5	20-50
20.	TG37xTG-51-18	5	22-38
Total plants selected		90	-
Entries selected		20	

Table 3d. Performance of F_5 generation of groundnut at Joydebpur during Rabi, 2021-22

Sl. No.	Pedigree	No. of plants selected	No. of pods/plant (range)
1.	Dh1xBINA4-17	4	19-44
2.	Dh1xBC9-17	5	20-39
3.	BINA4xBC9-17	5	18-43
4.	Dh1xIC00338-17	4	24-39
5.	BINA4xPK1-17	4	20-44
6.	BC9xPK1-17	4	21-39
7.	BC9xIC00338-17	5	20-43
8.	BC9xTG51-17	5	25-38
9.	Dh1xTG51-17	5	22-45
10.	BINA4xTG51-17	5	23-38
11.	Dh1xPK1-17	5	21-43
12.	BINA4xIC00338-17	5	25-38
Total plants selected		56	-
Entries selected		12	

Table 3e. Performance of F_6 generation of groundnut at Joydebpur during Rabi, 2021-22

Sl. No.	Pedigree	No. of plants selected	No. of pods/plant (range)
1.	BINA4xIC316-16	5	21-46
2.	Dh1xIC07219-16	5	20-39
3.	BINA4xIC0722-16	5	19-45
4.	BC9xIC07219-16	5	22-40
5.	BINA4xIC07219-16	5	23-45
6.	BINA4xBC9-16	5	22-41
7.	BC9xIC07220-16-1	5	25-38
	Total plants selected	35	-
	Entries selected	7	

Acknowledgement
'Enhance Production of Oil crops (BARI Part)' project.

OBSERVATION TRIAL OF GROUNDNUT(SET-I)

K C SAHA AND M S UDDIN

Abstract
Twenty entries including 2 checks, Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur during Rabi season, 2021-2022. Higher shelling percentage were found in the ISD 1314, ICGV 01105 and BARI Chinabadam-8. The genotype ICGV 284, ICGV 01105, BDGV 9112-2-1-2, JL-24, ICGV 07220, ICGV 07210, BDGN 14 and ICGV 9118 produced higher yield compared to the check variety BARI Chinabadam-8 and selected for Preliminary Yield Trial.

Introduction
Groundnut has been cultivating for long days in Bangladesh. Among the oilseed crops grown in Bangladesh, its position is third both in area and production. It is mostly grown in sandy soils of char areas of river basin under rainfed condition. In Bangladesh, 9% edible vegetable oil comes from groundnut. It's contribution in total oilseed production can be increased by cultivating superior high yielding genotypes. High yielding groundnut genotypes is a major constraints in groundnut cultivation. Therefore, the objective of this study was to find out high yield potential of groundnut genotypes.

Materials and methods
Twenty genotypes including two checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur during Rabi 2021-22. Seeds were sown on 29 December, 2021 in RCBD design with three replications. Unit plot size was 2 rows 4 m long with the spacing of 40cm x 15cm between rows and plants respectively. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of N P K S Zn B respectively. Intercultural operations were done properly as and when necessary to obtain optimum plant growth. Data on days to 1stflowering, days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like no. of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot. Pod yield per plot were converted pod yield per hectare. Recorded data were analyzed statistically.

Results and discussion
Data obtained from the experiment showed statistically significant differences among the genotypes for all the characters except days to 1st flowering and days to maturity (Table 4).

Table 4. Performance of 20 groundnut genotypes under OT at Joydebpur during Rabi, 2021-22

Sl. no.	Entries	DFF (days)	PH (cm)	MP/ plant	DM (days)	100 KW (g)	Shelling (%)	Y (kg/ha)	Rel. Pos.
1.	ISD 1314	55	40	27	150	52	70	2157	88
2.	ICGV 284	58	37	33	143	53	66	2977	122
3.	ICGV 92229	57	48	26	150	44	65	1997	82
4.	ICGV 93416	56	51	27	147	46	66	2127	87
5.	JL-24	55	40	31	150	48	63	2817	115
6.	ICGV 9118	55	43	29	145	46	65	2617	107
7.	ICGV 3479	56	47	25	151	47	68	1827	75
8.	ICGV 01105	55	48	32	144	47	70	2853	117
9.	ICGV 07220	54	43	31	150	44	62	2687	110
10.	ICGV 00351	56	43	23	149	42	62	1790	73
11.	BDGN 14	56	41	30	150	43	62	2663	109
12.	ISD 3014	56	42	27	145	44	68	2027	83
13.	ICGV 07210	56	41	31	145	40	64	2680	110
14.	BDGV 9112-2-1-2	56	38	31	145	48	63	2827	116
15.	Bom 115	57	43	24	150	45	67	1810	74
16.	TG51Bom115	55	52	23	145	45	67	1437	59
17.	TG37115	57	44	22	150	57	66	1387	57
18.	F_3-5	57	42	19	150	49	61	1323	54
19.	Dhaka-1	55	44	29	139	43	65	2213	91
20.	BARI Chinabadam-8	55	36	29	147	56	70	2443	100
Level of significance		NS	*	**	**	*	NS	**	
CV(%)		3.30	11.15	18.05	1.28	2.21	1.67	9.77	
LSD		3.04	7.96	8.08	3.10	1.71	1.81	360.74	

N.B.: DFF=days to 1st flowering, DM = days to maturity, PH=Plant height, MP = mature pods per plant, KW = kernel weight, Y = yield
**= Significant at 1% level of significance, * = Significant at 5% level of significance, NS=Non significant

Maximum shelling percentage were found in the genotypes ISD 1314 (70%), ICGV 01105 (70%) and BARI Chinabadam-8 (70%).Highest pod yield (2977 kg/ha) was obtained from the genotype ICGV 284 followed by the genotype ICGV 01105 (2853 kg/ha), BDGV 9112-2-1-2 (2827 kg/ha), JL-24 (2817 kg/ha), ICGV 07220 (2687 kg/ha), ICGV 07210 (2680 kg/ha), BDGN 14 (2663 kg/ha) and ICGV 9118 (2617 kg/ha) which were 22%, 17%, 16%, 15%, 10%, 10%, 9% and 7% higher than the check variety BARI Chinabadam-8 respectively. Maximum number of mature pods per plant was observed from the entry ICGV 284 (33). Highest 100 kernel weight (56 g) was obtained from the variety BARI Chinabadam-8. Considering the pod yield eight genotypes ICGV 284, ICGV 01105, BDGV 9112-2-1-2, JL-24, ICGV 07220, ICGV 07210, BDGN 14 and ICGV 9118 have been selected for PYT.

Conclusion

Eight genotypes ICGV 284, ICGV 01105, BDGV 9112-2-1-2, JL-24, ICGV 07220, ICGV 07210, BDGN 14 and ICGV 9118 have been selected for Preliminary Yield Trial.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

OBSERVATION TRIAL OF GROUNDNUT(SET-II)

K C SAHA AND M S UDDIN

Abstract

Nineteen entries including 2 checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur during Rabi season, 2021-2022. Higher hundred kernel weight were found in the Beijing-3 (62 g), ICGV 1352 (61 g), ICGV 07406 (61g), ICGV 93471 (59 g), SM-14, ICGV 910168 (59 g), ICGV 88388 (59 g), ICGV 864017(59 g), TMV-2(59 g) and BDGV 9112-2-1-1 (58g) The genotype BDGV 9112-5-1-1,ICGV 1352, BDGV 7112-2-2-1, TMV 2, ICGV 92269, ICGV 07406, BDGV 9112-2-1-1 and Mahshwa produced higher yield compared to the check variety BARI Chinabadam-8 and selected for Preliminary Yield Trial.

Introduction

Groundnut is one of the most important oilseed crop in Bangladesh. Among the oilseed crops grown in Bangladesh, its position is third both in area and production. It is mostly grown in sandy soils of char areas of river basin under rain fed condition. In Bangladesh, 9% edible vegetable oil comes from groundnut. Without roasted use, It has industrial use also .For industrial use we need bold seeded groundnut varieties. Oilseed Research Centre, BARI has developed two bold seeded groundnut varieties (BARI Chinabadam-6 and BARI Chinabadam-7). But long duration of these varieties is a major constrains for cultivation. Therefore, the objective of this study was to find out bold seeded, short duration and high yield potential of groundnut genotypes.

Materials and methods

Nineteen genotypes including two checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur during Rabi, 2021-22. Seeds were sown on 29 December, 2021 in RCBD design with three replications. Unit plot size was 2 rows 4 m long with the spacing of 40cm x 15cm between rows and plants respectively. Recommended doses of fertilizers were applied @ 10:70:50:30:4:2 kg/ha of N P K S Zn B respectively. Intercultural operations were done properly as and when necessary to obtain optimum plant growth. Data on days to 1stflowering, days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like no. of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot. Pod yield per plot were converted pod yield per hectare. Recorded data were analyzed statistically.

Results and discussion

Data obtained from the experiment showed statistically significant differences among the genotypes for all the characters except days to 1st flowering and days to maturity (Table 5).

Table 5. Performance of 19 groundnut genotypes under OT at Joydebpur during Rabi 2021-22

Sl. no.	Entries	DFF (days)	PH (cm)	MP/ plant	DM (days)	100 KW (g)	Shelling (%)	Y (kg/ha)	Rel. Pos.
1.	ICGV 93471	52	38	23	144	59	70	1787	75
2.	ICGV 1352	55	33	33	148	61	60	2803	118
3.	SM-14	52	30	24	145	59	60	1947	82
4.	ICGV 910168	54	29	23	145	59	61	1673	70
5.	ICGV 4514	54	35	23	151	54	60	1720	72
6.	Mahshwa	53	39	29	143	56	63	2417	102
7.	ICGV 88409	54	40	22	145	51	68	1500	63
8.	ICGV 88388	55	36	22	146	59	63	1633	69
9.	ICGV 864017	54	36	25	149	59	61	1967	83
10.	TMV-2	60	37	31	149	59	61	2647	111
11.	ICGV 92269	55	33	30	149	57	63	2633	111
12.	ICGV 98377	52	45	21	148	52	65	1467	62
13.	ICGV 07406	54	32	29	148	61	66	2557	107
14.	BDGV 7112-2-2-1	56	30	32	147	53	60	2743	115
15.	BDGV 9112-2-1-1	55	37	29	148	58	61	2533	106
16.	BDGV 9112-5-1-1	56	36	35	146	55	60	2937	123
17.	Beijing-3	62	30	22	147	62	63	1550	65
18.	Dhaka-1	55	33	27	141	42	62	2200	92
19.	BARI Chinabadam-8	55	39	29	144	55	67	2380	100
Level of significance		**	**	NS	**	**	**	**	
CV(%)		3.60	8.27	24.83	1.53	4.04	4.70	12.73	
LSD		3.27	4.82	11.05	3.72	3.79	4.91	455.99	

N.B.: DFF=days to 1st flowering, DM = days to maturity, PH=Plant height, MP = mature pods per plant, KW = kernel weight, Y = yield

**= Significant at 1% level of significance, * = Significant at 5% level of significance, NS=Non significant

Highest pod yield (2937 kg/ha) was obtained from the genotype BDGV 9112-5-1-1 followed by the genotype ICGV 1352 (2803 kg/ha), BDGV 7112-2-2-1(2743 kg/ha), TMV-2 (2647 kg/ha), ICGV 92269 (2633 kg/ha), ICGV 07406 (2557 kg/ha), BDGV 9112-2-1-1(2533 kg/ha) and Mahshwa (2417 kg/ha) which were 23%, 18%, 15%, 11%, 11%, 7 %, 6% and 2% higher than the check variety BARI Chinabadam-8 respectively. Highest value for hundred kernel weight were found in the Beijing-3 (62 g) followed by ICGV 1352 (61 g), ICGV 07406 (61g), ICGV 93471 (59 g), SM-14, ICGV 910168 (59 g), ICGV 88388 (59 g), ICGV 864017(59 g), TMV-2 (59 g) and BDGV 9112-2-1-1 (58g). Maximum number of mature pods per plant was observed from the entry BDGV 9112-5-1-1 (35). Considering the bold seeded, pod yield and duration eight genotypes BDGV 9112-5-1-1,ICGV 1352, BDGV 7112-2-2-1, TMV 2, ICGV 92269, ICGV 07406, BDGV 9112-2-1-1 and Mahshwa have been selected for PYT.

Conclusion

Eight genotypes BDGV 9112-5-1-1,ICGV 1352, BDGV 7112-2-2-1, TMV 2, ICGV 92269, ICGV 07406, BDGV 9112-2-1-1 and Mahshwa have been selected for Preliminary Yield Trial.

Acknowledgement

‘Enhance Production of Oil crops (BARI Part)’ project.

OBSERVATION TRIAL OF GROUNDNUT (SET-III)

M K ALAM, M I RIAD AND M KADIR

Abstract

The experiment was conducted at Regional Agricultural Research Station, Jamalpur during Rabi 2021-22 to evaluate the groundnut lines and to find out the best one(s) for their yield and yield contributing characters. The line, G-1 produced the highest nut yield. It produced 2536 kg/ha yield which was 19 % and 54 % higher than the check variety, BARI Chinabadam-8 and BARI Chinabadam-9, respectively. G-2 produced the 2nd highest yield. It produced 18 % and 53 % higher than the check variety, BARI Chinabadam-8 and BARI Chinabadam-9, respectively. The 3rd highest yield was recorded from the line ICGV-07406. This line produced 16% higher yield than BARI Chinabadam-8. These three lines took 153-154 days to mature. These lines may be selected for evaluation in preliminary yield trial.

Introduction

The groundnut is particularly valued for its protein content (26%). On equal weight basis (Kg for Kg), groundnuts contain more protein than meat and about two and a half times more than eggs. Being an oil seed crop, it contains 40 to 49% oil. In addition to protein and oil, groundnuts are a good source of calcium, phosphorus, iron, zinc and boron. The groundnuts also contain vitamin E and small amounts of vitamin B complex. Groundnut is one of the world's fifteen leading food crops and cultivated throughout the world. It is among the most important foods in international trade. Groundnut is popularly known as peanut in many countries though it is more a pea (a leguminous plant) than a nut. But it is considered as nut because of its high nutritional value. It is less expensive and nourishing food. Groundnut is a cash crop and useful rotation crop. It is easy to grow, withstands drought to some extent and so a choice crop for dry farming. It is soil erosion resistant crop. Being a legume crop it can fix atmospheric nitrogen. Thus maintains soil fertility. All parts of this plant can be commercially used. The plant stalks are fed to cattle in the form of green, dried and silage. Groundnut shell, haulms and hay are good fodder. Groundnut cake is a good feed for livestock and it is also used as manure.

Materials and Methods

The experiment was conducted at RARS, Jamalpur during Rabi 2021-2022 with 30 lines of groundnut including BARI Chinabadam-8 and BARI Chinabadam-9 as checks. The plot size was 4 rows 5m long. Seeds were sown on the 20th November, 2021 in 15 cm seed to seed and row was 30 cm apart from each. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MP, Gypsum and Boric acid. Fifty percent of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of peg development. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to mature, shelling% and yield per plot. The plot yield was converted into hectare. The data were analyzed statistically.

Result and Discussion

The results are presented in table 6. It was observed from the table that the groundnut line G-1 produced the highest nut yield. It produced 2536 kg/ha yield which was 19 % and 54 % higher than the check variety, BARI Chinabadam-8 and BARI Chinabadam-9, respectively. It produced significantly higher yield among the lines included in this trial. It took 153 days to mature. The line G-2 produced the 2nd highest yield. It produced 2512 kg/ha nut yield which was 18 % and 53 % higher than the check variety, BARI Chinabadam-8 and BARI Chinabadam-9, respectively. It took 153 days to mature. The third highest yield was recorded from ICGV-07406. It produced 2486 kg/ha which was 16% higher than check variety, BARI Chinabadam-8. This groundnut line took 154 days to mature. These lines may easily be grown and harvested before fresh flood at char area and selected for preliminary yield trial in next year.

Table 6. Performance of 30 groundnut genotypes under OT at Jamalpur during Rabi 2021-22

SL. No	Lines/ Varieties	Days to maturity	Plant Height (cm)	Mature POD	100 Kernel Wt.	Shelling %	Yield (kg/ha)
1	TAG-24	154 A-C	41 G-J	21.7D-I	35.3D-H	76 A-C	1,253 K
2	ISD-4114	153 BC	47 D -H	26.3 C-F	32.0 G-I	69 D-H	1,350 I-K
3	ICGV-07235	153 BC	39 IJ	16.5 I-L	36.5D-H	70 D-G	1,686 E-K
4	ICGV-06319	152 CD	39 IJ	25.4 C-G	33.4 F-I	76 A-C	1,553 G-K
5	ICGV-06145	153 BC	50 B-E	23.5 C-H	36.7D-H	71 C-F	1,952 B-H
6	ICGV-06150	151 D	45 E-I	23.6 C-H	23.2 I	64 H-K	1,825 D-K
7	ICGV-06194	154 A-C	43 E-J	21.4 E-J	35.3D-H	73 B-E	1,910 C-I
8	ICGV-07210	154 A-C	61 A	36.7 A	37.0D-H	65 G-J	1,805 D-K
9	ICGV-06178	156 A	50 B-F	27.5 B-E	38.0D-H	71 C-F	1,305 JK
10	ICGV-07217	153 B-D	56 A-C	25.7 C-G	41.3C-H	79 A	1,993 A-H
11	ICGV-07396	153 BC	50 B-E	26.0 C-G	37.4D-H	70 C-F	1,562 F-K
12	ICGV-07390	153 BC	60 A	26.3 C-F	33.4 F-I	62 I-M	1,328 JK
13	ICGV-07392	153 B-D	57 AB	32.9 AB	30.8 HI	66 F-I	2,155 A-E
14	ICGV-07395	153 BC	48 D-H	19.5 G-J	34.9 E-H	72 B-E	1,276 JK
15	**ICGV-07406**	**154 A-C**	**49 C-F**	**25.1 C-G**	**55.7A**	**74 A-D**	**2,486 A-C**
16	ICGV-99231	154 A-C	55 A-D	23.7 C-H	38.0D-H	73 A-E	1,436 H-K
17	**G-1**	**153 BC**	**47 D-H**	**28.4 BC**	**56.3 A**	**68 E-H**	**2,536 A**
18	**G-2**	**153 B-D**	**48 D-H**	**17.2 H-K**	**45.8A-E**	**58 M**	**2,512 AB**
19	G-3	154 A-C	50 B-F	15.0 J-L	53.9 AB	59 K-M	1,853 D-J
20	G-4	154 A-C	36 J	12.8 KL	41.7C-H	58 LM	2,319 A-D
21	G-5	155 AB	44 E-I	17.2 H-K	43.6 B-F	58 LM	1,526 H-K
22	G-6	156 A	49 C-G	22.2 C-I	45.8 A-E	58 M	2,124 A-G
23	G-8	154 A-C	47 D-H	33.3 AB	50.1 A-C	73 A-E	1,767 D-K
24	ICGV-06151	153 BC	43 E-J	10.5 L	43.5B-G	77 AB	1,424 H-K
25	L-10	152 CD	40 H-J	16.1 I-L	51.3 A-C	58 M	1,581 E-K
26	L-25	155 AB	42 F-J	18.3 H-K	41.4C-H	59 K-M	1,419 H-K
27	L-27	152 CD	45 E-I	17.6H-K	42.0C-H	63 H-L	1,565 F-K
28	L-29	153 B-D	46 E-I	17.7 H-K	41.7C-H	60 J-M	1,417 H-K
29	BARI-8	154 A-C	43 E-J	28.0 B-D	46.5A-D	75 A-C	2,134 A-F
30	BARI-9	153 BC	46 E-I	20.6 F-J	42.7B-G	76 A-C	1,647 E-K
CV%		0.56	8.25	14.18	13.85	4.02	16.09
Level of sig.		*	**	**	**	**	**
Lsd		2.092	7.971	6.537	11.568	5.554	578.08

PRELIMINARY YIELD TRIAL OF GROUNDNUT (SET-1)

M K ALAM, M I RIAD AND M KADIR

Abstract

The experiment was conducted at Regional Agricultural Research Station, Jamalpur during Rabi 2021-22 to evaluate the groundnut lines and to find out the best one(s) for their yield and yield contributing characters. The line ICGV-15373 produced the highest nut yield. It produced 1851 kg/ha yield which was 6 % higher yield than BARI Chinabadam-8. ICGV-15003 produced the 2nd highest yield. It produced 3 % higher yield than check variety, BARI Chinabadam-8. The 3rd highest yield was recorded from the line ICGV-15270. This line produced 1 % higher yield than BARI Chinabadam-8. These three lines took 153-155 days to mature. These lines may be selected for evaluation in regional yield trial.

Introduction

Groundnut is an economically important crop because of its wide spread commercial production and utilization as oil, food and fibre. Over two-third of the global groundnut production occurs in seasonally rain-fed region, where drought is a potential constraint for crop production. Development of genetic and management strategies to alleviates the effects of drought on peanut has been a long term goal of crop scientists. Breeding and selection for yield in a given drought condition is imperative, good and low cost technology to find out drought resistant or tolerant genotypes. Most of the groundnut grown in Bangladesh is cultivating at the sandy soil of river bed or char areas, where water scarce is a regular phenomenon .Rain is the only source of water supply for groundnut at those areas. Any groundnut genotypes tolerant or resistant to water scarce will definitely help to boost up production. Generally char land remain under water during raining season. It rises after receding of the flood water. Farmers sow their groundnut seed in the month of November. River water starts increasing slowly from last week of May. The time schedule for production of this crop is November-May. Only 150-160 days are available to complete its life cycle. Otherwise it may go under water and whole crop may be lost. So it is essential to select short duration high yielding varieties of groundnut for Bangladesh. Keeping this objective in mind, this experiment was conducted with 16 lines of groundnut to find out high yield potential lines suitable for that char area under the prevailing climatic condition.

Materials and Methods

The experiment was conducted at RARS, Jamalpur during Rabi 2021-2022 with 16 lines of groundnut including BARI Chinabadam-8 as checks. The plot size was 8 rows 4m long. The experiment was laid out in RCBD with three replications. Seeds were sown on the 8th November, 2021 in 15 cm seed to seed and row was 30 cm apart from each. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MP, Gypsum and Boric acid. Fifty percent of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of peg development. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to mature, shelling% and yield per plot. The plot yield was converted into hectare. The data were analyzed statistically.

Results and Discussion

The results are presented in table 7. It was observed from the table that the groundnut line ICGV-15273 produced the highest nut yield. It produced 1851 kg/ha yield which was 6% higher than the check variety BARI Chinabadam-8. It produced significantly higher yield among the lines included in this trial. It took 155 days to mature. The line ICGV-15003 produced the 2nd highest yield. It produced 1807 kg/ha nut yield which was 3% higher than BARI Chinabadam-8. It took 154 days to mature. The third highest yield was recorded from ICGV-15270. It produced 1767 kg/ha which was 1% higher than check variety, BARI Chinabadam-8. This groundnut line took 155 days to mature. These three lines may easily be grown and harvested before fresh flood at char area. These lines may be selected for evaluation in regional yield trial in the char area.

Table 7: Performance of 16 groundnut genotypes at Jamalpur during Rabi 2021-22

Lines/ Varieties	Days to maturity	Plant Height (cm)	Mature POD	100 Kernel Wt	Shelling%	Yield (kg/ha)
ICGV-15003	**154 A-C**	**76 A**	**31 A-D**	**47 A**	**72 BC**	**1,807 AB**
ICGV-15307	153 A-C	69 AB	33 AB	46 A	74 AB	1,747 A-D
ICGV-15266	155 A-C	52 E-G	30 A-F	45 AB	73 A-C	1,530 F
ICGV-15270	155 A-C	50 F-H	26 B-F	41 A-D	67 E-G	1,767 A-C
ICGV-15273	**155 A-C**	**60 C-E**	**39 A**	**46 AB**	**75 AB**	**1,851 A**
ICGV-15074	156 A	55 D-G	34 AB	45 AB	75 AB	1,606 C-F
ICGV-15080	154 A-C	68 A-C	33 A-C	42 A-C	76 A	1,573 EF
ICGV-15304	153 BC	59 C-F	29 A-F	41 A-D	76 A	1,596 D-F
ICGV-16705	152 C	56 D-G	21 C-G	41 A-D	70 C-E	1,661 B-F
ICGV-16669	155 A-C	52 E-G	31 A-E	35 D	65 FG	1,628 C-F
ICGV-171011	153 BC	63 B-D	21 C-G	28 E	63 G	1,651 B-F
ICGV-171012	153 BC	42 HI	11 G	19 F	67 D-F	1,590 D-F
ICGV-171014	152 C	37 I	19 E-G	42 A-C	67 E-G	1,671 B-F
ICGV-171015	155 AB	50 GH	19 D-G	38 CD	71 B-D	1,613 C-F
ICGV-171051	154 A-C	49 GH	18 FG	36 CD	72 A-C	1,713 A-E
BARI Badam-8	151 D	49 GH	29 A-F	39 B-D	69 C-E	1,746 A-D
CV%	0.98	9.57	26.56	9.98	3.38	5.76
Level of sig.	**	**	**	**	**	**

PRELIMINARY YIELD TRIAL OF GROUNDNUT (SET-II)

M K ALAM, M I RIAD AND M KADIR

Abstract

The experiment was conducted at Regional Agricultural Research Station, Jamalpur during Rabi 2021-22 to screen the groundnut lines and to find out the best one(s) for their yield and yield contributing characters. The line PN-02 produced the highest nut yield. It produced 1842 kg/ha yield which was 66 % and 24 % higher yield than the check varieties BARI Chinabadam-6 and BARI Chinabadam-7, respectively. PN-04 produced the 2nd highest yield. It produced 60 % and 20 % higher yield than the check varieties BARI Chinabadam-6 and BARI Chinabadam-7, respectively. These lines took 153-155 days to mature. These lines may be selected for evaluation in regional yield trial.

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the most important grain legumes in northern Ghana in terms of the area of cultivation and the use. Groundnuts can be eaten fresh, dry, roasted and it is also an important legume in the cropping systems of northern region. Being a leguminous crop, it contributes to the nitrogen budget of the poor and fragile soils. Groundnuts play an important role in maintaining soil fertility in cereal-based cropping systems northern region because of their ability to fix nitrogen. Groundnut is the sixth most important oilseed crop in the world. It contains 48%-50% oil and 26%-28% protein, and it is a rich source of dietary fiber, minerals and vitamins.

Materials and Methods

The experiment was conducted at RARS, Jamalpur during Rabi 2021-2022 with 14 lines of groundnut including BARI Chinabadam-6 and BARI Chinabadam-7 as checks. The plot size was 8 rows 4m long. The experiment was laid out in RCBD with three replications. Seeds were sown on the 18th November, 2021 in 15 cm seed to seed and row was 30 cm apart from each. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MP, Gypsum and Boric acid.

Fifty percent of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of peg development. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to mature, shelling% and yield per plot. The plot yield was converted into hectare. The data were analyzed statistically.

Results and Discussion

The results are presented in table 8. It was observed from the table that the groundnut line PN-02 produced the highest nut yield. It produced 1842 kg/ha yield which was 66 % and 24 % higher yield than the check varieties BARI Chinabadam-6 and BARI Chinabadam-7, respectively. It produced significantly higher yield among the lines included in this trial. It took 154 days to mature. PN-04 produced the 2nd highest yield. It produced 60 % and 20 % higher yield than the check varieties BARI Chinabadam-6 and BARI Chinabadam-7, respectively. It took 155 days to mature. The 3rd highest yield was recorded in PN-01. These three lines may easily be grown and harvested before fresh flood at char area. These lines may be selected for evaluation in regional yield trial.

Table 8. Performance of 14 groundnut genotypes at Jamalpur during Rabi 2021-22

Lines/ Varieties	Days to maturity	Plant Height (cm)	Mature POD	100 Kernel Wt.	Shelling (%)	Yield (kg/ha)
PN-01	**157 AB**	**43 B-D**	**20.07**	**34.37 D**	**71.3 B-D**	**1,727 A-C**
PN-02	**154 D-F**	**37 E**	**30.73**	**32.56 FG**	**70.0 C-E**	**1,842 A**
PN-04	**153 E-G**	**37 DE**	**28.20**	**32.71 E-**	**71.3 B-D**	**1,776 AB**
PN-05	155 A-D	29 F	25.13	46.85 A	72.0 B-D	1,582 C-E
PN-06	154 C-F	43 B-D	25.93	33.79 DE	74.7 AB	1,638 B-D
PN-07	157 AB	39 DE	16.33	34.55 D	66.3 EF	1,129 G
PN-08	156 A-C	39 DE	18.73	34.24 D	66.0 F	1,357 F
PN-10	155 B-E	40 C-E	23.60	34.00 D	74.7 AB	1,437 EF
PN-14	156 A-C	40 C-E	19.67	38.41 B	66.7 EF	1,111 G
PN-15	157 A	49 AB	22.20	33.77D-F	76.0 A	1,435 EF
PN-16	151 G	30 F	21.20	36.36 C	71.0 B-D	1,159 G
PN-09	153 E-G	52 A	21.93	31.96 G	73.3 A-C	1,518 D-F
BARI Badam-6	151 G	39 DE	25.80	34.59 D	69.3 D-F	909 H
BARI Badam-7	153 FG	46 BC	31.07	32.21 G	71.3 B-D	1,481 D-F
CV%	0.75	8.84	24.14	2.08	3.34	6.78
Level of Sig.	**	**	ns	**	**	**
Lsd	2.33	5.95	-	1.22	3.98	163.34

REGIONAL YIELD TRIAL OF GROUNDNUT (SET-I)

K C SAHA, M S UDDIN AND M B SARKER

Abstract

Eighteen groundnut genotypes along with 2 checks Dhaka-1 and BARI Chinabadam-8 were evaluated at Joydebpur, Gazipur and Burirhat, Rangpur during Rabi season 2021-2022 to find out promising lines with desirable characters. Highest shelling percentage was recorded from the genotype ICGV 07219 (74%). The entry ICGV 07219 produced maximum pod yield (2815 kg/ha) followed by Jhaldhaka (2341 kg/ha), ICGV SL-1 (2074 kg/ha), PK-1 (2062 kg/ha), 14-103 (2036 kg/ha), Choko 0314 (1985) and ISD 2914 (1878 kg/ha) which were higher than the check varieties over locations. Seven entries ICGV 07219, Jhaldhaka, ICGV SL-1, PK-1, 14-103, Choko 0314 and ISD 2914 were selected for Adaptive Trial.

Introduction

Regional Yield trial is conducted to evaluate the performance of lines and to select some promising lines having desirable characters from a large number of entries. The lines or entries having wider adaptability and better performances would be identified to be included in Adaptive Trial and finally to release variety.

Materials and Methods

The experiment was conducted with eighteen groundnut genotypes including 2 checks as Dhaka-1 and BARI Chinabadam-8 at Joydebpur, Gazipur and RARS, Burirhat, Rangpur in a randomized complete block design with 3 replications. The date of sowing was 29 December, 2021 at Joydebpur and 28 November, 2021 at Burirhat. Unit plot size was 6 rows 4m long with the spacing of 40cm between rows and 15 cm between plants. Recommended doses of fertilizers were applied @ 80:65:60:20:4 kg/ha of NPKS Zn respectively. Intercultural operations were done as and when necessary. Data on days to 1stflowering, days to maturity and pod yield per plot were taken on plot basis. The other yield contributing characters like number of mature pods per plant, 100-kernel weight and shelling percentage were recorded from 5 randomly selected plants of each plot. Pod yield per plot were converted into pod yield per hectare. Recorded data were analyzed statistically.

Results and discussion

Significant differences were observed among the genotypes for all the characters except days to 1stflowering studied at Joydebpur. Maturity duration ranged from 139-152 days. Highest number of mature pods/plant (32) was obtained by the entry ICGV 07219. The range of hundred kernel weight was 42-62 g. Highest shelling percentage was recorded in the genotype ICGV 07219 (74%). The genotype ICGV 07219 produced maximum pod yield (2830 kg/ha) followed by by Jhaldhaka (2743 kg/ha), 6112-6-1(2713 kg/ha), 14-403(2630 kg/ha), PK-1(2603 kg/ha) and 602-7-4-2(2563 kg/ha) which were 12%, 9%, 7%, 4%, 3% and 1% higher than the check variety BARI Chinabadam-8 respectively.

Table 9a. Performances of 18 groundnut genotypes in RYT (Set-I) at Joydebpur, during 2021-22

Sl. no.	Entries	PH (cm.)	MP/ plant	DM (days)	100 KW (g)	Shelling %	Yield (kg/ha)	Rel. Pos.
1	6112-6-1	34	30	146	50	62	2713	107
2	602-7-4-2	33	27	149	58	66	2563	101
3	702-6-2-1	39	25	148	51	63	1993	79
4	502-4-3-1	34	24	144	48	65	1863	74
5	ISD 0414	31	22	150	60	64	1443	57
6	Choko 0314	40	25	148	58	64	1960	78
7	Jhaldhaka	34	31	152	56	66	2743	109
8	PK-1	37	28	150	57	66	2603	103
9	ICGV 07219	45	32	138	62	74	2830	112
10	14-103	41	24	149	53	63	1800	71
11	14-403	41	29	146	51	66	2630	104
12	ISD 2914	37	23	148	50	68	1610	64
13	ICGV SL-1	42	23	147	50	67	1700	67
14	ICGV 38-3	37	23	148	60	63	1747	69
15	Tridana Cox'sbazar	40	22	145	56	68	1550	61
16	Galachipa	33	15	145	56	69	1357	54
17	Dhaka-1	43	25	139	42	68	2290	91
18	BARI Chinabadam-8	34	26	146	55	69	2527	100
Level of significance		**	**	**	**	**	**	
CV (%)		9.37	16.45	2.43	2.03	0.98	8.29	
LSD		5.83	6.98	5.90	1.82	1.07	289.66	

N.B.: DFF=days to 1st flowering, DM = days to maturity, PH=Plant height, MP = mature pods per plant, KW = kernel weight, Y = yield

**= Significant at 1% level of significance, * = Significant at 5% level of significance, NS=Non significant

Table 9b. Days to maturity of 18 groundnut genotypes at two locations during Rabi, 2021-22

Sl No.	Entry	Maturity (Days)			
		Joydebpur	Burirhat	Mean	Relative position
1.	6112-6-1	146	154	150	102
2.	602-7-4-2	149	154	152	103
3.	702-6-2-1	148	154	151	103
4.	502-4-3-1	144	154	149	101
5.	ISD 0414	150	154	152	103
6.	Choko 0314	148	155	152	103
7.	Jhaldhaka	152	154	153	104
8.	PK-1	150	154	152	103
9.	ICGV 07219	138	143	141	96
10.	14-103	149	155	152	103
11.	14-403	146	155	151	103
12.	ISD 2914	148	155	152	103
13.	ICGV SL-1	147	155	151	103
14.	ICGV 38-3	148	154	151	103
15.	Tridana Cox'sbazar	145	155	150	102
16.	Galachipa	145	155	150	102
17.	Dhaka-1	139	155	147	100
18.	BARI Chinabadam-8	146	155	151	103
Level of significance		**			
CV (%)		1.86			
LSD		1.85			

Table 9c. Yield performances of 18 groundnut genotypes at two locations during Rabi 2021-2022

Sl No.	Entry	Yield (Kg/ha)			
		Joydebpur	Burirhat	Mean	Relative position
1	6112-6-1	2713	750	1732	96
2	602-7-4-2	2563	821	1692	94
3	702-6-2-1	1993	979	1486	83
4	502-4-3-1	1863	999	1431	80
5	ISD 0414	1443	1625	1534	85
6	Choko 0314	1960	2010	1985	110
7	Jhaldhaka	2743	1938	2341	130
8	PK-1	2603	1521	2062	115
9	ICGV 07219	2830	2799	2815	156
10	14-103	1800	2271	2036	113
11	14-403	2630	698	1664	92
12	ISD 2914	1610	2146	1878	104
13	ICGV SL-1	1700	2448	2074	115
14	ICGV 38-3	1747	1563	1655	92
15	Tridana Cox'sbazar	1550	1125	1338	74
16	Galachipa	1357	875	1116	62
17	Dhaka-1	2290	896	1593	89
18	BARI Chinabadam-8	2527	1073	1800	100
Level of significance		**			
CV (%)		29.02			
LSD		344.37			

Mean performances over locations are presented in Table 9b and 9c. Average days to maturity at two locations were almost similar to the check varieties except ICGV-07219. ICGV-07219 took lowest no. of days to mature over two locations. Average days to maturity was 141. On an average the entry ICGV 07219 produced maximum pod yield (2815 kg/ha) followed by Jhaldhaka (2341 kg/ha), ICGV SL-1 (2074 kg/ha), PK-1 (2062 kg/ha), 14-103 (2036 kg/ha), Choko 0314 (1985) and ISD 2914 (1878 kg/ha) which were 56%, 30%, 15%, 15%, 13%, 10% and 4% higher than the check varieties.

Conclusion

Seven genotypes ICGV 07219, Jhaldhaka, ICGV SL-1, PK-1, 14-103, Choko 0314 and ISD 2914 have been selected for Adaptive Trial.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

REGIONAL YIELD TRIAL OF GROUNDNUT (SET-II)

K C SAHA , M S UDDIN AND M B SARKER

Abstract

The experiment was conducted with 15 selected lines of groundnut along with 3 check varieties Dhaka-1, BINA Chinabadam-4 and BARI Chinabadam-8 at two locations under Regional Yield Trial to find out promising lines with desirable characters. Shelling percentage was highest in the genotype 14-203(70%), ISD 4114(70%), TG-37(70%) and ICGV-0207(70%). The genotype ICGV 0207 produced the highest yield (2594 kg/ha) followed by ICGV 35-1 (2370 kg/ha), ICGV 93420 (2295 kg/ha), TG 37 (2279 kg/ha), TG 51 (2252 kg/ha) and ICGV 0704 (2247 kg/ha) over two locations which were 21%, 11%, 7%, 6%, 5% and 5% higher than the check varieties. Finally genotypes ICGV 0207, ICGV 35-1, ICGV 93420, TG 37, TG 51 and ICGV 0704 were selected for Adaptive Trial.

Introduction

Groundnut is cultivated in pockets throughout the country (Rahman *et al*. 2000). In the north, duration of this crop is 120 to 130 days; groundnut growth and development is inhibited at temperatures below 20ºC. This crop is therefore mainly distributed in regions with milder winter temperatures. Groundnut varieties that are recommended for Bangladesh should be short duration. Traditionally, groundnut is grown in the riverbed areas, planted in October to November and harvested in March to April. Rice-fallows in southern districts (Patuakhali, Borguna, and Bhola), central districts (Rajbari, Kushtia, and Faridpur) and also the southwestern districts of Laksmipur are suitable for introducing groundnut during winter after the harvesting of T.Aman rice. Also, rice-fallows found in Chittagong are suitable for introducing groundnut. There is potential for expansion of rabi groundnut in char (river basin) lands without much competition from other crops. Substantial rice-fallows found in the following districts Lalmonirhat, Gaibandha, Sirajganj, Jamalpur, Tangail, Kushtia, Faridpur, Dhaka, Narayanganj, Munshiganj, Noakhali, Patuakhali, and Bhola are suitable for groundnut production. Parts of Thakurgaon, Panchagar, and Nilphamari districts, in the northwest region of the country are also suitable for groundnut cultivation, provided irrigation is available during winter. This is mainly due to the low temperatures in these northern districts, which prevents planting of groundnut until early January. Thus the groundnut-growing season extends into April or May, and requires irrigation. Dhaka-1 is an obsolete variety occupied more than 95% groundnut area in Bangladesh. It is a low yield potential variety and susceptible to disease and insects. Therefore, it is very need to develop a variety which will be high yield and took minimum days to mature. The experiment was under taken to identify high yielding lines of ground with early maturity which would be suitable to cultivate at the river bed areas in our country.

Materials and methods

The experiment was conducted at Joydebpur, Gazipur and RARS, Burirhat, Rangpur during Rabi 2021-22 with 18 promising genotypes of groundnut including 3 checks Dhaka-1, BARI Chinabadam-8 and BINA Chinabadam-4. The experiment was laid out in Randomized Complete Block design having three replications. The date of sowing was 29 December, 2021 at Joydebpur and 28 November, 2021 at Burirhat. The plot size was 4m x 2.4m. Spacing was 15cm seed to seed and 40 cm row to row. Recommended doses of fertilizers were applied @ 80:65:60:20:4 kg/ha of NPKS Zn respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of peg development. All intercultural operations were done timely to raise the crop uniformly. Data were taken on, days to maturity, mature pods per plant, 100 kernel weight, immature pod per plant, shelling % and yield per plot. The plot yield was converted into kg per hectare. The data were analyzed statistically.

Results and discussion

Significant differences were observed among the genotypes for all the characters except days to 1stflowering studied at Joydebpur. Maturity duration ranged from 142-149 days. Highest number of mature pods/plant (31) was obtained from the entry ICGV 35-1.The range of hundred kernel weight was 42-62g. Highest shelling percentage (70) was recorded in the genotype 14-203, ISD 4114, TG-37 and ICGV-0207.

Table 10a. Performances of 18 groundnut genotypes in RYT (Set-II) at Joydebpur, during 2021-22

Sl No.	Entries	PH (cm)	MP/ plant	DM (days)	100 KW (g)	Shelling (%)	Yield (kg/ha)	Rel. pos.
1.	ICGV 87073	37	16	144	50	68	1800	69
2.	14-203	36	27	143	47	70	2847	110
3.	ICGV 93420	45	29	148	45	69	2887	111
4.	ISD 4114	33	18	147	55	70	1887	73
5.	ISD 3814	40	23	149	57	67	2097	81
6.	TG 51	29	25	146	58	66	2503	96
7.	TG 37	34	22	146	55	70	2073	80
8.	ICGV 02841	29	24	144	50	66	2187	84
9.	ICGV 91176	33	22	149	59	67	1903	73
10.	ICGV 0107	29	25	145	55	66	2517	97
11.	ICGV 0704	31	30	147	62	65	2960	114
12.	ICGV 0207	31	28	145	62	70	2873	111
13.	ICGV 09516	29	24	144	49	68	2190	84
14.	ICGV 35-1	31	31	148	62	66	2977	115
15.	ICGV-95090	29	17	146	45	67	1830	70
16.	Dhaka -1	30	25	144	44	67	2283	88
17.	BINA Chinabadam-4	31	25	142	42	68	2246	86
18.	BARI Chinabadam-8	32	25	142	55	69	2597	100
Level of significance		**	**	NS	**	*	**	
CV(%)		8.88	17.56	1.87	5.01	2.63	11.11	
LSD		4.84	7.35	4.50	4.42	2.97	436.80	

N.B.: DFF=days to 1st flowering, DM = days to maturity, PH = Plant height, MP = mature pods per plant, KW = kernel weight

**= Significant at 1% level of significance, * = Significant at 5% level of significance, NS=Non significant

Table 10b: Performances of days to maturity of 18 entries of groundnut genotypes in RYT at 2 locations during Rabi 2021-22

Sl No.	Entry	Maturity (Days)			
		Joydebpur	Burirhat	Mean	Relative position
1.	ICGV 87073	144	151	148	101
2.	14-203	143	150	147	101
3.	ICGV 93420	148	150	149	102
4.	ISD 4114	147	150	149	102
5.	ISD 3814	149	150	150	103
6.	TG 51	146	151	149	102
7.	TG 37	146	150	148	101
8.	ICGV 02841	144	151	148	101
9.	ICGV 91176	149	149	149	102
10.	ICGV 0107	145	151	148	101
11.	ICGV 0704	147	151	149	102
12.	ICGV 0207	145	150	148	101
13.	ICGV 09516	144	151	148	101
14.	ICGV 35-1	148	150	149	102
15.	ICGV-95090	146	149	148	101
16.	Dhaka -1	144	150	147	101
17.	BINA Chinabadam-4	142	149	146	100
18.	BARI Chinabadam-8	142	150	146	100
Level of significance		*			
CV (%)		1.45			
LSD		1.42			

Table 10c. Yield performances of 18 entries of groundnut genotypes in RYT (Set-I) at 2 locations during Rabi, 2021-22

Sl No.	Entry	Yield (Kg/ha)			
		Joydebpur	Burirhat	Mean	Relative position
1.	ICGV 87073	1800	1503	1652	77
2.	14-203	2847	1012	1930	90
3.	ICGV 93420	2887	1702	2295	107
4.	ISD 4114	1887	1150	1519	71
5.	ISD 3814	2097	2055	2076	97
6.	TG 51	2503	2001	2252	105
7.	TG 37	2073	2484	2279	106
8.	ICGV 02841	2187	1119	1653	77
9.	ICGV 91176	1903	2055	1979	92
10.	ICGV 0107	2517	1104	1811	85
11.	ICGV 0704	2960	1533	2247	105
12.	ICGV 0207	2873	2315	2594	121
13.	ICGV 09516	2190	1395	1793	84
14.	ICGV 35-1	2977	1763	2370	111
15.	ICGV-95090	1830	1763	1797	84
16.	Dhaka -1	2283	1288	1786	83
17.	BINA Chinabadam-4	2246	1564	1905	89
18.	BARI Chinabadam-8	2597	1687	2142	100
Level of significance		**			
CV (%)		21.32			
LSD		283.21			

The average result of Joydebpur and Burirhat locations were shown in Table 10b and 10c. Average days to maturity of two locations were varies from 146 to 150 days. The genotype ICGV 0207 produced the highest yield (2594 kg/ha) followed by ICGV 35-1 (2370 kg/ha) , ICGV 93420 (2295 kg/ha), TG 37 (2279 kg/ha), TG 51 (2252 kg/ha) and ICGV 0704 (2247 kg/ha) over two locations which were higher than the check varieties.

Conclusion

Six genotypes ICGV 0207, ICGV 35-1, ICGV 93420, TG 37, TG 51 and ICGV 0704 have been selected for Adaptive Trial.

Acknowledgement

‘Enhance Production of Oil crops (BARI Part)’ project.

REGIONAL YIELD TRIAL OF GROUNDNUT (SET-III)

M K ALAM, M I RIAD AND M KADIR

Abstract

The experiment was conducted at Regional Agricultural Research Station, Jamalpur during Rabi 2021-22 to evaluate the groundnut lines and to find out the best one(s) for their yield and yield contributing characters. The line BAG-19005 produced the highest nut yield. It produced 2416 kg/ha yield which was 51 % higher than the traditional variety, Dhaka-1. TG-51 produced the 2nd highest yield. It produced 44% higher yield than check variety, Dhaka-1. The 3rd highest yield was recorded from the line ICGV-93280. This line produced 23% higher yield than Dhaka-1. These three lines took 153 days to mature. These lines may be selected for evaluation in adaptive trial.

Introduction

Groundnut is one of the most nourishing foods available in the world. It contains five important nutrients such as food energy, protein, phosphorous, thiamin and niacin. Groundnuts have considerable medicinal value. They contain a good deal of oil, which is very easily digested, and for this reason they are useful consumptives. The oil is regarded as an excellent aperient or a mild laxative and emollient which softens the skin. Eating fresh roasted groundnuts with jaggery and goat's milk is a very nutritious food for growing children, pregnant women and nursing mothers. It builds a resistance against all infections, such as Hepatitis and tuberculosis. Ground nuts or groundnut products are useful in the treatment of hemophilia, and inherited blood decease, which causes hemorrhage. It is also useful in nose bleeding and incases of excessive bleeding during menstruation in women. Groundnuts are valuable in diabetes. It is also useful in diarrhea, especially chronic diarrhoea, which is more frequent immediately after meal. The patient can use it by drinking goat's milk in which lemon is squeezed with a handful of fresh roasted groundnuts. Diarrhoea is caused due to nicotinic acid deficiency mainly and groundnuts provide the required quantity of Niacin. Chewing fresh groundnuts with a pinch of salt strengthens the gums, cures stomatitis, and kills harmful bacteria. A teaspoon of refined groundnut oil mix with equal quantity of limejuice may be applied daily on the face before going to bed. It keeps the face fresh. Its regular use nourishes the skin and prevents acne also. A large number of food products are prepared from the groundnuts. Groundnuts are valuable in diabetes. It is also useful in diarrhea, especially chronic diarrhoea, which is more frequent immediately after meal. The patient can use it by drinking goat's milk in which lemon is squeezed with a handful of fresh roasted groundnuts. Diarrhoea is caused due to nicotinic acid deficiency mainly and groundnuts provide the required quantity of Niacin. Chewing fresh groundnuts with a pinch of salt strengthens the gums, cures stomatitis, and kills harmful bacteria. A teaspoon of refined groundnut oil mix with equal quantity of limejuice may be applied daily on the face before going to bed. It keeps the face fresh. Its regular use nourishes the skin and prevents acne also. A large number of food products are prepared from the groundnuts.

Materials and Methods

The experiment was conducted at RARS, Jamalpur during Rabi 2021-2022 with 12 lines of groundnut including BARI Chinabadam-8, BINA Chinabadam-4 and Dhaka-1 as checks. The plot size was 8 rows 5m long. The experiment was laid out in RCBD with three replications. Seeds were sown on the 20th November, 2021 in 15 cm seed to seed and row was 30 cm apart from each. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MP, Gypsum and Boric acid. Fifty percent of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of peg development. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to mature, shelling% and yield per plot. The plot yield was converted into hectare. The data were analyzed statistically.

Results and Discussion

The results are presented in table 11. Most of the lines produced higher nut yield than Dhaka-1. It was observed from the table that the groundnut line BAG-19005 produced the highest nut yield. It produced 2416 kg/ha yield which was 51 % higher than the traditional variety Dhaka-1. It produced significantly higher yield among the lines included in this trial. It took 153 days to mature. The line TG-51 produced the 2nd highest yield. It produced 2296 kg/ha nut yield which was 44 % higher than Dhaka-1. It took 153 days to mature. The third highest yield was recorded from ICGV-93280. It produced 1971 kg/ha which was 23 % higher than check variety, Dhaka-1. This groundnut line took 154 days to mature. These three lines may easily be grown and harvested before fresh flood at char area. These lines may be selected for evaluation in adaptive trial in the char area.

Table 11 Performances of 12 groundnut genotypes in RYT (Set-III) at Jamalpur, during 2021-22

Sl	Lines/ Varieties	Days to maturity	Plant Height(cm)	Mature POD	100 Kernel Wt	Shelling%	Yield (kg/ha)
1	TG-51	153 AB	48.5 BC	15 BC	39.27 A	75.8 A	2,296 A
2	ICGV-07214	183 AB	51.7 BC	23 AB	37.32 A	71.6 BC	1,611 C-E
3	ICGV-07245	153 A	50.8 BC	16 BC	35.90 A	70.7 B-D	1,762 B-D
4	**ICGV-93280**	**154 A**	**49.7 BC**	**16 BC**	**37.33 A**	**72.8 AB**	**1,971 B**
5	ICGV-97232	154 A	52.8 B	16 BC	41.26 A	72.4 A-C	1,452 DE
6	ICGV-14303	154 A	45.1 C	28 A	37.27 A	68.9 CD	1,111 F
7	**BAG-19005**	**153 A**	**52.9 B**	**25 A**	**38.69 A**	**73.0 AB**	**2,416 A**
8	BAG-19007	150 CD	48.9 BC	21 A-C	41.04 A	71.1 B-D	1,440 E
9	BAG-19011	153 AB	65.9 A	14 C	40.77 A	62.6 E	1,766 B-D
10	BARI-8	152 BC	49.9 BC	20 A-C	39.85 A	72.2 BC	1,790 BC
11	BINA-4	149 DE	49.1 BC	27 A	29.20 B	71.9 BC	1,770 B-D
12	Dhaka-1	148 E	47.8 BC	22 AB	29.73 B	67.6 D	1,598 C-E
CV%		0.5	8.79	24.78	8.63	3	10.77
Lvel of sig.		**	**	*	**	**	**
Lsd		1.538	7.606	8.502	5.449	3.596	318.96

ADAPTIVE TRIAL OF GROUNDNUT ADVANCED LINES AT CHAR AREA IN JAMALPUR

M K ALAM, M I RIAD AND M KADIR

Abstract

The experiment was conducted at Naubanger char, Jamalpur sadar, Jamalpur during Rabi 2021-22 to screen the groundnut advance lines and to find out the best one(s) for their yield and yield contributing characters. The line ICGV-00338 produced the highest nut yield. It produced 2205 kg/ha yield which was 49 % higher than the traditional variety, Dhaka-1. ICGV-07220 produced the 2nd highest yield. It produced 41% higher yield than check variety, Dhaka-1. The 3rd highest yield was recorded from the line BARI Chinabadam-11. This line produced 35 % higher yield than Dhaka-1. These three lines took 145-149 days to mature. These lines may be selected for further evaluation in another location as adaptive trial.

Introduction

Groundnut is an economically important crop because of its wide spread commercial production and utilization as oil, food and fibre. Over two-third of the global groundnut production occurs in seasonally rain-fed region, where drought is a potential constraint for crop production. Development of genetic and management strategies to alleviates the effects of drought on peanut has been a long term goal of crop scientists. Breeding and selection for yield in a given drought condition is imperative, good and low cost technology to find out drought resistant or tolerant genotypes. Most of the groundnut grown in Bangladesh is cultivating at the sandy soil of river bed or char areas, where water scarce is a regular phenomenon .Rain is the only source of water supply for groundnut at those areas. Any groundnut genotypes tolerant or resistant to water scarce will definitely help to boost up production.

Generally char land remain under water during raining season. It rises after receding of the flood water. Farmers sow their groundnut seed in the month of November. River water starts increasing slowly from last week of May. The time schedule for production of this crop is November-May. Only 150-160 days are available to complete its life cycle. Otherwise it may go under water and whole crop may be lost. So it is essential to select short duration high yielding varieties of groundnut for Bangladesh. Keeping this objective in mind, this experiment was conducted with 16 lines of groundnut to find out high yield potential lines suitable for that char area under the prevailing climatic condition.

Materials and Methods

The experiment was conducted at Naubangerchar, Jamalpur sadar, Jamalpur during Rabi 2021-22 with 6 lines of groundnut including Dhaka-1, as checks. The plot size was 8 rows 10 m long. Seeds were sown on the 22th November, 2021 in 15 cm seed to seed and row was 30 cm apart from each. Fertilizers were applied @ 12:32:43:54:1.8 kg/ha of N: P: K: S: and Boron from Urea, TSP, MP, Gypsum and Boric acid. Fifty percent of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at the initial stage of peg development. All intercultural operations were done timely to raise the crop uniformly. Data were taken on days to mature, shelling% and yield per plot. The plot yield was converted into hectare. The data were analyzed statistically.

Results and Discussion

The results are presented in table 12. It was observed from the table that the groundnut line ICGV-00338 produced the highest nut yield. It produced 2205 kg/ha yield which was 49 % higher than the traditional variety Dhaka-1. It took 146 days to mature. The line ICGV-07220 produced the 2nd highest yield. It produced 2078 kg/ha nut yield which was 41 % higher than Dhaka-1. It took 149 days to mature. The third highest yield was recorded from BARI Chinabadam-11. It produced 1993 kg/ha which was 35 % higher than check variety, Dhaka-1. This groundnut line took 142 days to mature. These three lines may easily be grown and harvested before fresh flood at char area. ICGV-07219 produced 27% high yield and took 148 days to mature. It has the potentiality to tolerate drought stress. These lines may be selected for further evaluation in adaptive trial in another char area.

Table 12. Performance of adaptive yield trial of groundnut advanced lines at char area of Jamalpur

Sl No.	Lines/ Varieties	Days to maturity	Plant Height (cm)	Mature POD	100 Kernel Wt	Shelling %	Yield (kg/ha)
1	ICGV-07219	148 A	41 C	22 AB	39.4 A	77 A	1,874 BC
2	**ICGV-07220**	**149 A**	**46 B**	**24 AB**	**33.1 C**	**73 B**	**2,078 AB**
3	**ICGV-00338**	**146 B**	**45 B**	**33 A**	**34.6 B**	**73 B**	**2,205 A**
4	ICGV-07214	145 C	43 BC	22 AB	34.3 B	72 C	1,946 A-C
5	BARI Chinabadam-11	142 E	54 A	14 B	34.9 B	69 D	1,993 A-C
6	Dhaka-1	141 D	41 C	28 A	30.3 D	67 E	1,478 C
CV%		0.51	4.04	28.02	1.66	0.73	7.93
Level of Sig.		**	**	ns	**	**	*
Lsd		1.616	3.294	-	1.039	0.956	285.590

C. SOYBEAN (*Glycine max* L)

The **soybean** (USA) or **soya bean** (UK, AU) (*Glycine max*) is a species of legume native to **East Asia**, widely grown for its edible bean which has numerous uses. The plant is classed as an oilseed rather than a pulse by the UN Food and Agricultural Organization (FAO). The genus *Glycine* Willd. is divided into two subgenera, *Glycine* and *Soja*. The subgenus *Soja* (Moench) F.J. Herm. includes the cultivated soybean, *Glycine max* (L.) Merr., and the wild soybean, *Glycine soja* Sieb. & Zucc. Both species are annuals. *Glycine soja* is the wild ancestor of *Glycine max* and grows wild in China, Japan, Korea, Taiwan, and Russia. The subgenus *Glycine* is wild perennial species: for example, *Glycine canescens* F.J. Herm. and *G. tomentella* Hayata, both found in Australia and Papua New Guinea. Perennial soybean originated in Africa and is now a widespread pasture crop in the Tropics. Soybeans are the main grains produced, ranking fourth in global production volume and first among the oil "major oilseeds," participating in the global agricultural economy. Soybean is one of the most important sources of protein and gaining popularity in Bangladesh. Now a day its oil is very popular as cooking purposes in the country. The extraction of soybean oil from the seed is not yet possible by the traditional method. So, most of the soybean produced in the country is used mainly in the feed industries. The soybean can also be used to prepare the quality food items like soyadal, soyakhechuri, soyamisty, soyapolao, soyamilk, soya cake, soya biscuits, and soyabread etc. Soybean seed contains 42-45% protein and 20-22% edible oil. Recently the crop has gained popularity for its meal used in an important ingredient of poultry and fish feed as a source of protein. Introduction of this temperate crop to sub-tropical climatic conditions like Bangladesh made it more vulnerable to problems like seed longevity, poor growth rate due to changed photoperiod, various biotic and abiotic stresses, etc (Hegde 2009). Therefore, the following experiments have been undertaken to develop high yielding, YMV resistant/tolerant varieties with other desirable characters.

MAINTENANCE AND EVALUATION OF SOYBEAN GERMPLASM

U. KULSUM AND M SHALIM UDDIN

Abstract

A total of one hundred twenty soybean germplasms with three check varieties were evaluated and maintained. Descriptive statistics and analysis of variance revealed a wide range of variability for different characters except pod length (cm) and 100-seed wt (g). Estimated hBS for all the measured traits ranged from 76.8% to 85.9%, indicating that all the traits were highly inheritable. Genetic variances were low to high for most of the traits, indicating complex genetic architecture.Based on the nine traits and evaluation of various genetic parameters, the germplasm G7, G32, G55, G49, G10, G105, G54, G48, G106, G17, G21, G100, G15, G56, G18, G1, G75 and G116 might be considered as best parents for the future breeding program of soybean improvement.

Introduction

Soybean is a leguminous and sub-tropical crop. It is considered to be a native of China. The crop was introduced in our country around 1942. Sporadic attempted has been taken to popularize the crop in Bangladesh. Now a day soybean is cultivated in some locations of Bangladesh like Noakhali, Luxmipur, Chandpur, Feni, Bhola, Patuakhali, Barisal, and different char areas. It provides nitrogen to the soil which helps to increase soil fertility. It contains a higher amount of protein and oil than any other legume crops. Soybean contains 18-20% oil, 40-45% protein, and 24-26% carbohydrate. The experiment was conducted to find out the desired potential entries and maintain the accessions of the collected germplasm.

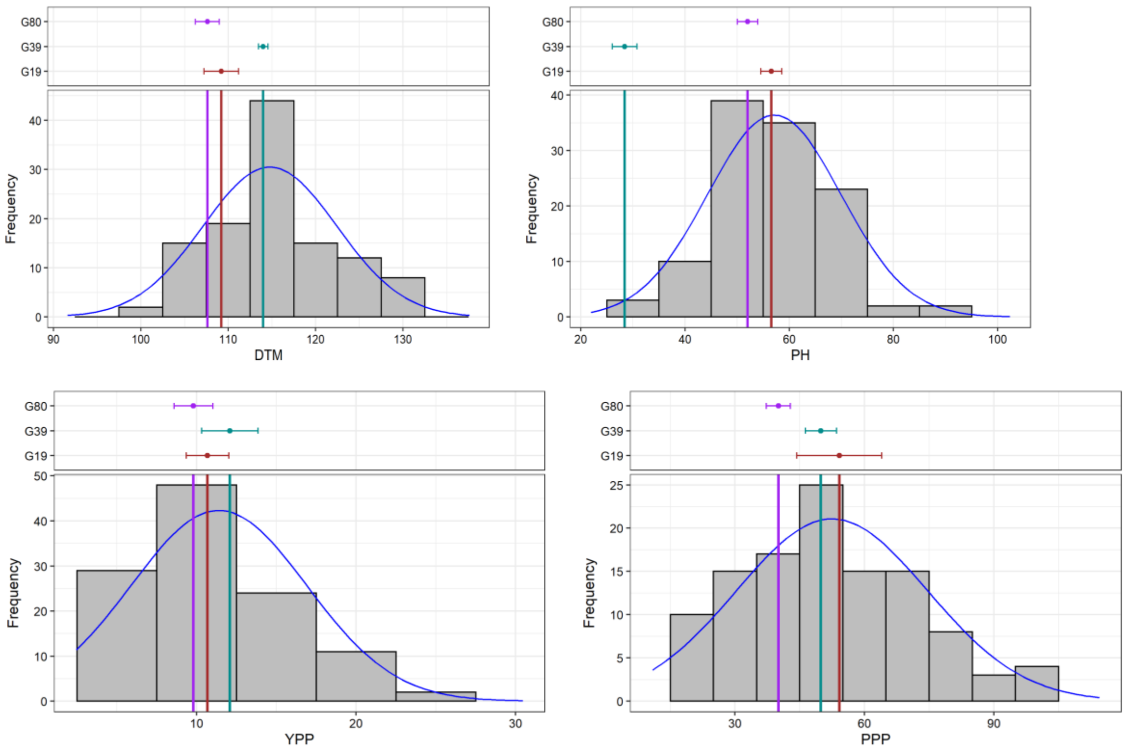
Materials and Methods

A total of one hundred twenty germplasms were planted in an augmented design at Joydebpur together with three check varieties, BARI Soybean-5, BARI Soybean-6, and BARI Soybean-7. The experimental area was divided into five blocks, with twenty-seven plots in each block. Seeds were sown in two rows of 4 m long, with line to line spacing of 40 cm and plant to plant spacing of 10 cm. The date for planting was January 13, 2022. Fertilizers were applied @ 25:35:55:18 kg per ha of NPKS, respectively from Urea, TSP, MP, and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the urea was applied as top dress during flower primordial stage. Two/three times roughing was done to maintain genetic purity of the germplasms. Other intercultural operations were done properly to obtain optimum plant growth.

Results and Discussion

Analysis of variance and frequency distribution of different characters :

A total of one hundred twenty soybean germplasms with three check varieties namly BARI Soybean-5, BARI Soybean-6, and BARI Soybean-7 were evaluated. Analysis of variance (ANOVA) revealed high significant variation among the germplasm with check for all the characters except pod length (cm) and 100-seed wt (g). ANOVA for all the traits also revealed significant differences among the check, germplasm by check interaction as well as among the germplasm (Table 1). The name of the germplasms is included in **Appendix I (a).**



G80= BARI Soybean-5
G39= BARI Soybean-7
G19= BARI Soybean-6

Fig. 1. Frequency distribution of days to flowering (DTM), plant height (PH), Pods per plant (PPP) and Yield per plant (YPP) with a normal probability curve of germplasm and check varieties of soybean.

Table 1. Analysis of variance of the different characters of soybean germplasm evaluated in Joydebpur, 2022

Source	*D/F (days)	*D/F (days)	*D/M (days)	Plant height (cm)	Branches /Plant	Pod length (cm)	Pods per plant	Seed per pod	Hundred seed wt (gm)	Seed yield/ plant (kg/ha)
Genotype (G) with C	116	29.82 *	53.19 *	200.37 **	1.33 **	0.17 ns	408.94 **	0.09 **	8.82 ns	27.32 **
Check (C)	2	14.47 *	55.47 *	1138.83 **	1.81 **	1.12 ns	262.47 **	0.05 ns	10.87 ns	6.61 **
Genotype (G) vs. C	1	351.7 **	277.51 **	1833.68 **	1.41 *	0.11 ns	243.04 **	0.8 **	17.08 ns	3.14 **
Genotype (G)	113	27.24 *	51.16 *	169.31 **	1.32 **	0.15 ns	413 **	0.08 *	8.71 ns	27.9 **
Adj.Block (B)	4	5.1 ns	6.9 ns	19.27 ns	0.64 ns	1.53 ns	281.37 ns	0.07 *	7.9 ns	19.16 ns
Residuals	8	8.55	11.8	23.84	0.2	1.02	154.73	0.02	11.2	6.47

D/F= days to flowering; D/M= days to maturity; ** = 1% level of significance; ns = Non significant

Descriptive statistics:

Descriptive statistics including means, standard error (std.Error), standard deviations (std.Dev), minimum (Min), maximum (Max), skewness, kurtosis CV% are summarized in **Table 2**. Wide ranges of phenotypic values were observed for all traits. The germplasm ranges for days to flowering, days to maturity, plant height, branches per plant, pod length , pods per plant, seeds per pod, hundred seed weight and seed yield per plant were 53.2-85.5 days, 91.6-137.6 days, 21.8-102.3 cm, 1.1-11, 1.9-5.7 cm, 10.8-114.4, 1.8-3.2, 2.6-21.6 gm and 2.5-30.5 gm respectively. The highest CV% was observed for Hundred seed weight 33.7%.

Table 2. Descriptive statistics of different characters of soybean germplasm

Characters	**Mean**	**Std. Error**	**Std. Deviation**	**Min**	**Max**	**Skewness**	**Kurtosis**	**CV (%)**
Days to flowering	62.85	0.5	5.41	53.2	85.53	1.01 **	5 **	4.68
Days to maturity	114.75	0.71	7.65	91.6	137.6	0.12 ns	3.36 ns	3.01
Plant height (cm)	57.11	1.19	12.82	21.93	102.33	0.26 ns	4.63 **	8.71
Branches per plant	3.9	0.11	1.16	1.12	11.12	1.75 **	14.57 **	11.66
Pod length (cm)	3.68	0.07	0.74	1.93	5.67	-0.84 **	3.26 ns	**27.34**
Pods per plant	52.46	2.05	22.15	10.84	114.44	0.43 ns	2.89 ns	**24**
Seeds per pod	2.43	0.03	0.34	1.79	3.19	0.32 ns	2.47 ns	5.48
Hundred seed weight (gm)	9.84	0.29	3.1	2.6	21.6	0.39 ns	4.46 *	**33.7**
Seed yield per plant (gm)	11.39	0.51	5.51	2.45	30.45	0.97 **	4.16 *	**22.54**

Genetic variability analysis:

The findings of different genetic parameters viz., phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), broad sense heritability (h^2 bs) and genetic advance as percent of mean (GAM) for all the characters are showed in Table 3. The Highest magnitude of both PCV (46.4%) and GCV (40.7%) were observed for seed yield per plant (gm) followed by pods per plant, branches per plant, and plant height (cm). For High PCV and high GCV suggesting that these characters were under the influence of genetic control. The character seeds per pod recorded for medium magnitudes of both PCV and GCV, respectively. The characters days to flowering and days to maturity recorded for low magnitudes of both PCV and GCV respectively. Estimated broad sense heretability (hBS) was high for all the characters under study reveled high inheretability.

Table 3. Genetic Variability Analysis of different characters

Trait	PV	GV	EV	GCV	PCV	ECV	hBS	GA	GAM
Days to flowering	27.2	18.7	8.6	6.9	8.3	4.7	68.6	7.4	11.8
Days to maturity	51.2	39.4	11.8	5.5	6.2	2.9	76.9	11.4	9.9
Plant height (cm)	**169.3**	**145.5**	23.8	**21.1**	**22.8**	8.6	85.9	23.1	40.4
Branches per plant	1.3	1.1	0.2	**27.1**	**29.4**	11.6	84.5	2	51.3
Pod length (cm)	0.2		1.0		10.5	27.4			
Pods per plant	**413**	**258.3**	154.7	**30.6**	**38.7**	23.7	62.5	26.2	49.9
Seeds per pod	0.1	0.1	0.02	10.7	11.9	5.4	79.4	0.5	19.6
Hundred seed weight (gm)	8.7		11.2		30	34.0			
Seed yield per plant (gm)	27.9	21.4	6.5	**40.7**	**46.4**	**22.3**	76.8	8.4	73.5

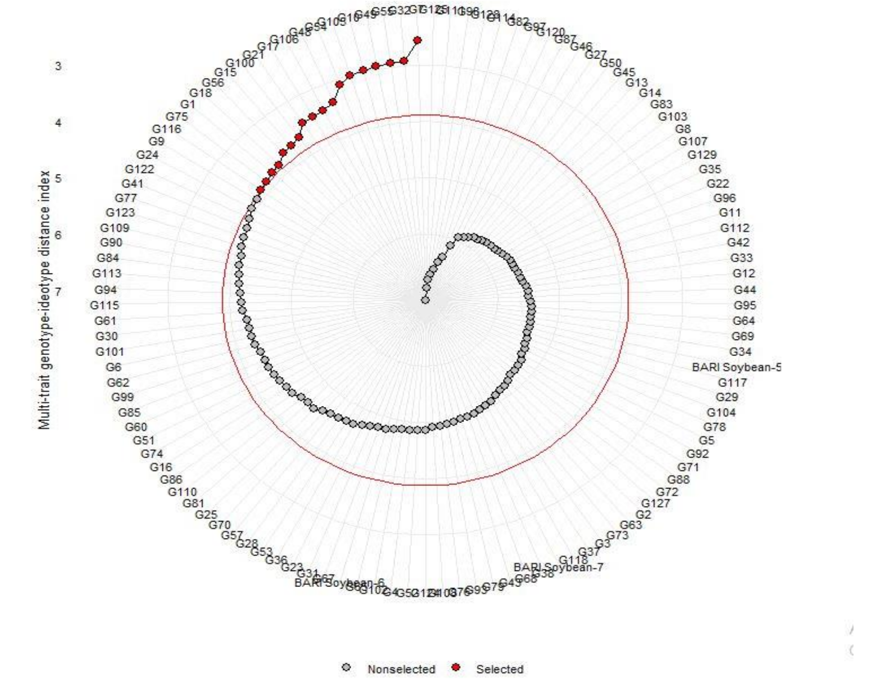


Fig.2. Genotype ranking based on the MTSI considering a selection intensity of 5% (red circle). Selected genotypes are highlighted in red.

Multi-trait index and genotype selection

The multi-trait stability index (Olivoto et al. 2021) has been proven useful for selecting genotypes for multiple traits based on mean performance and stability. Stable genotypes of soybean were also identified for stress conditions by Zuffo et al. (2020). Benakanahalli et al. (2021) made a suitable genotypic selection to identify stable guar genotypes with productive traits under differential environmental conditions through Multi-Trait Stability Index (MTSI) and Multi-Trait Genotype-Ideotype Distance Index (MGIDI). In the present study, the genotypes selected by the MGIDI index were G7 G32 G55 G49 G10 G105 G54 G48 G106 G17 G21 G100 G15 G56 G18 G1 G75 and G116 as indicated by the red line that suggests the number of genotypes selected based on the selection pressure (Fig. 2).

Conclusion

Based on all genetic parameters, genotypes selected on through seed yield per plant (gm) and pods per plant (gm) could significantly improve the grain yield of soybean. The germplasm G7, G32, G55, G49, G10, G105, G54, G48, G106, G17, G21, G100, G15, G56, G18, G1, G75 and G116 would be effective for future breeding programs of soybean improvement.

Acknowledgement
'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project.

DEVELOPMENT OF RECOMBINANT INBRED LINES (RIL) OF SOYBEAN

M SHALIM UDDIN AND U. KULSUM

Abstract

A total of nine single plants were selected and harvested based on earliness, flower color and bearing habit. The seeds of selected single plants with desirable characters were stored separately for next year sowing as F_3 generation.

Introduction

Soybean is a leguminous and sub-tropical crop. It is considered to be a native of China. The crop was introduced in our country around 1942. Sporadic attempted has been taken to popularize the crop in Bangladesh. Soybean is being cultivated extensively in Noakhali, Luxmipur, Feni, Bhola, Barisal and accounts for the second position of oil crops in acreage. There is a huge scope for expansion of soybean cultivation all over the country especially in coastal belts in the southern districts of the country. It provides nitrogen to the soil which helps to increase soil fertility. It contains a higher amount of protein and oil than any other legume crops. Recombinant inbred lines (RIL) are a common practice in plant breeding. It is formed by crossing two inbred lines followed by repeated selfing or sibling mating and the offspring that are produced (F1) will contain a combination of the alleles from the parents. This process is repeated five more times in order to produce an F6 generation that will contain mostly homozygous individuals for the desirable traits. One of the major ways to increase production of soybeans is to, first create a RIL from a base population, it is generally done in order to produce a genetic map, the genetic map is then used to detect the presence of certain alleles that will have desirable traits in the offspring. Thus,the experiment was conducted to create RILs and selection of plant/lines with higher seed yield and agronomic traits.

Materials and Methods

Two variety BARI Soybean-7 and BARI Soybean-6 developed by Oilseed Research Center, BARI was used to create RIL. The variety BARI Soybean-7 is a short,bold seeded and disease resistance and drought tolerant variety. Then, BARI Soybean-6 is a tall, heavy bearing but disease susceptible variety. The crossing between BARI Soybean-7 and BARI Soybean-6 was done in kharif, 2019-2020 at ORC field, BARI. F1 generation was grown at robi, 2020-21 and stored. The F_2 seeds along with the parents BARI Soybean-6 and BARI Soybean-7 were sown on 13 January, 2022. The selected progenies from F_2 seeds were allowed to grown space planted having a large plot to select desired plant types. Other intercultural operations were done as and when necessary.

Results and Discussion

A total of nine single plants were selected and harvested of which 6 had white and rest 3 had purple color flower (Table 4). The selection was done based on earliness, flower color and bearing habit. The seed yield of white flower plant ranged from 11.2-30.8 gm and purple flower plant 15.7-25.9 gm. The seed yield for check vaiety ranges was 10.1-12.4 gm.

Table 4. Performance of selected single plants during rabi 2022 at BARI, Gazipur

Characters	Range		
	White flower	Purple flower	Parents
Days to flowering (days)	52-56		54-57
Days to maturity (days)	106-114		110-114
Plant height (cm)	24-34	26-39	27-51
Root length (cm)	6.2-13.3	5.2-15	9.6-11.7
Pod length (cm)	3-4.2	3.5-4.5	3.4-3.6
Pods per plant	62--91	42-89	42-60
Seeds per pod	2-3	2-3	2-3
Hundred seed weight (gm)	9.3-13.0	9.8-11.7	10.1-11.2
Seed yield per plant (gm)	11.2-30.8	15.7-25.93	10.5-12.2

Conclusion

The seeds of selected single plants with desirable characters were stored separately for next year sowing as the F_3 generation.

Acknowledgement

'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project.

OBSERVATION TRIAL OF SOYBEAN

U. KULSUM AND M SHALIM UDDIN

Abstract

Twelve selected entries including two check variety, BARI Soybean-6 and BARI Soybean-7 were evaluated at ORC, BARI. The minimum days to mature was observed for BARI Soybean-7 (107 days) and maximum in Hayman (127 days).The entry ST-1 produced the highest pods per plant (83). The entry ST-1 produced the highest pods per plant (83). Besides, ST-1, MTD-453, Hayman and LG-92P-1825 were over yielded 31%, 24%, 16% and 7% respectively compared to the check variety BARI Soybean-7.. So, the entries ST-1, MTD-453, Hayman and LG-92P-1825 will be used for the next year yield trail program.

Introduction

Soybean is a leguminous and sub-tropical crop. It is considered to be a native of China. The crop was introduced in our country around 1942. Sporadic attempted has been taken to popularize the crop in Bangladesh. Soybean is being cultivated extensively in Noakhali, Luxmipur, Feni, Bhola, Barisal and accounts for the second position of oil crops in acreage. There is a huge scope for expansion of soybean cultivation all over the country especially in coastal belts in the southern districts of the country. It provides nitrogen to the soil which helps to increase soil fertility. It contains a higher amount of protein and oil than any other legume crops. The most important breeding objectives is yield inhanchment. Thus,the experiment was conducted to find out the desired potential entries with high seed yield to be cultivated in the farmer field.

Materials and Methods

Twelve entries including two check variety namely BARI Soybean-6 and BARI Soybean-7 were evaluated in an RCB design with three replications for seed yield and it's components at Joydebpur during rabi 2022. The unit plot size was 2 rows of 4 m and the spacing was maintained 40 cm row to row and 10 cm plant to plant. The sowing date was 13 January 2022. Fertilizers were applied @ 25:35:55:18 kg per ha of NPKS respectively, from Urea, TSP, MP, and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done as and when necessary. Data on days to flowering. days to maturity and seed yield per plot were taken on the plot basis. The other yield contributing characters such as plant height (cm), pod per plant, and hundred seed weight (g) were recorded from 5 randomly selected plants of each plot. Recorded data were analyzed statistically in R tools.

Results and Discussion

Statistically, a highly significant ($p<0.01$) genotypic differences were observed for all the characters under studied except branches per plant and root length (cm)(Table 5).

Days to maturity:

The study showed that days to maturity for the twelve entries ranged from 107 to 127 days with a mean value of 114.8 days. (Table 5). The minimum days to maturity was obsrved for BARI Soybean-7 (107 days) which was statistically similar to LG-92P-1825, ST-1, USDA-42, Santarose(L) and BARI Soybean-6. The entry Hayman (127 days) took the maximum days for maturity.The coefficient of variation for days to flowering was 3.4%.

Plant height(cm):

Entries differed in plant height that ranged from 27.1 cm to 63.3 (cm) with a mean value of 49.1 (cm). Among the entries, BARI Soybean-7 was the shortest (27.1 cm), which was statistically different from other entries except Santarose(L) while, the tallest genotype was USDA-42 (63.3 cm), which was followed by ST-1, USDA-85, MTD-453 and Hayman (Table 5). The coefficient of variation for plant height was 23.1% (Table 4).

Pods per plant:

Significant variations in pods per plant was ranging from 27 to 83 were observed with a mean value of 51.9 among the entries under this study. Higher number (83) of pods per plant produced by ST-1 and lower number of pods per plant produced by VIETKHAI which was followed by USDA-93. The coefficient of variation for pods per plant was 29.1%.

Hundred seed weight(g):

Hundred seed weight was maximal in MTD-453 (12.1 gm).

Yield(kg/ha):

The highest yield was 2174.3 kg/ha recorded in ST-1 and which was closely followed to MTD-453 and Hayman. The lowest yield was recorded 1029.2 kg/ha in VIETKHAI which was followed by USDA-85 and USDA-42. Those values ranged from 1029.2 to 2174.3 kg/ha with a mean value of 1542.1 kg/ha. The coefficient of variation for yield (kg/ha) was 26.1 % (Table 5). Out of 10 entries, ST-1, MTD-453, Hayman and LG-92P-1825 were over yielded 31%, 24%, 16% and 7% respectively compared to the check variety BARI Soybean-7.

Table 5. Mean performance of eleven soybean entries in OT at Joydebpur,BARI during rabi, 2021-22

SL.	Entries	*D/F (days)	*D/M (days)	Plant height (cm)	Branches /Plant	Root length (cm)	Pod length (cm)	Pods/ plant	100-seed wt (gm)	Yield (kg/ha)	Rel. Pos.
1	**LG-92P-1825**	58	113	47.4	3	13.0	3.9	56	8.9	1773.6	**107**
2	**ST-1**	59	114	49.8	4	13.8	3.8	83	10.3	**2174.3**	**131**
3	**USDA-42**	58	113	63.3	3	19.1	3.7	53	8.4	1032.6	62
4	**USDA-85**	61	113	58.9	3	12.2	3.7	43	6.7	1077.1	65
5	**USDA-93**	58	112	49.5	3	11.7	3.9	34	10.7	1228.5	74
6	**BD-2340**	59	114	46.9	3	12.6	3.4	68	10.6	1358.3	82
7	**VIETKHAI**	63	117	46.6	3	13.2	4.2	27	10.8	1029.2	62
8	**MTD-453**	64	116	55.6	4	13.5	4.2	61	12.1	**2059.7**	**124**
9	**Hayman**	67	127	57.9	4	15.4	3.8	43	10.2	1925.0	**116**
10	**Santarose(L)**	55	114	37.9	3	11.9	3.8	53	11.2	1481.3	89
11	**BARI Soybean-6 (Ch.)**	58	109	48.3	3	10.8	3.7	56	10.8	1703.5	102
12	**BARI Soybean-7 (Ch.)**	54	107	27.1	3	11.5	3.4	46	11.2	1662.5	100
LSD(0.05)		1.5	1.1	13.7	-	4.3	0.4	10.8	3.72	249.5	--
Level of Sig.		**	**	**	ns	ns	**	**	**	**	--
CV%		4.9	3.4	23.1	22.5	34.0	7.4	29.1	15.09	26.1	--

D/F= days to flowering; D/M= days to maturity; ** = 1% level of significance; ns = Non significant

Conclusion

After considering yield along with most of the yield related traits, ST-1, MTD-453, Hayman and LG-92P-1825 were out-yielded compare to check varieties. Selection of these entries would be useful for next year yield trial program for yield aspects.

PRELIMINARY YIELD TRIAL OF SOYBEAN

U. KULSUM AND M SHALIM UDDIN

Abstract

Twelve entries of soybean including two check varieties BARI Soybean-6 and BARI Soybean-7 were evaluated at Joydebpur,BARI to find out suitable soybean entries with desirable characters. Among the entries, BARI Soybean-7 was the most early maturing (106 days) and most dwarf one (25.9 cm). Maximum pods per plant were observed in USDA 72 while minimum in BS-29. In average, the entry USDA ST-1 produced the highest seed yield followed by MTD-453, USDA-40 and USDA-107 which were 24% 16%, 11% and 7% higher than the check variety BARI Soybean-7. So, considering yield and other yield contributing characters, ST-1,MTD-453, USDA-40 and USDA-107 will be selected for Regional Yield Trail program.

Introduction

Soybean is a leguminous and sub-tropical crop. It is considered to be a native of China. The crop was introduced in our country around 1942. Sporadic attempted was made to popularize the crop in Bangladesh. Now a day soybean is cultivated in some locations of Bangladesh like Noakhali, Luxmipur, Feni, Bhola, Barisal, and different char areas. It provides nitrogen to the soil which helps to increase soil fertility. It contains a higher amount of protein and oil than any other legume crop. Soybean contains 18-20% oil, 40-45% protein, and 24-26% carbohydrate. The experiment was conducted to find out the desired potential entries with higher seed yield to be cultivated in the farmer field.

Materials and Methods

Twelve entries, including two check varieties, BARI Soybean-6 and BARI Soybean-7, were evaluated for seed yield and its components in an RCBD design with three replications at Joydebpur in 2022. The unit plot size was 4 rows of 4 m and the spacing was maintained 40cm × 10cm apart. The sowing date was 17 January 2021 at Joydebpur, BARI. Fertilizers were applied @ 25:35:55:18 kg per ha of NPKS, respectively from Urea, TSP, MP, and Gypsum. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done as when necessary. Data on days to flowering. days to maturity and seed yield per plot were taken on the plot basis. The other yield contributing characters were recorded from 5 randomly selected plants of each plot. Seed yield was converted into kg per ha. All the data were analysed using statistical analysis package software R.

Results and Discussion

A significant difference was observed for yield and yield contributing characters except branches per plant and Pod length(cm) (Table 6).

Days to maturity:

The parameter days to maturity for the twelve entries ranged from 106 to 114 days with a mean value of 108.5 days. (Table 5). The minimum days to maturity was obsrved for BARI Soybean-7 (106 days) The entry ST-1 (114 days) took the maximum days for maturity which was similar to MTD-453 statistically .The coefficient of variation for days to flowering was 1.2%.

Plant height(cm):

Entries differed in plant height that ranged from 25.9 cm to 79.7 cm with a mean value of 52.2 (cm). Among the entries, BARI Soybean-7 was the shortest (25.9 cm) and the tallest genotype was USDA-95 (79.7 cm) (Table 5). The coefficient of variation for plant height was 24.4% (Table 4).

Pods per plant:

Significant variations in pods per plant was ranging from 27 to 62 were observed with a mean value of 44.3 among the entries under this study. Higher number (62) of pods per plant produced by ST-1 which was similar to other entries except BS-29, USDA-4 and USDA-9. And lower number of pods per plant produced by BS-29. The coefficient of variation for pods per plant was 22.3%.

Hundred seed weight(gm):

Hundred seed weight was maximal in GMOT-13 (11.7 gm). And the lowest in USDA-72 (5.8 gm). The hundred seed weight of check variety BARI Soybean-6 and BARI Soybean-7 was 10.6 gm.The coefficient of variation for yield (kg/ha) was 20.6 % (Table 5).

Yield(kg/ha):

The highest yield was 2135.4 kg/ha recorded in ST-1 and which was statistically similar to MTD-453 and **USDA 40**. The lowest yield was recorded 1077.1 kg/ha in BS 29 which was followed by USDA-4. Those values ranged from 1077.1 to 2135.4 kg/ha. The check varieties BARI Soybean-6 and BARI Soybean-7 ranged from 1715.3 to 1744.0 kg/ha. The coefficient of variation for yield (kg/ha) was 20.6 %.

Out of 10 entries, ST-1 (2135 kg/ha) followed by MTD-453 (1992 kg/ha), USDA-40 (1901 kg/ha) and USDA-107 (1837 kg/ha) which were 24%, 16%, 11% and 7% over yielded compared to the check variety BARI Soybean-7.

Table 6. Mean performance of nine soybean entries at Joydebpur,BARI during rabi, 2022 in PYT

#	Entries	*D/F (Days)	*D/M (Days)	Plant Height (cm)	Branches Per Plant	Root length (cm)	Pod length (cm)	Pods per Plant	100-seed wt (gm)	Yield (kg/ha)	Rel. Pos.
1.	**BS 29**	60	109	46.3	2	9.1	3.8	27	10.6	1077.1	63
2.	**GMOT 13**	58	109	46.8	4	9.7	3.8	55	11.7	1349.0	79
3.	**USDA 4**	57	111	52.9	4	13.2	3.9	35	11.1	1317.2	77
4.	**USDA 40**	58	109	47.4	4	10.6	3.6	49	11.4	1900.6	**111**
5.	**USDA 53**	59	110	60.0	3	12.1	3.4	48	6.1	1367.2	80
6.	**USDA 72**	62	109	57.0	3	12.2	3.5	62	5.8	1486.5	87
7.	**USDA 95**	62	111	79.7	3	13.9	3.5	51	7.6	1359.9	79
8.	**USDA 107**	62	109	59.0	3	9.9	3.3	53	7.0	1836.5	**107**
9.	**ST-1**	57	114	51.9	4	17.3	3.7	41	9.9	2135.4	**124**
10.	**MTD-453**	63	113	50.6	4	16.9	4.2	56	10.8	1992.3	**116**
11.	**BARI Soybean-6**	56	109	48.5	3	12.0	5.8	45	10.6	1744.0	102
12.	**BARI Soybean-7**	60	106	25.9	3	13.7	3.3	50	10.6	1715.3	100
LSD(0.05)		1.95	1.65	8.46	-	4.49	-	11.23	3.31	238.8	--
Level of Sig.		**	**	**	ns	**	ns	**	**	**	--
CV%		4.1	1.2	24.4	25.2	27.7	28.6	22.3	20.1in	20.6	--

D/F= days to flowering; D/M= days to maturity; ** = 1% level of significance; ns = Non significant

Conclusion

After considering yield along with most of the yield related traits, ST-1, MTD-453, USDA-40 and USDA-107 were out-yielded compare to check varieties. In the next year, these highest performing entries will be used for Regional Yield Trial program.

Acknowledgement

'Strengthening of Oilseed and Pulses Research and Development in Bangladesh' project.

D. Sunflower (*Helianthus annus* L.)

Sunflower is an important minor oilseed crop in Bangladesh. The oil of sunflower is rich in essential fatty acid like linoliec and linolenic acid compared to rapeseed and mustard oil. The crop can be grown throughout the year due to its photo insensitive nature. But rabi (winter) season is the best season for producing sunflower. This crop is suitable to grow after harvesting T. aman rice especially in the southern districts of our country. There are three composite varieties of sunflower *viz*. Kironi, BARI Surjomukhi-2 and BARI Surjomukhi-3 developed by Oilseed Research Centre, BARI. Kironi and BARI Surjomukhi-2 are tall and susceptible to lodging and it is the main constraint for its extension at the farmers' level. Recently, dwarf variety of sunflower BARI Surjomukhi-3 has been developed. But it is need to develop high yielding dwarf synthetic and hybrid variety of sunflower. Keeping all these ideas in mind, the following experiments have been undertaken. Considering all the things, the following experiments have been undertaken.

MAINTENANCE OF SUNFLOWER GERMPLASMS

S H HABIB

Abstract

Forty-three sunflower genotypes including two check varieties BARI Surjamukhi-2 and BARI Surjamukhi-3 were grown in the experimental field of Oilseed Research Centre, BARI, Gazipur during the rabi season 2020-2021. Five plants from each genotype were intermate to maintain the heterozygosity. At maturity that heads were harvested and bulked and will be grown in the next season for maintain the germplasm.

Introduction

Sunflower is an important minor oilseed crop in Bangladesh. Sunflower oil is rich in essential fatty acid like linoleic and linolenic acid compared to rapeseed and mustard oil. The crop might be grown all the year round due to its photo insensitive nature. However, *rabi* (winter) season is the best time to grow sunflower. This crop is suitable for growing after harvesting T. aman rice especially in the southern districts. The collection of sunflower germplasms in Oilseed Research Centre is very poor. This experiment was conducted to maintain and evaluate the existing collection of sunflower lines in ORC, BARI.

Materials and Methods

Forty-three sunflower accessions were grown at the research field of ORC, BARI Gazipur on 21 November 2021. BARI Surjamukhi-2 and BARI Surjamukhi-3 were also grown along with this germplasm. Seeds of each entry were sown in 2 rows x 4 m long plot, where row to row and plant to plant distance was maintained 50 cm and 25 cm, respectively. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Pollen of each entry within a plot was collected and bulked. Then dusting was done within the same genotype of that plot. After crossing, bagging was done properly to protect outcrossing. Other intercultural operations were done when necessary to obtain optimum plant growth.

Results and Discussion

Five healthy, disease free, vigorous plants were harvested and seeds were bulked from each entry. This seed will be used to maintain and grown to rejuvenate in the next season.

Conclusion

The sunflower germplasms with high variability might be a source for the development of synthetic, composite or hybrid sunflower variety.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

DEVELOPMENT OF DWARF INBRED LINES IN SUNFLOWER: FAMILY SELECTION FROM S_7 GENERATION

S H HABIB

Abstract

Bulked seeds from fifteen S_7 sunflower genotypes were grown separately allowed to intermate and evaluated and dwarf, early and high yield potential genotypes were selected. The selected genotypes will be grown in the next rabi season for competitive yield trial with check variety.

Introduction

The climatic condition of Bangladesh is suitable for sunflower cultivation. This oilseed crop can be grown after harvesting of T-Aman rice especially in the southern districts. The Oilseed Research Center of BARI has developed composite varieties viz. Kironi and BARI Surjomukhi-2. Farmers do not prefer these varieties due to susceptibility to lodging and lower yield. The experiment was conducted to develop dwarf, early and high yield potential sunflower inbred lines.

Materials and Methods

Bulked seeds from each of fifteen S_7 sunflower genotypes were grown separately at ORC research field, BARI, Gazipur during rabi season 2021-22. Seeds of each genotype were sown on 22 November 2021 in an 8 rows of 4 m long plot where the spacing was 50 cm between the rows and 25 cm between the plants. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. To obtain optimum plant growth other intercultural operations were done properly when necessary. Each plot was covered with nylon net to protect out crossing. The plants in each genotype were allowed to intermate by rubbing the pollen collecting within the same genotype. Data was recorded on plant height (cm), head diameter (cm), stem diameter (cm), seeds/head, seed weight/head (g), and 1000 seed weight (g) from ten randomly selected plants in each entry and plot yield (g) was taken on plot basis.

Results and Discussions

The mean performances of the recorded data were presented in Table 1. From the result it was found that on an average the most dwarf genotype was BUZZY DWARF (66.46 cm) followed by genotype GP04012 (74.50 cm). While the tallest genotype was GP04017 (110.20 cm) followed by genotype BYZZY TALL (108.50 cm). Highest 1000 seed weight was produced by the genotype GP04015 (87 g) followed by genotype GP04002 (86 g). Highest stem diameter, head diameter, number of seeds per head head, yield per head, and plot yield was given by the genotype GP04017. Among the 15 genotypes, the nine genotypes viz. GP01002, GP01009, GP04015, GP04017, GP04026, GP04028, GP04016(P16), GP04016(SP) and BUZZY DWARF were selected for testing in the yield performing trial.

Table 1. Performance of 15 S_7 genotypes of sunflower during Rabi 2021-22 at Gazipur

SL. No.	Entries	DM	PH (cm)	SD (cm)	HD (cm)	SH	YH (g)	1000 SW	PY (g)
1.	GP01002	102	89.80	1.29	17.40	167	14.77	86	1226.33
2.	GP01009	102	90.00	**1.41**	16.90	325	**22.62**	60	1361.63
3.	GP04012	99	74.50	0.90	14.40	63	**4.03**	30	544.37
4.	GP04015	99	93.40	1.42	18.10	174	14.30	87	**1409.30**
5.	GP04016	98	81.90	1.28	17.50	152	12.63	77	1387.62
6.	GP04017	102	**110.20**	**1.61**	**20.30**	**364**	**27.16**	83	**2212.41**
7.	GP04018	96	85.60	1.09	14.50	194	13.75	39	996.23
8.	GP04026	102	95.90	1.30	17.90	270	17.81	68	**1988.28**
9.	GP04028	104	84.50	1.39	17.50	174	9.65	82	**1505.04**
10.	GP04016(P18)	103	78.50	1.01	14.20	275	**24.27**	72	1259.48
11.	GP04016(P16)	104	101.90	**1.45**	15.90	179	13.57	64	**1567.55**
12.	GP04016(P10)	105	100.50	1.14	15.00	231	15.68	70	989.42
13.	GP04016(SP)	105	104.20	**1.40**	**19.20**	144	12.97	76	1221.21
14.	BUZZY DWARF	110	**66.46**	1.21	13.88	261	14.54	70	**1581.59**
15.	BUZZY TALL	113	108.50	**1.55**	16.67	428	**24.55**	58	1062.00

NOTE: DM: days to maturity height, PH: plant height (cm), HD: head diameter (cm), SH: number of seeds/head, and YH: seed weight/head (g), value in parenthesis are average value.

Conclusion

Among the 15 genotypes, best on different characters nine genotypes viz. GP01002, GP01009, GP04015, GP04017, GP04026, GP04028, GP04016(P16), GP04016(SP) and BUZZY DWARF were selected which will be testing in the yield performing trial.

Acknowledgement

‘Enhance Production of Oil crops (BARI Part)’ project.

IDENTIFICATION OF PARENTAL LINES FOR DEVELOPMENT OF HYBRID VARIETY IN SUNFLOWER

S H HABIB

Abstract

S_6 Seeds of CN001 and CN002 and S_8 seeds of Hysun-33 were grown and self-fertilized manually to find parental lines. Seeds from both male parents and CMS plants were stored for advancing generations.

Introduction

The climatic condition of Bangladesh is suitable for sunflower cultivation. This oilseed crop can be grown after harvesting of T-aman rice especially in the northern districts and Barind area. The Oilseed Research Center of BARI has developed two composite varieties viz. Kironi and BARI Surjomukhi-2. The variety has lost the uniformity especially for height. Farmers do not prefer the varieties due to susceptibility to lodging and lower yield. The experiment was conducted to identify parental lines for hybrid development in sunflower.

Materials and Methods

S_6 seeds of CN001 and CN003 S_8 seeds of Hysun-33 were used as experimental material in this experiment. Seeds were sown on 23 November 2021 in ORC research field in two rows of 4 m long plot with the spacing of 50 cm between the rows and 25 cm between plants. Anthers in flowers were observed visually. Plants having prominent anthers along with pollen grain in flowers were identified as pollen fertile plants. On the other hand, plants having rudimentary anthers without pollen grains or absent of anthers in flowers were identified as CMS plants. CMS plants were crossed with selected pollen fertile plant (male parent) and selected male fertile plants were selfed. Data on total number of plants, number of pollen fertile plants, and number of CMS plants were recorded.

Results and Discussions

Results on selfing of pollen fertile plants (male parents) and crossing between CMS plants and pollen fertile plants of hybrids are presented in Table 2. When, a self-fertilized plant or a cross between a CMS and a pollen fertile plant produce 100% fertile plant indicates that this plant may be a fertility restorer line of that hybrid. On the other hand, when, a self-fertilized plant or a cross between a CMS plant and a pollen fertile plant produce 100% CMS plant indicates that this plant may be a CMS maintainer plant of that hybrid.

In S_6 generation, cross between a CMS plant and a pollen fertile plant of hybrid CN001, and CN002 failed to produce 100% fertile or CMS plant (Table 2).

In S_8 generation different cross combination of hybrid Hysun-33 were evaluated and from the result it was found none of the cross combination could produce 100% fertile or CMS plant (Table 2).

Table 2. Percent CMS and fertile plants obtained from the sunflower hybrids CN001, CN002 & CN003 & Hysun 33 during Rabi 2021-22 at Gazipur

Hybrids	Total No. of Plant	No. of CMS Plant	% of CMS plants	No. of pollen fertile Plant	% of pollen fertile plants
CN001 L1	15	4	27	11	73
CN001 L2	15	6	40	9	60
CN001 L3	14	7	50	7	50
CN001 L4	19	7	37	12	63
CN001 L5	15	9	60	6	40
CN001 L6	17	5	29	12	71
CN001 L7	13	7	54	6	46
CN001 L8	17	6	35	11	65
CN001 L9	17	8	40	5	60
CN001 L10	13	6	46	7	54
CN002 L11	18	2	11	16	89
CN002 L12	16	7	44	9	56
CN002 L13	15	6	40	9	60
CN002 L14	15	5	33	10	67
CN002 L15	18	6	33	12	67
CN002 L16	14	2	14	12	86
CN002 L17	12	1	8	11	92
CN002 L18	20	2	10	18	90
Hysun-33 L19	16	7	44	9	56
Hysun-33 L20	15	4	27	11	73
Hysun-33 L21	16	7	44	9	65
Hysun-33 L22	14	6	43	8	57
Hysun-33 L23	12	8	67	8	33
Hysun-33 L24	13	8	62	5	38
Hysun-33 L25	12	6	50	6	50
Hysun-33 L26	15	6	40	9	60
Hysun-33 L27	18	5	28	13	72
Hysun-33 L28	7	3	43	4	57
Hysun-33 L29	14	5	36	9	64
Hysun-33 L30	10	6	60	4	40
Hysun-33 L31	12	6	50	6	50
Hysun-33 L32	12	7	58	5	42

Hybrids	Total No. of Plant	No. of CMS Plant	% of CMS plants	No. of pollen fertile Plant	% of pollen fertile plants
Hysun-33 L33	12	6	50	6	50
Hysun-33 L34	12	9	75	3	25
Hysun-33 L35	18	8	44	10	56
Hysun-33 L36	7	3	43	4	57
Hysun-33 L37	15	7	47	8	53
Hysun-33 L38	17	10	67	7	33
Hysun-33 L39	15	8	53	7	47
Hysun-33 L40	11	5	46	6	54

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

DEVELOPMENT OF SYNTHETIC AND COMPOSITE SUNFLOWER VARIETY

I) DEVELOPMENT OF SYNTHETIC SUNFLOWER VARIETY

S H HABIB

Abstract

Four inbred lines with best general combining ability (P1: P-S-2-OP1, P2: P-S-2-OP3, P6: P-S-2-OP2, and P8: P-S-2-OPb) were selected in rabi season 2018-19. To develop synthetic sunflower variety, all possible crosses (both cross and reciprocal cross)) were made between the inbreeds in rabi season 2019-20. Equal amount of seed from each cross and reciprocal cross were mixed, grown as Syn-1 and evaluated for yield attributes during rabi season 2020-2021. During rabi season 2021-22, Syn-2 generation was grown from desired heads of Syn-1 generation and evaluated for yield and yield components.

Introduction

The sunflower is one of the four most important oil seed crops in the world. The seed of the sunflower is the source of a high-quality vegetable oil which contains high level of unsaturated fatty acids, and free from toxic constituents such as linolenic and trans fatty acid. In Bangladesh it is an important minor oilseed crop. Sunflower is a thermo neutral crop, therefore can be grown both in Rabi and Kharif seasons anywhere in Bangladesh. Moreover, the relative tolerant to draught and saline condition encourage its cultivation in the problem area. So, there is a bright prospect for expansion of sunflower cultivation in Bangladesh. Oil seed Research Centre (ORC) of BARI has developed two composite varieties of sunflower viz Kironi and BARI Sunflower-2. Lodging susceptibility due to tallness of these varieties is one of the major constrains for expansion at the farmers field. On the other hand, hybrids of sunflower are dwarf and high yielder. But the hybrid seed is costly and farmers need to purchase hybrid seed every year. In this regard synthetic sunflower variety would be an alternative to hybrid variety to meet the requirement. A synthetic variety is a variety produced by crossing in all possible combinations a number of inbred lines (with high GCA that combine well with each other) and a synthetic variety is maintained by open pollination in isolation. The use of synthetic varieties for commercial cultivation was first suggested in maize (Hayes and Garber, 1919). This is a great way to create diverse new landraces and open-pollinated lines. The seed of synthetic varieties is much cheaper than single or double cross hybrids. Moreover, the seed can be afforded even by small farmers. Synthetic varieties are more adaptable to environmental changes than hybrids due to greater variability and broad genetic base. Synthetic varieties have vast genetic variability which provides then better protection from the infestation of new races of a disease. There is no need to purchase fresh seed every year. Farmers can use their own saved seed for 4-5 years without reduction in the yield potential (Lonnquist and McGill, 1956). Keeping this in mind scientist of ORC has taken this experiment to develop potential synthetic sunflower variety.

Materials and Methods

Development of synthetic varieties consists of three major steps: i) Isolation and evaluation of inbred and selected inbreds are allowed to intermate by open pollination in isolation. Jenkins (1940) suggested that inbred lines with one generation selfing can be used for development of a synthetic variety. ii) Single cross method (diallel crosses): all possible single crosses are made among selected inbreds. These crosses are evaluated for GCA of yield and other characters in replicated trial using local check. iii) The seed of all F_1 crosses made between the selected inbred lines is mixed together in equal quantity or equal number to constitute synthetic variety. The variety thus developed is called as Syn1, the seed of such variety is generally multiplied by open pollination in isolation for one or two generations (Syn1 and Syn2) and then distributed to the farmers for commercial cultivation.

To develop synthetic sunflower variety, four sunflower inbred lines (P1: P-S-2-OP1, P2: P-S-2-OP3, P6: P-S-2-OP2, and P8: P-S-2-OPb) were selected as good general combiner in the rabi season 2018-19. All possible crosses (both cross and reciprocal cross)) were made between the inbreeds in rabi season 2019-20. To develop Syn-1 generation, equal amount of seed from each cross and reciprocal cross were mixed and grown at the research field of ORC, BARI Gazipur on 18 November, 2021. Seeds were sown in a 562 m^2 plot, where row to row distance was 50 cm and plant to plant distance was 25 cm. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done when necessary to obtain optimum plant growth. The plants were allowed to intermate. During the crop growth period, the unwanted plants were rouged out to obtain uniformity and homogeneity in various morphological traits. From 20 randomly selected plants data were taken as on days to flower, days to maturity, plant height (cm), stem diameter (cm), head diameter (cm), seeds/ head, seed yield/head (g) and 1000 seed weight (g) and plot yield (kg/plot). The mean performances of the recorded data were presented in Table 3. After discarding the unwanted plats, desirable heads were harvested in bulk and kept for tested in the yield competing trials with check variety in the next rabi season.

Results and Discussion

To develop synthetic sunflower variety, four inbred lines with good general combining ability (selected in the rabi season of 2018-19) were grown at the research field of ORC, BARI Gazipur in 2019-20. All possible crosses (both cross and reciprocal cross) were made between the inbred as well as selfing of each inbred were also done to maintain the inbreeds. Equal amount of seed from each cross and reciprocal cross were mixed and developed as Syn-1 in 2020-21. Subsequently, the seeds from Syn-1 generation were grown as Syn-2 generation and evaluated. The average performance of Syn-2 generation was presented in Table 3. At maturity plants were selected for dwarf to medium dwarf height, thicker stem, bigger head, harvested and kept separately. Seeds from selected plants will be mixed and grown as Syn-3 generation in the next rabi season and will be evaluated for yield and yield contributing traits.

Table 3. Average performance of Syn-2 generation at Gazipur during Rabi, 2021-22

Sl. No.	Entry	DF	DM	PH (cm) (range)	SD (cm) (range)	HD (cm) (range)	No. SH (range)	YH (g) (range)	1000 SW (g)
1	Syn-2	56	104	81-138 (107.64)	1.3-3.0 (1.86)	14-29 (20.07)	205-1176 (663.07)	13.23-93.06 (45.25)	77

NOTE: DF: days to 50% flowering, DM: days to maturity, PH: plant height (cm) (range), SD: stem diameter (cm) (range), HD: head diameter (cm) (range), SH: numbers of seeds/head (range), YH: seed yield/head (g) (range), SW: 1000 seed weight (g). and PY: plot yield (kg). Values in parenthesis are average value.

Conclusion

After discarding the unwanted plants, desirable heads were harvested in bulked which will be grown in the next *rabi* season. Another one more generation selection is needed to develop a synthetic sunflower variety.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

DEVELOPMENT OF SYNTHETIC AND COMPOSITE SUNFLOWER VARIETY
II) DEVELOPMENT OF COMPOSITE SUNFLOWER VARIETY

S H HABIB

Abstract

The seeds from composite-5 (a mixed of equal number of seeds from eight inbred lines of sunflower) were grown and allowed for intermating to develop composite sunflower variety. The average plant height was 95.69 cm and takes 101 days to mature. Most of the plants shows uniformity and homogeneity in different characters. Therefore, after discarding the undesirable plants, the mature heads were harvested in bulk and kept for growing in yield competitive trial with check variety in the next rabi.

Introduction

The sunflower is one of the four most important oil seed crops in the world. The seed of the sunflower is the source of a high-quality vegetable oil which contains high level of unsaturated fatty acids, and free from toxic constituents such as linolenic and trans fatty acid. In Bangladesh it is an important minor oilseed crop. Sunflower is a thermo neutral crop, therefore can be grown both in Rabi and Kharif seasons in anywhere in Bangladesh. Moreover, the relative tolerant to draught and saline condition would encourage its cultivation in the problem area. So, there is a bright prospect for expansion of sunflower cultivation in Bangladesh. Oil seed Research Centre (ORC) of BARI has developed two composite varieties of sunflower viz Kironi and BARI Sunflower-2. Lodging susceptibility due to tallness of these varieties is one of the major constrains for expansion at the farmers field. On the other hand, hybrids of sunflower are dwarf and high yielder. But the hybrid seed is costly and farmers need to purchase hybrid seed every year. In this regards composite sunflower variety would be an alternative to hybrid variety to meet the requirement. In cross pollinated crops, the mixture of genotype from several sources is maintained bulk from one generation to the next is referred as composite variety. The seeds of desired selected lines mixed together and random mating is allowed for 4-5 generations. In the subsequent generation of random mating, the undesirable types are eliminated to achieve uniformity and homogeneity in various morphological characters. Such uniform population is tested in replicated trials, across environment along with standards checks and high yielding stable type can be released as composite variety. Cost of composite seed is less than hybrid. It shows more heterosis than synthetic. This experiment has been taken to develop composite variety of sunflower.

Materials and Methods

The seeds from composite-5 were grown at the research field of ORC, BARI Gazipur on 28 December 2021. Seeds were sown in 460 m^2 plot, maintaining row to row distance 50 cm and plant to plant distance 25 cm. The plants were allowed to intermate by open pollination in isolation. Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. Other intercultural operations were done when necessary to obtain optimum plant growth.

Results and Discussion

During the growing season, the undesirable types were discarded to achieve uniformity and homogeneity in various morphological traits. A total of 591 single plants were selected based on plant height, plant stature, leaf size, stem thickness and head size. The data were taken from all the selected plants on plant height (cm), stem diameter (cm), head diameter (cm), seeds/ head, seed yield/head (g) and 1000 seed weight (g). The days to 50% flowering, days to maturity and plot yield was taken on plot basis. The average recorded data were presented in Table 4. Seeds from all the selected plants were bulked and kept for growing in yield performing trial compare with check variety in the next rabi season to release as composite sunflower variety.

Table 4. Average performance Composite-5 generation at Gazipur during Rabi, 2021-22

Sl. No.	Entry	DF	DM	PH (cm) (range)	SD (cm) (range)	HD (cm) (range)	No. SH (range)	YH (g) (range)	1000 SW (g)
1	Composite-5	65	101	70-132 (95.69)	1.4-4.0 (2.22)	11-27 (19.46)	388-1295 (542)	22.44-83.86 (33.86)	72

NOTE: DF: days to 50% flowering, DM: days to maturity, PH: average plant height (cm) (range), SD: stem diameter (cm) (range), HD: head diameter (cm) (range), SH: numbers of seeds/head (range), YH: seed yield/head (g) (range), SW: 1000 seed weight (g) and PY: plot yield (kg). Values in parenthesis are average value.

Conclusion

The bulked seeds from the selected plants will be tested in yield performing trial compared with check variety in the next *rabi* season to release as composite sunflower variety.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

CREATING NEW GENETIC VARIABILITY IN SUNFLOWER USING INDUCED MUTATION: I) EVALUATION OF M5 MUTANT CREATED BY GAMMA RADIATION

S H HABIB

Abstract

Gamma radiation treated M5 seeds of released variety BARI Surjamukhi-2 were evaluated to develop suitable mutant sunflower variety. In M5 generation, based on plant height and plant stature mutants were grouped into very dwarf (plant height <65 cm), dwarf (plant height 65-100 cm), medium dwarf (plant height 100-120 cm), tall (plant height 120-150 cm), and very tall (plant height >150 cm). The individual plants from each group were harvested and kept. The family mutants will be grown using each group and will be evaluated in the next rabi season.

Introduction

Genetic variability among the plant population is a basic prerequisite for successful plant breeding. The collection of sunflower germplasms in ORC, BARI is limited. Moreover, variability present in the existing cultivated sunflower variety and sunflower germplasms is very narrow. Besides, the Oilseed Research Centre has developed two sunflower varieties which are tall, and having lodging tendency. Lodging or stem breakage can reduce yield significantly. Lessening plant height and increasing stem diameter may be useful to facilitate the standing ability of sunflower. Therefore, it is essential to develop reduced height germplasm as a strategy to increase yield potential. Genetic variability can be broadened by interspecies hybridization with wild species and mutation breeding. Mutation breeding has been successfully used in sunflower breeding by changing plant characteristics and productivity (Cvejic *et al.,* 2011). The most commonly used mutagens in sunflowers are X-, gamma and beta rays, thermal and fast neutrons, ultraviolet and infrared radiation (Skoric, 2012). Mutagenic treatments on seed have induced high-oleics, semi dwarfs and dwarfs, male-sterile plants, earliness and seed with thin hull

(Cvejić *et al.*, 2009). However, induced mutations on sunflower to produce mutant cultivar in Bangladesh have not been reported yet. Therefore, the main objective of this research was to broaden the genetic variability within the collection of sunflower variety using gamma radiation and thereby to develop mutants with desired changed agronomic traits and then to investigate productivity and stability of this mutants in comparative trial.

Materials and Methods

Gamma radiation treated M5 seeds of sunflower variety BARI Surjamukhi-2 were used in this study. All the M5 seeds along with a total of 150 non-irradiated seeds were sown at the research field of ORC, BARI Gazipur on 21 November, 2021 to generate M5 population. The seed were grown as head to row method in 4 m long plot maintaining 50 cm×25 cm row to row and plant to plant distance, respectively.

Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top-dressing during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth. Plot of each treatment was covered with nylon net to prevent outcrossing and selfing was done within the treatment. The entire M5 populations were grouped into very dwarf (plant height <65 cm), dwarf (plant height 65-100 cm), medium dwarf (plant height 100-120 cm), tall (plant height 120-150 cm), and very tall (plant height >150 cm) compared to the non-treated plants. The note on plant architecture such as big-headed mutant (head diameter greater than 17 cm) and robust stem girth (stem diameter thicker than 1.5 cm) also were taken in this study as important criteria. Mature heads of each group were harvested separately and kept for growing as M6 family mutants in the next rabi season.

Results and Discussion

In M5 generation, the T3 (300 Gy) radiated BARI Surjamukhi-2 seeds were categorized as very dwarf (plant height <65 cm), dwarf (plant height 65-100 cm), medium dwarf (plant height 1005-120 cm), tall (plant height 120-150 cm), and very tall (plant height >150 cm) mutant, respectively. Stem thickness play a vital role to avoid the lodging, greater the stem thickness lesser chance of lodging (Jan et al., 2017). Moreover, short stature and large leaf area is prerequisite for high yielding lodging resistant variety development (Ahmad et al., 2012). Head diameter is one of the most important characters related to yield. Large heads accommodate more seeds which help to increase production (Lakshman et al., 2020). Therefore, along with tall, dwarf and medium dwarf stature, careful consideration were also made taking note on larger leaf area, stem diameter, and head diameter of the mutants.

A total of 234 single mutants from five different groups were harvested and kept for further evaluation (Table 5). In this generation the mutants of each group show nearly homogenous, therefore, the single head of each genotype will be bulk and grown as family in the next rabi season.

Table 5. Performance of gamma radiation treated M5 mutants of different groups of BARI Surjamukhi-2 at Gazipur during Rabi, 2021-22

Sl. No.	Groups	No. of Pl. Selected in each group	PH (cm) (range)	SD (cm) (range)	HD (cm) (range)
1.	Very Dwarf	94	22-64	0.3-1.5	6.0-17
2.	Dwarf	94	65-100	0.7-2.5	6.0-23
3.	Medium dwarf	34	103-120	0.7-2.7	11.0-27.0
4.	Tall	11	122-145	1.5-2.6	17.0-28.0
5.	Very Tall	1	152	2.1	16.0
	Total pl. selected	234			

NOTE: PH: plant height (cm) (range), SD: stem diameter (cm) (range), HD: head diameter (cm) (range)

Conclusion

A total of 234 single mutants from five different groups of gamma radiated BARI Surjamukhi-2 were harvested. M6 family mutants will be grown from bulk seed of each group in the next rabi season.

Acknowledgement
'Enhance Production of Oil crops (BARI Part)' project.

CREATION OF SUNFLOWER MUTANT THROUGH EMS
ii) EVALUATION OF M4 MUTANTS

S H HABIB

Abstract

Chemical mutagenic agent ethyl methane sulfonate (EMS) treated M4 seeds of released variety BARI Surjamukhi-2 were evaluated to develop mutant sunflower inbreed lines. In M4 generation, mutants were grouped into very dwarf, dwarf, medium dwarf, tall and very tall based on plant height. Mutants with thick stem, bigger head and larger leaf also were selected. All the desired mutants were harvested separately and kept for growing in the next rabi season as family mutants.

Introduction

Exploitation of natural and induced genetic diversity is the basic requirement of plant breeding in developing plant varieties for sustainable food production. However, genetic variability within the sunflower is limited, as its genetic base of available inbred lines is narrow. Genetic variability can be broadened by interspecies hybridization with wild species and mutation breeding. Mutation breeding has been successfully used in sunflower breeding by changing plant characteristics and productivity (Cvejic et al., 2011). EMS (Ethyl Methane Sulfonate), as a chemical mutagen, can be used as a supplementary approach to improve desired identifiable characters such as plant height and yield. The collection of sunflower germplasms in ORC, BARI is limited. Moreover, variability present in the existing cultivated sunflower and sunflower germplasms is also narrow. Therefore, the objective of this research is to create variation within the variety BARI Surjamukhi-2 and thereby to develop dwarf sunflower variety by chemical mutagenic agent EMS.

Materials and Methods

EMS treated (0.5% EMS treated) M4 seeds of sunflower variety BARI Surjamukhi-2 (obtained from rabi season 2020-21) were sown in head to row method at the research field of ORC, BARI Gazipur on 22 November, 2021 to generate M5 population. Along with a total of 150 non-treated seeds of BARI Surjamukhi-2 were also sown. The seed were grown in 4 m long plot in required number of rows maintaining 50 cm×25 cm row to row and plant to plant distance, respectively.

Fertilizers were applied @ 25:35:55:18 kg/ha of NPKS, respectively from Urea, TSP, MP and Gypsum. Half of the Urea and other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top-dressing during flower primordial stage. Other intercultural operations were done properly to obtain optimum plant growth. Plot of each treatment was covered with nylon net to prevent outcrossing and individual head was self-fertilized using hand pollination by rubbing the head.

The entire M4 populations were grouped into very dwarf (plant height <65 cm), dwarf (plant height 65-100 cm), medium dwarf (plant height 1005-120 cm), tall (plant height 120-150 cm), and very tall (plant height >150 cm) compared to the non-treated plants. The mutants with big-headed (head diameter greater than 17 cm), and robust stem girth (stem diameter thicker than 1.5 cm) also were selected in this study as important criteria. Mature heads of each group were harvested separately and kept for grown as M5 family of each group in the next rabi season.

Results and Discussion

In M4 generation, EMS treated (0.5% EMS treated) BARI Surjamukhi-2 seeds were categorized into tall, medium dwarf, and dwarf mutant compared to non-treated control population. The plant with less than 65 cm, between 65-100 cm, between 100-120 cm, 120-150 cm, and above 150 cm in height were grouped into very dwarf, dwarf, medium, tall, and very tall mutant, respectively. Though the main objective of this study is to find and develop dwarf to medium height sunflower mutant, some tall mutants also were selected due to their vigorous growth and bigger head size. Stem thickness play a vital role to avoid lodging, greater the stem thickness lesser chance of lodging (Jan et al., 2017). Moreover, short stature and large leaf area is prerequisite for high yielding lodging resistant variety development (Ahmad et al., 2012). Head diameter is one of the most important characters related to yield. Large heads accommodate more seeds which help to increase production (Lakshman et al., 2020). These mutants could be used in the future breeding program for obtaining high yield potential mutants inbreeds.

A total of 425 single head from different groups were harvested (Table 6). As most of the mutants shows homogeneity in plant height in each group, the selected heads from each group will be bulk and will be grown as family of each mutant group and evaluated in the next rabi season.

Table 7. Performance of EMS treated M4 mutants of different groups of BARI Surjamukhi-2 at Gazipur during Rabi, 2021-22

Sl. No.	Groups	No. of Pl. Selected in each group	PH (cm) (range)	SD (cm) (range)	HD (cm) (range)
1.	Very Dwarf	157	35-65	0.5-1.1	4.0-16.0
2.	Dwarf	214	66-100	0.9-2.3	7.0-22.0
3.	Medium dwarf	35	102-120	0.8-2.9	12.0-24.0
4.	Tall	17	122-149	1.2-2.9	18.0-25.0
5.	Very Tall	3	155-163	1.8-3.0	23.0-28.0
	Total pl. selected	425			

NOTE: PH: plant height (cm) (range), SD: stem diameter (cm) (range), HD: head diameter (cm) (range).

Conclusion

A total of 425 single mutants from different groups of EMS treated BARI Surjamukhi-2 were harvested. The mutant family will be grown from each group, evaluated and inbreeds of mutants sunflower will be obtained.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

MOLECULAR CHARACTERIZATION OF SUNFLOWER DWARF MUTANTS BY THE EXPRESSION ANALYSIS OF *GA2OX1* GENE SEQUENCE

S H HABIB and MD MOTIAR RAHMAN

Abstract

EMS treated mutants of sunflower variety BARI Surjamukhi-2 were characterized molecularly. GA2ox gene *was found to be expressed in leaf tissue of sunflower mutant. Expression analysis of this plant height manipulating dwarfing gene in both EMS and gamma radiation treated and control plants are ongoing.*

Introduction

Dwarfism is one of the most important traits in sunflower breeding because semi-dwarf cultivars show lodging resistance by wind.

The reduction in plant height can led to an improved harvest index and to enhanced lodging resistance under high nitrogen fertilization. A strategy to control this trait is to modify GA content by genetic engineering (Sakamoto and Matsuoka, 2004). Gibberellins (GAs) are class of phytohormones, participating in the regulation of numerous developmental processes, such as seed germination, stem elongation, leaf stretching, flower induction, and fruit-setting. Reduction of active GAs content can be achieved by suppressing expression of biosynthetic genes (e.g. *GA20oxs* and/or *GA3oxs*) or by increasing expression of genes that encode GA-deactivation enzymes, such as *GA2oxs* (Busov *et al*., 2003; Sakamoto *et al*., 2003).

Materials and Methods

The genomic DNA was extracted from 3rd and 4th leaf by ORC lab optimized DNA extraction protocol. Then a total of 25 ng of genomic DNA was used to PCR amplified for the dwarfing gene *GA2ox1*.

Results and Discussion

We obtained sunflower mutant treated through chemical mutagenic agent EMS of sunflower variety BARI Surjamukhi-2. From the Semi-quantitative RT-PCR analysis in this experiment revealed that GA-deactivation enzymes, *GA2oxs* gene was expressed in EMS treated mutant sunflower leaf (Figure 1). Expression levels of *GA2oxs,* gene in EMS treated mutant plants thus suggesting that these genes might play an important regulating role in transcription level in GA biosynthesis of the dwarfing phenotype in sunflower.

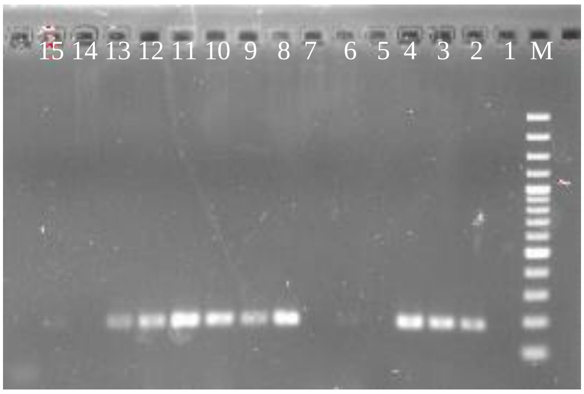


Figure 1: Semi-quantitative RT–PCR analysis for *GA2ox* transcripts in EMS treated mutants of BARI Surjamukhi-2. Lane: 1-13 treated plant; lane: 14-15 control plant; M: 100 bp TrackIt™ (Invitrogen) DNA ladder.

Conclusion

Expression analysis of candidate genes to manipulate plant height, would give better insights into dwarfing phenomenons. Therefore, analysis of expression of different genes regulating GA pathway in both EMS and gamma radiation treated and control plants are ongoing.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

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MOLECULAR CHARACTERIZATION OF SUNFLOWER MUTANTS
(I) BY THE EXPRESSION OF *FAD* and *SAD* GENE SEQUENCES

S H HABIB AND MD MOTIAR RAHMAN

Abstract

EMS treated 13 mutant of sunflower variety BARI Surjamukhi-2 was characterized molecularly for SAD and FAD gene expression. SAD gene was found to be expressed in 12 and FAD gene was found 7 among 13 plants, respectively.

Introduction

Screening of mutation is usually can be determined by the *FAD* and *SAD* gene expression in the mutant. *FAD* and *SAD* were used as a proof of concept to determine the quality of the sunflower mutant collection and to estimate the mutation density. Both these genes control the production of short to medium chain fatty acids (Zarhloul *et al*., 2007; Jones, *et al*., 1995). SAD (Srearoyl-ACP-desaturase) control the stearic acid production over oleic acid and inhibition of SAD can cause increase production of stearic acid (Zarhloul *et al*., 2007). SAD introduce double bond at Δ9 position and convert Stearic acid (STE) C18:0 to Oleic acid (OLE) C18:1.

Expression of FA desaturase (FAD) enzymes introduce additional double bonds into the mono-unsaturated OLE (Oleic acid at the position of Δ9) and produce linoleic acid (LIO)C18:2 Δ9,12 (Shanklin and Cahoon, 1998) and thereby increases the unsaturated fatty acid content of plants (Ohlrogge and Jaworski, 1997).

This study has been taken to analysis the *FAD* and *SAD* gene expression in mutant sunflower and its wild type.

Materials and Methods

EMS treated mutants and non-treated plants of BARI Sunflower-2.

Method: Genomic DNA was extracted from 3rd and 4th leaf of 13 mutants and non-treated plants and a chosen target was amplified from extracted DNA using PCR primers for two genes *FAD* and *SAD*.

Results and Discussion

From the Semi-quantitative RT-PCR analysis in this experiment *SAD* gene was found to be expressed in 12 (Figure 2a) and *FAD* gene was found express in 7 plant (Figure 2b) sample among 13 EMS treated leaf respectively. However, in this study non-treated control plant was not expressed for these genes. Expression levels of both *SAD* and *FAD* genes increases the total high unsaturated amount of fatty acid levels which is healthier for human consumption and helps regulating blood cholesterol. To confirm the *SAD* and *FAD* gene regulation further the expression of oleic gene is there for is needed.

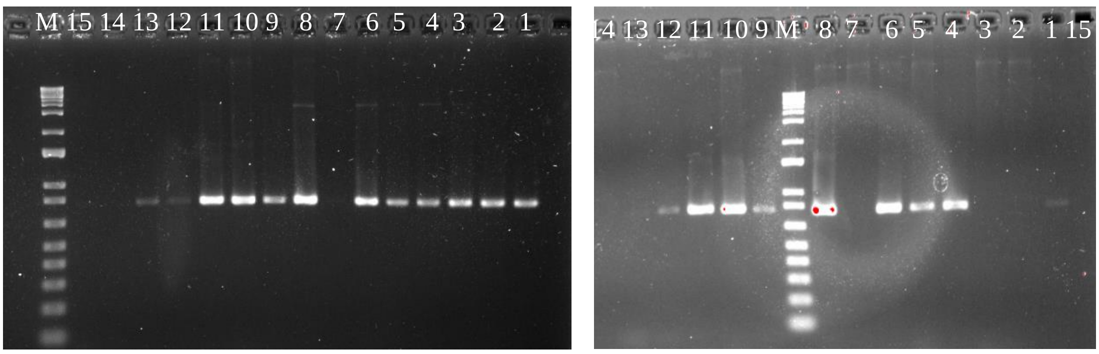

Figure 1: Semi-quantitative RT–PCR analysis for *SAD and FAD gene in EMS treated leaf sample* (a): Amplification of *SAD gene (*lane: 1-13 treated plant and lane 14-15 control plant), and (b): Amplification of *FADgene* (lane: 1-13 treated plant and lane 14 & 15 control plant),. Lane M: 100 bp TrackIt™ (Invitrogen) DNA ladder.

Conclusion

SAD and *FAD* gene was expressed in EMS treated leaf but not in non-treated control leaf. *SAD* and *FAD* gene expression in other EMS and Gamma radiation mutant is ongoing. Moreover, to confirm the *SAD* and *FAD* gene regulation, further the expression of oleic gene is there for needed.

SCREENING OF DIVERSE GENOTYPES OF OILSEED CROPS USING SSR PRIMERS

ASSESSMENT OF GENETIC DIVERSITY IN *BRASSICA RAPA* GENOTYPES USING SSR MARKERS

S H HABIB, PRYANKA ROY AND UMME KULSUM

Abstract

Brassica rapa species represent one of the most important oilseed crops in Bangladesh, nevertheless, their genetic diversity is barely known. A better understanding on this topic is essential for the proper utilization of genotypes in breeding programs. We evaluated the genetic diversity among 30 Brassica rapa genotypes including varieties/lines using 17 highly polymorphic SSR markers. A total 178 alleles were amplified across 17 markers among all the 30 genotypes. Genetic diversity varied from minimum 0.69 for marker Q2 to maximum 0.95 for marker Niab_ssr022 with an average value of 0.84. Polymorphism information content (PIC) value of the markers varied from minimum of 0.62 with the marker Q2 and maximum of 0.93 with primer Niab_ssr022 with a mean value of 0.83, so these primers can further be used for diversity analysis.

Introduction

Genetic distance among the breeding materials has significant implications for the improvement of crop plants. Knowledge on genetic diversity could help breeders and geneticists to understand the structure of germplasm, facilitate to widen the genetic basis of breeding material for selection as well as predict which combinations would produce the best off springs (Hu *et al.*, 2007; Qi, et al., 2008). To determine the genetic diversity among individuals or populations, morphological, biochemical and molecular approaches have been used **(**Mohammadi & Prasanna, 2003). Among various markers available for genetic analysis in plants, molecular markers are more efficient, precise and reliable in discriminating closely related species and cultivars (Mishra *et al*., 2011. There is increasing number of reports where molecular markers like Simple Sequence Repeats (SSRs; Abbas, et al., 2009; Wang et al., 2009; Redden, et al., 2009) have been used to study genome organization, varietal differences and diversity analysis. SSRs are co-dominant, highly polymorphic PCR-based markers and are very powerful in cultivar discrimination. For developing variety of oilseed crops, Oilseed research Centre, BARI dealing with eight different oilseed crops. Each oilseed crop has a number of varieties and sufficient number of germplasms. To identify the varietal differences and diversity present in the existing germplasm, molecular markers-based analysis is needed. Therefore, the present study has been taken to estimate the genetic diversity of variety and germplasm using SSRs markers which will be helpful in identifying genetically diverse genotypes.

Materials and Methods

Thirty genotypes including 10 varieties belonging to *Brassica rapa* was used in this study. Actively growing leaf samples from all the genotypes was harvested and stored at −80 °C in the deep freezer.

Genomic-DNA from fresh and young leaves was isolated and purified following ORC Molecular Biology Lab standardized protocol. The quality of the extracted DNA was evaluated by determination of A260/A280 absorbance ratio by spectrophotometer. DNA concentration and purity were estimated by 0.8% agarose gel electrophoresis. A portion of DNA was diluted in molecular grade water to a concentration of 25-50 ng/µl and stored at −20 °C.

Highly polymorphic SSR markers were obtained from journal article search. Then the genomic DNA was amplified using appropriate PCR protocol.

Data from the primers were analyzed to obtain the information on genetic diversity of the *B. rapa* accessions. The summary statistics including the number of alleles per locus, major allele frequency, gene diversity, Polymorphism Information Content (PIC) and genetic distance-based clustering was performed with Unweighted Pair Group Method for Arithmetic.

Average (UPGMA) tree using Power Marker v 3.25 (Liu and Muse, 2005) and the dendrogram was constructed using MEGA 5.0 software.

Results and Discussion

Diversity analysis of B. rapa genotypes was done using 17 highly polymorphic SSR markers. A total 178 alleles were amplified across 17 markers among all the 30 genotypes (Table 1). Genetic diversity varied from minimum 0.69 for marker Q2 to maximum 0.95 for marker Niab_ssr022 with an average value of 0.84. Polymorphism information content (PIC) value of the markers varied from minimum of 0.62 with the marker Q2 and maximum of 0.93 with primer Niab_ssr022 with a mean value of 0.83. From the result it was found that all 17 primers representing PIC value more than 50%, so these primers can further be used for diversity analysis.

A gel image of amplified fragments produced by primers CN53, and RM162 showed multiple alleles in Figures 1(a and b).

Table 1. List of SSR markers with their major allele frequency, allele number, gene diversity, heterozygosity and PIC values found among 30 *B. rapa*

Markers	Major Allele Frequency	Allele No.	Gene Diversity	Heterozygosity	PIC value
Na10-A09	0.3000	7.0000	0.7844	0.0000	0.7514
BRMS-008	0.2000	12.0000	0.8811	0.1000	0.8698
BRMS-019	0.2667	11.0000	0.8350	0.0333	0.8162
Na10-D09	0.3667	8.0000	0.7972	0.1667	0.7755
CN53	0.1167	22.0000	0.9317	0.2000	0.9276
Ra1-FO3	0.1667	21.0000	0.9228	0.3000	0.9179
SA63	0.1667	12.0000	0.8911	0.0000	0.8812
Na10-C06	0.2667	10.0000	0.8311	0.0000	0.8109
SAL-SRK-I	0.4000	12.0000	0.8022	0.0000	0.7889
Na10-G10	0.4000	7.0000	0.7689	0.0000	0.7424
Q1	0.3000	14.0000	0.8533	0.0667	0.8408
Q2	0.5000	13.0000	0.6989	0.1667	0.6724
CAPS1265	0.3333	10.0000	0.8222	0.0000	0.8041
CAPS37	0.3667	12.0000	0.8222	0.0000	0.8090
Niab_ssr022	0.1000	20.0000	0.9422	0.0000	0.9392
FAECON	0.2000	15.0000	0.9044	0.0000	0.8973
BN35D	0.2000	15.0000	0.8933	0.0000	0.8846
Mean	0.2735	13.0000	0.8460	0.0608	0.8311

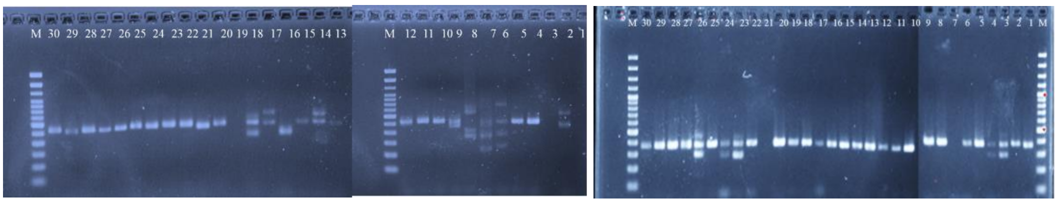

Fig. 1: Separation of alleles and its variation in 30 B. rapa using CN53 (a) and Na10-D09 (b) SSR Marker.

Genetic similarity analysis using UPGMA is presented in figure 2. Major three clusters were obtained *i.e.*, C-I, C-II and C-III, in which cluster C-I consisted of 7 genotypes (Figure 2). Cluster C-II and cluster C-III consisted of 11 and 12 genotypes, respectively which indicated that dissimilar accessions are grouped into distantly related clusters. This dissimilar grouping or distant clusters is so important because it helps the breeders to select the accession(s) with important dissimilar traits from the studied accessions for hybridization to get the higher heterotic responses.

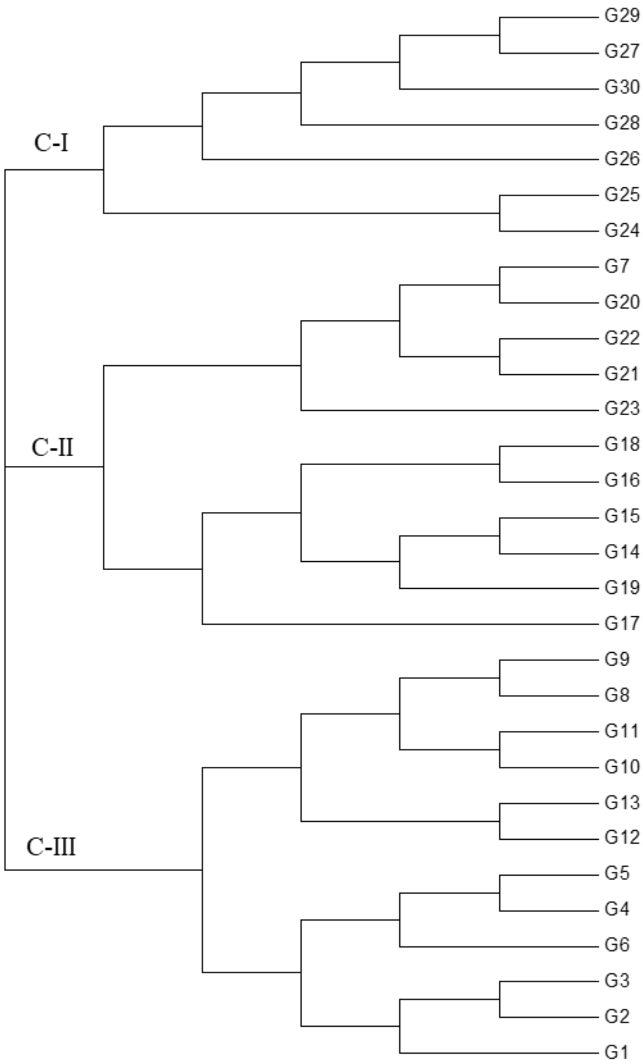

Fig. 2: UPGMA dendrogram based on Nei's (1972) genetic distance summarizing the data on differentiation between 30 *B. rapa*, according to SSR analysis.

Conclusion

SSR markers are the better tools to discriminate *B. rapa* genotypes based genetic variability present at molecular level. All 17 primers representing PIC value more than 50%, therefore, these primers could be used for diversity analysis in future. The genetic diversity information from this study will be useful for future *Brassica rapa* programs. Diversity at molecular levels of accessions will help the mustard breeders to find out suitable parent(s) containing economically important field crop traits for future hybridization.

NUCLEUS SEED PRODUCTION OF BARI SURJAMUKHI-3 AND SEED INCREASE OF DWARF ADVANCE LINES OF SUNFLOWER

S H HABIB

Abstract

A total of 27kg nucleus seed of released dwarf sunflower variety BARI Surjamukhi-3 was produced. A total of 1.2, 1.1, 0.7 and 0.7 kg seed were produced from four advance lines of sunflower viz. P1 (Syntjetic), P2(Synthetic), P6(Synthetic) and P8(Synthetic), respectively. The nucleus seeds will be used to maintain the varietal purity and the seed of advance lines will be used in breeding program.

Introduction

Unsatisfactory genetic purity, especially in cross pollinated crop, severely affects the performance of a variety. So it is very most importance to maintain the genetic purity of that variety. Production of nucleus seed could prevent the varietal deterioration. Therefore, nucleus seed of sunflower released variety BARI Surjamukhi-3 need to be produced which could be used to breeder seed production.

Sunflower varieties developed by ORC, BARI are tall and has lodging tendency. The farmers do not like these varieties due to the tallness of the varieties. Therefore, dwarf plant stature with high yielding sunflower variety for farmer's cultivation is needed. The scientists of ORC have developed some inbreed lines from the open pollinated varieties through selfing which are short in height. So, seed of these lines have to be increased for developing dwarf high yielding sunflower variety to meet the farmers need.

Materials and Methods

For nucleus seed production around 1000 heads were selected from the breeders' seed production field of BARI Surjamukhi-3. Seeds were threshed, dried, cleaned, and stored in bulk as nucleus stock.

For seed increase of advance lines, seeds from four advance lines of sunflower namely P1 (Syntjetic), P2 (Synthetic), P6 (Synthetic) and P8 (Synthetic), respectively were grown separately at ORC research field, BARI, Gazipur during rabi season 2021-22. Seeds of each genotype were sown on 1st December 2020 in a 8 X 4 m long plot where the spacing was 50 cm between the rows and 25 cm between the plants. Fertilizers were applied @ 90:35:80:30:3.6 and 1.8 kg/ha of NPKSZn and B, respectively, from urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid. Half of the Urea and all other fertilizers were applied at the time of final land preparation. The remaining half of the Urea was applied as top dress during flower primordial stage. To obtain optimum plant growth other intercultural operations were done properly when necessary. Each plot was covered with nylon net to protect out crossing. The plants in each genotype were allowed to intermate by rubbing the pollen collecting within the same genotype.

Table 9. Nucleus Seed production of BARI Surjamukhi-3 and seed increase of sunflower advance lines at Gazipur during Rabi, 2021-22

Sl. NO.	Entry	Total amount (kg)
1.	Nucleus stock (BARI Surjamukhi-3)	27
2.	P1 (Synthetic)	1.2
3.	P2(Synthetic)	1.1
4.	P6(Synthetic)	0.7
5.	P8(Synthetic)	0.7

Conclusion

The nucleus seeds will be used to maintain the varietal purity of BARI surjamukhi-3. The seeds of advance lines will be used in breeding program.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

E. LINSEED

MAINTENANCE AND EVALUATION OF LINSEED GERMPLASM

TOWHIDI ALMAS MUJAHIDI

Abstract

Forty linseed genotypes including check variety Neela were evaluated and maintained in the experimental field of Oilseed Research Centre, BARI, Gazipur during Rabi 2021-22. The highest % CV was recorded for the parameter plot yield followed by number of branches.

Introduction

Linseed is one of the important minor oilseed crops in Bangladesh. The seed contain about 32-43% oil. The color of the oil is yellow to brown, has acrid test and smell. In industries it has huge demand. Linseed oil is used in paint and varnishes industries. The oil cake can be used as cattle feed and organic manure. **High quality fiber is extracted from its' stem used for linen textile**. The plant is adapted to a wide range of environment. It is essential to maintain the genotype of linseed.

Materials and Methods

The experiment was carried at the research field of ORC, BARI, Joydebpur during rabi 2021-22 with forty genotypes of Linseed including the released variety Neela. Seeds were sown on November 23, 2021. The unit plot size of each genotype/line was 4m long with 4 rows with 40cm x 10cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly and when it was necessary.

Results and Discussion

Forty linseed genotypes including check variety Neela were evaluated and maintained. The ranges for days to 50% flowering, days to maturity, average plant height (cm), number of branches per plant, number of pods per plant, seeds per pod and plot yield (kg/ha) is shown in the table 1a. The highest % CV was recorded for the parameter plot yield (g) followed by number of branches (Table 1a). Collected seeds were preserved properly to evaluate in the next year.

Table 1a. Performances of forty linseed genotypes evaluated at BARI, Gazipur during Rabi, 2021-22

Characters	Range	Mean	%CV
Days to 50 % Flower	52-60	56	3.4
Days to Maturity	99-115	112	4.5
Plant Height (cm)	52-95	78	13.2
Number of Branches	5-8	6	21.6
Number of Pod/Plant	25-34	30	15.6
Number of Seed/Pod	5-10	7	18.9
Plot Yield (g)	133-510	309	35.1

Table 1b. Average of **y**ield contributing characters of 40 genotypes evaluated at BARI, Gazipur during Rabi 2021-22q

Sl	Entries	Days to flowering	Days to maturity	Plant height	Branches /plant	Pod/ plant	Seed/ pod	Plot Yield
1	Lin-1507/2	57	112	73.0	7	31	8	230.0
2	Lin-1903	56	112	85.2	6	28	8	432.0
3	Lin-2403	55	114	88.6	5	28	7	408.0
4	Lin-1703	54	113	84.2	5	31	7	455.0
5	JL-2	54	114	85.4	7	30	7	384.0
6	Jl-3	54	114	85.6	6	34	6	355.0
7	Lin-1203	54	114	79.0	6	32	6	443.0
8	Lin-503	55	114	83.2	6	32	6	261.0
9	Lin-1403	54	114	80.4	6	30	6	374.0
10	Lin-303	54	115	79.0	6	29	5	295.8
11	Lin-703	55	113	85.0	5	28	8	194.0
12	Lin-1503/2	57	113	89.2	7	29	8	368.0
13	Lin-V/2018	54	113	81.8	6	25	8	145.0
14	Lin(B)-18	54	113	79.0	6	28	9	245.0
15	Lin(S)-19	57	114	86.2	5	29	9	133.0
16	Lin(H)	57	114	78.2	6	31	8	392.0
17	BD-10696	57	114	87.0	6	32	9	442.0
18	BD-10698	53	99	65.0	3	30	10	143.0
19	Bd-10703	54	114	87.6	5	33	8	306.0
20	BS-10704	53	102	57.4	5	32	7	185.0
21	Lin-M-2017	61	113	64.0	7	31	6	150.0
22	Lin-C-2017	52	102	55.2	6	29	7	180.0
23	Lin-F-2017	56	114	60.8	6	29	6	220.0
24	Lin-T-2017	54	102	85.0	7	31	6	272.0
25	Lin-1308	57	115	59.8	6	29	6	265.0
26	Lin-C-2016	54	115	74.8	6	29	5	222.0
27	Lin-Chapai	54	115	94.8	7	29	5	352.0
28	Lin-603	57	113	69	6	29	6	150.0
29	Lin-103	57	113	88.2	0	29	6	510.0
30	Lin-MCGR	56	114	78.6	6	30	6	300.0
31	Lin-803	54	115	82.4	6	29	6	349.0
32	Lin-P-2018	54	115	81.0	6	29	6	403.0
33	BD-7148	57	106	86.0	6	30	6	270.0
34	Neela	54	114	86.0	6	30	6	210.0
35	BD-7141	57	108	90.8	6	31	5	499.0
36	BD-10710	53	99	83.0	5	30	6	280.0
37	BD-10707	54	115	63.4	6	3	6	375.0
38	BD-10708	59	104	64.8	8	27	7	500.0
39	BD-10716	59	104	66.6	7	30	6	331.0
40	BD-10705	57	104	87.0	6	29	5	327.0

Among the fourty lines BD-10708 gave the highest yield followed by Lin-1703.

Conclusion

Collected seeds were preserved separately which would be grown next year for further research work and breeding programme.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

F. NIGER

MAINTENANCE AND EVALUATION OF NIGER (Guizotia abyssinica) GERMPLASM

TOWHIDI ALMAS MUJAHIDI

Abstract

A total of twenty niger genotypes were grown to evaluate and maintain at ORC, BARI during rabi 2021-22. The highest % CV was observed for the parameter 10 plant yield followed by branches per plant. Collected seeds were stored properly to use for research work in the next year.

Introduction

Niger is known as Garzantil or Guzitil in Bangladesh. It is considered as minor oil crop in our country. Oil quality of niger for edible purposes is very good. Niger oil contains 50% linoleic acid which is an essential fatty acid for human health. BARI has developed one variety of niger named “Shova”. Yield potentiality of this variety is higher than the local varieties.

Materials and Methods

The experiment was carried at research field of ORC, Joydebpur during rabi 2021-22 with twenty genotypes of Niger. Seeds were sown on November 23, 2021. The unit plot size of each genotype/line was 4 rows 4 meter long maintaining 40cm and 10cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly.

Results and Discussion

Twenty niger genotypes were evaluated and maintained. The ranges for days to 50% flowering, days to maturity, average plant height (cm), number of branches per plant, number of pod per plant, seed per pod and 10 plant yield are shown in the table 1. The highest CV (%) was observed for the parameter 10 plant yield (g) followed by number of branches/ plant (Table 1).

Table 1a. Performances of twenty Niger genotypes evaluated at ORC, BARI, Gazipur during Rabi, 2021-22

Characters	Range	Mean	%CV
Days to Flower	55-57	56	1.5
Days to Maturity	113-117	115	1.3
Plant Height (cm)	107-137	116	6.8
Number of Branches	5-6	6	8
Number of Pod/Plant	28-31	29	3.4
Seed/Pod	17-29	19	4.2
10 Plant Yield (g)	40-86	55	23

Table 1b Performance of 20 Niger genotypes maintained and evaluated in ORC, BARI during 2021-22

Sl	Entries	Days to flowering	Days to maturity	Plant height	Branches/ plant	Pod/ plant	Seed/ pod	Plot yield
1	Nig-7706	55	114	137	5	29	20	600
2	Nig-140/6	56	115	114	6	30	19	600
3	Nig-5306	56	117	108	6	30	20	600
4	Nig-5806	55	113	108	5	31	19	621
5	Nig-7506	57	115	113	5	29	19	600
6	Nig-5706	57	114	116	6	30	19	538
7	Nig-5406	56	117	107	6	31	19	517
8	Nig-9206	55	117	119	6	30	20	746
9	Nig-8506	55	115	112	6	30	20	600
10	Nig-2206	56	116	111	6	31	19	559
11	Nig-8106	56	114	130	5	29	20	517
12	Nig-1606	57	114	116	6	29	20	684
13	Nig-3606	57	115	110	5	28	20	600
14	Nig-8706	55	117	112	6	28	18	663
15	Nig-3506	55	113	117	6	30	20	371
16	Nig-3006	56	116	117	6	30	19	705
17	Nig-3706	57	116	114	6	28	17	580
18	Nig-7806	57	117	127	6	31	19	580
19	Nig-2506	57	113	122	6	29	19	538
20	Nig-1306	55	114	137	5	29	20	600

Among 20 genotypes Nig-8506 showed highest yield followed by Nig-3706 and Nig-3606. Most dwarf plant was Nig-9206 followed by Nig-5806

Conclusion

The seed of the different entries were harvested and conserved properly in cold house for next year regeneration and for different breeding purposes.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

OBSERVATION TRIAL OF NIGER (GUIZOTIA ABYSSINICA)

TOWHIDI ALMAS MUJAHIDI

Abstract

A total of six Niger lines including released variety Shova were evaluated at ORC, BARI, Gazipur during Rabi 2021-22. Among the genotypes the most dwarf genotypes were Nig-3606 and the tallest entry was Shova. The maximum yield (kg/ha) were obtained from Nig-3706 followed by Shova.

Introduction

Niger is known as Garzantil or Guzitil in Bangladesh. It is considered as minor oil crop in our country. Oil quality of niger for edible purposes is very good. Niger oil contains 50% linoleic acid which is an essential fatty acid for human health. BARI has developed one variety of niger named "Shova". Yield potentiality of this variety is higher than the local varieties

Materials and Methods

The trial was carried out at ORC, BARI, Joydebpur during rabi 2021-22 with 6 genotypes including the check variety Shova. Seeds were sown on November 23, 2021. Each genotype/line was grown in a 6 rows 4m long unit plot maintaining 40cm and 10cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (30 days after germination) and reproductive (70 days after germination) stages in two splits. Other intercultural management was done properly.

Results and Discussion

Six Niger lines including one check variety Shova were evaluated for yield and yield contributing characters at ORC, Gazipur during rabi 2021-22. Among the characters pod per plant showed highly significant variation, followed by branches per plant. Most dwarf line was Nig-3706 and Nig-3606 and highest yield was found from Nig-3706 .

Table 5. Average performance of six Niger lines in observation trails at ORC, BARI, Gazipur during Robi, 2021-22

Sl	Entries	Days to maturity	Plant height (cm)	Branches /plant	Pod/ plant	Seed / pod	Plot yield (gm)
1	Nig-140/6	118	108	7	32	19	455
2	Nig-5806	116	100	7	33	21	425
3	Nig-8506	113	112	7	30	23	470
4	Nig-3606	114	98	6	29	19	478
5	Nig-3706	114	98	6	24	20	490
6	Shova	112	116	7	30	20	428
Level of Significance		ns	*	*	*	*	*
CV%		1.9	7.4	7.7	10.6	7.4	5.8

Conclusion

Considering yield and other yield contributing characters, Nig-3706 showed best performance followed by Nig-3606.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

G. SAFFLOWER

MAINTENANCE AND EVALUATION OF SAFFLOWER GERMPLASM

TOWHIDI ALMAS MUJAHIDI

Abstract

Seven Safflower genotypes including released variety BARI Saff-1 were grown to maintain and evaluation during rabi 2020-21. Maximum %CV were found for the parameter10 plant yield(g) followed by number of pod per plant.Collected seeds were preserved properly which would be grown next year for further research work.

Introduction

Safflower is another minor oilseed crops in Bangladesh. It is mainly grown in less fertile lands. Because of presence of spines in the leaves it is also grown in the border of other crop fields. Safflower oil is used for cosmetics and industrial purposes. ORC, BARI has developed a variety BARI Safflower-1. At present there is no statistics of area and production of this crop.

Materials and Methods

The trial was carried out at the research field of ORC, BARI Joydebpur during rabi 2020-21 with seven genotypes of safflower including the check variety namely BARI Saff-1. Seeds were sown on November 23, 2021. Each genotype was grown in a 4m long x 4 rows plot, maintaining 40cm and 10cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (20 days after germination) and reproductive (40 days after germination) stages in two splits. Other intercultural management was done properly.

Results and Discussion

Eight genotypes of safflower were grown for maintenance during rabi, 2021-22. The ranges for days to 50% flowering, days to maturity, average plant height (cm), number of branch per plant, number of pod per plant, seed per pod and 10 plant yield (g) were 91-101, 125-127,69-97, 4-5,9-24, 8-14 and 16-87 respectively. The highest % CV was observed for the parameter10 plant yield (g) followed by number of pod per plant (Table. 4).

Table 4. Maintenance and evaluation of eight safflower lines during Rabi, 2021-22 at ORC, BARI, Gazipur

Characters	Range	Mean	%CV
Days to Flower	90-99	93	3
Days to Maturity	121-125	124	2
Plant Height (cm)	69-92	78	9
Number of Branches	4-6	5	2
Number of Pod/Plant	16-24	19	8
Number of Seed/Pod	10-14	12	3
10 Plant Yield (g)	49-80	52	25

Conclusion

The seeds of these safflower genotypes were harvested and kept in the cold storage for evaluation and maintenance in the next rabi season.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

OBSERVATION TRIAL OF SAFFLOWER (*Carthamus tinctorius*)

TOWHIDI ALMAS MUJAHIDI

Abstract

A total of five Safflower lines including released variety BARI Saff-1 were valuated at ORC, BARI, Gazipur during Rabi 2021-22. Among the genotypes the most dwarf genotype were SAF-503.The maximum yield (kg/ha) were obtained from SAFF-T-2017.

Introduction

Safflower is another minor oilseed crops in Bangladesh. It is mainly grown in less fertile lands. Because of its spiny leaf character it also can be grown in the border of other crop fields. Safflower oil is used for cosmetics and industrial purposes. At present there is no statistics of area and production of this crop.

Materials and Methods

The trial was carried out at ORC, BARI, Joydebpur during rabi 2021-21 with 5 genotypes including the check variety BARI Saff-1. Seeds were sown on November 23, 2021. Each genotype/line was grown in a 4 rows 4m long unit plot maintaining 40cm and 10cm spacing between rows and plants respectively. Fertilizers were applied @ 120: 80: 60: 40: 4:1 kg/ha of N: P: K: S: Zinc and Boron from Urea, TSP, MP, Gypsum, Zinc sulphate and Borax. All the fertilizers were applied during the final land preparation except urea. The urea was applied at vegetative (30 days after germination) and reproductive (70 days after germination) stages in two splits. Other intercultural management was done properly.

Results and Discussion

Five safflower lines including one check variety BARI Saff-1were evaluated for yield and yield contributing characters at ORC, Gazipur during rabi 2021-22. Plant height, pod per plant and yield showed significant variation. Among the entries the most dwarf entries were SAF-503. Maximum numbers of pods/plant were also observed in SAF-503. Highest yield were recorded for SAF-T-2017 followed by BARI SAFF-1.

Table 6. Average performance of five safflower lines in Observation Trial at ORC, BARI, Gazipur during Rabi, 2019-20

Sl No	Entries	Days to flowering	Days to maturity	Plant height (cm)	Branches/ plant	Pod/ Plant	Seed/ pod	Plot Yield (gm)
1	BARI SAFF-1	94	126	110	7	26	13	260
2	SAF-503	102	132	99	7	38	13	210
3	SAF-504	106	138	113	6	29	14	180
4	SAF-T-2017	96	126	112	6	23	12	280
5	SAF-502	94	123	102	7	22	13	240
Level of significance		ns	ns	ns	ns	*	ns	*
CV (%)		5.5	4.7	5.9	8.3	23.3	5.4	17.0

Conclusion

Among the entries the most dwarf lines were SAF-503. The maximum yield (kg/ha) were obtained from SAFF-T-2017. Further evaluation is needed for these lines to confirm the results.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

II. CROP AND SOIL MANAGEMENT

EFFECT OF IRRIGATION ON GROWTH AND YIELD OF CANOLA TYPE MUSTARD VARIETY

P. ROY, F. BEGUM AND M.M.KARIM

Abstract

An experiment was conducted at the Oilseed Research Centre, BARI, Gazipur during the rabi season of 2021-2022 to study the effect of irrigation regimes on the growth and yield of canola type mustard variety BARI Sarisha-18 at different growth stages. There were five treatments viz. T_1: Irrigation as and when necessary (four times), T_2: Irrigation at vegetative and flowering stage, T_3: Irrigation at vegetative and seed development stage, T_4: Irrigation at flowering and seed development stage and T_5: Irrigation at vegetative, flowering and seed development stage. The crop variety was BARI Sarishai-18. The maximum seed yield (2.00 t/ha) was recorded in T_1 treatment (Irrigation as and when necessary; four times times irrigations were applied) followed by T_5 treatment (Irrigation at vegetative, flowering and seed development stage (1.62 t/ha)). But the maximum BCR (1.66) were obtained from T_5 treatment. The maximum oil content (42.50%) was recorded in T_1 treatment.

Introduction

In regions where water scarcity is the principal limiting factor for cultivation, farmers are interested in growing crops that are able to adapt to drought conditions (Bannayan *et al*., 2008). Mustard is a crop that fits well in the existing cropping system. Crop growth rate (CGR) and crop growth duration along with other vegetative and reproductive parameters have significance for development of high yielding variety. Information regarding dry matter accumulation, leaf area index (LAI), crop growth rate and duration are some of the key parameters for evaluation of cultivars (Soriano et al., 2004; Nadjafi, 2006). There was positive correlation between maximum CGR, total LAD, number of fertile seed head-1and concentration of oil in the achene and yield of achenes. Substantially high yields could be obtained from irrigated mustard, provided suitable varieties and irrigation techniques are used. Hybrid cultivars having high seed cost can give the highest yield only when irrigated (Flagella et al., 2002). BARI recently developed a canola type mustard variety named BARI Sarisha-18. In view, a field experiment is designed to study the effect of different irrigation regimes at different growth stages on the growth and yield of canola type mustard variety.

Materials and Methods

The experiment was conducted at the research field of Oilseed Research Centre (ORC), BARI, Gazipur during the rabi season of 2021-2022. There were five treatments viz. T_1: Irrigation at as and when necessary (4 times), T_2: Irrigation at vegetative and flowering stage, T_3: Irrigation at vegetative and seed development stage, T_4: Irrigation at flowering and seed development stage and T_5: Irrigation at vegetative, flowering and seed development stage. The experiment was design in RCB with three replications. Seeds of BARI Sarisha-18 were sown on 11 November 2021 at Gazipur with a plot size of 3m x 4m. Fertilizers were applied at the rate of $N_{88}P_{34}K_{80}S_{28}Zn_3B_2$ kgha^{-1} in the form of urea, TSP, MoP, gypsum, zinc oxide and boric acid, respectively. Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied in equal amounts at 30 & 55 days after sowing (DAS). Irrigation was applied according to the treatment followed. Plant samples were collected at one month interval starting from 20 DAS to measure the LAI (leaf area index), and total dry matter content. Percentage of oil content was estimated for each treatment after harvesting the crop. Data on yield and yield contributing characters were recorded and analyzed statistically using SPSS program.

Results and Discussion

Yield components

All measured parameters of BARI Sharisha-18 like plant height, siliquae/plant, number of seed per siliquae and 1000 seed weight (g) differed significantly among the treatments except plant population and number of branches per plant (Table 1). However, both the initial and final plant population/m^2 were recorded maximum at treatment T_1 (Irrigation as and when necessary(four times) and minimum at treatment T_3 (Irrigation at vegetative and seed development stage). The tallest plant (122.7 cm) was obtained from T_1 treatment (Irrigation as and when necessary (four times) and shorter (97.90 cm) from T_3 treatment (Irrigation at vegetative and seed development stage).

Highest number of siliqua per plant (60.55) was found from treatment T_1 (four times irrigations were applied) which was statistically similar to that of T_5 treatment (59.00). On the other hand, the lowest siliqua per plant (42.00) were produced in T_3 treatment (Irrigation at vegetative and seed development stage) which might be due to facing water scarcity in their critical growth stage (either vegetative or flowering or seed development stage). Leaf area index significantly varied in response to changing irrigation regimes during the crop growing period. Maximum LAI was recorded after 60 days of sowing in all the treatments. Proper irrigation management showed higher LAI value than limited irrigation management (Fig. 1). Dry matter accumulation was maximum in T_1 that received proper irrigation in their critical growth stages (Figure 2). The maximum number of seed per siliquae (36.95) was recorded in T_1 (Irrigation as and when necessary(four times) followed by T_5 treatment (34.45). The maximum 1000 seed weight recorded in T_1 treatment (3.9g) followed by T_5 treatments (3.7g).

Significantly the highest seed yield was recorded in T_1 (2.00t/ha) which might be due to higher number of seed per siliqua and seed weight followed by T_5 (2.26 t/ha). Similar findings was observed by Flagella *et al*., 2002. The lowest seed yield (1.10t/ha) was recorder in T_3 treatment (Irrigation at vegetative and seed development stage) which might be due to lower number of siliquae per plant and lower seed weight. Similar result also recorded by Monira *et al*., 2015. The maximum oil content (42.50%) was recorded in T_1 treatment and followed by T_5 treatment.

Table 1. Effect of different irrigation regimes on yield performance of mustard variety during the rabi season of 2021-22

Treatments	Initial pop. (no.)	Final pop. (no.)	Plant height (cm)	Branches/ plant (no.)	Siliquae /plant (no.)	Seeds/ siliqua (no.)	1000 seed wt (g)	Stover Yield	Seed yield (t/ha)		Oil content (%)
									2020-21	2021-22	
T_1	98	85	122.70a	4.50a	60.55a	36.95a	3.9a	159.5	2.34a	2.00a	42.50
T_2	96	83	113.70bc	4.25a	50.12c	28.30cd	3.2d	122.5	1.88d	1.20d	40.25
T_3	93	80	97.90d	3.00b	42.00d	27.20d	3.2d	108.5	1.10e	1.10e	41.70
T_4	95	81	110.65c	3.75ab	55.40b	29.55c	3.5c	119.5	1.97c	1.50c	41.80
T_5	97	84	118.0ab	4.00a	59.00a	34.45b	3.7b	159.0	2.26b	1.88b	42.00
CV(%)	NA	NA	7.10	6.8	5.3	10.1	7.1		8.6	7.2	-

NA= Not applicable. T_1: Irrigation as and when necessary (four times), T_2: Irrigation at vegetative and flowering stage, T_3: Irrigation at vegetative and seed development stage, T_4: Irrigation at flowering and seed development stage and T_5: Irrigation at vegetative, flowering and seed development stage.

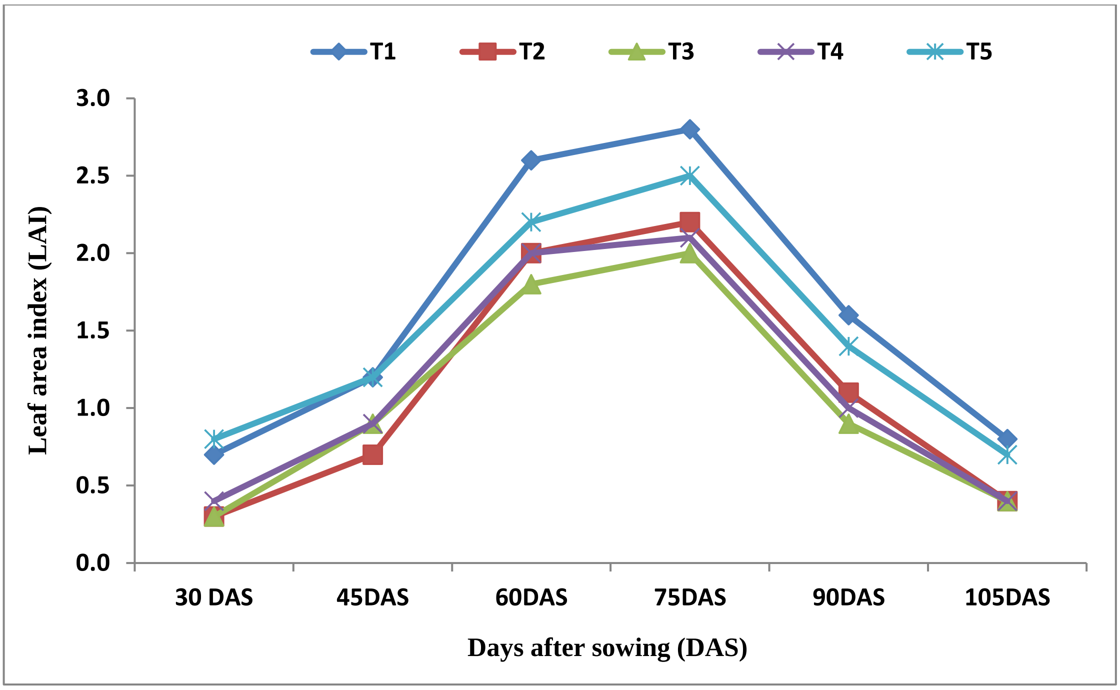

Fig. 1. Leaf area index (LAI) of mustard at different DAS as affected by different irrigation regimes.

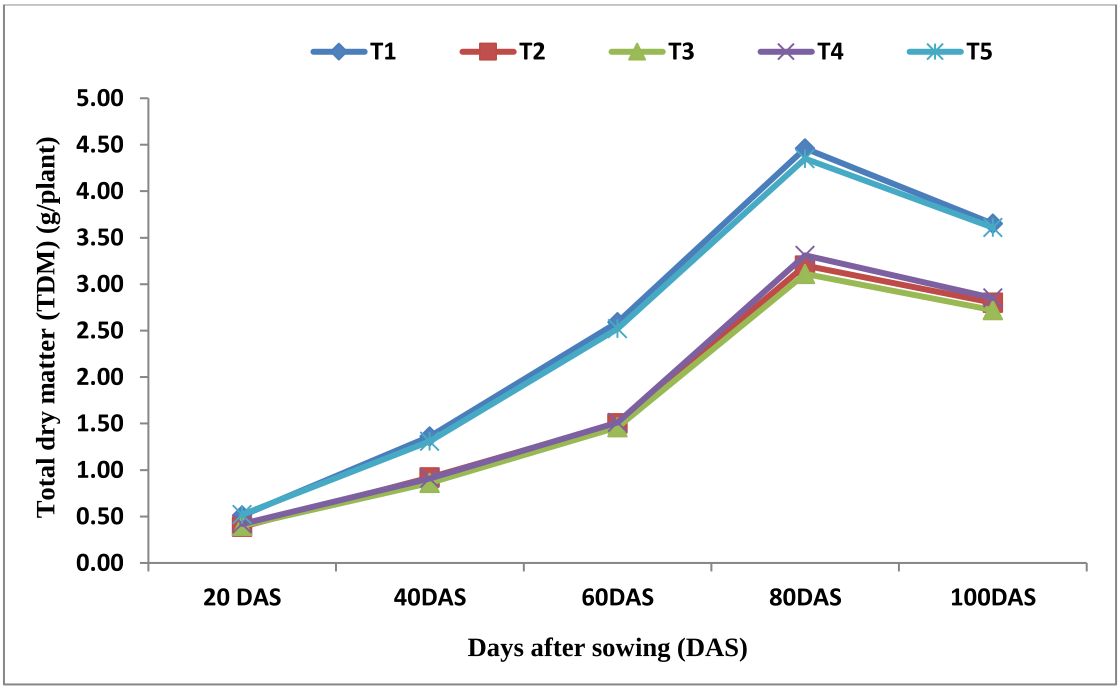

Fig.2. Total dry matter (TDM) of mustard at different DAS as affected by different irrigation regimes.

Cost and return analysis

Cost and return data are presented in the Table 2. From the cost and return analysis, it was revealed that maximum gross margin Tk. 54400 ha^{-1} and gross return was recorded in T_1treatment. But the highest BCR (1.66) was obtained from T_5 treatment. Lowest BCR was in T_3 treatment (1.02).

Table 2. Cost and financial return analysis of irrigation management in mustard during 2021-22

Treatments	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
T_1	140000	85600	54400	1.63
T_2	84000	75350	8650	1.11
T_3	77000	75350	1650	1.02
T_4	105000	75350	29650	1.39
T_5	131600	79100	52500	1.66

T_1: Irrigation as and when necessary, T_2: Irrigation at vegetative and flowering stage, T_3: Irrigation at vegetative and seed development stage, T_4: Irrigation at flowering and seed development stage and T_5: Irrigation at vegetative, flowering and seed development stage.
Mustard seed price: 70 tk/kg

Conclusion

The maximum seed yield (2.00 t/ha) was recorded in case of T_1 treatment (Irrigation 4 times) followed by T_5 (Irrigation at vegetative, flowering and seed development stage) treatment (1.88 t/ha). But the maximum BCR (1.66) were obtained from T_5 treatment. From one tear study, it may be revealed that three irrigations at vegetative, flowering and seed development stage would be optimum for canola type mustard. For confirmation of the result need to be repeated next year.

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DETERMINATION OF FERTILIZER DOSE FOR CANOLA TYPE MUSTARD VARIETY

M. M.KARIM, P.ROY AND F.BEGUM

Abstract

An experiment was conducted at the Oilseed Research Centre, BARI, Gazipur during the rabi season of 2021-2022 to fined out the optimum fertilizer doses for newly developed canola type mustard variety. The experiment was conducted with five treatments viz. T_1: Recommended dose (RD) (N_{138} P_{35} K_{50} S_{32} Z_{25} B_7). T_2: 20% less than RD, T_3:20% more than RD. T_4: 30% more than RD, and T_5: 40% more than RD. The crop variety was BARI Sarisha-18. Seed yield (1.91 t/ha) was maximum in T_3: 20% more than RD and lowest (1.70 t/ha) in T_2: 20% less than RD. From the cost and return analysis, it was revealed that the highest gross return (Tk. 168080/ha) was obtained from T_3 treatment (20% more than RD) and the lowest gross margin (Tk. 140800/ha), BCR (2.50) was obtained from T_2 treatment (20% less than RD).

Introduction

Mustard is a main oilseed crop in Bangladesh. It contributes a lion share to the total edible oil production in the country. Oilseed Research Centre of BARI recently developed one canola type mustard variety which requires 110-115 days to mature. Now it is essential to establish a proper management guideline for these new lines. Traditionally, farmers cultivate mustard through conventional methods where farmers are not aware of proper fertilizer application. Among various factors, fertilizer application is considered to be the most important for increasing yield. On the other hand, Mustard has a high nitrogen requirement prior to flower initiation otherwise it reduces the yield. Phosphorus is also limiting the mustard production as phosphorus is more prone for fixation rendering it as non-available to plants due to many soil reactions and interactions with other elements. Boron is another component required for proper pollination. Hence, this experiment was conducted to find out the optimum fertilizer dose of newly developed canola type mustard for getting maximum yield.

Materials and Methods

An experiment was conducted at the Research field of Oilseed Research Centre, BARI, Gazipur during rabi season of 2021-22 to find out the optimum dose of fertilizer for newly developed canola type mustard variety BARI Sarisha-18.

The experiment was conducted with five treatments viz. T_1: Recommended dose (RD) (N_{138} P_{35} K_{50} S_{32} $Z_{2.5}$ B_7) for BARI Sarisha-18. T_2: 20% less than RD, T_3:20% more than RD. T_4: 30% more than RD, and T_5: 40% more than RD. The experiment was laid out in RCB design with three replications. Before final land preparation the field was arranged according to plot size of (3m×4m). During final land preparation the fertilizer were applied as per treatment combinations in the form of Urea, TSP, MOP, Gypsum, Zinc oxide and boric acid, Where the half of urea and full amount of others fertilizers were broadcasted in the experimental plot the rest of urea was applied in two equal split at the time of 30 and 50 days after sowing (DAS). All the intercultural operations like irrigation, weeding, pest control etc were done as and when necessary. Harvesting of BARI Sarisha-18 was done on 21 February, 2022. Randomly five plants from each plot were tagged to take data an different agronomic parameters of BARI Sarisha-18. Data on growth, yield and yield contributing characters' were recorded and statistically analyzed with the help of the statistical package. R software and mean Separation was tested by least significance Difference (LSD) (Steel and Torric, 1960).

Results and Discussion

The effect of different doses of fertilizer on the growth as presented in (Fig.1). From figure1 it was clearly observed that after emergence the growth of BARI Sarisha-18 was increased gradually with the time up to 9 February then it's trend was declined. The growth in all the treatments was almost similar during 10 December to 21 January. The highest growth was found in T_5 (40% more than RD) treatment at 8^{th} February and it was followed by T_4 (30% more than RD) treatment. The lowest was observed in T_2 treatment where fertilizer was applied less than 20% of recommended dose of mustard.

The effect of different doses of fertilizer on the growth (Fig.1), yield and yield components are summarized in Table2. Seed yield, number of siliquae/plant and number of seeds/plant are significantly influenced by different management of fertilizer on BARI Sarisha-18. Number of plants/m^2, plant height and days to first flowering are insignificantly varied with the treatments. From the Table2 it was observed that the highest plant population (53)was recorded in T_2 (20% less than RD) treatment and the lowest 44 in T_4 (30% more than RD) treatment. The highest plant height (137.6 cm) was recorded in T_4 (30% more than RD) treatment which was followed by T_5 (40% more than RD) treatment. Days to first flowering was identified all most similar in all the treatments which was varied within 35 to 38 days, Days to maturity was 111 days in all the treatments. The maxinum siliquae/plant (200) was obtained from T_3(20% more than RD) treatment and the minimum was found in T_2 treatment. 1000 seed wt (3.43gm) was maximum in T_3 treatments followed by T_5 treatment. The highest yield (1.91t/ha) was obtained from the treatment T_3 (20% more than RD) and the lower (1.70 t/ha) was recorded from T_2 (20% less than RD) treatment.

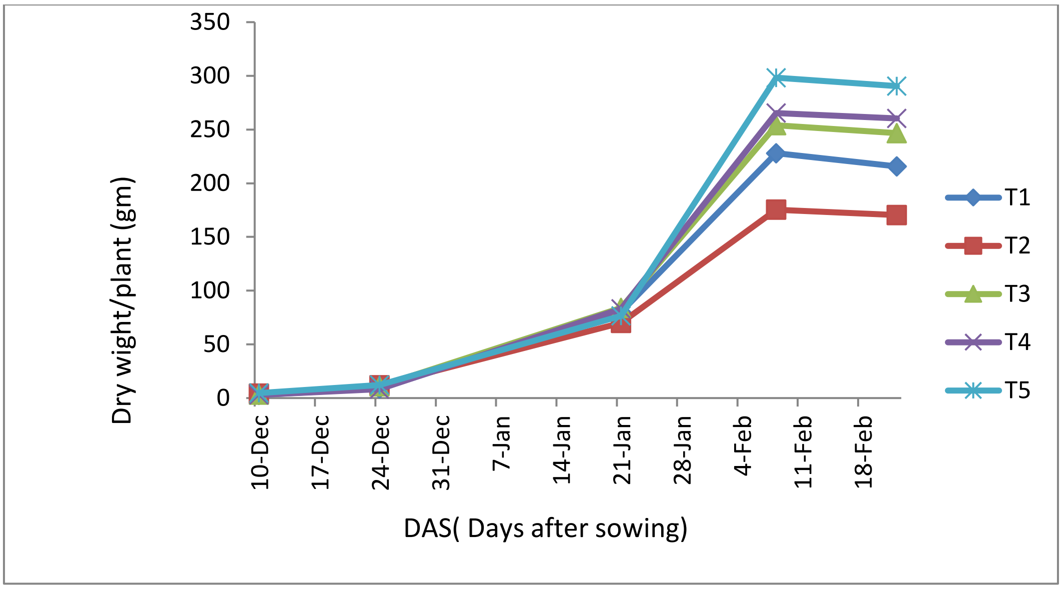

Fig 1 Effect of different dose of fertilizer on growth of BARI Sarisha-18.

Table 1. Effect of different fertilizer doses on yield component of canola type mustard variety during the rabi season of 2021-22

Treatments	Plant/m^2 (no.)	Plant height (cm)	Days to first flowering	Days to maturity	Siliquae/ plant (no.)	Seeds/ siliquae (no.)	1000 seed wt (gm)	Yield t/ha
T_1	47	111.67	37	111	182	22	3.04	1.84
T_2	53	108.17	36	111	170	27	2.88	1.70
T_3	49	126.47	35	111	200	28	3.43	1.91
T_4	44	137.60	37	111	175	25	3.12	1.75
T_5	49	131.53	38	111	177	26	3.15	1.75
LSD (.05)	NS	NS	NS	NS	5.86	2.69	0.31	2.32
CV (%)	7.96	8.92	4.72	8.02	3.75	3.80	8.21	10.44

T_1: Recommended dose (RD) (N_{138} P_{35} K_{50} S_{32} $Z_{2.5}$ B_7). T_2 : 20% less than RD, T_3:20% more than RD. T_4: 30% more than RD, and T_5: 40% more than RD.

Table 2. Cost and financial analysis of fertilizer management in mustard during rabi season 2021-22

Treatment	Yield (t/ha)	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross Margin (Tk/ha)	BCR(Tk/Tk)
T_1	1.84	149600	69380	80220	2.16
T_2	1.70	140800	54843	85957	2.56
T_3	1.91	168080	86080	82000	1.95
T_4	1.75	154000	87751	66249	1.75
T_5	1.75	154000	93088	60912	1.65

T_1: Recommended dose (RD) (N_{138} P_{35} K_{50} S_{32} Z_{25} B_7), T_2: 20% less than RD, T_3:20% more than RD, T_4: 30% more than RD and T_5: 40% more than RD. Prize of Mustard @88tk/kg.

Cost and return analysis

Cost and return of BARI Sarisha-18 cultivation have been described in the Table (3) Among the treatments the highest gross margin (Tk.85957 ha^{-1}) was obtained from T_3 treatment. Where as the BCR was highest (2.56) in T_2 treatment. On the other hand the lowest gross margin (Tk. 60915 ha^{-1}) was obtained in the T_5 treatment. Though the highest yield (1.91 ton ha^{-1}) was found in T_3 (20% more than RD) treatment but BCR of this treatment was not highest because of higher production cost.

Conclusion

From the results and discussion of the experiment it may be concluded that 20% more than recommended dose was found optimum and profitable dose of fertilizer for the production of BARI Sarisha-18.

EFFECT OF SOWING TIME AND TILLAGE METHODS ON THE YIELD OF MUSTARD IN SOUTH-WESTERN SALINE AREAS

O. A. FAKIR, F. BEGUM AND M. M. HOSSAIN

Abstract

The experiment was conducted at Agricultural Research Station (ARS), Binerpota, Satkhira during the rabi season of 2021-2022 to find out optimum sowing time and method for the maximum mustard yield in saline areas. There were six treatment combinations in two factorial RCBD approach where factor A was sowing times viz. T_1*: 15 November,* T_2*: 30 November and* T_3*: 15 December. Factor B was sowing methods considering 3 levels viz.* S_1*: Farmer's practice (Broadcasting after tillage by power tiller),* S_2*: Broadcasting with no tillage and* S_3*: Sowing with reduced tillage by PTOS. From the result it was evident that among different treatment combinations, significantly higher grain yield (1.52 tha*$^{-1}$*) was obtained from 30 November sowing and sowing with reduced tillage by PTOS (*T_2S_3*). Seed sowing on 15 December broadcasting with no tillage (*T_3S_3*) produced the lowest seed yield (0.17 tha*$^{-1}$*). The lowest level of average soil salinity (3.55 dS/m) was recorded from* T_1S_2 *at the sowing time and the highest level of average salinity (8.25 dS/m) was recorded for* T_3S_3 *at the harvesting time.*

Introduction

The constraints of oilseed expansion are largely related to use of long duration aman varieties, and inadequate knowledge of crop management under saline conditions. In coastal Bangladesh, planting of dry season crops is often delayed until January or even February because water remains on the land until December, at which time the weather becomes cold and foggy, and it is only after the weather starts to warm up in the later part of January that significant soil drying starts to take place. On the other hand, it is also seen that grain yield reduced gradually with the advancement of delay of sowing. Production of any crops is influenced by several factors, of which sowing method is very important. Deep tillage improves the physical, chemical and biological properties of soil carried out an experiment on mustard in saline field at Agricultural Research Institute (ARI), Pakistan. Sarkees (2013) reported that maximum total yield of 1091.9 kg ha-1 was obtained when crop was grown by drill-row sowing, which was significantly higher (140.9%) than broadcasting method. In coastal areas of Bangladesh, excessive tillage results in late planting and reduces yields of mustard. This ploughing takes time and often results in late planting and decline in mustard yield potential, plus many other negative effects (Hobbs & Gupta 2003, 2004). Cultivation using a two-wheel, tractor operated power tiller is only possible once the topsoil has dried below field capacity. As a result, valuable soil moisture is lost while waiting for the soil to dry, and the late planted crops are exposed to damaging levels of soil and water salinity in March and April. Further, these late planted crops are at risk of being damaged by pre-monsoon rains that start from early May. Early planting, preferably in November and December, is essential to prevent the crops from exposure to increasing soil salinity and the pre-monsoon rains. In the case of small seeded crops like mustard, early planting can be achieved by broadcast sowing shortly prior to rice harvest (Rashid *et al*. 2012a).

The relay cropping of mustard as broadcasting in moist soil on 10- 12 days before of t. aman harvest may create opportunity to reduce the cost of land preparation and timely planting mustard and boro (Rashid et al. 2012a). Mustard can be relayed with T.aman to ensure the right sowing time. The productivity and quality of mustard and rapeseeds can be improved by proper adjustment of variety, sowing time and technique. Keeping this view in mind the present experiment was undertaken.

Materials and Methods

Experimental site and design

The experiment was conducted at a farmer's field in Satkhira sadar during the *rabi* season of 2021-22 to find out optimum sowing time and sowing method for the best mustard yield in saline areas. The soil belonged to the AEZ-11 and AEZ-13. The land topography was medium low. The soil of the experimental field was clay loam in texture with pH 7.15. There were seven treatment combinations in two factorial RCBD approach with three replications where factor A was sowing times viz. T_1, 15 November, T_2, 30 November and T_3, 15 December. On the other hand, factor B was sowing methods considering 3 levels viz. S_1, Farmer's practice (Broadcasting after tillage by power tiller), S_2, broadcasting with no tillage and S_3, sowing with reduced tillage by PTOS.

Physical Properties of Soil

In order to investigate the physical and chemical properties of various parts of the lands, nine random samples from each replicate were taken by the Auger of 0-15 cm depth and then transported to the laboratory for further analysis. To obtain soil weighted moisture content, the amount of 10 g of soil was poured into metal cans and was placed in the oven for 24 hours at a temperature of 110 ° C. Once cooled, the moisture content was calculated based on the oven-dried soil. Particle size distribution was done by hydrometer method and the textural class was determined using the USDA textural triangle. The measurement of soil bulk density (g/cm^3), soil sample were randomly taken at a depth of 0–15 cm, from the main test plot. The diameter of core sampler was measured with venire caliper. The samples were dried in a hot air oven at 105^{0}C and dry weight of soil sample was recorded. The bulk density of soil was determined by using the using the RNAM (1995) formula. Cylinder method was exercised to determine soil porosity in the samples (Blake and Hartch, 1986). Soil porosity in each sample was calculated by the following equation (Daniel chipped and Sooterland, 1986).

Soil Porosity = [1-(bulk density/particle density)]*100

Table 1. Physical properties of initial soil of the experimental plot, 2021-2022

Particle size distribution	Value
Sand (%)	45
Silt (%)	22
Clay (%)	33
Textural class	Clay Loam
Bulk density (g/cm3)	1.32
Particle density (g/cm3)	2.28
Total porosity (%)	42.10

Chemical properties of the soil

After following the standard methods, soil samples were analyzed for pH, OM, N, P, K, S, Zn, B, Cu, Fe, Mn, Ca, Mg and Na. Soil pH was measured using a glass electrode pH meter (WTW pH 5.22) at a soil-water ratio of 1:2.5 as described by Ghosh, soil organic C was measured by Walkley and Black's wet oxidation method as described by Jackson *et. al,* and total N was measured by micro-Kjeldahl method; available P was determined following the Bray and Kurtz method, exchangeable K was determined using NH_4OAC extraction method, S was determined by turbidimetric method with the help of a spectrophotometer using a wave length of 420 nm, Ca was determined by complexometric method of titration using Na_2-TA as a complexing agent, Mg was determined by using NH_4OAC extraction method, available Zn, Cu, Fe, and Mn were determined by using diethylenetriaminepentaacetic acid (DTPA) extraction method, B was determined by spectrophotometry method and Na was determined by flame photometry method. CEC (Cation Exchange Capacity) was measured as the summation of the K, Ca, Mg and Na content.

Table 2. Chemical properties of the Initial soil and post-harvest soil

Soil characteristics	Analytical value (Initial soil)		Analytical value (Soil after harvest)		Critical levels
	Value	Interpretation	Value	Interpretation	
Soil p^H	7.15	Neutral	7.28	Neutral	-
Organic matter (%)	1.05	Medium	1.40	Medium	C:N= 10:1
Total N (%)	0.075	Very low	0.10	Very low	0.12
Available P (ppm)	14.55	Medium	23.12	Optimum	10.0
Exchangeable K (meq/100g soil)	0.58	Very high	0.80	Very high	0.12
Available S (ppm)	13.42	Low	15.80	Medium	10.0
Available Zn (ppm)	0.60	Low	0.72	Low	0.6
Available Boron (ppm)	0.18	Low	2.05	Very high	0.2
Available Cu (ppm)	0.92	Very high	0.80	Very high	0.2
Available Fe (ppm)	16.20	Very high	14.60	High	4.0
Available Mn (ppm)	0.70	Very low	0.55	Very low	1.0
Exchangeable Ca (meq/100g soil)	4.30	Medium	7.90	Very high	2.0
Exchangeable Mg (meq/100g soil)	7.50	Very high	6.15	Very high	0.5

Field measurement of soil salinity

Soil salinity at different dates was recorded at 09:00-10:30 a.m. every 15 days interval, starting from sowing until harvest. The salinity was measured by EC meter (HANNA: HI 9835). Data were taken at the middle of the plot. Once a week, a calibration for the meter was made by comparing with laboratory data and results have been shown in Figure 1.

Tillage implements, Seed sowing & crop management

The conventional tillage for farmers practice was conducted by a power tiller, whereas the Reduce tillage was maintained by PTOS. Broadcasting was done by the hand spreading of seeds in a non-tilth land without maintaining any spacing and depth. The mustard variety was BARI Sorisha-18. Unit plot size was 5m X 3.6m. The crop was harvested on 20 February 2022 for T_1, 28 February 2022 for T_2 and 07 March 2022 for T_3. Two times irrigation at 30 and 60 days after sowing was applied during the growing period. Weeding was done at 14 days after sowing followed by thinning. Disease and insect pests were always well controlled using suggested applies (BARI, 2014). The crop was harvested at the time of maturity.

Fertilizer application methods

Fertilizers were applied following fertilizer recommendation guide 2018 (BARC, 2018). Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of seed sowing as per treatment. The rest half of urea was applied in equal amounts at 25 & 50 days after emergence.

Results and Discussion

Soil Properties

Bulk density (1.31 g/cm^3) was (Table 03) the lowest in reduced tillage by PTOS but significantly lower than the conventional tillage by power tiller. Also the lowest particle density (2.42 g/cm^3) was obtained from reduced tillage which was significantly lower than the other treatments. The highest porosity (47.00 %) was recorded in broadcasting with no tillage treatment which was significantly higher than the all other treatments.

Table 3. Effect of tillage practices on physical properties of soil, 2021-2022

Treatment	Bulk density (gcm^{-3})	Particle density (gcm^{-3})	Porosity (%)
S_1	1.35b	2.48b	45.68b
S_2	1.40a	2.67a	47.00a
S_3	1.31c	2.42c	45.65b
CV (%)	0.32	1.40	1.47

Agronomic Properties

Initial and final plant population

Sowing method and sowing time showed significant influence on the initial and final plant population of mustard. Sowing on 30 December with reduced tillage by Farmer's practice (Broadcasting after tillage by power tiller) gave the highest number of effective plant m^{-2}. And the final plant population for sowing on 30 November with reduced tillage by PTOS showed the lowest value. But the number of initial plant m^{-2} at germination period over the treatments varied from 45-258.

Plant Height

The effect of different treatments on plant height was statistically significant (Table 4). Plant height was varied from 119.40cm to 71.87 cm among the treatments (Table 4). Results showed that the tallest plant (119.40cm) was obtained from sowing on 15 December as broadcasting with no tillage (Table 4). Plant height increased with the early sowing time except T_1S_2. This is might be due to steady availability of soil moisture during growth period. The plant height obtained from different treatments ranked in the order of $T_2S_3 > T_1S_2 > T_2S_1 > T_1S_1 > T_3S_3 > T_3S_1 > T_1S_2$.

Number of Siliqua plant $^{-1}$

The number of Siliqua plant^{-1} was significantly influenced by different treatment combinations. The highest number of Siliqua plant^{-1} (216.60) was produced in T_2S_3 while the lowest (31.53) in T_2S_2 which has shown in Table 4.

1000 seed weight (TSW)

The TSW (g) was significantly influenced by different treatment combinations. The highest TSW (g) (2.25) was recorded in T_1S_3 while the lowest (1.57) in T_2S_1 and T_3S_2 which has shown in Table 4.

Seed yield

The grain yield of mustard was significantly influenced by sowing time and tillage method (Table 4). The range of seed yield was from 1.52 to 0.17 t ha^{-1}. Significantly the highest seed yield (1.52 t ha^{-1}) was obtained from 30 November sowing with reduced tillage by PTOS (Table 4). The highest seed yield was mostly the outcome of the highest number of effective plant, total number of siliqua plant^{-1} and thousand seed weight compared to other treatments. The early sowing of mustard gave statistically higher seed yield across all other treatments. Seed sowing on 15 December by broadcasting with no tillage (T_3S_3) produced the lowest seed yield (0.17 t ha^{-1}).

Table 4. Interactive effect of different sowing methods and times on the yield of mustard at Satkhira during the *rabi* season of 2021-22

Treatments	Initial plant population/m^2 (no.)	Final plant population/m^2 (no.)	Plant ht. (cm)	Branches/ plant (no.)	Siliqua /plant (no.)	Seeds/ siliqua (no.)	1000 seed wt. (g)	Straw yield (t/ha)	Seed yield (t/ha)	Days to maturity
T_1S_1	187b	116bc	91.40b	4.27ab	130.33bc	24.93b	2.08ab	2.21a	1.28b	98
T_1S_2	207ab	170ab	71.87c	1.87e	37.27e	23.67b	2.08ab	0.52cd	0.20e	98
T_1S_3	85c	48d	103.33b	3.73bc	122.73c	25.07ab	2.25a	1.62b	1.21b	98
T_2S_1	177b	143ab	97.27b	4.60a	152.60b	28.47a	1.57d	2.10a	1.19b	91
T_2S_2	179b	130abc	69.07c	1.73e	31.53e	26.33ab	1.73cd	0.45cd	0.29de	91
T_2S_3	93c	69cd	119.40a	4.67a	216.60a	27.13ab	1.93bc	2.27a	1.52a	91
T_3S_1	258a	185a	73.67c	2.67d	78.73d	26.20ab	1.69cd	2.47a	0.66c	82
T_3S_2	161bc	46d	64.33c	1.67e	32.53e	23.80b	1.57d	0.21d	0.36d	82
T_3S_3	85c	65cd	76.53c	3.20cd	69.47d	24.87b	1.60d	0.82c	0.17e	82
CV (%)	4.36	4.67	9.18	4.74	6.14	7.14	9.16	10.92	10.67	0.00

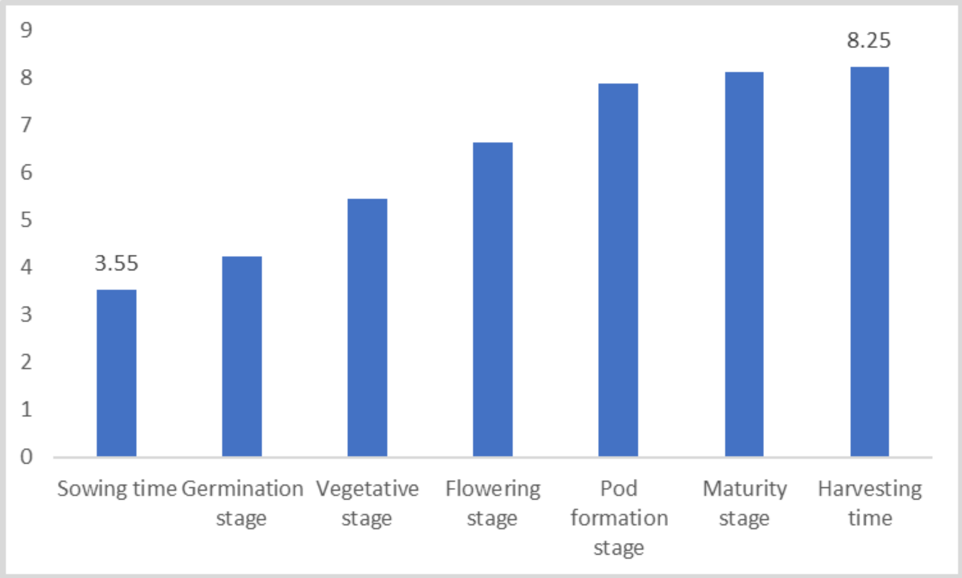

Fig. 1. Average soil Salinity at different growth stages

Conclusion

From one year data the results revealed minimum tillage through PTOS produced the maximum yield of mustard. It was the first year of experiment. Therefore, it should be replicated for next three years for final recommendation.

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EFFECT OF SOWING TIME ON YIELD AND YIELD COMPONENTS OF SESAME IN CUMILLA REGION

M A H KHAN AND M O KAISAR

Abstract

An experiment was carried out at the research field of Regional Agricultural Research Station (RARS), Bangladesh agricultural Research Institute (BARI), Cumilla during the period from February to June 2021 to investigate the effect of sowing time on yield and yield components of sesame in Cumilla region. The experiment was consisted of five sowing times viz., 20 February, 2 March, 12 March, 22 March and 2 April 2021. The variety was used BARI Til-4. The experiment was laid out in a randomized complete block design with three replications. The highest plant height (127.3 cm), number of seeds capsule^{-1} (65.3), 1000 seed weight and the highest seed yield (1366 kg ha^{-1}) was obtained from the crop sown on 20 February 2021. Most of these characters were statistically identical and very close to 2 March sowing. Significantly the lowest yield was recorded in 2 April sowing. The highest seed yield was obtained from 20 February to 2 March sowing and thereafter reduced with delay in sowing.

Introduction

Sesame (*Sesamum indicum*) is one of the important oil crops in Bangladesh. It is an important summer crop with high nutrition value. It contains 5.3% water, 5.2% mineral, 2.9% fibre, 18.3% protein, 43.4% fat and 25% carbohydrate per 100 g edible portion. In Bangladesh sesame is grown on area of 0.87 lac ha with total production of 0.88 lac metric tons making an average of 1.01 metric ton per ha during 2008-09. Sesame is very sensitive to water logging. Unfortunately, due to high water-logging every year farmers are facing to huge damage in this crop. In this reason, it needs to adjust sowing time for avoiding heavy rainfall or water logging. So, optimum sowing time should be determined for getting higher yield and avoiding damage. So, the experiment was undertaken to find out the optimum sowing time of sesame in Cumilla region.

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Cumilla during Kharif-I 2021. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 3.0 m × 3.0 m. The experiment was conducted with five treatments, viz. 5 sowing time i) 20 February ii) 2 March iii) 12 March iv) 22 March and v) 2 April 2021. The variety was used in BARI Til-4. The seeding was done in continuous sowing and row was 30 cm apart from each other. Fertilizers were applied @ 120: 80: 60: 40: 4: 1 kg ha^{-1} of N: P: K: S: Zn and B from urea, TSP, MoP, gypsum, zinc sulphate and boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. The seedlings were thinned after few days of germination. All intercultural operations were done timely to raise a good crop. Plants were maintained in good condition by adopting all recommended package of practices. The plants were harvested at maturity stage at five different times. Ten plants of each plot from each replication were randomly selected for recording data. The plot yield was converted into kg ha^{-1}. The data were statistically analyzed by using statistical package statistx10.

Results and Discussion

Table1. Effect of sowing time on seed yield and yield components of sesame at RARS, BARI, Cumilla during Kharif 2021

Treatment	Plant height (cm)	Branch plant^{-1} (no.)	Capsule plant^{-1} (no.)	Seeds capsule (no.)	1000-seed weight (g)	Seed yield (Kg ha^{-1})
20 February	127.3	3.4	135.0	65.3	2.60	1366
2 March	125.0	3.4	143.0	62.3	2.58	1357
12 March	122.6	3.4	121.0	57.7	2.49	1260
22 March	117.6	3.5	101.0	56.7	2.20	1101
2 April	110.3	3.6	64.0	53.0	2.19	714
$LSD_{(5\%)}$	6.2	NS	36.8	3.7	0.11	105
CV(%)	9.0	12.0	3.2	2.8	1.1	7.0

Yield and yield attributes of sesame was significantly influenced by the different sowing times where branch plant^{-1} did not show any significant variation (Table 1). The tallest plant (127.3) was obtained in 20 February sowing which was statistically similar to 2 March (125.0) and 12 March (122.6) sowing time and the smallest plant (110.3) was obtained in 2 April sowing. Increment in plant height was faster at early sowing and there-after it was slower from 12 March sowing and continued up to 2 April sowing. Mulkey *et al*. (1987) also reported that delayed sowing affected plant height. The highest number of capsule plant^{-1} (143) was found in 2 March sowing which was identical to 20 February (135) and 12 March (121) sowing and the lowest number of capsule plant^{-1} (64) was obtained 2 April sowing. It was observed that, the number of capsule plant^{-1} was decreased markedly up to 2 April sowing. Tilak *et al*. (1971) also reported that the number of capsule plant^{-1} was decreased with delay in sowing. The highest number of seeds capsule^{-1} (65.3) was obtained in 20 February sowing which was statistically identical with 2 March sowing and the lowest number of seeds capule^{-1} (53.0) was obtained from 2 April sowing. The maximum weight of 1000 seeds (2.60 g) was obtained from 20 February sowing which was identical with 2 March (2.58 g) and 12 March (2.49) sowing, it might be due to optimum maturity and accumulation of maximum dry matter. The minimum weight of 1000 seeds (2.19 g) was obtained from 2 April sowing. The highest seed yield (1366 kg ha^{-1}) was obtained from 20 February sowing which was statistically identical with 2 March (1357 kg ha^{-1}) sowing. The lowest seed yield (714 kg ha^{-1}) was obtained from 2 April sowing. Alam *et al.* (2007) also reported that the highest seed yield was obtained when sown on 26 February sowing and yield was decreased with delay in sowing. The higher seed yield produced in 20 February and 2 March sowing was mainly due to production of higher number of capsule plant^{-1}, higher seeds capsule^{-1} and higher 1000 seed weight.

Conclusion

The results indicated that, 20 February to 2 March sowing would be the optimum sowing time for sesame to have maximum seed yield and higher economic return in Cumilla region.

EFFECT OF DIFFERENT TRANSPLANTING TIME ON YIELD AND SEED QUALITY OF SUNFLOWER VARIETY

P. ROY AND F. BEGUM

Abstract

The experiment was conducted at Oilseed Research Centre, BARI, Gazipur during rabi season of 2021-22 to find out the optimum transplanting time of sunflower seedling for getting higher yield. The treatments of the experiment were five dates of transplanting of sunflower seedlings viz., T_1 = 7 November 2021, T_2 = 22 November 2021, T_3 = 12 December 2021 (delay sowing due to rain), T_4 = 27 December 2021 & T_5=11 January 2022. For all the treatments, 15 days old sunflower seedlings were transplanted. The experiment was laid out in randomized complete block design with three replications. The variety of sunflower was BARI Sunflower-3. Experimental results showed that transplanting time had significant effect on plant height, head diameter, number of seeds/head and seed yield. Highest seed yield (1.81 t/ha) with higher no. of seed/plant and higher seed weight was found in T_2 treatment (22 November). The lowest yield (1.05 t/ha) was recorded in T_5 treatment (11 January). The maximum matured seed number (1008) and the highest 1000 seed weight (79.00g) were obtained from T_2 (22 November) treatment. Sunflower could be cultivated through transplanting at 22 November just after early harvesting of T.aman rice.

Introduction

Sunflower is emerged as a promising potential oilseed crop because of its special characteristics viz., wider adaptability to varied climatic conditions, photo insensitivity, low seed rate, high yield potential, short duration, response to applied nutrients, high quality oil content, high seed multiplication ratio and its easy cultivation. The lower productivity of crop is mainly ascribed to cultivation of sunflower in less fertile marginal lands under low and uncertain rainfall situations with low and imbalanced use of fertilizers (Ramulu *et al*., 2011). In Bangladesh it is an important minor oilseed crop. Sunflower is a thermo neutral crop, therefore can be grown both in Rabi and Kharif seasons. Moreover, the relative tolerant to drought and saline condition would encourage its cultivation in the problem area. So there is a prospect for expansion of sunflower cultivation in Bangladesh. In southern region of Bangladesh, an average of about 31% land remain fallow (29.45%, 55.10% and 8.45% in *Rabi, Kharif*-1 and *Kharif-2* seasons, respectively) after harvesting of T.*aman* rice mainly due to delaying harvest of T*aman* rice, soil and water salinity, water logging, drought, tidal flooding, lacking of suitable adaptation technologies and so on (Rahman, 2015). Oilseed Research Centre of BARI recently developed some dwarf lines of sunflower. In the southern region of Bangladesh, sowing of sunflower is delayed due to late maturity of aman rice as well as late drainage of soil moisture. Although short duration aman varieties are developed by BRRI but still farmers are using their local practices, as a result sunflower sowing is delaying. In this situation transplanting of sunflower seeding might be an option. To keep this in mind, this experiment was designed to maintain the optimum sowing time of sunflower by scheduling different transplanting dates for getting maximum yield.

Materials and Methods

The experiment was conducted at Oilseed Research Centre, BARI, Gazipur during rabi season of 2021-22. The experimental site belongs to the agro-ecological zone Ganges Tidal Floodplain (AEZ-13). The soil type was medium high land and soil texture was loamy. The treatments of the experiment were five transplanting time viz., T_1 = 7 November 2021, T_2 = 22 November 2021, T_3 = 12 December 2021 (delay sowing due to rain), T_4 = 27 December 2021 & T_5=11 January 2022. For all the treatments 15 days old seedlings were transplanted. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 5 m x 4 m. The variety of sunflower was BARI Surjamukhi-3. Seedlings of sunflower were transplanted with spacing 50 cm row to row distance and 25 cm plant to plant distance. Fertilizers were applied in the experiment field at the rate of 200-180-170-170-10-12 kg/ha urea TSP, MOP, gypsum, zinc sulphate and boric acid respectively along with 8-10 t/ha cowdung (FRG, 2012). Half of urea, all other fertilizers and cowdung will be applied as basal. The rest half amount of urea will be applied as side dressing in two equal installments, one at 20-25 days after seedling emergence (DAE) and the other at 40-45 DAE (before flowering). Irrigation was applied for three times and other intercultural operations were done as when necessary following the recommended production technologies of the crops (BARI, 2017). Data were collected on different parameters namely, phenology (days to maturity and field duration), plant population, plant height, head diameter, number of seed/head, seed weight/head, thousand seed weight and plot yield. The plot yields were then converted into ton/hectare. Data were analyzed statistically and the mean differences were adjudged with Duncan's Multiple Range Test (DMRT) following Gomez and Gomez (1984).

Results and discussion

The transplanting time had significant effect on seed yield and yield contributing characters but no significant effect was found on plant population (Table 1). Field duration became the lowest (102 days) in T_5 (11 January). The highest field duration (112 days) was found in T_2treatment. Results showed that the field duration reduced gradually with increasing the time of transplanting of seedlings, which can save the crop from the adverse effect of natural calamities like heavy rainfall strong wind etc. The results further indicated that T_2 (22 November) produced the longest plant height (80.0 cm) followed by T_1 (66.53 cm) but the shortest plant (51.28 cm) was found in T_5 treatment. Largest head was found (13.06 cm) in T_2 treatment followed by T_1 which was statistically similar to T_4 treatment. Similarly, the highest number of seeds/head (1204) was obtained from T_2 and lowest in T_5 treatment (470). Transplanting at 22 November gave the highest yield of seed (1.81 t/ha) followed by T_1 treatment (1.75t/ha) which was statistically identical with T_3 treatment might be due to largest head, highest number of seeds & 1000 seed weight. Howerver, similar result also observed by bulbul *et al*, 2012. The lowest yield (1.05 t/ha) was recorded in T_5 treatment which might be due to lower number of mature seed (327) and lowest head diameter (8.50cm), similar result also found by Demir, 2019.

Table 1. Effect of different transplanting time on the yield and yield components of sunflower during the rabi season 2021-22

Treatments	Days to First Flowering (days)	Days to Maturity (days)	Final plant pop. (no.)	Plant height (cm)	Diameter of head (cm)	Seeds/ Head (no.)	Mature seeds/ Head (no.)	Immature Seeds/ plant (no.)	1000 seed wt (g)	Stover yield	Seed yield (t/ha)
T_1	45	111	111	66.53b	12.63b	765bc	501bc	260a	58.65c	230.00a	1.75ab
T_2	55	112	112	80.00a	13.06a	1204a	1008a	207ab	79.00a	226.66ab	1.81a
T_3	58	109	95	61.00b	11.00c	689bc	545bc	145b	73.42b	144.33d	1.58b
T_4	51	105	97	55.23bc	12.05bc	779b	624b	156b	68.88b	190.00bc	1.51b
T_5	60	102	92	51.28c	8.50d	470c	327c	143b	70.06b	166.66c	1.05c
CV(%)	-	-	-	2.30	1.40	10.1	4.1	13.32	5.93	10.29	8.6

T_1 = 7 November 2021, T_2 = 22 November 2021, T_3 = 12 December 2021 (delay sowing due to rain), T_4 = 27 December 2021 & T_5=11 January 2022

Conclusion

Sunflower could be cultivated with 15 days age seedling transplanting at 22 November just after early harvesting of T.aman rice. This year outcome might be hampered due to rain and therefore final recommendation will be made by repeating the experimentation in the next year with other locations in the southern region of Bangladesh.

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EFFECT OF PLANT GROWTH REGULATORS ON PRODUCTION TRAITS OF SUNFLOWER

M A H KHAN AND M O KAISAR

Abstract

An experiment was conducted at the research field of Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Cumilla during rabi season of 2021-22 to observe the effect of growth regulators on seed yield of sunflower. The experiment was laid out in a randomized complete block design with five treatments (T_1= IAA-100 ppm, T_2= IAA-150 ppm, T_3= GA_3-100 ppm, T_4= GA_3-150 ppm and T_5= Control). The seed yield and yield attributes like head diameter, seed per head and thousand seed weight were influenced significantly due to application of plant growth regulators. The highest seed per head (583), thousand seed weight (62.8) and seed yield (2320 kg ha^{-1}) was found at GA_3-150 ppm concentration. The lowest value of these parameters was found at control condition. The highest BCR (2.33) was achieved in GA_3-150 ppm followed by (2.29) IAA-150 ppm.

Introduction

Sunflower (*Helianthus annuus* L.) oil is quality oil compared to rapeseed and mustard. Sunflower currently is the world's fourth most important oil crop with a harvested area of about 25 million hectares in which 36 million tons of seeds are produced on average. The climatic condition of Bangladesh is suitable for sunflower cultivation. The seed of sunflower is the source of high quality vegetable oil which contains high level of unsaturated fatty acids and free from toxic constituents such as linolenic acid and trans fatty acid. In Bangladesh it is important minor oilseed crop. Plant growth regulators are the chemical substances, when applied in small amounts modify the growth of plants by stimulating or inhibiting part of the natural growth regulatory system. About 60 plant growth regulators are now commercially available and several of them have reached considerable importance in crop production. Though plant growth regulators have great potentialities, its application and actual assessments etc. have to be judiciously planned in terms of optimal concentrations, stage of application etc. for obtaining higher seed yield and quality (Kore*et al*., 2003). Quality seed determines the stability of yields in crops. Keeping in this view, the present experiment has been undertaken with the objective to know the effect of plant growth regulators on seed yield and oil content of sunflower

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station, BARI, Cumilla during 2021-22. The experiment was laid out in randomized complete block design with five treatments; i) IAA- 100 ppm ii) IAA- 150 ppm, iii) GA_3-100 ppm, iv) GA_3-150 ppm & v) Control. The 100 ppm and 150 ppm solutions of plant growth regulators were prepared by dissolving 100 mg and 150 mg is in small quantity of acetone dissolve all granules of PGR in acetone completely. Make final volume of 1 litre by adding distilled water slowly. Finally 100 ppm and 150 ppm concentrations of plant growth regulator solutions were prepared. The unit plot size was 2.5 m × 2.0 m. The variety was used in BARI Surjamukhi-3.The seeding was done on 8 November 2021 in 50 × 30 cm spacing. Fertilizers were applied @ 120: 80: 60: 40: 4: 1 kg ha^{-1} of N: P: K:S:Zn and B from urea, TSP, MoP, gypsum, zinc sulphate and boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied two splits at 25 days after germination and 45 days after germination. All intercultural operations were done timely to raise a good crop. Plants were maintained in good condition by adopting all recommended package of practices. Ten plants of each plot from every replication were randomly selected for recording data. The plot yield was converted into kg ha^{-1}.

Results and Discussion

Yield and yield attributes of sunflower was significantly influenced by the different concentrations of PGR where plant height did not show any significant variation (Table 1).

Table 1. Effect of plant growth regulators on seed yield and yield attributes of sunflower at RARS, BARI, Cumilla during 2021-22

Treatment	Plant height (cm)	Head diameter (cm)	Seed/head (no.)	1000 seed weight (g)	Yield (kg ha^{-1})	% Yield increased over control
T_1 (IAA -100ppm)	90.13	13.87	575.22	61.0	2086	14.87
T_2 (IAA -150ppm)	91.00	13.47	567.3	61.7	2253	24.06
T_3 (GA_3-100 ppm)	88.80	12.90	548.0	59.2	2150	18.39
T_4 (GA_3-150 ppm)	87.80	12.93	583.0	62.8	2320	27.75
T_5 (Control	85.27	10.47	437.3	53.6	1816	-
CV (%)	4.02	8.71	15.95	13.23	9.35	
LSD(0.05%)	NS	2.0	126.8	8.3	177.5	

The highest head diameter (13.87) was obtained in IAA-100 ppm which was statistically similar to IAA-150 ppm, GA_3-100 ppm and GA_3-150 ppm and the lowest (10.47) was obtained from control plot. The highest seed per head (583) was observed in GA_3-150 ppm which was statistically similar to IAA -100 ppm, IAA -150 ppm and the lowest (437) was obtained from control treatment. The highest 1000 seed weight (62.8g) was found in GA_3-150 ppm which was identical to IAA-150 ppm, IAA-100 ppm, GA_3-100 ppm and the lowest (53.6) was found in control condition. The highest seed yield (2320 kg ha^{-1}) was obtained from GA_3-150 ppm which was statistically similar to IAA -150 ppm, GA_3-100 ppm and the lowest seed yield (1816 kg ha^{-1}) was found in control plot. The maximum percentage yield increase (27.75%) over the control was obtained from GA_3-150 ppm and lowest (14.87%)was obtained from IAA -100 ppm.

The highest gross return (2,08800/-), the highest cost of production (89500/-), the highest gross margin (119300/-) and the highest BCR (2.33) was found in GA_3-150 ppm followed by IAA-150 ppm.

Table 2. Cost and return analysis of sunflower under different concentration of plant growth regulators at RARS, BARI Cumilla during 2021-22

Treatment	Yield (ton ha^{-1})	Gross return (Tk./ha)	Total cost of production (Tk./ha)	Gross margin (Tk./ha)	Benefit cost ratio (BCR)
IAA-100ppm	2086	1,87740	87000	100740	2.15
IAA-150 ppm	2253	2,02770	88500	114270	2.29
GA_3-100 ppm	2150	1,93500	87500	106000	2.21
GA_3-150 ppm	2320	2,08800	89500	119300	2.33
Control	1816	1,63440	80500	82940	2.03

Price of Sunflower seed-90/- Kg.

Several reports indicated that, application of plant growth regulators improved the plant growth and yield (Hernandez, 1997). GA_3 enlarged length of stem and flower number $plant^{-1}$. GA_3 accelerated stem elongation and bud development. The maximum seed yield GA_3-100 ppm was due to more number of larger pods as well as increased vegetative growth and balanced C/N ratio, which might have increased the synthesis of carbohydrates that ultimately promoted higher seed yield. It has been also reported that, the secrets of hormones like IAA, cytokinine, auxin and GA_3 which might have been another factor for increasing seed yield. These above results are in agreement with Brown *et. Al* (1993).

Conclusion

Results revealed that, GA_3-150 ppm and IAA -150 ppm concentration gave better performance than the others. About 10-15% seed yield was increased when plant growth regulators was applied to the sunflower.

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EFFECT OF SPACING ON GROWTH AND YIELD OF BARI SOYBEAN-7

M M KARIM, F BEGUM AND P ROY

Abstract

The experiment was conducted at the research field of Oilseed Research Centre (ORC), BARI, Gazipur during rabi season 2021-22. There were four treatments viz. T_1 *: 40cm x 10cm,* T_2*: 35cm x 10cm,* T_3*: 30cm x 10cm and* T_4*: 40 cm x 5cm,* T_5*: 45cm x 10cm (recommended spacing). The crop variety was BARI Soybaen-7. The experiment was design in RCB with three replications. Seed were sown in 27 December 2021. The 100 seed weight (g) was recorded maximum (13gm) in the treatment of* T_1*: 40cm x 10cm and it was followed by* T_5*: 45cm x 10cm treatment. The seed yield was obtained height (1.85 t/ha) in the treatment of T1 and lowest (1.68 t/ha) in the treatment of* T_5*. Though the no of pod/plant was not highest in the treatment of* T_1 *but yield was maximum it may be due to number of seed/pod and 100 seed weight were height. So* T_1*: 40cm x 10cm treatment is suitable spacing for maximizing the yield of BARI Soybean-7.*

Introduction

Soybean is a leguminous crop. It becomes a high potential crop in our country due to its multipurpose use like soya milk, soya naget, fish, cattle and poultry feed etc. It contain high protein (80-85%) and 19-22% oil. BARI has recently released a soybean variety named BARI soybean-7 which is YMV (Yellow Mosaic Virus) tolerant and have a yield potential. As a new variety we have to know the some informations reading spacing, because spacing is a important factor to boost up the yield of soybean. Considering above factors this experiment was undertaken to know the optimum spacing of BARI soybean-7.

Materials and Method

The experiment was conducted at the research field of Oilseed Research Centre (ORC), BARI, Gazipur during the rabi season of 2021-2022 to identify the suitable plant to plant and row to row spacing of newly developed BARI Soybaen-7 variety in Bangladesh. There were four treatments viz. T_1 : 40cm x 10cm, T_2: 35cm x 10cm, T_3: 30cm x 10cm and T_4: 40 cm x 5cm, T_5: 45cm x 10cm (recommended spacing). The crop variety was BARI Soybaen-7. The experiment was design in RCB with three replications. Seed were sown in 27 December 2021 at Gazipur. Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied in equal amounts at 30 & 55 days after sowing (DAS). Two times irrigation at 30 & 70 days after sowing were applied during the growing period. Tenb plants were selected for collecting data on various parametre. Data on yield and yield contributing characters were recorded and analyzed statistically using SPSS program.

Table 1. Effect of different treatments on yield performance of BARI Soybean-7 variety during the rabi season of 2021-2022

Treat.	No of Plant/m^2	No of leaf/ pl.	1st Flowering/ date	plant height (cm)	No of Pod/ plant	No of seed/ pod	100 seed wt(gm)	Yield(t/ha)
T_1	29	16.00	49.00	53.00	46.00	3.00	13.00	1.85
T_2	31	16.33	44.00	54.00	47.00	2.00	11.50	1.54
T_3	37	17.02	41.00	51.00	51.00	2.00	11.48	1.73
T_4	36	172.20	40.00	49.00	50.00	2.00	12.26	1.79
T_5	26	16.93	40.00	51.00	47.00	2.00	12.58	1.68
LSD(0.05)	2.90	3.76	1.31	1.58	3.30	0.09	0.77	0.18
CV(%)	15.68	15.25	4.36	6.03	11.80	6.54	10.89	17.49

T 1 : 40cm x 10cm, T2: 35cm x 10cm, T3: 30cm x 10cm and T4: 40 cm x 5cm, T5: 45cm x 10cm (recommended spacing).

Result and discussion

The yield contributing components like no of pod/plant, no of seed/pod and seed weight (g) are differ among the treatments. In the (Tab-1). The number of plant populations at final stage was recorded maximum (37) in the treatment T_3: 30cm x 10cm and minimum in the treatment T_4: 45cm x 10cm. The first flowering date varies from 40 to 49 days in all the treatments. The plant height was statically similar in all the treatments but it was found highest (53cm) in T_1: 40cm x 10cm treatment; followed by T_2: 35cm x 10cm treatment. The highest (50) no of pod/plant was found in T_3: 30cm x 10cm treatment and it was statically identical with the treatment T_4: (40cm x 5cm). The lowest no of pod/plant was recorded in the treatment T_1: 40cm x 10cm No of seeds/pod was varied from 2-3 in all the treatments. The 100 seed weight (g) was recorded maximum (13gm) in the treatment of T_1: 40cm x 10cm and it was follower by T_5: 45cm x 10cm treatment. The seed yield was obtained height (1.85 t/ha) in the treatment of T1 and lowest (1.68 t/ha) in the treatment of T5. Though the no of pod/plant was not highest in the treatment of T1 but yield was maximum it may be due to no of seed/pod and 100 seed weight were higher.

Conclusion

From the above result and discussion, it may be concluded that, T1: 40cm x 10 cm would be the suitable spacing for BARI, Soybean-7 cultivation for maximum yield.

PERFORMANCE OF SOYABEAN GENOTYPES IN SOUTHERN REGION OF BANGLADESH

M. M. HOSSAIN, O. A. FAKIR, M. M. U CHOWDHURY, A. H. M. AMIR FAISAL AND F. BEGUM

Abstract

A field trial was conducted in on-station of Agricultural Research Station, Benarpota, Satkhira and at West Al-Amin, Subarnachar upazilla in Noakhali during rabi season, 2021-2022. The aim of the study was to identify the salt tolerant soybean genotype(s). Four soybean genotypes viz. Sohag, BARI Soybean-5, BARI Soybean-6 and BARI Soybean-7 were taken as treatment in this experiment. All the tested genotypes gave statistically similar yield but BARI Soyabean-6 produced the highest yield (1.48 t/ha) and the lowest yield was recorded in BARI Soyabean-7 (1.17 t/ha) at Satkhira location but at Noakhali location, the highest seed yield was obtained from BARI Soybean-6 (2.10 t ha^{-1}) and the lowest yield (1.87 t ha^{-1}) was obtained from local variety (Shohag). Highest gross margin was obtained from BARI Soybean-6 (Tk. 63820 ha^{-1}) at Noakhali location. The lowest level of soil salinity was (2.25 ds/m) recorded in the sowing time and the highest level of salinity was (6.65 ds/m) recorded in the harvesting time (Fig. 1) at Satkhira location

Introduction

Leguminous crops are generally sensitive to salinity, though there is a considerable difference in salt tolerance between legume species (Maas and Hoffman, 1977). Soybean is among the most important oil seed crops of the world and has great value for food, feed, fodder, fuel (straw), and as a cover crop. Soybean is also a salt sensitive crop like other legume (Ashraf and Rasul, 1988). Despite its great economic importance insufficient work has been undertaken to improve its salt tolerance. For the improvement of salt tolerance, the existence of genetic variation in a crop is of prime importance. Moreover, it has been reported by a number of workers that in some crops selection for salt tolerance at the early growth stages may not correlate with their tolerance at the later growth stages (Asharf and McMeilly, 1988). Nevertheless, seed germination and seedling establishment are the most critical stages in life cycles of plants in saline environments (Blum, 1985) and are of importance in assessing the overall tolerance of a crop to salinity stress (Akber and Yabuno, 1974) Keeping this in mind, the experiment was conducted to examine the variation in salt tolerance of selected soybean genotypes up to maturity.

Materials and Methods

The experiment was conducted at on-station of Agricultural Research Station (ARS), Binerpota, Satkhira and at West Al-Amin, Subarnachar upazilla in Noakhali during rabi season, 2021-2022 . The objective of the study was to examine the variation in salt tolerance of selected soybean genotypes under salinity condition. Four soyabean genotypes viz. Shohag, BARI Soybean-5, BARI Soybean-6 and BARI Soybean-7 were taken as treatment in this experiment. The experiment was laid out in RCB design with six dispersed replications. The soil was sandy clay loam to silty clay loam belonging to Young Meghna Estuarine Flood plain of Bangladesh (AEZ 18) at Noakhali location. The unit plot size was 5m x 3m. The land was prepared by 2-3 ploughing followed by laddering to gain suitable tilth condition and was fertilized with 28-35-60-21-2 kg/ha of N-P-K-S-B in the form of urea, TSP, MoP, gypsum and boric acid. All fertilizers were applied during final land preparation. Seeds were sown on 22 December, 2021 in *joe* condition. The seeds were sown @ 50 kg ha^{-1} from 18 January to 20 January 2022 in line with the spacing of 30 x 5 cm at Noakhali .Before sowing seeds were treated with Provax-200 WP and seeds sown in line maintaining 30 cm row to row spacing. Weeding and thinning were done as and when necessary. No disease was seen at standing crop but leaf roller infestation was observed and controlled by spraying Sevin 20 EC @ 2g/L for 4 time keeping 10 days interval.

The crop was harvested on 6 April, 2022 at maturity stage and harvesting was done from 26 April to 7 May, 2022 (Satkhira and Noakhali). Yield and yield components of soybean were recorded and data were analyzed statistically and mean differences were calculated by Duncan's Multiple Range Test (Gomez and Gomez, 1984) at Satkhira location. Data on different plant, yield and yield contributing characters were recorded. The collected data were analyzed by the R project for statistical Computing software (Version 3.3.3)at Noakhali.

Results and Discussion

At Satkhira

Yield and yield attributes of four soyabean genotypes are presented in Table 1. Yield of soyabean genotypes ranged from 1.17 to 1.47 t/ha. Among three genotypes, BARI Soyabean-6 produced the highest yield and it was 1.48 t/ha. It might be due to higher branches per plant (1.87), pod/plant (56.67) and seed/pod (2.67). The second highest yield was obtained from BARI Soyabean-5 (1.24 t/ha) and it was statistically similar with the lowest yield of BARI Soyabean-7 (1.17 t/ha) because of lowest number of branches per plant (1.73) and pods per pod (23.87). The lowest level of soil salinity was (2.25 ds/m) recorded in the sowing time and the highest level of salinity was (6.65 ds/m) recorded in the harvesting time (Fig. 1).

Table 1. Yield and yield attributes of soybean genotypes influenced by soil salinity in on- station, ARS, Binerpota, Satkhira during 2021-2022

Genotypes	Plant Population/m^2 (no.)	Plant ht. (cm)	Branches/ plant (no.)	Pods/ plant (no.)	Seeds/ pod (no.)	HSW (g)	Seed yield (t/ha)
Sohag	24.33	50.67	1.80	40.33	2.50	11.00	1.20b
BARI Soyabean-5	24.67a	57.09a	1.87a	45.27b	2.53a	11.67a	1.24b
BARI Soyabean-6	25.33a	57.09a	1.87a	56.67a	2.67a	11.00a	1.48a
BARI Soyabean-7	25.67a	33.78b	1.73a	23.87c	2.60a	11.33a	1.17b
CV (%)	5.53	5.72	10.67	9.72	7.02	9.53	7.65

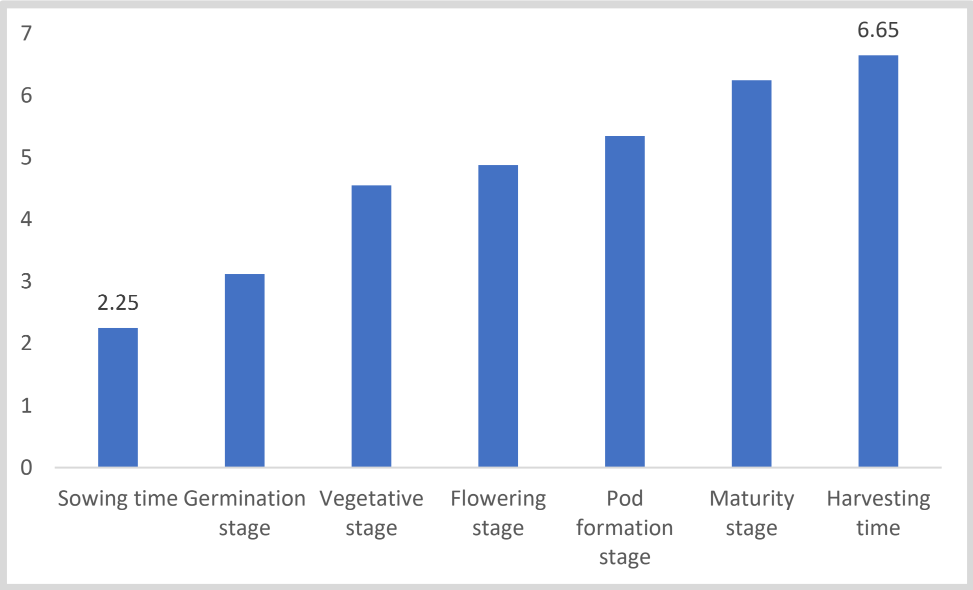

Fig. 1. Salinity levels (ds/m) of soil at different growth stages

At Noakhali

Days to 50 % flowering and maturity were recorded in all varieties (Table 1). Especially in farmer's field crop duration is an essential criterion for the selection of that crop which will be well adapted to cropping pattern. In that sense BARI Soybean-5, BARI Soybean- 6 & BARI Soybean- 7 required 100, 102 and 102 days to mature followed by Shohag (107 days). Local variety Shohag took 5-7 days more to mature compared to early maturing varieties BARI Soybean-5.

Response of soybean varieties on yield and yield contributing characters are presented in tabular format. In case of plant height, there are statistical difference was observed among the treatment. The highest plant height was found in BARI Soybean-6 (58.8 cm) which was statistically identical with BARI Soybean-5. In case of number of branch per plant, there was no significant variation among the varieties. Highest number of branch plant^{-1} was found in BARI Soybean-6 (3.0) followed by BARI Soybean-5 (2.3). The minimum number of branch plant^{-1} was observed in BARI Soybean-7 (2.1). The maximum number of pods plant^{-1} (60.5) was recorded in BARI Soybean-6 which was statistically similar with BARI Soybean-5(56.0). The minimum number of pods plant^{-1} was found in Shohag (42.8). The highest number of seeds pod^{-1} (2.5) was recorded in BARI Soybean-6 which was statistically different with BARI Soybean-5, BARI Soybean-7 and Shohag. Statistical difference was not observed among the treatment in 100 seeds weight. The maximum 100 seeds weight (10.95 g) was recorded in BARI Soybean-6 which was statistically similar with Shohag (10.85 g) and BARI Soybean-5 (10.35). The highest seed yield (2.10 t ha^{-1}) was obtained in BARI Soybean-6 which was statistically identical with BARI Soybean-5 (2.01 tha^{-1}) while the lowest yield (1.87 t ha^{-1}) was found in local variety (Shohag). In Table 2 the highest gross margin was recorded in BARI Soybean-6 (TK. 63820 ha^{-1}) followed by BARI Soybean-5 (TK. 53920 ha^{-1}) and the lowest gross margin from Shohag (TK. 47170 ha^{-1}).

Table 1. Yield and yield contributing characters of Soybean varieties at Char Wapda and West Al-Amin, in Noakhali district during Rabi season of 2021-2022

Varieties	Plants/m^2 (no.)	Days to 50% Flowering	Days to Maturity	Plant height (cm)	Branches plant^{-1} (no.)	Pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	100 seeds weight (g)	Seed yield (t ha^{-1})
BARI Soybean-5	17.5	58	100	56.4	2.3	56	2.3	10.85	2.01
BARI Soybean-6	17.2	57	102	58.8	3.0	60.5	2.5	10.95	2.10
BARI Soybean-7	17	59	102	49.8	2.1	55.9	2.4	10.20	1.89
Shohag	17.5	60	107	50	2.2	42.8	2.2	10.35	1.87
LSD (0.05)	NS	NS	NS	3.61	NS	3.28	0.21	0.79	0.48
CV (%)	4.52	3.91	7.83	8.41	2.49	7.02	7.95	5.41	12.49

Table 2. Cost and return analysis of soybean varieties at FSRD site, CharWapda and West Al-Amin, Subarnachar,Noakhali during Rabi season of 2021-2022

Treatments	Gross return (Tk.. ha^{-1})	Total variable cost (Tk.. ha^{-1})	Gross margin (TK.. ha^{-1})
BARI Soybean-5	88200	34280	53920
BARI Soybean-6	98100		63820
BARI Soybean-7	81450		47170
Shohag	81450		47170

Price of Soybean per kg = TK..45.0

Farmers' Opinion

BARI Soybean-6 is highly accepted by the farmers for its early maturity and higher yield. Sometimes farmers are disabled to collect seeds for the next season when heavy rainfall occurred during maturity stage of soybean at Noakhali location.

Conclusion

All the tested genotypes gave statistically similar yield but BARI Soyabean-6 produced the highest yield (1.48 t/ha) and the lowest yield was recorded in BARI Soyabean-7 (1.17 t/ha). but at Noakhali location, the highest seed yield was obtained from BARI Soybean-6 (2.10 t ha^{-1}) and the lowest yield (1.87 t ha^{-1}) was obtained from local variety (Shohag). But other genotypes are also promising for saline area in terms of yield. It was 2nd year experiment so it needs to successive three years trial for final conclusion.

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EFFECT OF DIFFERENT TILLAGE CONDITIONS ON THE GROWTH AND YIELD OF SOYBEAN VARIETIES IN SOUTHERN REGION OF BANGLADESH

M.A. RAHMAN, F. BEGUM AND M.M. RAHMAN

Abstract

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during the Rabi season of 2021-22 under the project entitled, "Enhence Production of Oilseed Crops (EPOC)" ORC, BARI to evaluate the performances of soybean varieties under different tillage conditions in southern region of Bangladesh. The treatments of this experiment were of two factors viz., Factor A. Three tillage conditions (T_1 = Conventional tillage, T_2 = Minimum tillage and T_3 = Zero tillage i.e. relay cropping with T.aman rice); Factor B. Three soybean varieties (V_1 = Bangladesh Soybean-4, V_2 = BARI Soybean-5 and V_3 = BARI Soybean-6). The experiment was laid out in randomized complete block design with three replications. The tillage condition created significant differences in plant population/m^{2,} root length/plant, root surface area/plant, days to 50% flowering, days to maturity, plant height, number of branches/plant, number of pod/plant and seed and straw yields. Treatment T_1 gave the highest yield of seed (2075 kg/ha) and the lowest yield (1194 kg/ha) was obtained from T_3 treatment. Seed yield achieved from T_2 treatment was 1548 kg/ha. The soybean varieties had significant effects on plant population/m^2, days to maturity, number of pod/plant and seed yield. Among the tested varieties, V_3 gave the highest yield of seed (1763 kg/ha), which was partially similar to V_1 (1619 kg/ha) and the lowest yield was obtained from V_2 (1434 kg/ha). The interaction effects of tillage condition and variety were found to be significant in terms of plant population/m^{2,} root length/plant, days to 50% flowering, days to maturity, plant height, number of pods/plant and seed yield. The interaction of T_1V_3 gave the highest yield of seed (2233 kg/ha) that was partially identical to that of T_1V_1 (2122 kg/ha) and T_1V_2 (1869 kg/ha). Besides, seed yields recorded in T_2V_3, T_2V_1, T_2V_2, T_3V_1, and T_3V_3 were 1794, 1536, 1314, 1200 and 1261 kg/ha, respectively. Among the interactions, the highest gross return of Tk. 180175/ha was obtained from T_1V_3. Somewhat similar gross return was also obtained from the interactions of T_1V_1 (Tk. 171171) and T_1V_2 (Tk. 150969/ha). The highest gross margin (Tk. 109103/ha) was obtained from the interaction of T_1V_3 that was to some extent similar to that of T_1V_1 (Tk. 101261/ha) and T_1V_2 (Tk. 80478/ha). The interaction of T_1V_3 showed the highest value (2.54) of benefit cost ratio (BCR). Higher BCR values were also found in T_1V_1 (2.45), T_1V_2 (2.14), T_2V_3 (1.88) and T_2V_1 (1.87). Therefore, BARI Soybean-6 and Bangladesh Soybean-4 could be cultivated under conventional tillage condition for getting higher yields and economic returns under rice based cropping systems in southern region of Bangladesh. However, the experiment should be repeated in the next year(s) for final recommendation.

Introduction

The agro-ecosystem of the southern region of Bangladesh is comprised of both saline and non-saline tidal wetlands. Rahman (2015) reported that about 29.45% and 55.10% lands remain fallow in *Rabi* and *Kharif*-1 seasons, respectively after harvesting of previous T.*aman* rice mainly due to delaying harvest of T.*aman* rice, salinity, drought, tidal flooding, lacking of suitable adaptation technologies and so on. Cropping intensity may be increased in very slight and slightly saline areas by adopting proper soil and water management practices with the introduction of different salt tolerant crop or varieties. Soybean (*Glycine max* L) is also one of the most important oilseed crops and the area under this crop is increasing in the coastal region. The total area under soybean cultivation is about 62.00 thousand hectares and annual production is about 1.11 lac metric ton. The soybean cultivation is mainly concentrated in the coastal districts of the country like Laksmipur, Noakhali, Bhola, Barishal and Chandpur (BBS, 2020). The major cropping pattern in southern coastal region is T.*aman*–Fallow/*Rabi* crops-Fallow. Cultivation of long duration local T.*aman* rice varieties (e.g. *Sadamota*, *Lalmota* etc.) need more time (even upto the mid week of January) to become maturity. Nevertheless, after recession of tidal water, conventional tillage only possible when it attains at the field capacity (*joh* condition) but it is needed more time for proper land preparation before sowing of subsequent *Rabi* crops. Delay planting of *Rabi* crops produces cause poor yields and economic return due to increasing temperature, soil salinity and drought stress conditions. The crop experiences high temperature with the advancement of growth stages which reduces the duration for grain-filling and dry matter accumulation resulting in small grain size (Thompson, 1986). On the other hand, the natural calamities (like cyclone, heavy rainfall, hail storm etc.) affect the delay planting *Rabi* crops that deteriorates the crop yield severely. Zero tillage sowing is very ideal for transplanting of sunflower seedling especially for the low-lying areas for saving the tillage cost and timely establishment of the crop. Under zero tillage condition sunflower seedling can be transplanted in moist soil in optimum time just after receding of excess water. By reducing the turnaround time to a minimum, zero-tillage can get crop planted on time and thus increase yield without greater input cost (Hobbs and Gupta, 2003). Zero or minimum tillage may ensure the timely establishment of soybean crop plant, which may increase the yield and farmers' income. Early establishment would protect the crop from the impacts of severe soil salinity, drought and natural calamities at its terminal growth stage. Zero or minimum tillage will also reduce the turn-around period (from harvest of previous T.*aman* rice to make conventional tillage). Bangladesh Agricultural Research Institute (BARI) has developed a good number of soybean varieties like BARI Soybean-5 and BARI Soybean-6 can be introduced in the existing cropping systems in southern region. However, the performances of varieties are yet to be examined under different tillage conditions in terms of phenology, growth and yield. Therefore, the experiment was designed to evaluate the performances of soybean varieties under different tillage conditions under rice based cropping systems in southern region of Bangladesh.

Materials and Methods

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during the *Rabi* season of 2021-22 with the funding of the project entitled, "Expanded Production of Oilseed Crops (EPOC)" Oilseed Research Centre, BARI, Gazipur with different planting ratios to evaluate the performances of soybean varieties under different tillage conditions for the southern region of Bangladesh. The experimental site is situated in the latitudes and longitudes of 22º47/3.00844//N and 90º17/32.53736///E. The site belongs to the agro-ecological zone Ganges Tidal Floodplain (AEZ-13). The soil type is medium high land and soil texture is loamy. The treatments of this experiment were of two factors viz., Factor A. Three tillage conditions (T_1 = Conventional tillage, T_2 = Minimum tillage and T_3 = Zero tillage i.e. relay cropping with T.*aman* rice); Factor B. Three soybean varieties (V_1 = Bangladesh Soybean-4, V_2 = BARI Soybean-5 and V_3 = BARI Soybean-6). The experiment was laid out in randomized complete block design with three replications. The unit plot size was 4 m × 3 m. After harvesting of previous T.*aman* rice (var. BRRI dhan52), soybean seeds were sown considering the soil environment condition or field capacity of the experimental plots. In case of zero tillage (T_3), seeds were sown through broadcasting at the rate of 30 kg/ha on 22 December 2021 as relay cropping with existing T.*aman* rice before 10 days earlier of rice harvest). However, soybean seeds were sown on 2 and 10 January 2022 for minimum tillage (T_2) and conventional tillage (T_1), respectively. In case of minimum or conventional tillage, seeds were sown in rows following row to row distance 30 cm and plant to plant 5 cm. The experimental plots were fertilized with 60-175-120-115-10 kg/ha urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and boric acid, respectively along with 5 t/ha cowdung (FRG, 2018). All type of chemical fertilizers and cowdung were applied as a basal. Seeds were treated with Provex 200 @ 3g/kg seed to control seed borne disease before sowing. Irrigation was applied for one time and other intercultural operations (weeding, mulching etc.) were done as when necessary following the recommended production technologies of the crops (BARI, 2020). The soybean crop was harvested on 21-24 April 2022 after attaining to their physiological maturity. Data were collected on different parameters such as plant population/m^{2,} root length/plant, root surface area/plant, days to 50% flowering, days to maturity, plant height, number of branch/plant, number of pod/plant, number of seed/pod, 1000-seed weight, seed and straw yields/plot. The plant root length and root surface area were measured by using computer based Root Scanner (Model: CI-600, Brand: CID-Bio science, USA). The plot yields were then converted into ton/hectare. Data were analyzed statistically using windows based computer software of Statistix 10 version and then the mean differences were adjudged with Duncan's Multiple Range Test (DMRT) following the protocol as suggested by Gomez and Gomez (1984).

Results and Discussion

Effect of tillage condition on plant characters of soybean

The tillage condition created significant differences for the plant characters of soybean in terms of plant population/m^{2,} root length/plant, root surface area/plant, days to 50% flowering, days to maturity, plant height, number of pod/plant, seed yield and straw yield (Table 1). Treatment T_1 (conventional tillage) gave the highest population (58.25) due to creating favourable growing condition of the crop. Treatment T_2 (minimum tillage) and T_3 (zero tillage) showed the population of 44.54 and 34.21, respectively. The highest length of root/plant (177.41 cm) was obtained from T_1, which was statistically at par to T_2 treatment (170.80 cm) and the lowest length (143.37 cm) was observed in T_3. Likewise, treatment T_1 gave the highest root surface area/plant (34.36 cm^2) at it was partially identical to T_2 (31.98 cm^2) and the lowest surface area (29.39 cm2) was exhibited in T_3 treatment. Treatment T_1 and T_2 needed statistically similar number of days to become flowering (67.56 and 67.00 days, respectively). Number of days to maturity was the highest (122.22 days) in T_1 and the lowest (119.11 days) was found in T_3 but T_2 took 121.00 days for being maturity. The longest plant (66.62 cm) was found in T_1 treatment and the shortest plant (51.29 cm) was obtained from T_2 treatment. The number of pod/plant became the highest (75.00) in T_1 treatment. On the other hand, T_2 and T_3 treatments produced the pod of 65.53 and 57.26, respectively. Treatment T_1 gave the highest yield of seed (2075 kg/ha) and the lowest yield (1194 kg/ha) was obtained from T_3 treatment. Seed yield achieved from T_2 treatment was 1456 kg/ha. The highest yield of straw (2877 kg/ha) was recorded in T_1 treatment, while T_2 gave the yield of 2260 kg/ha and the lowest yield of straw (1696 kg/ha) was found in T_3 treatment.

Table 1. Effect of tillage condition on yield and yield contributing characters of soybean at RARS, Rahmatpur, Barishal during 2021-22

Treatment	Plant pop/m^2 (no.)	Root length/ plant (cm)	Root surface area/plant (cm^2)	Days to 50% flowering	Days to maturity	Plant height (cm)	Pod/ plant (no.)	Seed/pod (no.)	1000-seed wt (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
T_1	58.25a	177.41a	34.36a	67.56a	122.22a	66.62a	75.00a	2.76	85.09	2075a	2877a
T_2	44.54b	170.80a	31.98ab	67.00a	121.00b	51.29b	65.53b	2.71	84.95	1456b	2260b
T_3	34.21c	143.37b	29.39b	65.56b	119.11c	52.36b	57.26c	2.76	84.78	1194c	1696c
CV (%)	5.65	12.36	14.43	1.13	0.44	11.33	8.92	5.55	3.39	10.68	10.99
F-test	*	**	*	**	**	**	**	NS	NS	**	**

Note: Tillage condition: T_1 = Conventional tillage, T_2 = Minimum tillage and T_3 = Zero tillage
* and ** Significant at 5% and 1% level of probability, respectively; NS = Not significant

Effect of variety on yield and yield contributing of soybean

The soybean varieties had significant effects on plant population/m^2, days to maturity, number of pod/plant, seed yield and straw yield (Table 2). The highest number of plant population (47.23) were found in V_1 (Bangladesh Soybean-4), which was partially at par to (45.69) that of V_3 (BARI Soybean-6) and the lowest population (44.08) were observed in V_2 (BARI Soybean-5). The highest number of days (121.33) to maturity was recorded in V_2 but V_1 and V_2 needed 120.56 and 120.44 days, respectively. Number of pod/plant was the highest (70.52) in V_3 that was statistically identical to that of V_1 (66.71) and the lowest number was found in V_2 (60.56). Among the tested varieties, V_3 gave the highest yield of seed (1670 kg/ha), which was similar to V_1 (1619 kg/ha) and the lowest yield was obtained from V_2 (1434 kg/ha). On the other hand, V_1 produced the highest yield of straw (2416 kg/ha) that was somewhat identical to that of V_3 (2292 kg/ha) and the lowest yield (2125 kg/ha) was obtained from the variety V_2.

Table 2. Effect of variety on yield and yield contributing characters of soybean at RARS, Rahmatpur, Barishal 2021-22

Treatment	Plant pop/m^2 (no.)	Root length/ plant (cm)	Root surface area/plant (cm^2)	Days to 50% flowering	Days to maturity	Plant height (cm)	Pod/plant (no.)	Seed/pod (no.)	1000-seed wt (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
V_1	47.23a	158.45	32.00	66.56	120.56b	56.69	66.71a	2.71	84.21	1619a	2416a
V_2	44.08b	171.06	33.09	66.56	120.44b	58.18	60.56b	2.76	86.13	1434b	2125b
V_3	45.69ab	162.08	30.63	67.00	121.33a	55.40	70.52a	2.76	84.49	1670a	2292ab
F-test	*	NS	NS	NS	**	NS	**	NS	NS	*	*

Note: Variety: V_1 = Bangladesh Soybean-4, V_2 = BARI Soybean-5 and V_3 = BARI Soybean-6
* and ** Significant at 5% and 1% level of probability, respectively; NS = Not significant

Interaction effects of tillage condition and variety on yield and yield contributing **characters of soybean**

Plant population/m^{2,} root length/plant, days to 50% flowering, days to maturity, plant height, number of pod/plant, seed and straw yields influenced significantly due to interaction effect of tillage condition and variety (Table 3). Treatment T_1 in combination with V_3 gave the highest population of plant/m^2 (73.15) and the lowest population (30.97) were found in the interaction of T_3V_3. The highest length of root/plant (189.96 cm) was measured in T_2V_2, which was statistically similar to T_1V_3 (184.29 cm) and T_1V_1 (179.80 cm) interactions and the lowest length was observed in T_3V_1 (131.70 cm). The V_3 under conventional tillage condition needed the highest number of days (68.00) to flowering that was statistically identical to T_1V_2 but partially similar to the interactions of T_2V_3, T_2V_1, T_2V_2 and T_1V_1. The lowest number of days (65.00) were required for T_3V_2. Likewise, the treatment interaction T_1V_3 needed the highest number of days become maturity. The interaction T_3V_2 exhibited the lowest number of days (118.67). The longest plant (69.80 cm) was achieved from T_1V_2 that was somewhat similar to that of T_1V_3 (66.47 cm) and T_1V_1 (63.60 cm) interactions. The shortest plant (48.73 cm) was obtained from T_3V_3. The interaction of T_1V_3 produced the highest number of pod/plant (79.87), which was partially at par to that of T_1V_1 (74.20) and T_1V_2 (70.93). The lowest number of pod/plant (49.40) was found in T_3V_2 interaction. The interaction of T_1V_3 gave the highest yield of seed (2233 kg/ha) that was partially identical to that of T_1V_1 (2122 kg/ha) and T_1V_2 (1869 kg/ha). The lowest yield was achieved from T_3V_2 (1119 kg/ha). Besides, seed yields recorded in T_2V_1, T_2V_3, T_2V_2, T_3V_3, and T_3V_1 were 1536, 1517, 1314, 1261 and 1200 kg/ha, respectively. Straw yield became the highest (3018 kg/ha) in T1V3, which was partially at par to that of T_1V_2 (2828 kg/ha) and T_1V_1 (2787 kg/ha) and the lowest yield was recorded in T_3V_2 (1522 kg/ha).

Table 3. Interaction effect of tillage condition and variety on plant characters of soybean at RARS, Rahmatpur, Barishal during 2021-22

Treatment	Plant pop/m^2 (no.)	Root length/ plant (cm)	Root surface area/plant (cm^2)	Days to 50% flowering	Days to maturity	Plant height (cm)	Pod/plant (no.)	Seed/ pod (no.)	1000-seed wt (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
T_1V_1	59.32a	179.80a	34.29	67.00ab	122.00b	63.60a-c	74.20ab	2.73	83.85	2122ab	2787ab
T_1V_2	55.62a	168.15ab	35.76	67.67a	121.67bc	69.80a	70.93a-c	2.73	87.50	1869b	2828ab
T_1V_3	59.82a	184.29a	33.03	68.00a	123.00a	66.47ab	79.87a	2.80	83.93	2233a	3018a
T_2V_1	43.83b	163.85a-c	31.41	67.00ab	120.67d	50.67d	66.73b-d	2.60	83.83	1536c	2520bc
T_2V_2	43.48b	189.96a	34.99	67.00ab	121.00cd	52.20d	61.33cd	2.87	86.17	1314cd	2027de
T_2V_3	46.30b	158.61a-c	29.54	67.00ab	121.33b-d	51.00d	68.53b-d	2.67	84.84	1517c	2234cd
T_3V_1	38.53c	131.70c	30.30	65.67c	119.00ef	55.80b-d	59.20de	2.80	84.95	1200d	1942d-f
T_3V_2	33.13c	155.08a-c	28.53	65.00c	118.67f	52.53cd	49.40e	2.67	84.71	1119d	1522f
T_3V_3	30.97c	143.33bc	29.32	66.00bc	119.67e	48.73d	63.17cd	2.80	84.69	1261cd	1625ef
F-test	*	*	NS	**	*	*	*	NS	NS	*	*

Note: Tillage condition: T_1 = Conventional tillage, T_2 = Minimum tillage and T_3 = Zero tillage
Variety: V_1 = Bangladesh Soybean-4, V_2 = BARI Soybean-5 and V_3 = BARI Soybean-6
* and ** Significant at 5% and 1% level of probability, respectively; NS = Not significant

Cost-return analysis of soybean cultivation under different tillage conditions

Among the treatment interactions, the highest gross return of Tk. 180175/ha was obtained from T_1V_3 (Table 4). Somewhat similar gross return was also obtained from the interactions of T_1V_1 (Tk. 171171) and T_1V_2 (Tk. 150969/ha). The lowest gross return was computed in T_3V_2 (Tk. 90316/ha). The highest gross margin (Tk. 109103/ha) was obtained from the interaction of T_1V_3 that was to some extent similar to that of T_1V_1 (Tk. 101261/ha) and T_1V_2 (Tk. 80478/ha), but the lowest return (Tk. 26663/ha) was observed in T_3V_2. Gross margins obtained from interactions of T_2V_1 and T_2V_3 were Tk. 57829 and 57293/ha, respectively. The interaction of T_1V_3 showed the highest value (2.54) of benefit cost ratio (BCR). Higher BCR values were also found in T_1V_1 (2.45), T_1V_2 (2.14), T_2V_3 (1.88) and T_2V_1 (1.87). The lowest BCR was observed in the interaction of T_3V_2 (1.42).

Table 4. Cost-return analysis of soybean cultivation under different tillage conditions at RARS, Rahmatpur, Barishal during2021-22

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Gross return (Tk/ha)	Total variable cost (Tk/ha)	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1V_1	2122	2787	171171	69910	101261	2.45
T_1V_2	1869	2828	150969	70491	80478	2.14
T_1V_3	2233	3018	180175	71072	109103	2.54
T_2V_1	1536	2520	124149	66320	57829	1.87
T_2V_2	1314	2027	106125	64577	41548	1.64
T_2V_3	1517	2234	122450	65158	57293	1.88
T_3V_1	1200	1942	96971	63072	33899	1.54
T_3V_2	1119	1522	90316	63653	26663	1.42
T_3V_3	1261	1625	101701	61910	39791	1.64

Note: Tillage condition: T_1 = Conventional tillage, T_2 = Minimum tillage and T_3 = Zero tillage
Variety: V_1 = Bangladesh Soybean-4, V_2 = BARI Soybean-5 and V_3 = BARI Soybean-6
Price: Soybean seed: Tk. 80/kg, bi-product: Tk. 0.50/kg

Conclusion

BARI Soybean-6 and Bangladesh Soybean-4 could be cultivated under conventional tillage condition for getting higher yield and economic returns under rice based cropping systems in southern region of Bangladesh. However, the experiment should be repeated in next year(s) for final conclusion.

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INTERCROPPING BUNCHING ONION WITH GROUNDNUT

P.ROY, F. BEGUM AND M M KARIM

Abstract

A field experiment of intercropping bunching onion with groundnut was conducted in Oilseed Research Centre, BARI, Gazipur during rabi season of 2021-22 to find out the optimum row arrangement of bunching onion as intercrop with groundnut for higher productivity and return. Six treatments were T_1 = Sole groundnut, T_2 = One row of bunching onion (15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of bunching onion in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of bunching onion, T_5=Bunching onion broadcast in between two normal rows of groundnut (40cmX15cm) & T_6= Sole bunching onion. Although intercropping reduced groundnut yield but total productivity was increased due to addition of bunching onion yield. Total productivity in terms of groundnut equivalent yield (GEY) (7.68 t/ha) was found the highest from T_2 (One row of bunching onion (15cmX10cm) in between two normal rows of groundnut (40cmX15cm)) treatment while the lowest (5.24 t/ha) in T_4 (Two groundnut rows alternate with two rows of bunching onion). Highest benefit cost ratio (BCR) (3.18) was also recorded in T_2 treatment (one row of bunching onion in between two normal rows of groundnut. Results revealed that one row of bunching onion in between two normal rows of groundnut would be agronomically feasible and economically profitable for the farmers in intercropping system.

Introduction

Intercropping is claimed to be one of the most significant cropping techniques in sustainable agriculture (Mahfuza *et al.*, 2012). Higher productivity from intercropping depends on judicious selection of component crops, suitable planting system or proportion of component crops (Islam *et al.*, 2006). Usually plants differing in growth duration, height, rooting systems and nutrient requirements are considered to grow together in intercropping systems (Reddy and Willey, 1981).Groundnut (*Arachishypogaea* L.) is the second important oilseed crop that covered a considerable area in Bangladesh and it is a long durated crop. On the other hand, onion is a very important and valuable spices crop which is usually grown as sole and in some cases as intercrop in farmers field at various parts of Bangladesh. BARI released leafy onion variety has high potentiality to incorporate as a intercrop with groundnut due to its growth behaviour. Although its duration is 150 days but we can harvest earlier in around 100 days. In this life time we can harvest around 4 to 5 times from bunching onion as vegetables. However, yield of BARI bunching onion-1 is 14-15t/ha as leafy vegetable. As the spacing for groundnut cultivation is 40 cm X 15 cm, so there is a scope to intercrop leafy onion as a spice crop with groundnut. This may be economically profitable for the farmers. Hence this experiment will be undertaken to find out the optimum row arrangement of bunching onion for intercropping with groundnut for higher productivity and return.

Materials and Methods

The field experiment was conducted at the research field of Oilseed Research Centre, Bangladesh Agricultural Research Institute, Gazipur during rabi season of 2021 -2022. There were six treatments viz. T_1 = Sole groundnut, T_2 = One row of bunching onion (15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of bunching onion in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of bunching onion & T_5=Bunching onion broadcast in between two normal rows of groundnut (40cmX15cm).The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 4m x 5m. Groundnut seeds (BARI Chinabadam-8) were sown on 23 November, 2021 and bunching onion (BARI Bunching onion-1) were transplanted (40 days seedling) in the main field at same date. Fertilizers at the rate of $N_{12}P_{31}K_{43}S_{55}B_{1.5}$ kg/ha in the form of urea, TSP, MOP, gypsum and boric acid, respectively were applied for both sole groundnut & intercrop. Full amount of triple super phosphate, muriate of potash (MOP), gypsum, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied 40 days after seedling emergence. On the other hand, for sole bunching onion, fertilizers at the rate of TSP $_{275}$MoP$_{150}$Urea$_{250}$Gypsum$_{110}$Zn$_{10}$ kg/ha were applied. Full amount of triple super phosphate, muriate of potash and gypsum and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied at 30 days after sowing (DAS). In sole bunching onion plt all the fertilizers applied during final land preparation except urea and MoP. Half of them applied during final land preparation and rest were applied into 3 split later at the 25 days, 55 days and 75 days of plant. At harvest, the yield data was recorded plot wise. Collected data were analyzed statistically and means were adjusted by LSD test at 5% level of significance using SPSS. Yield of individual crop was converted to groundnut equivalent yield (GEY) considering prevailing market price of the crops according to Bandyopadhyay (1984). Marginal benefit cost analysis was also done.

Groundnut equivalent yield (GEY) (kg/ha) = Yig + (Yir*Pr) / Pg

Where,
Yig = Groundnut yield (kg/ha) in intercropping
Yir = Bunching onion yield (kg/ha) in intercropping
Pr = Price of bunching onion
Pg = Price of groundnut

Results and Discussion

Effect of groundnut

Nut yield and yield attributes of groundnut was significantly influenced by intercropping system where as total number of branches per plant, seeds per plant and shelling % did not show any significant difference (Table 1). Plant height, total no. of nuts per plant, mature nuts per plant, immature nuts per plant, 100 seeds weight and yield of groundnut were significantly differed under different treatment combinations. Plant height showed higher in treatment T_3 and others are similar. Maximum no. of nut per plant (35) and highest nut yield (2.35 t/ha) were obtained from sole crop (T_1). Lowest yield (1.25 t/ha) was obtained from T_5 treatment which might be due to lowest number of mature nut per plant (18) and lower 100 seed weight (43 g).

Table 1. Yield and yield components of groundnut under groundnut + bunching onion intercropping system during rabi season 2021-22

Treat	Days to first flow. (day)	Days to maturity (day)	Plant height (cm)	Branches / Plant (no.)	Nuts / Plant (no.)	Mature nuts/ plant (no.)	Immature nuts/ plant (no.)	Seeds/ nut (no.)	100 seeds Wt. (g)	Nut yield (t/ha)	Shelling (%)	(%) Yield reduction over sole crop
T_1	52	180	30.86	9	35	25	10	2	48.00	2.35	72	-
T_2	50	180	37.10	8	33	28	5	2	49.25	1.81	73	28
T_3	50	180	27.90	10	29	23	6	2	46.12	1.65	71	36
T_4	52	180	33.12	7	25	22	3	2	45.00	1.39	70	40
T_5	51	180	31.54	9	29	18	10	2	43.02	1.25	72	44
LSD (0.05)	NS	NS	4.7	NS	5.5	2.2	1.8	NS	1.7	1.7	NS	-
CV%	-	-	1.9	1.7	8.4	8.2	8.1	-	1.6	5.7	3	-

T_1 = Sole groundnut, T_2 = One row of bunching onion (15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of bunching onion in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of bunching onion & T_5=Bunching onion broadcast in between two normal rows of groundnut (40cmX15cm).

Companion crop yield

In intercropping system, the highest seed yield of bunching onion was recorded when it was intercropped as one row of bunching onion in between two normal rows of groundnut (T_2). The lowest yield of bunching onion was observed in T_4 (Two groundnut rows alternate with two rows of bunching onion) (Table 2). Although six rows of component crops may get higher number of plant population than single row cultivation but lowest yield was observed here which might be due to higher competition of crop**.**

Intercrop efficiency

Table 2 shows the cost return analysis of bunching onion and groundnut intercropping system. It was observed that one or two row bunching onion in between two rows of groundnut combinations produced higher groundnut equivalent yield (GEY) over the sole groundnut system. The highest GEY (3.21 t/ha) was obtained from T_2 (one row of bunching onion in between two normal rows of groundnut) treatment while the lowest (1.60 t/ha) in sole bunching onion. Maximum gross return (Tk. 321000/ha) and highest gross margin (Tk. 220350/ha) were recorded in T_2 (one row of bunching onion in between two normal rows of groundnut) while lowest in T_6 (sole bunching onion) treatment due to lower GEY (1.60 t/ha). However, the highest benefit cost ratio (BCR) (3.18) was obtained from T_2 (one row of bunching onion in between two normal rows of groundnut) treatment which might be due to higher GEY and gross return. All the intercrop treatments showed much higher benefit over sole groundnut but highest in one row of bunching onion in between two normal rows of groundnut.

Table 2. Groundnut equivalent yield and benefit cost analysis of groundnut bunching onion intercropping system during rabi season 2021-22

Treatment	Bunching onion yield (t/ha)	Groundnut Equivalent Yield (t/ha)	Gross Return (Tk/ha)	Total cost of production (Tk/ha)	Gross Margin (Tk/ha)	BCR (TK/TK)
T_1	-	2.35	235000	102215	132785	2.29
T_2	7.02	3.21	321000	100650	220350	3.18
T_3	6.33	2.91	291000	100000	191000	2.91
T_4	6.98	2.78	278000	103500	174500	2.68
T_5	6.25	2.50	250000	101100	148900	2.47
T_6	8.00	1.60	160000	102000	58000	1.56

T_1 = Sole groundnut, T_2 = One row of bunching onion(15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of bunching onion in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of bunching onion, T_5=Bunching onion broadcast in between two normal rows of groundnut (40cmX15cm) & T_6= sole bunching onion.
Selling price: Groundnut seed = Tk.100 /kg, Bunching onion as leafy vegetable = Tk.20/kg

Conclusion

Results revealed that one row of bunching onion (15 cmx10 cm) in between two normal rows of groundnut (40cmx15cm) would be agronomically feasible and economically profitable for the farmers in intercropping system.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

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INTERCROPPING FIRINGI WITH GROUNDNUT

P.ROY, F. BEGUM AND M.M.KARIM

Abstract

A field experiment of intercropping firingi with groundnut was conducted in Oilseed Research Centre, BARI, Gazipur during rabi season of 2021-22 to find out the optimum row arrangement of firingi as intercrop with groundnut for higher productivity and return. Five treatments were T_1 = Sole groundnut, T_2 = One row of firingi (15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of firingi in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of firingi & T_5=Firingi broadcast in between two normal rows of groundnut (40cmX15cm). Although intercropping reduced groundnut yield but total productivity was increased due to addition of firingi yield. Total productivity in terms of groundnut equivalent yield (GEY) (7.97 t/ha) was found the highest from T_2 (One row of firingi (15cmX10cm) in between two normal rows of groundnut (40cmX15cm)) treatment while the lowest (2.30 t/ha) in T_1 (sole groundnut). Highest benefit cost ratio (BCR) (8.4) was also recorded in T_2 treatment (one row of firingi in between two normal rows of groundnut).

Introduction

Intercropping is claimed to be one of the most significant cropping techniques in sustainable agriculture (Mahfuza *et al.*, 2012). Higher productivity from intercropping depends on judicious selection of component crops, suitable planting system or proportion of component crops (Islam *et al.*, 2006). Usually plants differing in growth duration, height, rooting systems and nutrient requirements are considered to grow together in intercropping systems (Reddy and Willey, 1981).Groundnut (*Arachishypogaea* L.) is the second important oilseed crop that covered a considerable area in Bangladesh and it is a long durated crop. Firingi is one of the oldest medicinal plants with exceptional medicinal and nutritional profile. Firingi seeds contain a substantial amount of fiber, phospholipids, glycolipids, oleic acid, linolenic acid, linoleic acid, choline, vitamins A, B_1, B_2, C, nicotinic acid, niacin, and many other functional elements. It may grow well under diverse and a wide range of conditions; it is moderately tolerant to drought and salinity, and can even be grown on marginal lands in profitable way. Owing to these characteristics and heavy metal remediation potential, firingi may well fit several cropping systems. In addition to its medicinal uses, it may serve as an excellent off-season fodder and animal food supplement. As the spacing for groundnut cultivation is 40 cm X 15 cm, so there is a scope to intercrop firingi with groundnut also. This might be economically beneficial for the farmers. Hence this experiment has been undertaken to find out the optimum row arrangement of firingi for intercropping with groundnut for higher productivity and return.

Materials and Methods

The field experiment was conducted at the research field of Oilseed Research Centre, Bangladesh Agricultural Research Institute, Gazipur during rabi season of 2021 -2022. There were five treatments viz. T_1 = Sole groundnut, T_2 = One row of firingi (15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of firingi in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of firingi & T_5=Firingi broadcast in between two normal rows of groundnut (40cmX15cm).The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 4m x 5m. Both the seeds of groundnut (BARI Chinabadam-8) and firingi (BARI Firingi-1) were sown on 23 November, 2021. Fertilizers at the rate of $N_{12}P_{31}K_{43}S_{55}B_{1.5}$ kg/ha in the form of urea, TSP, MOP, gypsum and boric acid, respectively were applied for both sole groundnut & intercrop. Full amount of triple super phosphate, muriate of potash (MOP), gypsum, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied 40 days after seedling emergence. On the other hand, for sole firingi, fertilizers at the rate of $N_{80}P_{34}K_{68}S_{20}$ kg/ha in the form of urea, TSP, MOP, gypsum, respectively were applied. Full amount of triple super phosphate, muriate of potash and gypsum and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied at 30 days after sowing (DAS). At harvest, the yield data was recorded plot wise. Collected data were analyzed statistically and means were adjusted by LSD test at 5% level of significance using SPSS. Yield of individual crop was converted to groundnut equivalent yield (GEY) considering prevailing market price of the crops according to Bandyopadhyay (1984). Marginal benefit cost analysis was also done.

Groundnut equivalent yield (GEY) (kg/ha) = Yig + (Yir*Pr) / Pg
Where,
Yig = Groundnut yield (kg/ha) in intercropping
Yir = Firingi yield (kg/ha) in intercropping
Pr = Price of firingi
Pg = Price of groundnut

Results and Discussion

Light availability

Availability of light on groundnut and firingi in intercropping was not markedly affected with each other. Because firingi was harvested at 90 DAS. At that time firingi canopy could not produce much shade which might affect groundnut. Irrespective of treatments availability of light on groundnut canopy was almost 100% at earlier growth stage, 30 DAS of groundnut and it decreased with the increase of shade produced by firingi canopy over the time up to 60 DAS or up to harvest of groundnut. However, among the intercropping treatments, the higher light availability on groundnut was observed inT_1treatment followed by T_2 throughout the growing period. The lower light availability on groundnut was observed in T_5 treatment.

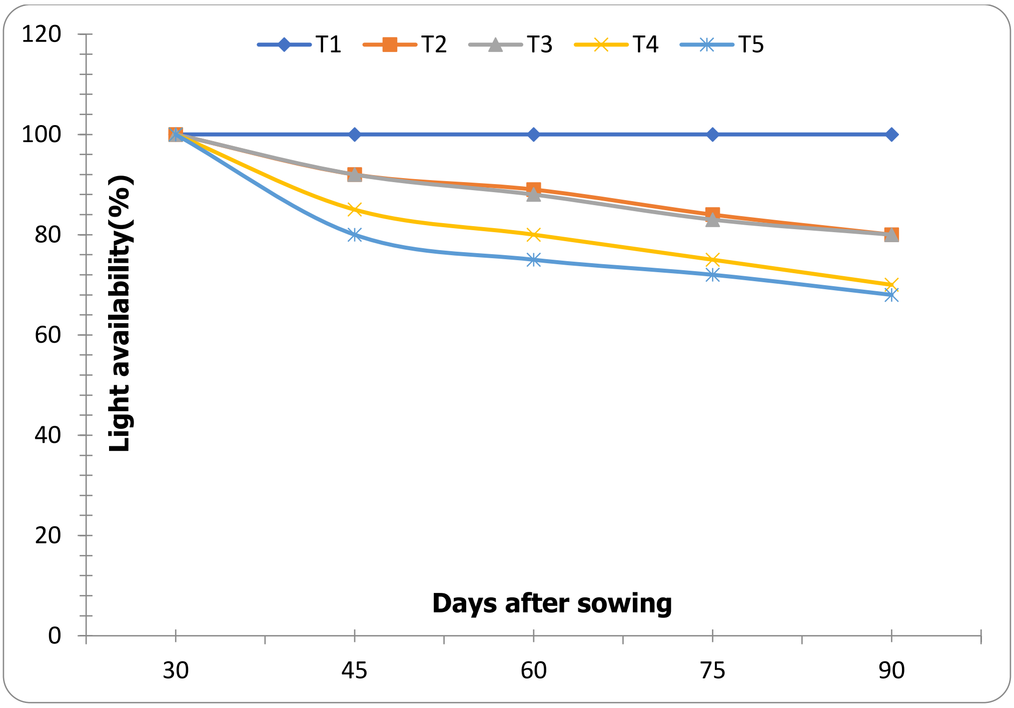

Fig **1.** Light availability on groundnut and firingi in intercropping during rabi season, 2021-22

Effect of groundnut

Nut yield and yield attributes of groundnut was significantly influenced by intercropping system where as total number of branches per plant, seeds per plant and shelling % did not show any significant difference (Table 1). Plant height, total no. of nuts per plant, mature nuts per plant, immature nuts per plant, 100 seeds weight and yield of groundnut were significantly differed under different treatment combinations. Plant height showed higher in treatment T_3 and others are similar. Maximum no. of nut per plant (34), mature nut per plant (28) and highest nut yield (2.30t/ha) were obtained from sole crop (T_1). Lowest yield (1.40 t/ha) was obtained from T_5 treatment which might be due to lowest number of mature nut per plant (18) and lower 100 seed weight (42 g).

Table 1. Yield and yield components of groundnut under groundnut + firingi intercropping system during rabi season2021-22

Treat	First flow. (day)	Maturity (day)	Plant height (cm)	Branches / Plant (no.)	Nuts / Plant (no.)	Mature nuts/ plant (no.)	Immature nuts/ plant (no.)	Seeds/ nut (no.)	100 seeds Wt. (g)	Nut yield (t/ha)	Shelling (%)	(%) Yield reduction over sole crop
T_1	52	185	29.86	9	34	28	9	2	48	2.30	72	-
T_2	50	185	28.93	8	31	25	6	2	46	1.65	70	28
T_3	50	185	35.20	7	28	23	5	2	51	1.50	71	36
T_4	52	185	31.86	6	24	22	2	2	43	1.48	70	40
T_5	51	185	30.33	8	28	18	10	2	42	1.40	72	44
LSD (0.05)	NS	NS	4.9	NS	5.5	2.2	1.8	NS	1.7	1.7	NS	-
CV%	-	-	1.8	1.7	8.4	9.2	8.1	4.2	1.6	5.7	3	-

T_1 = Sole groundnut, T_2 = One row of firingi (15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of firingi in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of firingi & T_5=Firingi broadcast in between two normal rows of groundnut (40cmX15cm).

Companion crop yield

In intercropping system, the highest seed yield of firingi was recorded when it was intercropped as one row of firingi in between two normal rows of groundnut (T_2). The lowest yield of firingi was observed in T_4 (Two groundnut rows alternate with two rows of firingi) (Table 2). Although six rows of component crops may get higher number of plant population than single row cultivation but lowest yield was observed here which might be due to higher competition of crop**.**

Intercrop efficiency

Table 2 shows the cost return analysis of firingi and groundnut intercropping system. It was observed that one or two row firingi in between two rows of groundnut combinations produced higher groundnut equivalent yield (GEY) over the sole groundnut system. The highest GEY (7.97 t/ha) was obtained from T_2 (one row of firingi in between two normal rows of groundnut) treatment while the lowest (2.30 t/ha) in sole groundnut. Maximum gross return (Tk. 797000/ha) was recorded in T_2 (one row of firingi in between two normal rows of groundnut) and also highest gross margin (Tk. 702350/ha) while lowest in T_1 (sole groundnut) treatment due to lower GEY (2.30/ha). However, the highest benefit cost ratio (BCR) (8.4) was obtained from T_2 (one row of firingi in between two normal rows of groundnut) treatment which might be due to higher GEY and gross return. All the intercrop treatments showed much higher benefit over sole groundnut but highest in one row of firingi in between two normal rows of groundnut.

Table 2. Groundnut equivalent yield and benefit cost analysis of groundnut firingi intercropping system during rabi season 2021-22

Treatment	Firingi yield (t/ha)	Groundnut Equivalent Yield (t/ha)	Gross Return (Tk/ha)	Total cost of production (Tk/ha)	Gross Margin (Tk/ha)	BCR (TK/TK)
T_1	-	2.30	230000	98215	131785	2.3
T_2	1.58	7.97	797000	94650	702350	8.4
T_3	1.40	7.10	710000	92000	618000	7.7
T_4	1.11	5.92	592000	96500	495500	6.1
T_5	1.20	6.20	620000	95100	524900	6.5

T_1 = Sole groundnut, T_2 = One row of firingi(15cmX10cm) in between two normal rows of groundnut (40cmX15cm), T_3 = Two rows of firingi in between two normal rows of groundnut, T_4= Two groundnut rows alternate with two rows of firingi & T_5=Firingi broadcast in between two normal rows of groundnut (40cmX15cm).
Selling price: Groundnut seed = Tk.100 /kg, Firingi seed = Tk.400/kg

Conclusion

Results revealed that one row of firingi (10cmx10cm) in between two normal rows of groundnut (40 cmx15cm) would be agronomically feasible and economically profitable for the farmers in intercropping system.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

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INTERCROPPING OF PEA AND KHESHARI AS VEGETABLES AND FODDER CROP WITH DWARF TYPE SUNFLOWER VARIETY

P. ROY, F.BEGUM AND M.M.KARIM

Abstract

A field experiment of intercropping pea and khesari with sunflower was conducted in Oilseed Research Centre, BARI, Gazipur during rabi season of 2021-22 to find out the optimum row arrangement of pea and khesari as intercrop with sunflower for higher productivity and return. Six treatments were T_1= Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50cmX25cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50cmX25cm), T_5 = Two rows of kheshari in between two normal rows of sunflower& T_6= Broadcast kheshari in between two normal rows of sunflower. Although intercropping reduced sunflower yield but total productivity was increased due to addition of pea and khesari yield. Total productivity in terms of sunflower equivalent yield (SEY) (6.64 t/ha) was found the highest from T_3(two rows of pea in between two normal rows of sunflower treatment while the lowest (1.72 t/ha) in T_1 (sole sunflower). Highest benefit cost ratio (BCR) (3.80) was recorded in T_2 treatment (one row of gardenpea in between two normal rows of sunflower) with highest gross margin (Tk.244012/ha).

Introduction

Intensive sunflower production is mainly focused on increasing seed yield, but less importance is given to soil properties, potential ecosystem services and resource conservation. This practice can cause the reduction in organic matter content in the soil, loss of soil fertility, increased erosion, as well as pollution of ground waters. Hence, it is necessary to introduce alternative practices such as intercropping that has raised much attention because it could improve agriculture production for many crops. Previous research has show that it is best to combine two crops, including one from the Fabaceae family. Plants from this family have the ability to create a large amount of above-ground mass, strong root systems with high absorption power, ability to adapt to shady conditions, suppressive effect on weeds and the ability to fix atmospheric nitrogen and provide nitrogen for other plant species that are intercropped with (de la Fuente *et al*., 2014). Commonly intercropped with legumes are crops from a Poaceae family, whereas the combination of sunflower with legumes is relatively rare. The reason for this may be that in an earlier period there were no hybrids tolerant to different diseases and pests. However, today there are justifiable reasons for studying combinations of sunflower and the most important legumes. The goal of this research is to analyze and recommend sustainable technology of sunflower cultivation in intercropping systems and select the legumes most suitable for intercropping with sunflower, aiming to increase productivity per unit area.

Materials and Methods

The field experiment was conducted at the research field of Oilseed Research Centre, Bangladesh Agricultural Research Institute, Gazipur during rabi season of 2021-2022. There were six treatments viz. T_1 = Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50cmX25cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50cmX25cm), T_5 = Two rows of kheshari in between two normal rows of sunflower &T_6=Broadcast kheshari in between two normal rows of sunflower. The experiment was laid out in Randomized Complete Block Design with three replications. The unit plot size was 4m x 5m. Both the seeds of sunflower (BARI Surjomukhi-3), khesari (BARI Khesari-4) and gardenpea (BARI Motorshuti-3) were sown on 21 November, 2021. Fertilizers at the rate of $N_{88}P_{34}K_{80}S_{28}Zn_3B_2$ kgha^{-1} in the form of urea, TSP, MOP, gypsum, zinc oxide and boric acid, respectively. Full amount of triple super phosphate, muriate of potash, gypsum, zinc oxide, boric acid and half of urea were broadcasted in the experimental plot at the time of final land preparation. The rest half of urea was applied in equal amounts at 30 & 55 days after sowing (DAS). At harvest, the yield data was recorded plot wise. Collected data were analyzed statistically and means were adjusted by LSD test at 5% level of significance using SPSS. Yield of individual crops was converted to sunflower equivalent yield (SEY) considering prevailing market price of the crops according to Bandyopadhyay (1984). Marginal benefit cost analysis was also done.

Sunflower equivalent yield (SEY) (kg/ha) = Yis + (Yig*Pg) / Ps &Yis + (Yik*Pg) / Pk
Where,
Yis = Sunflower yield (kg/ha) in intercropping
Yig = gardenpea yield (kg/ha) in intercropping
Yik = khesari yield (kg/ha) in intercropping
Pg = Price of gardenpea
Pk = Price of khesari
Ps = Price of sunflower

Results and Discussion

Light availability

Availability of light on sunflower and pea &khesari intercropping was not markedly affected with each other. Becausepea &khesariwas harvested at 70 to 100 DAS. At that time sunflower canopy could not produce much shade which might affect gardenpea & khesari. Irrespective of treatments availability of light on pea &khesari canopy was almost 100% at earlier growth stage, 30 DAS of gardenpea & khesari and it decreased with the increase of shade produced by sunflower canopy over the time up to 60 DAS or up to harvest of gardenpea & khesari. However, among the intercropping treatments, the higher light availability on intercrop system was observed inT_1 treatment followed by T_2 throughout the growing period. The lower light availability on groundnut was observed in T_5 treatment.

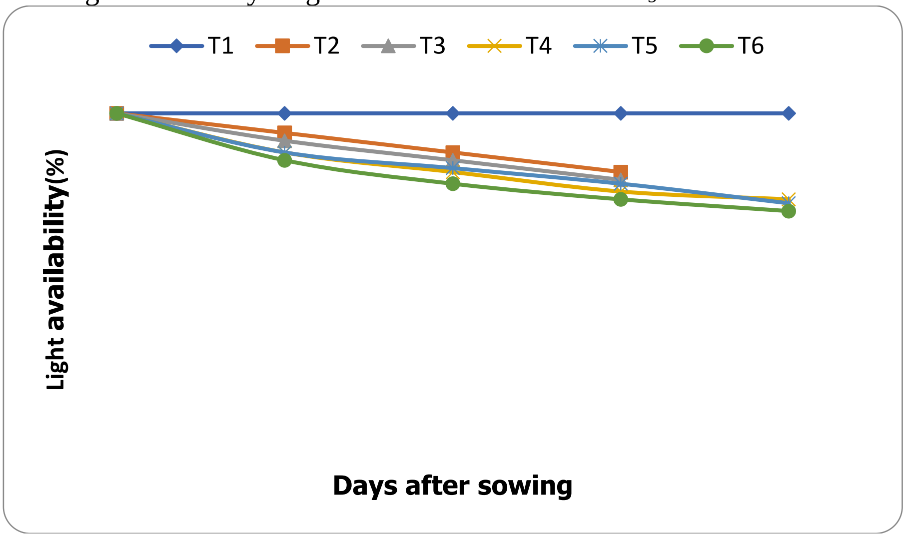

Fig 1. Light availability on sunflower and pea & khesari intercropping during rabi season, 2021-22

Effect of sunflower

Seed yield and yield attributes of sunflower was significantly influenced by intercropping system where as total number of branches per plant and seeds per plant did not show any significant difference (Table 1).Total number. of seeds per plant, mature seeds per plant, immature seed per plant, 100 seeds weight and yield of sunflower were significantly differed under different treatment combinations. Plant height showed higher in treatment T_1 and others are similar. Maximum number of seeds per plant (801), mature seed per plant (669) and highest seed yield (1.72 t/ha) were obtained from sole crop (T_1). Lowest yield (1.33 t/ha) was obtained from T_6 treatment which might be due to lowest number of mature seed per plant (455) and lower 1000 seed weight (61.02 g).

Table 1. Yield and yield components of sunflower under sunflower + pea and sunflower + khesari intercropping system during rabi season 2021-22

Treat	Days to 1st flow.	Days to maturity	Plant height (cm)	Seeds / Head (no.)	Mature seed / head (no.)	Immature seed/ head (no.)	Head diameter (cm)	100 Seeds Wt. (g)	Seed yield (t/ha)	
									2020-21	2021-22
T_1	32	95	79.02	801	669	132	20.01	78.28	1.88	1.72
T_2	30	95	77.05	753	689	64	18.50	76.51	1.76	1.56
T_3	31	95	76.13	720	625	95	18.11	62.30	1.62	1.42
T_4	32	95	77.10	755	650	105	14.33	75.12	1.70	1.60
T_5	31	95	75.22	622	605	117	12.20	61.13	1.63	1.45
T_6	34	95	77.90	580	455	125	11.13	61.02	1.50	1.33
LSD (0.05)	NS	NS	4.9	5.5	2.2	1.8	NS	1.7	1.7	1.2
CV%	-	-	1.8	8.4	9.2	8.1	4.2	1.6	5.7	

T_1= Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50cmX25cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50cmX25cm), T_5 = Two rows of kheshari in between two normal rows of sunflowerand T_6=Broadcast kheshari in between two normal rows of sunflower.

Companion crop yield

In intercropping system, the highest yield (4.35 t/ha) of pea was recorded when it was intercropped as two rows of pea in between two normal rows of sunflower (T_3). The lowest yield of pea was observed in T_2 (4.20 t/ha) (Table 2). In case of khesari, yield was highest (4.62 t/ha) in T_5 i.e. two rows of kheshari in between two normal rows of sunflower and lowest (2.44 t/ha) in T_6 when it was broadcasted with sunflower which might be due to the lower plant population at harvest.

Intercrop efficiency

Table 2 shows the cost return analysis of sunflower with pea and khesari intercropping system. It was observed that all the intercrop combinations produced higher sunflower equivalent yield (SEY) over the sole sunflower. The highest SEY (6.64 t/ha) was obtained from T_3 (two rows of pea in between two normal rows of sunflower) treatment while the lowest (1.72 t/ha) in sole sunflower. Maximum gross return (Tk. 332000/ha) was recorded in T_3 (two rows of pea in between two normal rows of sunflower) and highest gross margin (Tk.244405/ha) was in T_2 (One row of gardenpea in between two normal rows of sunflower) treatment. However, the highest benefit cost ratio (BCR) (3.80) was obtained from T_2 (one row of pea in between two normal rows of sunflower) treatment which might be due to higher SEY and gross return. All the intercrop treatments showed much higher benefit over sole sunflower but highest in one row of pea in between two normal rows of sunflower.

Table 2. Sunflower equivalent yield and benefit cost analysis of sunflower + pea and sunflower + khesari intercropping system during rabi season 2021-22

Treatment	Companion crop yield (t/ha)	Sunflower Equivalent Yield (t/ha)	Gross Return (Tk/ha)	Total cost (Tk/ha)	Gross Margin (Tk/ha)	BCR
T_1	-	1.72	86000	62100	23900	1.37
T_2	4.20	6.60	330000	85595	244405	3.80
T_3	4.35	6.64	332000	87988	244012	3.77
T_4	3.50	2.30	115000	64550	50450	1.78
T_5	4.62	2.37	118500	68320	50180	1.73
T_6	2.44	1.81	90500	67110	23390	1.34

T_1= Sole sunflower, T_2 = One row of gardenpea in between two normal rows of sunflower (50cmX25cm), T_3 = Two rows of gardenpea in between two normal rows of sunflower, T_4 = One row of kheshari in between two normal rows of sunflower (50cmX25cm), T_5 = Two rows of kheshari in between two normal rows of sunflower andT_6=Broadcast kheshari in between two normal rows of sunflower.
Selling price: Sunflower seed = Tk.50 /kg, Pea = Tk.60/kg (green vegetable), khesari= Tk.10/kg (green vegetable)

Conclusion

Results revealed that one row of pea in between two normal rows of sunflower (50 cmx 25cm) would be agronomically feasible and economically profitable for the farmers in intercropping system.

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INTERCROPPING OF SOYBEAN WITH SUNFLOWER AT DIFFERENT PLANTING RATIOS FOR INCREASING TOTAL PRODUCTIVITY AND LAND USE EFFICIENCY IN SOUTHERN REGION

M.A. RAHMAN, F. BEGUM AND M.M. RAHMAN

Abstract

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during the Rabi season of 2021-22 under the project entitled, "Expanded Production of Oilseed Crops (EPOC)" ORC, BARI to find out the suitable sunflower and soybean intercropping system(s) for the southern region of Bangladesh. Eight treatments (intercrop ratio) viz., T_1 *= Sunflower: Soybean = 1:1,* T_2 *= 1:2,* T_3 *= 1:3,* T_4 *= 2:1,* T_5 *= 2:2,* T_6 *= 2:3,* T_7 *= Sole sunflower and* T_8 *= Sole soybean were examined in this experiment. The plant spacing for sunflower single row was row to row distance 50 cm and plant to plant distance 25 cm. Spacing for sunflower double row was row to row 40 cm and plant to plant distance 25 cm. Spacing for soybean was row to row distance 30 cm and plant to plant distance 5 cm in between two sunflower sows as well as for sole soybean. The experiment was laid out in randomized complete block design with three replications. Sunflower and soybean varieties were BARI Surjomukhi-3 (dwarf type) and BARI Soybean-6, respectively. All the studied parameters of sunflower varied significantly except plant height and number of seed/head. The highest photosynthetically active radiations were recorded in both sole sunflower and soybean crops (605.44 and 603.00* $\mu mol\ m^{-2}s^{-1}$*, respectively), which were somewhat identical to* T_6 *treatment (413.22* $\mu mol\ m^{-2}s^{-1}$*). In case of sunflower crop, sole sunflower gave the highest yield (2643 kg/ha) and partially similar yields were also obtained from* T_4 *and* T_5 *treatments (2541 and 2420 kg/ha, respectively). The treatments varied significantly in terms of all the studied parameters of soybean, Sunflower equivalent yield (SEY) and Land equivalent ratio (LER). For soybean crop, sole soybean gave the highest yield of seed (1726 kg/ha). In respect of SEY, treatment* T_2 *showed the highest yield (2983 kg/ha), which was partially similar to the treatments of* T_6 *(2871 kg/ha),* T_4 *(2708 kg/ha),* T_5 *(2682 kg/ha) and* T_3 *(2673 kg/ha). The highest LER (1.34) was computed in* T_2 *treatment and statistically similar value (1.28) was also observed in* T_6 *treatment. The gross margin became higher in* T_2 *and* T_6 *treatments (Tk. 144614 and 137200/ha). Among intercropping systems, treatments* T_2 *(Sunflower : Soybean = 1-row : 2-row) and* T_6 *(Sunflower : Soybean = 2-row : 3-row) gave more Sunflower equivalent yield (SEY) and Land equivalent ratio (LER) and economic return than that of other treatments. The SEY and LER values of* T_2 *and* T_6 *treatments indicated their suitability towards increasing the total productivity and land use efficiency in southern region of Bangladesh. The treatment* T_2 *and* T_6 *were also more profitable as compared to that of other treatments. However, the experiment should be repeated in the next year(s) for final recommendation.*

Introduction

Sunflower (*Helianthus annus* L.) is an important oilseed crop for the southern coastal area of Bangladesh. The area under this crop is increasing day by day and gains popularity among the farmers for its adaptability under salinity condition. As salinity tolerant crop, soybean (*Glycine max* L) is also one of the most important oilseed crops and the cultivation of this crop is increasing in the coastal region mostly due to its increasing demand in the poultry sector. The total area under sunflower cultivation is about 1.30 hectares and annual production is about 1.98 thousand metric tons. The major sunflower growing districts are Barguna, Bagerhat, Pirojpur, Jhalokati, Gopalganj, Patuakhali and Bhola. On the other hand, the total area under soybean cultivation is about 62.00 thousand hectares and annual production is about 1.11 lac metric ton. The soybean cultivation is mainly concentrated in the coastal districts of the country like Laksmipur, Noakhali, Bhola, Barishal and Chandpur (BBS, 2020). Bangladesh Agricultural Research Institute (BARI) has developed a dwarf type of sunflower variety namely BARI Surjomukhi-3 and the soybean varieties like BARI Soybean-5 and BARI Soybean-6 that can be introduced in the existing rice based cropping systems in the southern region (BARI, 2020). There is a need to develop additional information on the intercropping of sunflower and soybeans as component crops in southern region of Bangladesh so that production can be maximized. Intercropping could be considered as a way of ecological intensification allowing the increase of natural resources use efficiency by positive interspecific interactions (Hauggard-Nielsen and Jensen, 2005). Land equivalent ratio values for intercrops were much greater than 1.0 indicating less land requirements of intercropping systems than sole sunflower (Wahab and Manzlawy, 2016). Fuente *et al*. (2014) evaluated the effects of sunflower/soybean sole and intercrops, indicated that intercrops were more productive than sole crops. Intercrops may suppress weed growth more effectively than sole crops mainly through competition (Poggio, 2005). Sunflower can be intercropped with soybean, enabled farmers to raise income by cultivating two crops in same piece of land, above all conserve the fertility of land (Obong *at al*., 2016). Intercrops with a legume are often presumed to be more efficient for N acquisition tanks to the potential complementary use of nitrogen sources (soil and air). Indeed, legumes have the ability to increase their atmospheric nitrogen fixation rate in intercrop to fulfil their demand (Bedoussac and Justes, 2010). Intercropping of soybean with sunflower can increase the total productivity, land use efficiency and farmers' income in southern region. In this respect, the experiment has been undertaken to find out the suitable planting ratio of sunflower and soybean intercropping system(s) for increasing the total productivity and land use efficiency in the southern region of Bangladesh.

Materials and Methods

The field experiment was conducted at Regional Agricultural Research Station, BARI, Rahmatpur, Barishal during the *Rabi* season of 2021-22 with the funding of the project entitled, "Expanded Production of Oilseed Crops (EPOC)" Oilseed Research Centre, BARI, Gazipur with different planting ratios to find out the suitable sunflower and soybean intercropping system(s) for the southern region of Bangladesh. The experiment site is situated in the latitudes and longitudes of $22^{o}47^{/}2.67745^{//}$N and $90^{o}17^{/}31.76741^{///}$E. The site belongs to the agro-ecological zone Ganges Tidal Floodplain (AEZ-13). The soil type is medium high land and soil texture is loamy. There were eight treatments (intercrop ratio) in this experiment viz., T_1 = Sunflower: Soybean = 1:1, T_2 = 1:2, T_3 = 1:3, T_4 = 2:1, T_5 = 2:2, T_6 = 2:3, T_7 = Sole sunflower and T_8 = Sole soybean. The experiment was laid out in randomized complete block design with three replications. The unit plot size was 4 m × 3 m. The variety of sunflower and soybean were BARI Surjomukhi-3 (dwarf type) and BARI Soybean-6, respectively. Seeds of sunflower and soybean were sown on 22 December 2021. The plant spacing for sunflower single row was row to row 50 cm and plant to plant distance 25 cm. Spacing for sunflower double row was row to row 40 cm and plant to plant distance 25 cm. Plant spacing for soybean was row to row distance 30 cm and plant to plant distance 5 cm in between two sunflower sows as well as for sole soybean. The experimental plots were fertilized with 200-180-170-170-10-12 kg/ha urea, triple super phosphate (TSP), muriate of potash (MP), gypsum, zinc sulphate and boric acid, respectively along with 6 t/ha cowdung. Half of urea, all other fertilizers and cowdung were applied as a basal. The rest half amount of urea was applied as side dressing in two equal installments, one at 20-25 days after seedling emergence (DAE) and the other at 40-45 DAE (before flowering). Seeds of sunflower and soybean were treated with Provex 200 @ 3g/kg seed to control their seed borne diseases before sowing. Irrigation was applied for three times and other intercultural operations (weeding, mulching etc.) were done as when necessary following the recommended production technologies of the crops (BARI, 2020). The Photosynthetically active radiation (PAR) (μmol $m^{-2}s^{-1}$) of different experimental plots was measured during 10:00 AM to 10:30 AM by using the device Sunflex Ceptometer (Model: LP-80, Decagon Device Inc., USA) at the maximum vegetative growth stage (85 days after sowing) of the crops. The plant root parameters (root length, surface area and volume) were measured by using computer based Root Scanner (Model: CI-600, Brand: CID-Bio science, USA). The Sunflower equivalent yield (SEY) was calculated by the following formula:

$$\text{SEY} = \frac{\text{Intercrop yield (kg/ha) x Price of intercrop yield (Tk/kg)}}{\text{Price of main crop (Tk/kg)}}$$

The Land equivalent ratio (LER) was determined as the sum of fractions of the yields of sunflower and soybean intercrops compared with their sole crop yields by the following formula (De Wit and Bergh, 1965):

$$\text{LER} = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

where, Y_{ab} is the yield of sunflower "a" intercropped with soybean "b", Y_{aa} is the pure stand yield of sunflower "a", Y_{ba} is the yield of soybean "b" intercropped with sunflower "a", and Y_{bb} is the pure stand yield of soybean "b". Any value greater than 1.0 indicates a yield advantage for intercrop. A LER of 1.2 for example, indicates that the area planted to monocultures would need to be 20% greater than the area planted to intercrop for the two species to produce the same combined yields.

The sunflower and soybean crops were harvested on 10 and 17 April 2022, respectively after attaining to their physiological maturity. Data were collected on different parameters such as Photosynthetically active radiation (PAR), plant pop/m^2, plant height, root length/plant, root surface area/plant, root volume/plant, number of seed/head or pod, 1000-seed weight, plot yields of sunflower seed and soybean crops. The plot yields were then converted into ton/hectare. Data were analyzed statistically using windows based computer software of Statistix 10 version and then the mean differences were adjudged with Duncan's Multiple Range Test (DMRT) following the protocol as suggested by Gomez and Gomez (1984).

Results and Discussion

Effects of sunflower-soybean intercropping systems on photosynthetically active radiation (PAR) and yield and yield contributing **characters of sunflower**

All the studied parameters of sunflower under sunflower-soybean intercropping systems varied significantly except plant height and number of seed/head (Table 1). The highest photosynthetically active radiations were recorded in both sole sunflower (T_7) and soybean crops (605.44 and 603.00 µmol m^{-2}s^{-1}, respectively), which were somewhat identical to T_6 treatment (413.22 µmol m^{-2}s^{-1}). However, with increasing the intercrop competition, the PAR was decreasing gradually. The lowest PAR was found in T_1 treatment (214.00 µmol m^{-2}s^{-1}). The plant population of sole sunflower crop was the highest (6.92) and it differed significantly with varying planting ratios. The lowest population (3.56) was obtained from T_3 treatment. Treatment T_6 showed the highest length of root/plant (416.98 cm), which was partially at par to the treatments of T_4 (405.48 cm), T_3 (388.83 cm), T_1 (387.56 cm), T_7 (358.68 cm) and T_2 (342.72 cm). The lowest length of root/plant was found in T_5 (320.67 cm) treatment. In terms of root surface area, the value (134.79 cm^2) was recorded in T_3 and it was to some extent identical to T_6 (132.15 cm^2), T_1 (120.69 cm^2) and T_5 (115.98 cm^2) treatments. The lowest surface area of root/plant (109.64 cm^2) was observed in T_7. Similarly, treatment T_3 gave the highest volume of root/plant (4.29 cm^3), which was partially at par to T_5 (3.71 cm^3), T_6 (3.41 cm^3) and T_1 (3.19 cm^3) treatments but the treatment T_4 gave the lowest volume (2.52 cm^3). Weight of 1000-seed became the highest (60.09 g) in treatment T_6 and statistically identical results were also observed in the treatments of T_3 (58.99 g), T_7 (57.97 g) and T_2 (57.95 g). Treatment T_4 gave the lowest weight (51.87 g) of 1000-seed. Sunflower seed yield varied significantly due to different intercropping systems as per the treatment specifications. The sole sunflower (T_7) gave the highest yield (2643 kg/ha) and partially similar yields were also obtained from T_4 and T_5 treatments (2541 and 2420 kg/ha, respectively). Besides, treatments T_2, T_1 and T_6 produced the seed yields of 2205, 2167 and 2148 kg/ha, respectively. The lowest yield (1804 kg/ha) was obtained from T_3 treatment.

Table 1. Effects of sunflower-soybean intercropping systems on PAR and different yield and yield contributing characters of sunflower during 2021-22

Treat-Ment	Photosynthetically active radiation (PAR) (μmol $m^{-2}s^{-1}$)	Sunflower							
		Plant pop/m^2 (no.)	Plant height (cm)	Root length/ plant (cm)	Root surface area/plant (cm^2)	Root volume/ plant (cm^3)	Seed/ head (no.)	1000-seed weight (g)	Seed yield (kg/ha)
T_1	214.00b	5.75b	110.27	387.56ab	120.69ab	3.19a-c	345.33	53.52ab	2167b-d
T_2	339.11b	4.16c	107.07	342.72ab	111.08b	2.97bc	378.20	57.95ab	2205bc
T_3	339.55b	3.56d	106.67	388.83ab	134.79a	4.29a	373.07	58.99ab	1804d
T_4	287.11b	5.78b	108.93	405.48ab	111.25b	2.52c	348.93	51.87b	2541ab
T_5	293.11b	4.53c	107.93	320.67b	115.98ab	3.71ab	392.67	55.46ab	2420a-c
T_6	413.22ab	4.41c	105.73	416.98a	132.15ab	3.41a-c	399.47	60.09a	2148cd
T_7	605.44a	6.92a	106.00	358.68ab	109.64b	2.72bc	342.40	57.97ab	2643a
T_8	603.00a	-	-	-	-	-	-	-	-
CV (%)	30.40	6.11	7.10	10.14	12.46	12.24	15.38	7.94	9.46
F-test	**	**	NS	*	**	**	NS	**	**

Note: T_1 = Sunflower: Soybean = 1:1, T_2 = 1:2, T_3 = 1:3, T_4 = 2:1, T_5 = 2:2, T_6 = 2:3, T_7 = Sole sunflower and T_8 = Sole soybean.

* and ** Significant at 5% and 1% level of probability, respectively; NS = Not significant

Effects of sunflower-soybean intercropping systems on yield and yield contributing characters of soybean, SEY and LER

The effects of sunflower-soybean intercropping systems were found to be significant on all the studied parameters of soybean, Sunflower equivalent yield (SEY) and Land equivalent ratio (LER) (Table 2). The sole soybean (T_8) showed the highest population of plant (16.02). Plant population in T_3, T_1, T_6 and T_5 treatments were 4.19, 3.97, 3.97 and 3.27, respectively and the lowest population (2.72) were found in T_2 treatment. Treatment T_2 produced the longest plant of soybean (65.47 cm), which was partially at par to T_5, T_4 and T_6 treatments (61.00, 60.80 and 60.33 cm, respectively). The shortest plant (57.47 cm) was obtained from T_1 treatment. The highest length of root/plant (185.58 cm) was recorded in sole soybean (T_8) but comparatively reduced root lengths were found in other treatments. Similarly, sole soybean produced the highest root surface area and root volume/plant (41.64 cm^2 and 0.79 cm^3, respectively) among the treatments. However, the values (root surface area and root volume) in other treatments significantly lower. The highest number of pod/plant (70.00) was recorded in sole soybean that was statistically identical to T_1 (56.13), T_2 (51.00) and T_6 (44.93) treatments. The lowest number of pod/plant (34.73) was found in T_4 treatment. Treatment T3 exhibited the highest weight (117.56 g) of 1000-seed, which was somewhat identical to T_4 (116.13 g), T_5 (116.03 g), T_6 (116.03 g), T_8 (115.72 g) and T_2 (115.35 g) treatments. The lowest weight (114.38 g) of 1000-seed was observed in T_1 treatment. Seed yield of sole soybean attained to the highest (1726 kg/ha) but the yields in other treatments were comparatively low due to different intercrop combinations. Thus the lowest seed yield of soybean (167 kg/ha) was obtained from T_4 treatment. In terms of SEY, Treatment T_2 showed the highest yield (2983 kg/ha), which was partially similar to the treatments of T_6 (2871 kg/ha), T_4 (2708 kg/ha), T_5 (2682 kg/ha) and T_3 (2673 kg/ha). The lowest SEY (1726 kg/ha) was computed in sole soybean crop. The treatment T_2 exhibited the highest LER (1.34) and statistically similar result (1.28) was also observed in T_6 treatment but it was partially at par to T_3 (1.24) treatment. LER values for T_5, T_4 and T_1 treatments were 1.12, 1.11 and 1.09, respectively. The experimental results further indicated that LER values for all the intercrop treatments were greater than 1.00 (sole crops). The value greater than 1.0 indicated a yield advantage for intercrop. A LER of 1.34 for example, indicates that the area planted to monocultures would need to be 34% greater than the area planted to intercrop for the two species to produce the same combined yields.

Table 2. Effects of sunflower-soybean intercropping systems on different, yield and yield contributing characters of soybean, SEY and LER during 2021-22

Treat-Ment	Soybean								Sunflower equivalent yield (SEY) (kg/ha)	Land equivalent ratio (LER)
	Plant pop/m^2 (no.)	Plant height (cm)	Root length/ plant (cm)	Root surface area/plant (cm^2)	Root volume/ plant (cm^3)	Pod/ plant (no.)	1000-seed weight (g)	Seed yield (kg/ha)		
T_1	3.97b	57.47b	110.79b	21.80b	0.35b	56.13a	114.38b	375bc	2542bc	1.09c
T_2	2.72b	65.47a	107.73b	23.86b	0.44b	51.00a	115.35ab	778b	2983a	1.34a
T_3	4.19b	60.27b	90.85b	20.38b	0.37b	44.13ab	117.56a	869b	2673a-c	1.24ab
T_4	2.75b	60.80ab	75.74b	15.30b	0.44b	34.73b	116.13ab	167c	2708a-c	1.11bc
T_5	3.27b	61.00ab	103.10b	21.61b	0.37b	43.67ab	116.03ab	262bc	2682a-c	1.12bc
T_6	3.97b	60.33ab	117.83b	24.36b	0.36b	44.93a	116.03ab	723b	2871ab	1.28a
T_7	-	-	-	-	-	-	-	-	2509c	1.00c
T_8	16.02a	57.87b	185.58a	41.64a	0.79a	70.00a	115.72ab	1726a	1726d	1.00c
CV (%)	8.39	5.58	3.30	8.95	4.70	7.41	1.63	10.55	7.64	7.13
F-test	**	**	**	**	**	*	**	**	**	**

Note: T_1 = Sunflower: Soybean = 1:1, T_2 = 1:2, T_3 = 1:3, T_4 = 2:1, T_5 = 2:2, T_6 = 2:3, T_7 = Sole sunflower and T_8 = Sole soybean.

* and ** Significant at 5% and 1% level of probability, respectively; NS = Not significant

Cost-return analysis of different treatments of sunflower-soybean intercropping systems

The highest gross return (Tk. 243764/ha) was obtained from T_2 treatment (Table 4). Besides, gross returns computed from T_6 and T_4 treatments were Tk. 234618 and 221015/ha, respectively. Sole sunflower (T_7) and sole soybean (T_8) gave the gross returns of Tk. 215496 and 140914/ha, respectively. Similarly, the highest gross margin (Tk. 144614/ha) was found in T_2 treatment. Gross margin achieved from T_6 treatment was Tk. 137200/ha. Treatments T_4, T_3 and T_5 showed that gross margins of Tk. 112847, 111715 and 110848/ha, respectively. The lowest gross margin (Tk. 63754/ha) was found in sole soybean (T_8) but sole sunflower (T_7) gave the gross margin of Tk. 107346/ha. The treatments T_2 and T_6 showed comparatively the higher BCR (2.46 and 2.41, respectively) as compared to that of other treatments. Treatments T_3, T_4 and T_5 gave the BCR values of 2.05, 2.04 and 2.02, respectively. The lowest BCR (1.83) was observed in sole soybean (T_8) but sole sunflower gave the BCR value of 1.99. The economic analysis of different treatments of sunflower-soybean intercropping systems indicated that treatments T_2 (Sunflower : Soybean = 1-row : 2-row) and T_6 (Sunflower : Soybean = 2-row : 3-row) were more profitable as compared to that of other treatments.

Table 4. Cost-return analysis of different treatments of sunflower-soybean intercropping systems at RARS, Rahmatpur, Barishal during 2021-22

Treatment	Sunflower seed yield (kg/ha)	Soybean seed yield (kg/ha)	Sunflower straw yield (kg/ha)	Soybean Straw Yield (kg/ha)	Gross return (Tk/ha)	Total variable cost (Tk/ha)	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1	2167	375	7477	603	207697	108180	99517	1.92
T_2	2205	778	7718	1283	243764	99150	144614	2.46
T_3	1804	869	6279	1390	218374	106659	111715	2.05
T_4	2541	167	8206	268	221015	108168	112847	2.04
T_5	2420	262	8107	419	219028	108180	110848	2.02
T_6	2148	723	7518	1193	234618	97419	137200	2.41
T_7	2643	-	8192	-	215496	108150	107346	1.99
T_8	-	1726	-	2848	140914	77160	63754	1.83

Note: T_1 = Sunflower: Soybean = 1:1, T_2 = 1:2, T_3 = 1:3, T_4 = 2:1, T_5 = 2:2, T_6 = 2:3, T_7 = Sole sunflower and T_8 = Sole soybean. Price: Sunflower seed: Tk. 80/kg, soybean seed: Tk. 80/kg, sunflower bi-product: Tk. 0.50/kg, soybean bi-product: Tk. 1.0/kg

Conclusion

Among the sunflower-soybean intercropping systems, treatments T_2 (Sunflower : Soybean = 1-row : 2-row) and T_6 (Sunflower : Soybean = 2-row : 3-row) gave more Sunflower equivalent yield (SEY) and Land equivalent ratio (LER) and economic return than that of other treatments, where plant spacing for sunflower single row was row to row distance 50 cm and plant to plant distance 25 cm. Plant spacing for sunflower double row was row to row 40 cm and plant to plant distance 25 cm. Plant spacing for soybean was row to row distance 30 cm and plant to plant distance 5 cm in between two sunflower sows as well as for sole soybean. The SEY and LER values of T_2 and T_6 treatments indicated their suitability towards increasing the total productivity and land use efficiency in southern region of Bangladesh. The treatments T_2 and T_6 were also more profitable as compared to that of other treatments. As this was the first year experiment, therefore, it should be repeated in the next year(s) for final recommendation.

Acknowledgement

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STUDY ON PHYSICOCHEMICAL PROPERTIES AND FATTY ACID COMPOSITION OF PERILLA AND CHIA

P.ROY AND F.BEGUM

Introduction

Perilla and chia are recently introduced as Oil crop in Bangladesh. Oilseed Research Centre, BARI collected some seeds of these two crops from local sources and demonstrated an observation trial on these crops to observe their growth behaviors and yield characteristics. However, their oil content and fatty acid compositions need to be estimated as they are grown as oilseed crops. To keep this in mind, this study is undertaken to assess the oil content, and fatty acid composition of perilla and chia.

Materials and methods

Seed samples of chia and perilla were collected from ORC, BARI Joydebpur, Gazipur. Fatty acid composition was determined by Gas-liquid chromatographic method at Central Laboratory, BARI. About 12mg of oil or equivalent amount of oilseeds (Seeds are crushed in an oil paper and then transferred into a test tube) were used. The small sample was extracted and trans esterified at the same time with 5 ml ethylate reagent (Petroleum ether/0.02 M Sodium hydroxide in ethanol (2/3) and shaked. The samples were kept for overnight at room temperature. A salt solution (80g NaCl and 3g sodium hydrogen sulphate in 1 litre water) 10ml was added and shaked. As soon as the two layers were separated, the benzene phase was transferred to small test tubes and was than ready for Gas Chromatography. Instruments:

Thermo Fisher Scientific, Trace GC Ultra-with Tri-Plus Autosampler

Results and Discussion

Table 1 represents fatty acid composition of perilla and chia. Unsaturated fatty acid level is much higher than saturated fatty acid in both perilla and chia. Oleic acid percentage is 24.44 and 7.48 in perilla and chia, respectively. Lenolenic acid is 61.48% in chia and 48.84% in perilla. Lenoleiec acid is also higher in chia (19.78%) than perilla (17.67%). On the other hands, chia contains 2.86% and 8.11% stearic acid and palmitic acid, respectively whereas perilla seed contains 1.91% and 6.79%.

Table 1. Fatty acid composition of Perilla and Chia

Fatty acid	**Fatty acids (%)**	
	Perilla	**Chia**
Saturated fatty acids		
Myristic ($C_{14.0}$)	0.20	0.17
Palmitic ($C_{16.0}$)	6.79	8.11
Stearic ($C_{18.0}$)	1.91	2.86
Arachidic ($C_{20.0}$)	0.08	-
Unsaturated fatty acids		
Palmitolic ($C_{16.1}$)	0.08	0.13
Oleic/ω-9($C_{18.1}$)	24.44	7.48
Lenoleic/ω-6($C_{18.2}$)	17.67	19.78
Lenolenic/ω-3($C_{18.2}$)	48.84	61.48

VALIDATION OF INTERCROPPING BLACK CUMIN WITH GROUNDNUT IN CHARLAND AREAS

M. A. H. KHAN, S. ROY, T. TASMIMA AND M. M. RAHMAN

Abstract

An experiment was conducted at the MLT site, Bhuapur during the Rabi season of 2021-22 to find out the optimum row arrangement of black cumin for intercropping with groundnut for higher productivity and return. Four treatments viz., T_1= Sole groundnut (100%), T_2= One row of black cumin in between two rows of groundnut, T_3= Two rows of black cumin in between normal rows of groundnut, T_4= Sole black cumin (100%). Spacing of groundnut was maintained at 40 cm × 15 cm and black cumin (15 cm x 10 cm). Groundnut intercropping with black cumin makes effective use of land and other resources and results in reduced cost of production. Increased agricultural production through intercropping with minimal cost is need of time to feed the increasing population. The reported work evaluates the productivity and economics of groundnut and black cumin growing as sole crops and when groundnut is intercropped with black cumin. Groundnut equivalent yields were recorded higher from all intercrop treatments as compared to sole groundnut and sole black cumin production. Analysis of intercropping treatments revealed that two rows of black cumin in between two rows of groundnut resulted in the highest groundnut equivalent yield (3.06 t ha^{-1}) as well as gross margin (Tk. 99398 ha^{-1}) and the lowest groundnut equivalent yield (1.43 t ha^{-1}) as well as gross margin (Tk. 29848 ha^{-1}), were obtained from sole groundnut treatment.

Introduction

An estimated 6.5 million people, around 5% of the Bangladeshi population live on the Charland's and of the total area of the country, 5% is Char, which comes to about a total area of approximately 7200 square kilometers. The achar dwellers mainly depend on agriculture and agriculture related activities. Groundnut (*Archis hypogea* L.) is the second important oilseed crop that covered a considerable area in Bangladesh and it is a long duration crop. On the other hand, black cumin is a very important and valuable spices crop which is usually grown as sole and in some cases as intercrop in farmers field in various Charland areas of Bangladesh. The spacing for groundnut cultivation is 40 cm X 15 cm. So, there is a scope to intercrop black cumin with groundnut. This might be economically profitable for the farmers. Hence this experiment was undertaken to find out the optimum row arrangement of black cumin for intercropping with groundnut for higher productivity and return.

Materials and methods

The experiment was conducted at the MLT site Bhuapur, Tangail under AEZ # 8 during the Rabi season 2021-22. The experiment was laid out following RCB design with five replications. The unit plot size was 5 m x 4 m. There were four treatments viz., T_1= Sole groundnut (100%), T_2= One row of black cumin in between two normal rows of groundnut, T_3= Two rows of black cumin in between two normal rows of groundnut, T_4= Sole black cumin (100%). Spacing of groundnut was maintained at 40 cm × 15 cm and black cumin (15 cm x 10 cm). The plot was fertilized with 45-36-75-30-2-1 kg NPKSB ha^{-1} for sole and intercropping treatments. ½ N and full quantity of other fertilizers will be applied as basal. The remaining N will be top dressed at the flowering stage and covered with soil followed by irrigation. The variety of groundnut was BARI Chinabadam-9 and black cumin (BARI Kalozira-1). Seeds of groundnut and black cumin were planted on 3 November, 2021. Intercultural operations were done properly for the normal growth and development of the crops. The black cumin was harvested on 20 March, 2022, and the groundnut on 30 March, 2022. Data on yield and yield contributing attributes were recorded and analyzed with CropStat analytical package. The cost and return analysis were computed on the basis of the prevailing market price.

Results and discussions

Effect of intercropping treatments on yield and yield attributes of groundnut: Statistical analysis of the data obtained on different yield characteristics of groundnut revealed that there were no significant differences between intercropping treatments except yield. The highest plant height, number of effective pods plant^{-1}, and 1000 seed weight were observed in T_1 treatment (sole groundnut) which results in the highest yield (1.43 t ha^{-1}). A significant decrease (4.38-5.92%) occurred in pod yield when groundnut was intercropped with black cumin which may be due to decreased number of pods plant^{-1} and 1000 seed weight. This may be occurred due to an active competition between two crops for attaining essential nutrients for their growth.

Table 1. Yield and yield components of groundnut affected by intercropping with black cumin at MLT site Bhuapur, Tangail during the rabi, 2021-22

Treatment	Plant height (cm)	Effective pod plant^{-1} (no.)	1000 seed weight (g)	Pod yield (t ha^{-1})
T_1	36.27	17.47	520.60	1.43
T_2	34.40	17.07	527.93	1.37
T_3	34.67	17.20	508.60	1.35
$LSD_{0.05}$	4.56	2.61	48.47	0.04
CV (%)	5.70	6.70	4.10	1.40

T_1= Sole groundnut (100%), T_2= One row of black cumin in between two rows of groundnut and T_3= Two rows of black cumin in between two rows of groundnut, T_4= Sole black cumin (100%)

Effect of intercropping treatments on the yield of black cumin: Statistical analysis of data obtained on different yield characteristics of black cumin revealed that there was a significant difference between intercropping treatments except for plant height. The maximum plant height was observed in the T_4 (35.90 cm) treatment whereas the lowest was in T_2 (34.60 cm). The highest thousand seed weight (3 g) was found in the T_4 treatment which results in the maximum seed yield (0.51 t ha^{-1}) and the lowest in seed yield the T_2 (0.29 t ha^{-1}) treatment (Table 2). The maximum seed yield was found in T_4 where black cumin was grown as the sole crop. The higher groundnut equivalent yields were recorded from all intercrop treatments as compared to sole groundnut.

Table 2. Yield and yield components of black cumin affected by intercropping with black cumin at MLT site Bhuapur, Tangail during the rabi, 2021-22

Treatment	Plant height (cm)	Effective pod plant^{-1} (no.)	1000 seed weight (g)	Yield (t ha^{-1})
T_2	34.60	10.40	2.83	0.29
T_3	35.33	8.43	2.80	0.41
T_4	35.90	9.47	3.00	0.51
$LSD_{0.05}$	5.70	0.63	0.15	0.03
CV (%)	7.10	2.90	2.30	3.60

T_1= Sole groundnut (100%), T_2= One row of black cumin in between two rows of groundnut and T_3= Two rows of black cumin in between two rows of groundnut, T_4= Sole black cumin (100%)

Table 3. The yield of groundnut, black cumin, and groundnut equivalent yield of groundnut intercropping with black cumin at MLT site Bhuapur, Tangail during rabi, 2021-22

Treatment	Yield of groundnut ($t\ ha^{-1}$)	Yield of black cumin ($t\ ha^{-1}$)	Groundnut equivalent yield ($t\ ha^{-1}$)
T_1	1.43	-	1.43
T_2	1.37	0.29	2.58
T_3	1.35	0.41	3.06
T_4	-	0.51	2.12

T_1= Sole groundnut (100%), T_2= One row of black cumin in between two rows of groundnut, T_3= Two rows of black cumin in between two rows of groundnut, T_4= Sole black cumin (100%) and Farm gate price: Black cumin: Tk. 250 kg^{-1}, Groundnut: Tk. 60 kg^{-1}

Cost and return analysis

The highest groundnut equivalent yield (3.06 t ha^{-1}) was observed in T3 treatment as well as the highest gross return (Tk. 183600 ha^{-1}) and gross margin (Tk. 99,398 ha^{-1}) (Table 3).

Table 4. Cost and return analysis of groundnut intercropping with black cumin at MLT site Bhupaur, Tangail during the rabi 2021-22

Treatment	Gross return (Tk. ha-^{1})	Total cost of production (Tk ha-^{1})	Gross margin (Tk ha-^{1})
T_1	85800	55952	29848
T_2	154800	79652	75148
T_3	183600	84202	99398
T_4	127200	43200	84000

T_1= Sole groundnut (100%), T_2= One row of black cumin in between two rows of groundnut, T_3= Two rows of black cumin in between two rows of groundnut, T_4= Sole black cumin (100%) and Farm gate price: Black cumin: Tk. 250 kg^{-1}, Groundnut: Tk. 60 kg^{-1}

Pest infestation: No remarkable pest incidence was observed during the cropping period.

Farmers' opinion: Intercropping groundnut with black cumin is a profitable technology. But the germination of black cumin was hampered in groundnut and black cumin intercropping. Farmers are less interested to follow this intercropping combination.

Conclusion

From the results, it can be concluded that groundnut can be grown with black cumin. Farmers can earn better economic benefits by following the cultivation of two rows of black cumin (15cmX 5cm) in between two normal rows of groundnut (40cmX 15cm).

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INTERCROPPING OF BLACK CUMIN WITH GROUNDNUT AT SANGU RIVER BANK OF BANDARBAN HILL DISTRICT

M. T. ISLAM AND F.BEGUM

Abstract

The experiment was carried out at the farmers' field of On-Farm Research Division, Bangladesh Agricultural Research Institute (BARI), Bandarban during the rabi season, 2021-22 to find out the suitable intercropping system for increasing crop productivity and profitability of black cumin with groundnut intercropping system. The treatments were T_1=sole groundnut, T_2=sole black cumin, T_3= one row of black cumin in between two rows of groundnut and T_4= two rows of black cumin in between two rows of groundnut. Spacing of groundnut was maintained at 40 cm × 15 cm and black cumin (15 cm x 10 cm). Treatments were arranged in a randomized complete block design with three replications. Between intercropped treatments, single row of black cumin within paired rows of groundnut (T_3) showed higher groundnut equivalent yield (3331.12 kg ha^{-1}), highest land equivalent ratio (1.43), gross return (Tk. 199867 ha^{-1}), net return (Tk. 149367 ha^{-1}) and benefit cost ratio (3.96) over the respective sole groundnut crop (T_1), sole black cumin (T_2) and Two rows of black cumin in between two rows of groundnut (T_4). The result showed that groundnut + black cumin (single row) intercrop system was most productive and profitable than sole groundnut cultivation in Bandarban region.

Introduction

Intercropping is the cultivation of two or more crops simultaneously on the same piece of land during the same season (Ofori & Stern, 2000; Sullivan, 2000). The benefits associated with intercropping includes increased soil fertility (Shen & Chu, 2004), reduced risk of crop failure (Mutsaers *et al*., 1993), decreased disease severity (Zinsou et al., 2005) and efficient utilization of environmental resources (Francis, 1989; Zhang & Li, 2006).

Intercropping is widely practiced by many farmers in the tropics. Intercropping gives a greater stability of yield over monoculture (Willey and Reddy, 1981). Besides, intercropping ensures greater resource use efficiency (Herrara and Harwood, 1974; Poathick and Malla, 1979). The black cumin (*Nigella sativa* L.), an important source for a spice and in pharmaceutical industries, is one of the most important medicinal minor spice plants in Bangladesh. Seed of black cumin contain about 21% protein, 35% carbohydrates and 35-38% plant fats and oils. It contains all essential amino acids and rich source of vitamins and minerals. Total cultivable area of Bangladesh is 14.86 million hectares. Black cumin is an annual plant, originally grown in arid and semi-arid regions. On the other hand, groundnut is the third major oil crop in Bangladesh in area and production. It contains maximum oil content. Groundnuts are a popular source of food throughout the world, consumed either as peanut butter or crushed and used for groundnut oil or simply consumed as a confectionary snack. Groundnut is one of the best sources of protein and consuming groundnut is very beneficial for our health especially promote our heart health, promotes fertility, helps in weight loss, prevents gallstones, helps fight depression, boosts hair growth etc. Groundnuts are cultivated in the tropical and subtropical regions of the world on sandy soils. In Bandarban district, it is grown in the river bank of Sangu during rabi season where farmers normally grow groundnut as sole crop. The cropping intensity of this area is 150%. An extra crop may be introduced as intercrop and cropping intensity may be increased. That is why this experiment was taken to evaluate the performance of intercropping black cumin with groundnut.

Materials and Methods

The experiment was conducted in a farmer's field of sangu river bank in Bandarban during the rabi season, 2021-22. Four treatments viz. T_1: Sole groundnut, T_2: Sole black cumin, T_3: Groundnut + Black cumin (single row) and T_4: Groundnut + Black cumin (double row) were used for the experiment. It was laid out in randomized complete block design (RCBD) with three replications. The unit plot size was 5 m × 4.5 m. Local Groundnut (Tridana Badam) and Black cumin (BARI Black cumin-1) were used as testing material. For groundnut, spacing was 40 cm × 15 cm and in between two line of groundnut, black cumin seed were sown maintaining 10 cm distance from each other for single line. For double row of black cumin (T_4), 15 cm line-line and 10 cm plant-plant distance were maintained. Both groundnut and black cumin seeds were sown on 13 November, 2021. Fertilizers were applied @

15-35-20-15 kg N-P-K-S ha^{-1} for groundnut. All fertilizers were applied as basal at the time of final land preparation in the form of urea, triple super phosphate, muriate of potash and gypsum respectively. Two times weeding and earthing up were done. The component crop was harvested on 12-14 March, 2022 and groundnut was harvested on 04 April, 2022. At harvest, the yield and yield attributes were recorded and analyzed statistically. Groundnut equivalent yield, LER and economic analysis were done for each treatment on a hectare basis considering the farm rate of crop. Groundnut equivalent yield (GEY) was calculated by converting the yield of black cumin to the yield of groundnut. Index of yield was calculated by the following formula: (Index of yield= Intercrop yield/Sole crop yield × 100). Land equivalent ratio (LER) was computed according to Shaner et al. (1982) as follows: LER= yield of sole groundnut/ yield of intercrop groundnut + yield of sole black cumin / yield of intercrop black cumin.

Results and Discussion

Yield of groundnut and black cumin was significantly differing from one another in each treatment. Yield of sole groundnut and sole black cumin was higher due to no intercrop competition. Black cumin yield was converted into groundnut equivalent yield and T_3: Groundnut + Black cumin (single row) showed highest GEY (3331.12 kg ha^{-1}) and lowest GEY (1632.78 kg ha^{-1}) was found from T_2: Sole black cumin. Highest LER (1.43) was found from treatment T_3: Groundnut + Black cumin (single row). Index of yield for both sole groundnut and black cumin was 100 but in T_3: Groundnut + Black cumin (single row), groundnut index of yield was 87.32 and for black cumin was 56.41. In T_4: Groundnut + Black cumin (double row), the index of yield for groundnut and black cumin was 69.93 and 51.38 respectively.

Highest gross return, net return and BCR was found from T_3 (199867 Tk. ha^{-1}, 149367 Tk. ha^{-1} and 3.96) over sole groundnut cultivation (T_1) (165600 Tk. ha^{-1}, 118100 Tk. ha^{-1} and 3.49) and T_4: Groundnut + Black cumin (double row) was not profitable (166133 Tk. ha^{-1}, 114133 Tk. ha^{-1} and 3.19) than sole groundnut cultivation. Lowest gross return, net return and BCR was found from T_2: Sole black cumin (97967 Tk. ha^{-1}, 49167 Tk. ha^{-1} and 2.01).

Table 1. Yield, groundnut equivalent yield (GEY) and LER of Groundnut-Black cumin intercropping system in Bandarban during 2021-2022

Treatments	Yield (kg ha^{-1})		GEY (kg ha^{-1})	LER	Index of yield	
	Groundnut	Black cumin			Groundnut	Black cumin
T_1= Sole groundnut	2760	-	2760	1	100	-
T_2= Sole black cumin	-	979.67	1632.78	1	-	100
T_3: Groundnut + Black cumin (single row)	2410	552.67	3331.12	1.43	87.32	56.41
T_4: Groundnut + Black cumin (double row)	1930	503.33	2768.88	1.21	69.93	51.38
CV(%)	4.07	1.27	-	-	-	-
LSD $_{(0.05)}$	0.079	7.04	-	-	-	-

LER= Land equivalent ratio

Table 2. Cost-benefit analysis of Groundnut-Black cumin intercropping system in Bandarban during 2021-2022

Treatments	Gross return (Tk ha^{-1})	Total cost of production (Tk ha^{-1})	Net return (Tk ha^{-1})	B:C ratio
T_1= Sole groundnut	165600	47500	118100	3.49
T_2= Sole black cumin	97967	48800	49167	2.01
T_3: Groundnut + Black cumin (single row)	199867	50500	149367	3.96
T_4: Groundnut + Black cumin (double row)	166133	52000	114133	3.19

Selling price (Tk kg^{-1}): Groundnut: 60, black cumin: 100.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

Farmer's opinion

Groundnut + Black cumin (single row) was found to be more profitable practice with higher economic return. Therefore, this intercropping system could help to meet up the medicinal spice crop requirement of the family without hampering the main crop.

Conclusion

From the result it was found that intercrop combinations was better than sole crop in terms of yield and economic return. The intercrop combination T_3 (Groundnut + Black cumin (single row) performed better and contributed higher benefit cost ration. It can be a good option to river bank of Bandarban farmers for cultivating groundnut with black intercropping system.

VALIDATION OF INTERCROPPING CHILI WITH GROUNDNUT IN HAOR AREAS

M. I. NAZRUL AND F.BEGUM

Abstract

A field experiment was conducted at farmer's field during winter 2021-22 under MLT site, Moulvibazar. Three intercrop combinations such as T1 = Groundnut sole (40 cm X15cm), T2 = Groundnut (100%) + 1 row of chilli at 40 cm spacing (seedling to seedling distance) and T3 = Groundnut + 1 row of chilli at 60 cm spacing (seedling to seedling distance) were considered. The variety BARI Chinabadamm-8 and locally populay chilli cultivar was used in this trial. The experiment was setup in randomized complete block design with three replications. Between two combinations, the highest pod yield (2.62 t ha-1) was observed in T2 (groundnut+ 1 row chilli at 40 cm spacing). On the contrary, in intercrop situation the yields of chilli 6.48 and 5.97 t ha-1 was obtained in T2 (groundnut+ 1 row of chilli at 40 cm spacing) and T3 (groundnut + 1 row of chilli at 60 cm spacing), respectively. The highest groundnut equivalent yield (10.84 t ha-1) was also recorded in T2 (groundnut+ 1 row of chilli at 40 cm spacing) with gross return of Tk. 650400 ha-1 and gross margin of Tk. 509500 ha-1, respectively. Finally, T3 combination (groundnut + 1 row of chilli at 60 cm spacing) provided higher BCR (4.95) compared to that of T2 (groundnut+ 1 row of chilli at 40 cm spacing) and sole groundnut.

Introduction

Haors with their unique hydro-ecological characteristics are large bowl shaped floodplain depressions located in the north-eastern region of Bangladesh covering about 1.99 million ha of area and accommodating about 19.37 million people. Total 373 haors cover an area of about 858,000 ha which is around 43% of the total area of the haor region. Agriculture and fisheries are the main base of the diversified economic resources of the area. A total of about 0.71 million ha of net cultivable land is available in this area, which produces more than 5.25 million tons of paddy each year. However, sudden intrusion of flash flood may destroy agricultural production from about 0.33million ha, worth Tk. 3,486 million or 3% of the national agricultural contribution to the GDP (UNDP, 2012). Agriculture is the principal livelihood of the farmers who practice mono-agriculture. This single crop remains under the constant threat of partial to complete damage from the early onrush of flash floods. Such a situation intercropping might be an option to minimize the sudden loss of farmers doing monoculture. Groundnut (*Arachis hypogaea* L.) is the second important oilseed crop that covered a considerable area in Bangladesh and it is a long durated crop. On the other hand, chili is a very important and valuable spices crop which is usually grown as sole and in some cases as intercrop in farmer's field in various parts of Bangladesh. As the spacing for groundnut cultivation is 40 cm X 15 cm, so there is a scope to intercrop chili with groundnut. This might be economically beneficial for the farmers. Hence this experiment will be undertaken to find out the optimum row arrangement of chili for intercropping with groundnut for higher productivity and return.

Materials and Methods

The experiment was conducted at MLT site, Moulvibazer during the year 2021-22. Three intercrop combinations, $T_{1:}$ Groundnut sole, $T_{2:}$ Groundnut (100%) + 1 row of chilli at 40 cm spacing (seedling to seedling) and $T_{3:}$ Groundnut + 1 row of chilli at 60 cm spacing (seedling to seedling) were considered. The variety BARI Chinabadamm-8 and local chilli was used in this trial. The experiment was setup in randomized complete block design with three replications. The seed of groundnut were sown with maintaining the spacing of 40 cm × 15 cm. The crop was fertilized as per fertilizer recommendation guide (FRG, 2018) BARC, Farm gate, Dhaka. The seeds and seedlings of groundnut and chilli were sown and transplanted on 5-9 December, 2021. Intercultural operations were done as and when necessary. There was no remarkable disease and pest attack. The chilli harvest duration was 15 February to 20 April 2022 and groundnut was harvested during 10-15 May, 2022. Data on yield components were collected from 10 plants selected at random in each plot and seed yield was recorded plot wise. The collected data were analyzed statistically using "STAR" software package and means were separated by LSD.

Results and Discussion

Yield and yield attributes of groundnut

There was no statistically difference in seeds per pod and shelling per cent of groundnut during intercropping with chilli i.e. growing of chilli in interspaces between groundnut rows did not affect the shelling per cent and seeds per pod. Though the pods plant^{-1} was non significant but higher pods plant^{-1} were obtained in sole groundnut (41.50). Maximum seeds pod^{-1} (2.66) was recorded in sole ground nut and lowest (2.00) was recorde in T_3 (groundnut + 1 row of chilli at 60 cm spacing.

The sole groundnut cultivation practice also provided the highest 100 kernel weight (48.40 g) with highest pod yield (2.92 t ha^{-1}) followed by T_2 (groundnut+ 1 row chilli at 40 cm spacing). On the contrary, the lowest pod yield (2.31t ha^{-1}) was obtained from the combination of groundnut + 1 row chilli at 60 cm spacing.

Table 1. Yield and yield attributes of groundnut intercropped with chilli at farmer's field under MLT site, Moulvibazer during 2021-22

Treatment	Pods $plant^{-1}$	Seeds pod^{-1}	100 kernel wt.(g)	Shelling %	Pod yield ($t\ ha^{-1}$)
T_1: Groundnut sole	41.50	2.66	48.40	74.71	2.92
T_2: Groundnut+ 1 row chilli (40 cm)	34.48	2.15	44.90	71.12	2.20
T_3: Groundnut + 1 row chilli (60 cm)	31.72	2.00	44.03	7.56	2.31
CV (%)	10.28	5.57	2.86	2.32.	5.46
LSD $_{(0.05\%)}$	NS	0.29	2.97	NS	0.21

Yield of chilli as companion crop

The yields and market price of companion crops always influenced the treatments combinations of intercropping experimentations. On an average, in intercrop situation the yields of chilli was 6.48 and 5.97 t ha^{-1} in T_2 (groundnut+ 1 row of chilli at 40 cm spacing) and T_3 (groundnut + 1 row of chilli at 60 cm spacing), respectively (Table 2). Results showed that T_2 produced higher yield of chilli over T_3, it might be due to higher number plant population accumodated in T_2 at 40 cm spacing.

Groundnut Equivalent Yield (GEY)

Equivalent yields were expressed in total productivity of system base trials. Groundnut equivalent yields were higher in intercrops (10.84 and 10.27 t ha^{-1}) than sole crop of ground nut (2.92 t ha^{-1}). The highest groundnut equivalent yield (10.84 t ha^{-1}) was recorded in T_2 (groundnut+ 1 row of chilli at 40 cm spacing) intercropped combination which was followed by T_3 (10.27 t ha^{-1}) and the total productivity also increase of 271 and 251 percent over sole bush bean (Table 2).

Table 2. Yield of chilli and groundnut equivalent yield (GEY) in intercropping system 2021-22

Treatments	Yield of chilli ($t\ ha^{-1}$)	GEY ($t\ ha^{-1}$)	% increase of GEY over sole groundnut
T_1: Groundnut sole	-	2.92	-
T_2: Groundnut+ 1 row chilli (40 cm)	6.48	10.84	271
T_3: Groundnut+ 1 row chilli (60 cm)	5.97	10.27	251

GEY: Groundnut equivalent yield; Price (Tk. Kg^{-1}): groundnut- 60, chilli- 80

Cost benefit analysis

Intercrop combination of groundnut with chilli showed higher monetary return than sole crop (Table 3). The highest gross return (Tk. 650400 ha^{-1}) was recorded from T_2 (groundnut+ 1 row of chilli at 40 cm spacing) intercrop combination which was more than 271 percent higher over sole groundnut. On the contrary, T_3 (groundnut + 1 row of chilli at 60 cm spacing) combination gave gross return of Tk. 616200 ha^{-1} and gross margin of Tk. 491767 ha^{-1} with higher BCR (4.95).

Table 3: Cost benefit analysis of groundnut intercropped with chilli, 2021-22

Treatments	Gross return ($Tk.ha^{-1}$)	Total cost ($Tk.ha^{-1}$)	Gross margin ($Tk.ha^{-1}$)	BCR
T_1: Groundnut sole	175200	91500	83700	2.91
T_2: Groundnut+ 1 row chilli (40 cm)	650400	140900	509500	4.61
T_3: Groundnut+ 1 row chilli (60 cm)	616200	124433	491767	4.95

Price (Tk. Kg^{-1}): groundnut- 60, chilli- 80

Farmer's opinions

Farmers cultivating groundnut in Hakaluki area mainly as sole crop but through the experimentation they learned a profitable intercropping practice. As such farmers can earn extra income easily without hampering the main crop and also boost up their family nutrition.

Conclusion

From the result it was found that intercrop combinations was better than sole crop in terms of yield and economic return. The intercrop combination T_3 (groundnut + 1 row of chilli at 60 cm spacing (seedling to seedling) performed better and contributed higher benefit cost ration. It can be a good option to haor farmers for cultivating groundnut with chilli intercropping system.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

VALIDATION OF INTERCROPPING GARLIC, ONION, FENUGREEK, BLACK CUMIN WITH GROUNDNUT IN CHARLAND AREAS BHUAPUR

S. ROY, M. A. H. KHAN, M. M. RAHMAN AND T. TASMIMA

Abstract

An experiment was conducted at the MLT site, Bhuapur during the rabi season of 2021-22 to find out the suitable intercrop combination of groundnut for higher productivity and profitability of Charland areas stakeholders. Five treatments viz., T_1= Sole groundnut (100%)(40cmX15cm), T_2= Two rows of black cumin (15 cm x 10 cm) in between two rows of groundnut(40cmX15cm), T_3= One row of fenugreek(15 cm x 10 cm) in between two rows of groundnut, T_4= One row of garlic (15 cm x 5 cm)in between two rows of groundnut, T_5= One row of onion (15 cm x 5 cm) in between two normal rows of groundnut. Analysis of intercropping treatments revealed that one row of onion in between one row of groundnut resulted in the highest groundnut equivalent yield (9.48 t ha^{-1}) as well as gross margin (Tk. 450348 ha^{-1}) and the lowest groundnut equivalent yield (1.47 t ha^{-1}) as well as gross margin (Tk. 32248 ha^{-1}), were obtained from sole groundnut treatment.

Introduction

An estimated 6.5 million people, around 5% of the Bangladeshi population live on the Char land. Of the total land area of the country, 5% is Char, which comes to about a total area of approximately 7200 square kilometers. The Char dwellers mainly depend on agriculture and agriculture related activities. Groundnut (*Archis hypogea* L.) is the second important oilseed crop that covered a considerable area in Bangladesh and it is a long duration crop. On the other hand, black cumin, onion, garlic, and fenugreek are very important and valuable spices crop which is usually grown as sole and in some cases as intercrop in farmers field in various Charland areas of Bangladesh. The spacing for groundnut cultivation is 40 cm X 15 cm. So, there is a scope to intercrop black cumin, onion, garlic, and fenugreek with groundnut. This might be economically profitable for the farmers. Hence this experiment was undertaken to find out the suitable intercrop combination of groundnut for higher productivity and profitability of Charland areas stakeholders.

Materials and Methods

The experiment was conducted at the MLT site Bhuapur, Tangail under AEZ # 8 during the rabi season 2021-22. The experiment was laid out following RCB design with four replications. The unit plot size was 5 m x 4 m. There were five treatments viz., T_1= Sole groundnut (100%), T_2= Two rows of black cumin in between two rows of groundnut, T_3= One row of fenugreek in between two rows of groundnut, T_4= One row of garlic in between two rows of groundnut, T_5= One row of onion in between two rows of groundnut. Spacing of groundnut was maintained at 40 cm × 15 cm. The plot was fertilized with 45-36-75-30-2-1 kg N-P-K-S-Zn-B ha^{-1} for sole and intercropping treatments. All fertilizers and ½ N of Urea were applied during final land preparation and the rest of Urea was top dressed at flowering stage and covered with soil followed by irrigation. The variety of groundnut was BARI Chinabadam-9, black cumin (BARI Kalozira-1), fenugreek (BARI Methi-1), garlic (BARI Rashun-2), and onion (Taherpuri). Seeds of groundnut and onion were planted on 4 November, 2021. Intercultural operations were done properly for the normal growth and development of the crops. The onion was harvested on 8 March, 2022, black cumin on 20 March, 2022, garlic on 29 March, 2022, fenugreek on 28 March, 2022 and the groundnut on 30 March, 2022. Data on yield and yield contributing attributes were recorded and analyzed with CropStat analytical package. The cost and return analysis were computed on the basis of the prevailing market price.

Results and Discussions

Statistical analysis of data obtained on different yield characteristics of groundnut revealed that there were significant differences between intercropping treatments except for the number of effective pod plant^{-1}. The maximum plant height (37.60 cm) was observed in T_5 treatment. The highest thousand seed weight (547.60 g) and pod yield (1.47 t ha^{-1}) was found when groundnut is grown solely followed by T_5 (1.44 t ha^{-1}) treatment. The maximum groundnut equivalent yield was observed in T_5 (9.48 t ha^{-1}) whereas the lowest in T_1 (1.47 t ha^{-1}). In cost and return analysis, the maximum gross return (Tk. 568800 ha^{-1}) and gross margin (Tk. 450348 ha^{-1}) was observed in T_5 treatment. On the other hand, the lowest gross return (Tk. 568800 ha^{-1}) and gross margin (Tk. 450348 ha^{-1}) were found in T_1 treatment.

Pest incidence: Imitaf was sprayed to control caterpillar and Rovral against fungal infection.

Farmers' opinion: Farmers are interested to grow onion, garlic with groundnut. But they are not willing to grow black cumin and fenugreek with groundnut as intercropping because of germination problem of black cumin and fenugreek.

Conclusion

From the result it was found that intercrop combinations was better than sole crop in terms of yield and economic return. The intercrop combination one row of onion without a significant reduction in groundnut yield. Farmers can earn better economic benefits by following the cultivation of one row onions (15 cm x 5 cm) in between two rows of groundnut (40 cm x 15 cm).

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

Table 1. Yield and yield components of groundnut affected by intercropping with black cumin, fenugreek, garlic, onion at MLT site Bhuapur, Tangail during the rabi, 2021-22

Treatment	Plant height (cm)	Effective pod plant^{-1} (no.)	1000 seed weight (g)	Pod yield (t ha^{-1})
T_1	35.07	17.00	547.60	1.47
T_2	35.80	16.40	508.47	1.30
T_3	33.33	16.07	509.47	1.29
T_4	36.80	17.13	507.33	1.35
T_5	37.60	17.33	525.63	1.44
$LSD_{0.05}$	2.93	NS	25.95	0.14
CV (%)	4.40	5.10	2.70	5.60

Table 2. Yield of black cumin, fenugreek, garlic, and onion affected by different intercropping with groundnut and groundnut equivalent yield at MLT site Bhuapur, Tangail during the rabi, 2021-22

Treatment	Pod yield (t ha^{-1}) of groundnut	Seed yield of black cumin (t ha^{-1})	Seed yield of fenugreek (t ha^{-1})	Bulb yield of garlic (t ha^{-1})	Bulb yield of onion (t ha^{-1})	Groundnut equivalent yield (t ha^{-1})
T_1	1.47	-	-	-	-	1.47
T_2	1.30	0.29	-	-	-	2.51
T_3	1.29	-	0.38	-	-	1.93
T_4	1.35	-	-	2.83		3.71
T_5	1.44	-	-	-	8.04	9.48

Farm gate price (Tk. Kg^{-1}): Groundnut: 60, Black cumin: 250, Fenugreek: 100, Garlic: 50, Onion: 60

Table 3. Cost and return analysis of groundnut intercropping with black cumin, fenugreek, garlic, and onion at MLT site Bhupaur, Tangail during the rabi 2021-22

Treatment	Gross return (Tk. Ha^{-1})	TVC (Tk ha^{-1})	Gross margin (Tk ha^{-1})
T_1	88200	55952	32248
T_2	80852	24900	55952
T_3	115800	78827	36973
T_4	222600	97022	125578
T_5	568800	118452	450348

T_1= Sole groundnut (100%), T_2= Two rows of black cumin in between two rows of groundnut, T_3= One row of fenugreek in between two rows of groundnut, T_4= One row of garlic in between two rows of groundnut and T_5= One row of onion in between two rows of groundnut

VALIDATION OF INTERCROPPING GARLIC, ONION, FENUGREEK, BLACK CUMIN WITH GROUNDNUT IN CHAR LAND AREA JAMALPUR

J. RAHMAN, M M KADIR, M K ALAM AND F. BEGUM

Abstract

The experiment was conducted at Nawvanger char, sadar, Jamalpur. The experiment was conducted at the during rabi 2021-2022 to find out the suitable intercrop combination of groundnut for higher productivity and profitability of Charland areas stakeholders. Five treatments viz., T_1= Sole groundnut (100%) (40cmX15cm), T_2= Two rows of black cumin (15 cm x 10 cm) in between two rows of groundnut(40cmX15cm), T_3= One row of fenugreek (15 cm x 10 cm) in between two rows of groundnut, T_4= One row of garlic (15 cm x 5 cm) in between two rows of groundnut, T_5= One row of onion (15 cm x 5 cm) in between two normal rows of groundnut. Analysis of intercropping treatments revealed that one row of onion in between one row of groundnut resulted in the highest groundnut equivalent yield (7.04 t ha-1) as well as BCR (4.48) and the lowest groundnut equivalent yield (2.10 t ha-1) as well as BCR (1.63) were obtained from sole groundnut treatment.

Introduction

Groundnut is one of the most important annual crops in the world, rich in food nutrients with about 20% protein, 40% oil, minerals and vitamins (Daudi, H. *et al.* 2018). In Bangladesh, there are about 0.82 million hectares of char land "Charland'' is the Bengali term, its English meaning is "Riverine Island" for mid-channel island that emerges periodically from riverbed as a consequence of accretion. Intercropping is the cultivation of two or more crop species in close intermingling on the same field for the whole or a part of their growing period. Intercropping generally produces more yields per unit of land than sole cropping and reduces the risk of crop failure due to pests and diseases (Zhang et al., 2019). Intercropping is receiving increasing global interest as an agricultural practice as farmers strive to be more sustainable and maintain soil health (Glaze-Corcoran et al., 2020). Intercropping has greatly induced plant growth and the interspecific interactions give some crops nutrient competitive advantages significantly superior yield levels (Salgado, G.C. et al; 2021). Due to decreasing cultivable land, farmers of char areas (Riverine Island) in Bangladesh have been practicing intercropped garden pea with onion, coriander with onion, sweet gourd with onion, vegetables, pulse and oilseed crops with wheat, different gourds with brinjal are common practice to the farmers of char areas. Intercropping of groundnut with different spices crops may increase total productivity as well as increase crop diversity instead of sole spices crop or sole groundnut. In context, the present validation programme will be conducted to the suitable combination of groundnut for higher productivity and profitability of charland area stakeholders.

Materials and Methods

The experiment was conducted at Nawvanger char, sadar, Jamalpur, Bangladesh 24°57´ north latitudes and 89°55´ east longitudes. The experimental site was of medium high land belonging to the agro-ecological zone Old Brahmaputra Floodplain under Agro-Ecological Zone 9 (UNDP & FAO, 1988). The experiment was conducted at the during *rabi* 2021-2022 to find out the suitable combination of groundnut for higher productivity and profitability of charland area stakeholders. Design of the experiment was RCB with 03 (three) replications having the unit of plot 3m × 2m. BARI Badam-9, BARI Methi-2, BARI Rasun-2, BARI Piaj-4 and BARI Kalozira-1 were used as a variety in the experiment. Treatments included in the experiment were: T_1=Sole groundnut, T_2= two rows of black cumin in between two normal rows of groundnut, T_3= one row of fenugreek in between two normal rows of groundnut, T_4= one row of garlic in between two normal rows of groundnut and T_5 = one row of onion in between two normal rows of groundnut. ½ N and all other fertilizers as basal. Rest N will be applied at 30-35 and 55-60 DAS after irrigation (FRG, 2018). Crops were sown on November 23, 2021 and harvested from April 02, 2022 to April 29, 2022. Intercultural operations like watering, weeding and spraying insecticides were followed as and when necessary. Collected data were analyzed statistically with the help of STAR software and mean separation was done as per LSD test at 5% level of significance.

Results and Discussion

Although total yields of groundnut/spices intercropping were higher than that of sole spices and groundnut. Another important aspect for groundnut/spices intercropping is the efficient use of light because of complementary use of space between the spices plants and the groundnut plants. The complementary effect is also shown for the length of the growth period because their life cycles are different with the maturity of intercropped. The yield, gross return, variable cost and BCR of groundnut/spices are presented in Table 1. From the table, it was revealed that groundnut/spices intercrop gross return and BCR per hectare were found higher than from sole crop system. In sole crop system which performed less BCR than intercropped system which range 1.63 - 4.48. Groundnut Equivalent Yield (GEY) was highest from one row of garlic in between two normal rows of groundnut (7.04 t/ha) intercropped system which was statistically similar to one row of onion in between two normal rows of groundnut (6.23 t/ha).

Table 1. Yield and economics of intercropping spices with groundnut at charland 2021-2022

Treatment combination	Yield (t/ha)		Gross return	TVC	BCR	GEY
	Groundnut	Spices crop	($Tk.ha^{-1}$)	($Tk.ha^{-1}$)		
Sole groundnut	2.10	-	147000	90000	1.63	2.10
Two rows of black cumin in between two normal rows of groundnut	1.76	0.7	207200	100000	2.1	2.96
One row of fenugreek in between two normal rows of groundnut	1.81	0.9	207700	100500	2.1	2.97
One row of garlic in between two normal rows of groundnut	1.83	7.30	493100	110000	4.48	7.04
One row of onion in between two normal rows of groundnut	1.86	10.2	436200	120000	3.64	6.23

Groundnut= 70 Tk per kg; black cumin = 120 Tk per kg; fenugreek = 90 Tk per kg; garlic = 50 Tk per kg and onion = 30 Tk per kg

Conclusion

The increased yield with the intercropping was largely due to improved interspecies interaction and facilitation. Intercropping in order to improve land use efficiency, take advantage of intercropping facilitation and improve economic benefits. Also, linked with the higher yield, the associated higher amount of spice-legume by-product is preferred for animal feed or human consumption. Therefore, groundnut/spices intercropping systems increase productivity, economic and nutritional development of charland stakeholders.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

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ON-FARM ADAPTIVE TRIAL OF MUSTARD GENOTYPE IN LEVEL BARIND TRACT AREAS

MS ALAM, MRA MOLLAH AND MA ISLAM

Abstract

The experiment was carried out at the MLT site, Joypurhat, during the rabi season of 2021-22, to observe the performance of three promising mustard genotypes, i.e., BJDH-11, BJDH-12 and Jun-536, regarding yield potentiality, where BARI Sarisha-16 was as check. The experimentation consisted of four treatments, i.e., BJDH-11, BJDH-12, Jun-536 and BARI Sarisha-16. The highest seed yield of 2.19 t ha-1 was recorded from BARI Sarisha-16,followed by Jun-536 (1.91 t ha-1), and BJDH-11 (1.75t ha-1), and the lower seed yield of 1.63 t ha-1 was obtained from BJDH-12. The highest yield contributed to the highest gross return (Tk. 201780 ha-1) and gross margin (Tk. 156437ha-1) in BARI Sarisha-16, followed by Jun-536, whereas the lowest gross return Tk. 150670 ha-1 and gross margin Tk. 105327 ha-1 was recorded in BJDH-12.

Introduction

Bangladesh has a great deficit in oilseed production. The production is only one-third of the requirement. A huge amount is being spent on importing edible oil and oilseeds to meet the need. Rapeseed and mustard, groundnut, soybean, niger and sunflower are the major oil crops grown in Bangladesh. These crops cover an area of about 0.75 million hectares producing about 0.36 million tons of edible oil. So far, BARI has released 18 varieties of mustard. Among the mustard varieties, BARI Sharisha-11 and 16 (*B. juncea* type) are high yielding, long-duration (105-115 days) and suitable for late planting where Boro rice cannot be grown to lack of irrigation facilities. The *B. juncea* type is more popular, especially in the Barind region, for its higher yield and fuel purposes. There are some promising lines/genotypes in the pipeline for release. They need to go for an adaptive trials at the on-farm level to assess their yield potential. Therefore, the experiment was conducted to screen out high yield potential long-duration mustard genotype capable of giving yield with minimum exploitation of water in level Barind areas of Joypurhat.

Materials and methods

The experiment was conducted at the MLT site, Joypurhat, under the AEZ-25 during the rabi season of 2021-22 to assess the yield potentiality of mustard genotypes compared to check variety BARI Sarisha-16. The experiment was laid out in an RCB design with three replications. It consisted of four treatments, i.e., T_1= BARI Sarisha-16,T_2=Jun-536, T_3=. BJDH-11 and T_4= BJDH-12. The unit plot size was 20 m^2. Seeds of each variety were sown continuously in the field, maintaining a distance of 30 cm from row to row on 30 November, 2021. The fields were fertilized with 120-34-45-30-1.8 kg N-P-K-S-B ha^{-1} respectively. All the total amount and half of urea fertilisers were applied during final land preparation. The rest half urea was applied as a top-dress at 26 DAS, followed by irrigation. Single weeding to control dryland weeds alongwith thinning were done before irrigation to keep the optimum plant population on the field. The fields were infested with aphids and *Alternaria* leaf spots. Insecticide Sobicron and fungicide Rovral 50wp were applied three times at 7 to 10 days, depending on pest incidence. The crops were harvested on 15 March 2022. All the relevant data were recorded carefully and analysed statistically.

Results and Discussion

From table 1, it has been shown that all the plant and yield contributing characters varied significantly among the treatments. Plant height was varied among the mustard genotypes. The highest plant height (168.07cm) was observed in BARI Sarisha-16 followed by BJDH-12 (161.47 cm), BJDH-11 (16140 cm) and the lowest plant height was found in Jun-536 (151.60 cm). The higher number of branch/plant (4.26) was recorded from BARI Sarisha-16 followed by Jun-536 (3.63), and the lowest was found in BJDH-11 (3.20), which was identical to BJDH-12 (3.23). The plant population was non-significant among the treatments, ranging from 90.86 to 95.40 plants m^{-2}. The maximum nos. of siliqua $plant^{-1}$ was obtained from BARI Sarisha-16 (52.40). The lowest no. of siliqua $plant^{-1}$ was found in BJDH-12 (39.33) identical to Jun-536 and BJDH-11. The highest nos. of seeds $siliqua^{-1}$were also found in BARI Sarisha-16 (12.83) and the lowest from BJDH-11 (8.87). The 1000- seeds weight (g) was significantly varied among the treatments. The maximum 1000- seeds weight was obtained from BARI Sarisha-16 (4.40 g), and the minimum 1000- seeds weight was found in BJDH-11 (3.40 g), which was statistically similar to that of BJDH-12 (3.50 g) and Jun-536 (3.43 g). The maximum seed yield was observed in BARI Sarisha-16 (2.19 t ha^{-1}), followed by Jun-536 (1.91 t ha^{-1}), and the minimum was obtained from BJDH-12 (1.63 t ha^{-1}). Higher yield contributing characters like nos. of siliqua $plant^{-1}$, seeds $siliqua^{-1}$, and thousand seed weight resulted in higher seed yield in BARI Sarisha-16 followed by the tested genotypes. Like grain yield, the straw yield was also significant among the mustard varieties. The highest stover yield was found from BARI Sarisha-16 (3.02 t ha^{-1}) followed by Jun-536 (2.92 t ha^{-1}), and the lowest stover yield was observed in BJDH-12 (2.41 t ha^{-1}).

Table 1.Yield and yield contributing characters of mustard varieties from the experimentation conducted at MLT site, Joypurhat during rabi season of 2021-22.

Treatment	Plant height (cm)	Plant population no	No of Branch / Plant	No. of siliqua/ plant	No. of seed/ siliqua	1000 seed weight (g)	Grain yield (tha^{-1})	Stover yield (tha^{-1})
T_1= BARI Sarisha-16	168.07 a	90.86	4.26 a	52.40 a	12.83a	4.40a	2.19 a	3.02 a
T_2=Jun-536	151.60 b	92.83	3.63 b	43.93 b	11.03 b	3.43 b	1.91 b	2.92 b
T_3= BJDH-11	16140 b	95.40	3.20 c	43.53 b	8.87 d	3.40 b	1.75 c	2.72 c
T_4= BJDH-12	161.47 b	93.97	3.23 c	39.33 b	10.00 c	3.50 b	1.63 c	2.41 d
CV (%)	4.57	NS	4.94	6.95	3.40	2.57	4.56	5.69

Cost and return analysis

Cost and return analysis from table 2 indicated that the highest gross return Tk. 201780.0 was obtained from BARI Sarisha-16,followed by Jun-536 (Tk. 176840), BJDH-11 (Tk. 162160) and the lowest gross return, Tk. 150670 was from BJDH-12. Higher gross return contributed to the higher gross margin in BARI Sarisha-16 (Tk. 156437 ha^{-1}) and lower in BJDH-12 (Tk. 105327 ha^{-1}) against the cultivation cost Tk. 45343 ha^{-1}.

Table 2: Cost and return analysis of different mustard genotypes obtained from experimentation conducted during the rabi season, 2021-22 at MLT site, Joypurhat

Treatment	Total return (Tk ha^{-1})			Total cost (Tk ha^{-1})	Gross margin (Tk ha^{-1})
	From grain(Tk)	From straw (Tk)	Total (Tk)		
T_1= BARI Sarisha-16	192720	9060	201780	45343	156437
T_2=Jun-536	168080	8760	176840	45343	131497
T_3= BJDH-11	154000	8160	162160	45343	116817
T_4= BJDH-12	143440	7230	150670	45343	105327

*Grain= 88.0 Tk kg^{-1} *Straw= 3.0 Tk kg^{-1}

Farmer's opinion

Sl. No.	Points to be considered	Farmer's evaluation
1.	Yield potentiality	BARI Sarisha-16 and Jun-536 were high yield potential
2.	Crop duration	Long duration crop (about 90 days)
3.	Pest infestation	Less but *Alternaria* spot and Aphid were found

Conclusion

From the above discussion, the tested genotypes i.e., BARI Sarisha-16 and Jun-536 were higher yielders than BJDH-11 and BJDH-12. As it was first-year of observation, therefore, the tested genotypes needed next year's trial for final recommendation.

PERFORMANCE OF GROUNDNUT VARIETIES AT CHARLAND IN FARIDPUR

S. AHMED, AFM R. QUDDUS AND F..BEGUM

Abstract

An adaptive trial was conducted at North channel (char area) of Faridpur sadar, Faridpur under AEZ-10 during the kharif I, 2021 to find out a suitable groundnut variety for the charland and to popularize the variety (ies) among the farmers. Three high yielding varieties of groundnut viz., BARI Chinabadam-8, BARI Chinabadam-9, BARI Chinabadam-10 and one local variety (Dhaka-1) were used as check in this experiment. The experiment was laid out in randomized complete block design (RCBD) with five dispersed replications. The highest average nut yield (2.75 t ha-1) was recorded in BARI Chinabadam-10 which was statistically similar with other tested varieties except local. The highest number of nuts plant-1 and 100 kernel weights were closely associated providing the highest nut yield ha-1 of BARI Chinabadam-10. The lowest nut yield (1.72 t ha-1) was obtained from the local variety, Dhaka-1. The yield was 60% higher in BARI Chinabadam-10 over Dhaka-1.The highest gross return (Tk. 192500 ha-1) and gross margin (Tk. 107802 ha-1) was also observed in BARI Chinabadam-10 variety might be due the highest yield potentiality.

Introduction

Groundnut (*Arachis hypogaea*) is an important and leguminous oilseed crop. It is cultivated during rabi and kharif seasons under rainfed condition. Each of 100 g edible portion of groundnut contain 3.0 g moisture, protein 25.3 g, fat 40.1 g, minerals 2.4 g, crude fiber 3.1 g, carbohydrates 26.1 g, energy 567 Kcal, calcium 90 mg, phosphorus 350 mg, iron 2.5 mg (Gopalan *et. al.*, 1989). *Brady rhizobium* bacteria form nodules in the roots of groundnut plant which fixes atmospheric nitrogen. Farmers of charland of Faridpur usually grow groundnut with local variety, Dhaka-1. But there is a lot of scope to cultivate the BARI released HYV of groundnut in this area. Hence, the study was under taken to find out a suitable groundnut variety for char land and to popularize the variety (ies) among the char farmers.

Materials and Method

The experiment was conducted at charland of Faridpur named North channel under AEZ-10 during the kharif I, 2021 to find out a suitable groundnut variety for the charland and to popularize the variety (ies) among the farmers. Three improved varieties of groundnut viz., BARI Chinabadam-8, BARI Chinabadam-9, BARI Chinabadam-10 and one local variety (Dhaka-1) was used as check in the experiment. The experiment was laid out in randomized complete block design (RCBD) with five dispersed replications. Crop management practices used was shown in Table 1. Before sowing, seeds were treated with Provax @ 0.2% to prevent seed and soil borne diseases. The entire amount of urea, TSP, MP, gypsum, zinc sulphate mono hydrate and boric acid were applied during final land preparation. One hand weeding was done at 45 DAS. The cost and return were calculated on the basis of prevailing market price of the commodities. At harvesting stage, different data were collected properly and analyzed statistically using open-source software "R" and the means were separated by DMRT (Gomez and Gomez, 1984).

Table 1. Crop management practices used at Faridpur during kharif I, 2021

Sowing time	**Harvesting time**	**Fertilizer dose (N-P-K-S-Zn-B kg ha^{-1})**
11 February 2021	10 June 2021 (119 DAS)	50-50-30-35-2-1.5

Results and Discussion

All the yield and yield contributing characters showed significant difference among the tested varieties (Table 2). The highest plant height (50.92 cm) was obtained from BARI Chinabadam-10 and the lowest from local (37.7 cm). Number of plant population m^{-2} ranged between 16.40 to 18.00. The highest number of effective nut plant^{-1} (27.68) was recorded in BARI Chinabadam-10 followed by BARI Chinabadam-9 (27.48) which were significantly similar among the tested varieties. The significantly lowest number of effective nut plant^{-1} (24.66) was recorded from local. The statistically similar 100-nut weight was recorded in BARI Chinabadam-8, 9 & 10 (71.6 to 72.6 g) whereas the lowest was in local (67.8 g). The highest 100 kernel weight was calculated from BARI Chinabadam-10 (42.8 g) which was statistically similar with BARI Chinabadam-8 (42.6 g) and BARI Chinabadam-9 (42.8g). The highest 100 kernel weight was calculated from local (37.8 g). The highest average nut yield (2.75 t ha^{-1}) was recorded in BARI Chinabadam-10 which was significantly similar among the tested varieties except local. The highest number of effective nuts plant^{-1} and 100 kernel weight were closely associated with highest nut yield ha^{-1} for BARI Chinabadam-10. The lowest nut yield (1.72 t ha^{-1}) was obtained from the local variety, Dhaka-1.

The highest gross return was observed Tk. 192500 ha^{-1} from BARI Chinabadam-10 and the gross margin Tk. 107802 ha^{-1} was also maximum in the same variety might be due to the highest yield potentiality. The lowest gross return Tk. 120400 ha^{-1} was recorded in local. The highest BCR (2.27) was also obtained from BARI Chinabadam-10 (Table 3).

Table 2. Yield and yield contributing characters of groundnut at char land of Faridpur during kharif I, 2021

Variety	Plant height (cm)	Plant population (m^{-2})	Effective nut plant^{-1} (no.)	Hundred nut wt. (g)	Hundred kernel wt. (g)	Nut yield (t ha^{-1})
BARIChinabadam-8	46.76 a	16.80 b	25.84 ab	71.8 a	42.6 a	2.58 a
BARIChinabadam-9	46.09 a	17.00 ab	27.48 ab	72.6 a	42.4 a	2.64 a
BARI Chinabadam-10	50.92 a	16.40 b	**27.68** a	71.6 a	**42.8** a	2.75 a
Local (Dhaka-1)	37.70 b	18.00 a	24.66 b	67.8 b	37.8 b	1.72 b
CV (%)	7.83	4.73	8.13	2.67	2.38	6.21

Table 3. Cost and return of groundnut varieties in Faridpur during kharif I, 2021

Treatment	Nut yield ($t\ ha^{-1}$)	Gross return ($Tk\ ha^{-1}$)	Variable cost ($Tk\ ha^{-1}$)	Gross margin ($Tk\ ha^{-1}$)	BCR
BARIChinabadam-8	2.58	180600	84698	95902	2.13
BARIChinabadam-9	2.64	184800	84698	100102	2.18
BARI Chinabadam-10	2.75	192500	84698	107802	2.27
Local (Dhaka-1)	1.72	120400	79898	40502	1.51

Price of input ($Tk\ kg^{-1}$): Urea: 16.00, TSP: 22.00, MoP: 15.00, Gypsum: 10.00, Zinc: 220.00, Boron: 250.00, whole nut: 200.00
Output price ($Tk\ kg^{-1}$): Nut: 70.00

Farmer's opinion

Farmers preferred BARI Chinabadam-10 for its the highest yield. They also opined less pest infestation all HYV varieties compared to local one. They want short duration groundnut variety for avoiding flood situation during 1st week of June (harvesting time).

Conclusion

The yields of all the high yielding groundnut varieties were higher than local one. The yield was 60% higher in BARI Chinabadam-10 over Dhaka-1. The HYV groundnut varieties were also less susceptible to pest infestation as compares to Dhaka-1. This was first year trial. For final decision, next year trial will be conducted.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

PERFORMANCE OF SUNFLOWER GENOTYPES IN SOUTHERN REGION OF BANGLADESH

O. A. FAKIR AND F. BEGUM

Abstract

The experiment was executed in on-station of Agricultural Research Station, Binerpota, Satkhira during the rabi season of 2021-2022. The purpose of the study was to evaluate the performance of sunflower varieties in coastal saline area. Two sunflower varieties viz. BARI Surjamukhi-2 and BARI Surjomukhi-3 were taken in this study. Yield was significantly varied. Between two varieties BARI Surjomuhi-2 gave the highest yield and it was 2.73 t/ha while BARI Surjomukhi-3 produced 2.17 t/ha. During crop growing period the average soil salinity was 4.65 to 5.75 dS/m.

Introduction

Out of 2.85 million hectares of the coastal and offshore areas of Bangladesh about 1.06 million hectares lands are affected by different degrees of salinity (Banglapedia, 2015). This is more than 30% of the total cultivable lands. Agricultural land use in the coastal districts is very poor. Salinity causes unfavorable environment and hydrological situation that restrict normal crop production throughout the year. The cultivation of dry season crop in this situation requires suitable crops and agronomic options suitable for early planting in the excess moist soil, (more than field capacity) which is unable to plough to increase the productivity and cropping intensity.

Sunflower is an important minor oilseed crop in Bangladesh. The oil of sunflower is rich in essential fatty acid like linoleic and linolenic acid compared to rapeseed-mustard oil. The present domestic edible oil seed production is 373 thousand tons which meets only one third of the national demand. The present per capita oil consumption is only 10 g/day as compared to the total need of 22 g/day.

The cultivation of sunflower may be suitable in the coastal saline environment because of its high yield as well as its extensive adaptability and acclimation, high photosynthesis potential and high harvest index. According to water stress day index, sunflower was determined as a moderately sensitive crop to salinity. Being a deep rooted crop sunflower can overcome soil salinity in some extent. Bangladesh Agricultural Research Institute has developed three sunflower in breed varieties which can easily grown in coastal saline area. Therefore the production programme is undertaken to increase cultivation and popularize this oil seed crop in farmers level.

Materials and Methods

The experiment was conducted in on-station of Agricultural Research Station (ARS), Binerpota, Satkhira during rabi season, 2021-2022. The objective of the study was to evaluate the performance of BARI developed two sunflower varieties in saline area of Satkhira. Two sunflower varieties were BARI Surjomukhi-2 and BARI Surjomukhi-3 were taken as treatment in this experiment. The experiment was laid out in randomized complete block design (RCBD) with three replications. The unit plot size was 11mx4m. The land was prepared by 2-3 ploughing to gain good tilth condition and fertilized with 90-35-80-30-4 kg/ha of N-P-K-S-Zn+5 t/ha CD in the form of urea, TSP, MoP, gypsum and zinc sulphate. All fertilizers and half of total amount of urea were applied as basal during final land preparation. Rest amount of urea was broadcasted at 25 and 45 days after emergence (before flowering). Seeds were sown on 22 December, 2021 in joe condition. Before sowing seeds were treated with Provax-200 WP at the rate of 2.5 g/kg of seed. Weeding and thinning were done as and when necessary. The land was irrigated two times. No insect and disease was seen at standing crop. The crop was harvested on 24 March, 2022 at physiological maturity stage. Yield and yield components of sunflower were recorded and data were analyzed statistically.

Results and Discussion

Yield and yield attributes of sunflower varieties grown in on-station, Agricultural Research Station, Binerpota, Satkhira are presented in Table 1. Significant differences was found in yield and few yield components. The highest seed yield was recorded from BARI Surjamukhi-2 and it was 2.73 t/ha. Higher number of seeds per head contributed to make this variety higher yielder. The lowest yield was recorded from BARI Surjamukhi-3 with the yield of 2.17 t/ha. During crop growing period the average soil salinity was 4.65 to 5.75 dS/m.

Table 1. Yield and yield attributes of sunflower grown in on-station, ARS, Benarpota, Satkhira during the rabi season 2021-2022

Variety	Days to first flowering	Field duration	Plant Population (no.)	Plant ht. (cm)	Single head wt. (g)	Head diameter (cm)	Seeds/ head (no.)	HSW (g)	Seed yield (t/ha)
BARI Surjamukhi-2	57.00	92.00	8.00	141.45a	265.07a	16.153a	709.80a	7.00	2.73a
BARI Surjamukhi-3	55.00	92.00	8.00	70.05b	204.40a	14.293a	510.87b	5.00	2.17b
CV (%)	-	-	-	4.46	18.58	3.88	6.16	-	3.33

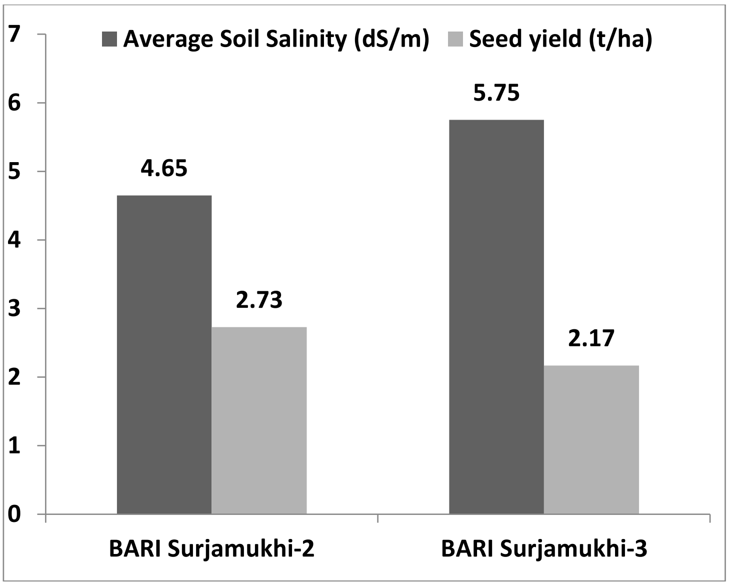

Fig. 1. Average soil Salinity and Yield performance

Conclusion

Results showed that BARI Surjamukhi-2 gave the highest yield. Further trial was required with this same varieties to draw final recommendation.

Acknowledgement

The authors are grateful to honourable Director General, BARI along with all respected Directors, all Divisional CSO, In-charge, ARS, Satkhira and ‘Enhance Production of Oil crops (BARI Part)’ project for their inspiration, financial support and regular supervision.

PERFORMANCE OF SUNFLOWER GENOTYPES IN THE HILLY AREAS OF BANGLADESH

M. A. HOSSAIN, M. ISLAM AND M.KARIM

Abstract

An experiment was conducted at the Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati Hill District during rabi season 2021-22. There were two varieties of Sunflower BARI Surjamukhi-2 and BARI Surjamukhi-3. The objective was to compare the performance of developed varieties of sunflower. The days taken for first flowering of BARI Surjamukhi-2 was 61.3 which was similar to BARI Surjamukhi-3 (59.3). The variety BARI Surjamukhi-3 was the most dwarf (93.3 cm) and significantly different from BARI Surjamukhi-2 (172.0 cm). Head weight was highest in the BARI Surjamukhi-2 (144.0 g) followed by BARI Sunflower-3 (136.3 g). Hundred seed weight was higher than others in BARI Surjamukhi-2 (9.3 g). The seed yield was significantly higher in BARI Surjamukhi-2 (2.3 t/ha) followed by variety BARI Surjamukhi-3 (1.9 t/ha).

Materials & Methods

The land was prepared with 4-5 crossed plough and harrowing for pulverizing the soil. The materials were two varieties of sunflower BARI Surjamukhi-2 and BARI Surjamukhi-3. The seeds were sown on 14 December 2021 maintaining 50 × 25 cm spacing. The fertilizer applied @ 200 kg urea, 150 kg TSP and 150 MoP, 120 kg gypsum, 8-10 kg Zinc Sulphate, 10 kg Boric acid per hectare. Urea was applied as split and One third Urea and other fertilizers were applied during land preparation. The rest of urea was applied during 20-25 days and 40-45 days after germination. Other intercultural operations were done according to BARI technology hand book. The crop was harvested on Mid-March 2022. Data were recorded properly and analyzed with ‘R’ open source software.

Result and discussions

Yield and yield contributing characters are significantly different between two varieties.

The days taken for first flowering of BARI Surjamukhi-2 was 61.3 which was similar to BARI Surjamukhi-3 (59.3). The variety BARI Surjamukhi-3 was the most dwarf (93.3 cm) and significantly different from BARI Surjamukhi-2 (172.0 cm). Head weight was highest in the BARI Surjamukhi-2 (144.0 g) followed by BARI Sunflower-3 (136.3 g). Hundred seed weight was higher than others in BARI Surjamukhi-2 (9.3 g). The seed yield was significantly higher in BARI Surjamukhi-2 (2.3 t/ha) followed by variety BARI Surjamukhi-3 (1.9 t/ha)

Table. Performance of Sunflower genotypes in the Hilly areas of Bangladesh during rabi season 2020-21

Variety/Line	First flowering (days)	Plant height (cm)	Single head weight (g)	Seeds/ head (no.)	Head diameter (cm)	100 seed weight (g)	Yield (t/ha)
BARI Surjamukhi-2	61.0 a	172.0 a	144.0 a	460.0 a	15.6	9.3 a	2.3 a
BARI Surjamukhi-3	59.3 b	93.3 b	136.3 b	440.0 b	13.0	8.5 b	1.9 b
CV (%)	6.7	13.6	15.2	9.8	5.4	6.2	7.4

Conclusion

Both varieties of sunflower showed good performance. Considering the yield and other character, both varieties of sunflower may be selected for cultivation in hilly areas.

PERFORMANCE OF SUNFLOWER VARIETIES IN BORGUNA

MM ISLAM, KN ISLAM AND MSI KHAN

Abstract

The experiment was conducted at Amtoli, Borguna during the Rabi season, 2021-22 to evaluate the performance of sunflower varieties in coastal saline environment under farmers' field condition. Three sunflower varieties i.e. BARI Surjamukhi2, BARI Surjamukhi-3 and Hysan-33 were evaluated in the trial. Statistically significant differences were found in grains/head, 1000 grain wt. and grain yield. The highest yield was observed from the Hysun-33 (1.98 t/ha) that are statistically similar to BARI Surjamukhi-2 (1.95) and the lowest yield was obtained from the BARI Surjomukhi-3 (1.72t/ha).

Introduction

Sunflower (*Helianthus annuus)* known as surjomukhi is an annual or perennial herb. In accordance with the current forecast scenarios of the increase in human population and climate change, it is assumed that current sunflower production is insufficient for the future needs (Radanovic *et al.,* 2018). Sunflower contains 42% oil. It also contains linolic acid and Omega 3 & 6 fatty acid which is most essential for human health. One kg Sunflower seed brings 500-600 ml oil which is greater than any other oil seeds. In every year we spend a lot of money for importing oil to meet the national demand. In the southern part of Bangladesh, most of the land remains fallow in the winter Rabi season due to scarcity of rain or irrigation water and soil salinity constraints. A single crop of T. aman rice is grown in a calendar year. Knowledge on the effect of the environmental factor on growth and development of the crop could reduce the possibilities of significant yield loss and improve the selection of specific cultivars for growing in the target region (Jeromela et al., 2011). Marinkovic et al., (2011) concluded that the variation of seed yield in sunflower was mainly caused by location, indicating the narrow adaptability of specific environment. There is scope to introduce saline and drought tolerant crops like sunflower in coastal areas. Now, the need is adopting high yielding varieties in coastal climate. BARI has already released 02 sunflower varieties of which BARI Surjamukhi -2 is high yielder. BRAC is marketing a variety, Hysan-33 that is popular to southern farmer. So, the trial was under taken to compare the performance of BARI Surjamukhi -2, BARI Surjamukhi -3 with locally popular variety Hysan-33 variety.

Materials and Methods

The experiment was conducted at Amtoli, Borguna during the Rabi season, 2021-22 to evaluate the performance of advanced lines and varieties of sunflower in coastal saline environment under farmers field condition. Three sunflower varieties BARI Surjamukhi-2, *BARI* Surjamukhi-*3 and* Hysan-33 were evaluated in the trial. BARI Surjamukhi-2 and 3 is a composite variety. Hysan-33 is a hybrid variety marketed by BRAC. The materials were evaluated in RCB design with 3 compact replications. The experimental land was ploughed with 4 pass then laddered to prepare plots. Chemical fertilizer was applied @ $N_{90}P_{75}K_{30}S_{25}$ kg/ha. Half Urea and full doses of all other fertilizers were applied at final land preparation. The rest Urea was applied in two equal split at 25 days after sowing (DAS) and 45 DAS. Unit plot size was 8mx5m. Seeds were sown on 07 January 2022 maintain 60cm x 25cm spacing. The field was irrigated twice at 25 DAS and 45 DAS in the growing season. To control catterpiller, Admair and Cortan Plus were sprayed twice at flowering stage and grain filling stage. Soil samples were collected from each plot at 15 days interval for salinity measurement in laboratory. The crops were harvested 10 April to 25 April 2022. Yield and yield attributes were recorded properly and analyzed over the location.

Result and Discussion

The growth and yield contributing characters of the tested varieties were presented in Table 1. The significant variations were found among the varieties in terms of growth and yield contributing characters. Among the varieties flowering started earlier in BARI Surjamukhi-3 and also matured 8-10 days earlier than BARI Surjomukhi-2. Hysan 33 took the highest times (120 days) to be matured. The tallest plants were found in BARI Surjamukhi-2 (159.4 cm) that was statistically similar with Hysun 33. The variety Hysun -33 produced the biggest size head (69.1 cm) with the highest number of seeds (447.1) but 1000 seed weight was lower than BARI developed variety. The highest yield was observed in Hysun-33 (1.98 t/ha) followed by BARI Surjomukhi-2 (1.95 t/ha) and lowest yield was found in BARI Surjomukhi-3 (1.72 t/ha). Considering economic analysis the highest return was obtain from Hysun 33 (Tk.138600) but higher gross margin (Tk.60900) as well as higher BCR (1.81) was found in BARI Surjamukhi-2 of its lower seed price and less fertilizer requirement. BARI Surjomukhi-3 was dwarf variety and early maturity but bird infestation were so high.

Table 1. Yield and yield contributing characters of Sunflower varieties/lines during Rabi 2021-22 at Amtoli, Borguna

Varieties/lines	Plants/ m2	Days to maturity	Plant height (cm)	Head diameter (cm)	No of seed/head	1000 seed wt. (g)	Seed yield (t/ha)
BARI Surjomukhi 2	08	105	159.4a	62.7a	425.8a	65.23a	1.95a
BARI Surjomukhi-3	08	90	90.1b	52.5b	387.7b	61.97b	1.72b
Hysun 33	06	115	153.8a	69.1a	447.1a	63.24b	1.98a
CV (%)			2.031	4.986	5.176	4.02	4.78
$LSD_{5\%}$			6.184	6.946	9.784	3.867	0.896

Table2. Average yield and economic return of sunflower during Rabi season 2021-22

Varieties/lines	Total yield (t/ha)	Gross return (Tk/ha)	TVC (Tk/ha)	Gross margin (Tk/ha)	BCR
BARI Surjomukhi 2	1.95	136500	75600	60900	1.81
BARI Surjomukhi-3	1.72	120400	75600	44800	1.60
Hysun-33	1.98	138600	85400	53200	1.62

Note: Sunflower @ 70Tk/kg

Farmers' reaction

Farmers opined that among the three varieties Hysun-33 performed better, plants were similar in height, flowers initiation start in a same time in all the plants. The yield of BARI Surjomukhi-2 is about to same of Hysun-33. Plants of BARI Surjomukhi-3 are very short but yield is very low and bird attack is severe in this variety. The farmers showed their interest to grow sunflower next year to fulfill their oil consumption if the seeds were made available in the local market.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

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PROJECT III: DISEASE MANAGEMENT

SCREENING OF RAPESEED-MUSTARD VARIETIES/LINES AGAINST ALTERNARIA BLIGHT DISEASE OF MUSTARD

M. S. HOSSAIN

Abstract

The experiment was conducted during 2021-2022 at Joydebpur to find out the resistant lines of rapeseed-mustard against Alternaria blight disease. A total of thirty nine (39) lines of Brassica campestris. were tested. A susceptible check variety Tori-7 was used as standard check. Among the 39 test lines all the lines were found susceptible.

Introduction

Blight of mustard caused by *Alternaria brassicae* is one of the major diseases of mustard in Bangladesh. Blight occurs in almost all mustard growing areas with varying degrees of severity causing substantial loss in yield and seed quality. Severity of the disease increase with plant age and disease development becomes faster after flowering stage. The disease causes blight of leaf, pod and stem (Meah *et al.* 1988). It is endemic in Bangladesh and all cultivars of mustard variety are susceptible (Meah *et al.* 1995). Severe blight cause force maturity of the crop. This disease may be control effectively by using fungicides but it may cause environmental hazard. So, search of resistant source is urgently needed. In view of this fact, thirty nine (39) promising lines of rapeseed-mustard were evaluated against *Alternaria* blight to observe their reaction against the disease.

Materials and methods

The experiment was conducted for screening of mustard lines against *Alternaria* leaf blight disease at Oilseed Research Centre, BARI, Joydebpur during rabi 2021-2022 cropping season. Thirty nine (39) lines of *B. campestris,* (Table-1) were used in the study. Seeds were sown on 25 November 2021 in a randomized block design with three replications. A susceptible variety BARI Sarisha-14 was used in the experiment as check. Every test lines were sown in two rows of 3 m long separated by single row of susceptible infector (BARI Sarisha-14). Cultural and intercultural operations were done as recommended by Oilseed Research Centre (ORC), BARI. Disease data were recorded at 60 days after sowing (DAS) for leaf and70 DAS for pod following standard disease rating scale. *Alternaria* Blight of mustard scored according to 0-5 scale. The scale was 0= leaves free from leaf spot (HR), 1= 0.1-6% leaf or pod area diseased (R), 2= 6.1-12% leaf or pod area diseased (MR), 3= 12.1-25% leaf or pod area diseased (MS), 4= 25.1-50% leaf or pod area diseased (S) and 5 = above 50% leaf or pod area diseased (HS).

Results

From the table-1, It is revealed that all the test lines were found susceptable.

Table 1. Disease severity of the test Entries against Alternaria blight of Mustard in 2021-2022 cropping session at ORC, BARI, Joydebpur

Sl No	Name of Entry	Reaction	Sl No	Name of Entry	Reaction
1.	BC-100614(4)-10	S	21.	BC-14010(Y)	S
2.	BC-100614(8)-1	S	22.	OTBC-18003	S
3.	BC-100614(8)-2	S	23.	OTBC-18064	S
4.	BC-100614(8)-3	S	24.	BC-14043(Y)	S
5.	BC-100614(8)-7	S	25.	BC-15010(Y)	S
6.	BC-100614(4)-2	S	26.	BC-15044(Y)	S
7.	BC-100614(4)-4	S	27.	BC-18007(Y)	S
8.	BC-100614(4)-5	S	28.	BC-18021(Y)	S
9.	BC-100614(4)-6	S	29.	BC-19020(Y)	S
10.	BC-100614(4)-8	S	30.	BC-14021(B)	S
11.	BC-100614(4)-11	S	31.	BC-15005(B)	S
12.	BC-100614(4)-18	S	32.	BC-15003(B)	S
13.	BC-100614(4)-19	S	33.	BC-15025(B)	S
14.	BC-100614(4)-20	S	34.	BC-15033(B)	S
15.	BC-100-614(7)-3	S	35.	BC-18008(B)	S
16.	BC-110714(7)-4	S	36.	BC-18020(B)	S
17.	BC-110714(7)-7	S	37.	BC-19004(B)	S
18.	BC-110714(7)-8	S	38.	BC-19020(B)	S
19.	BC-110714(9)-5	S	39.	BC-19043(B)	S
20.	BC-14003(Y)	S	40.	BARI Sarisha-14	S

S = Susceptible

Reference

Meah, M.B., Begum, H.A., Howlider, M.A.R. and Islam. N. 1995. Development of Alternaria blight on *Brassica campestris* in relation to crop management practices. Bangladesh J. Pl. Pathol. 11:29-31

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EFFICACY OF DIFFERENT GRUOP OF COMMERCIAL FUNGICIDES AGAINST ALTERNARIA BLIGHT OF MUSTARD

M. S. HOSSAIN

Abstract

An experiment was conducted during 2021-2022 cropping season in the field of Oilseed Research Centre (ORC), BARI, Joydebpur to evaluate twelve fungicides of different groups in controlling Alternaria blight disease of mustard. The fnugicides were Rovral 50 WP, (Iprodian), Dithane M- 45(Mancozeb),Secure(Phenamidan 10% and Mancozeb 50%),Ridomil Gold MZ 68 WG (Mancozeb 64% and Metalaxyl 4%) , Autostin 50 WDG (Carbendazem), Infinity Pro (Fluopicolide 6% and Propinabe 66.7%), Nativo75WG (Tebuconazole50% and Tryfloxystrobin 25%)Tilt250 EC (Propiconazole), Folicur250 EC (Tebuconazole), Score 250EC (Dyfenoconazole), Tipoff 28 SC (Azoxystrobin20% and Cyporoconazole 8 %), Amister Top 325 SC (Azoxytrobin + Difenoconazole), The fungicides were sprayed 3 times at 10 days intervasl. All the fungicides significantly reduced the disease as compared to control. Among the fungicides Rovral, Amistertop, Score, Nativo, Folicur,Tip of performed better than the other fungicides. In case yield the highest yield was obtained from Rovral followed by Amister top.

Introduction

Rapeseed-mustard suffered from at least 14 diseases in Bangladesh. *Alternaria* blight or leaf spot of mustard caused by *Alternaria brassicae* (Brek) zacc. is one of the major diseases of mustard in Bangladesh. *Alternaria* blight, is one of the most widespread fungal disease of *Brassica* crops and exists in almost every country worldwide. It occur quite regularly every year during the cropping season. The disease caused blight of leaf, pod and stem (Meah *et al*., 1995) and seed abnormalities. It is endemic in Bangladesh and all cultivar of mustard varieties are susceptible. This disease causes an average yield loss of 40-70% in India (Vishwanath and kolt, 1997) and 30-60% in Bangladesh (Meah e*t. al*., 1988). In addition to direct losses of yield the disease adversely affects the seed quality reducing seed size, seed discoloration and reduction in oil contents. Chemically this disease may control effectively but only one chemical fungicide is suggested. With a view to this point some fungicides were evaluated against *Alternaria* blight disease of mustard so that farmers can get more than one fungicide to Rovral 50 WP in a parallel way for successfully manage the disease.

Materials and Methods

The experiment was conducted at Oilseed Research Centre, BARI, Joydebpur during 2021-2022croping season. Seeds of BARI Sarisha 14 was sown on 22 November 2021. The experiment was designed in RCB with 3 replications where plot size was 3m x 1.6m with 40 cm row spacing. Fertilizers were applied @ 120:80:60:40:4:1 kg/ha of N:P:K:S:Zn and Boron from Urea, TSP, MP, Gypsum, Znic Sulphate and Boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The rest of the urea was applied at flower initiation stage. All intercultural operations were done timely to raise a good crop. Twelve fnugicides namely; Rovral 50 WP, (Iprodian), Dithane M- 45(Mancozeb),Secure(Phenamidan 10% and Mancozeb 50%),Ridomil Gold MZ 68 WG(Mancozeb 64% and Metalaxyl 4%) ,Autostin 50 WDG (Carbendazem), Infinity pro(Fluopicolide 6% and Propinabe 66.7%), Nativo75WG(Tebuconazole50% and Tryfloxystrobin 25%) Tilt 250 EC(Propiconazole), Folicur250 EC (Tebuconazole), Score 250EC (Dyfenoconazole), Tipoff 28 SC (Azoxystrobin20% and Cyporoconazole 8 %), Amister Top 325 SC (Azoxytrobin + Difenoconazole), A control treatment was maintained for comparison. Rovral, Dithane, Secure, Redimil, Nativo, Autostnne and Innfinity Pro were sprayed @ 0.2 % and Amister top, Folicur, Tilt, Score and Tip off, and Innfinity Pro were sprayed @ 0.1% at 10 days interval beginning from the first appearance of the disease and continued 3 times. Fife plant were randomly selected and tagged in each plot for taking disease data. Percent leaf infection and percent leaf area infection was recoded 60 DAS collected from 25 leaf of the 5 selected plant. Similarly percent siliqua infection and percent siliqua surface area infection was recoded 75 DAS collected from 25 siliqua of the 5 selected plant. seed yield (t/ha) were recorded. Recorded data were analyzed statistically.

Results and Discussion

Results are presented in the Table 1.From table 1it is revealed that Significant variation of Percent disease severity was found among the treatments. All the fungicides significantly reduced the disease as compared to control/. The highest disease severity (% leaf infection ,percent %leaf area infection, % siliqua infection and % siliqua surface area infection) was observed in controlplot. In case of leafe area infection the lowest disease was observed in Rovral treated plot whice was statisticaly identical with Amistertop, Score, Nativo, Folicur, Tilt Tipoff and Infinity pro.Incase of siliqua surface area infection although the effct of effect of all fungicides were statisticaly similar but performance of Rovral was the best. In case of yield the highest yield was obtained from Rovral followed by Amister top.

Table 1: Effect of fungicides in controling alternaria blight disease of mustard

Sl. No.	Treatment	%Leaf infection	% leaf area infection	% siliqua infection	% siliqua surface area infection	yield (t/ha)
1	Rovral	53.33ef	3.67 d	28.33 c	2.67 b	1.32 a
2	Dithane	76.67b	11.67 b	80.00 b	11.67 b	1.09 f
3	Secure	63.33cde	10.00 bc	68.33 b	10.00 b	1.21 bcd
4	Ridomil	76.67b	8.67 bcd	71.67 b	13.33 b	1.25 abc
5	Tilt	66.67bcd	8.00 bcd	63.33 b	9.33 b	1.20 cd
6	Folicur	56.67def	4.67 cd	33.33 c	4.67 b	1.18 cdef
7	Score	56.67def	4.33 cd	33.33 c	4.00 b	1.15 def
8	Nativo	50.00f	4.33 cd	36.67 c	3.67 b	1.18 cdef
9	Autostin	73.33bc	10.00 bc	73.33 b	13.33 b	1.10 ef
1	Tip off	56.67def	4.67 cd	35.00 c	4.33 b	1.15 def
1	Infinitipro	70.00bc	6.67 bcd	58.33 b	13.33 b	1.19 cde
12	Amister	53.33ef	4.33 cd	30.00 c	4.00 b	1.30 ab
13	Control	100a	28.33 a	100.00 a	51.67 a	0.93 g

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Meah, M.B.,Howlider, M.A.R. Jalaluddin, M. and Rahman, A. 1988. Effect of fungicide spray at different time and frequencies on Alternaria blight of mustard. Thai.J. Agric.Sci. 21:101-107.

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SCREENING OF GROUNDNUT LINE(S) AGAINST LEAF SPOT AND RUST DISEASES

M. S. HOSSAIN

Abstract

An experiment was conducted at ORC, BARI, Joydebpur during rabi 2021-2022 season under natural epiphytotic condition to evaluate groundnut entries against leaf spot and rust diseases. Among the 40 tested lines. Sixteen liens were selected as moderately resistance against leaf spot and rust diseases.

Introduction

Groundnut (*Arachis hypogaea* L.) is a promising oil legume crop cultivated in Bangladesh. More than 40 fungal diseases have been reported on groundnut (Jackson and Bell 1969); but in Bangladesh, the crop is subjected to attack by more than a dozen of diseases (Talukder 1974, Anon. 1984). Among them, leaf spot caused by *Cercospora arachidicola* Hori.and *Cercosporidium personatum* Berk. and Curt. and rust caused by *Puccinia arachidis* Speg. are serious foliar fungal diseases (Fakir 1980, Khaleque 1985). Losses in nut yield due to the diseases were recorded to be above 70% (Subrahmanyam *et al.* 1980). In addition to direct yield losses, they also lower seed quality by reducing seed size (South 1912, Arthur 1929) and oil content (Castellani 1959). Among various methods applied to control both the diseases, growing of resistant variety is the most effective and economically feasible. This study was under taken to screen promising genotypes of groundnut to identify the sources of resistance to leaf spot and rust diseases.

Materials and Methods

The experiment was conducted at ORC, BARI, Joydebpur. Forty entries of groundnut were evaluated during 2021-2022 rabi season under natural epiphytotic condition against leaf spots and rust diseases using infector row method. (Table-1) Every tested genotypes were sown in two rows of 3 m long separated by single row of highly susceptible variety Dhaka-1 as infector. Disease severity was recorded using 0-5 and 1-9 scale respectively, for leaf spot and rust 5 days before harvest the crop. Fife plants from each entry were randomly selected and tagged for collecting disease data.Leaf spot disease was scored by using 0-5 scale where 0= no infection (HR), 1= Up to 10% leaf area infection ®, 2= 11-30% leaf area infection (MR), 3 = 31-50% leaf area infection (MS), 4= 51-75% leaf area infection (S), 5= 76-100% leaf area infection (HS).Again rust disease also recorded by using 1-9 scale where, 1= no pustules visible (HR), 3= few scattered pustules, usually seen after searching®, 5= pustules common on leaves and easily observed but causing no apparent damage (MR), 7= pustules very common and damaging, few pustules on petioles and stem (S) and 9= pustules very extensive on all plant parts, some death of leaves and other plant parts (HS).

Table 1. List of test liens used in the experiment.

Sl No	Name of entry	Sl No	Name of entry	Sl No	Name of entry	Sl No	Name of entry
1	ICGV-02841	12	TMV-2	23	TG-51	34	ICGV-93420
2	BDBN-6112-6-1	13	ICGV-09516	24	ICGV-4514	35	JALDHAKHA
3	ISD-3841	14	BDGV-702-6-2-1	25	BDGV-14-103	36	ISD-4114
4	ICGV-Sl-1	15	NCGV-0704	26	ISD-2414	37	ICGV-1352
5	CHOKO-0314	16	ICGV-07406	27	NCGV-0107	38	NCGV-0504
6	BDGV-14-40	17	ICGV-35-1	28	PK-1	39	ICGV-04096
7	ICGV-38-3	18	I ICGV--07219	29	TG-37	40	ICGV-06423
8	GOLACHIPA	19	ICGV-95090	30	ISD-0414	41	Dhaka-1
9	ICGV-87073	20	NCGV-02096	31	NCGV-0207		
10	ICGV-91176	21	ICGV-06285	32	BDGV-502-4-3-1		
11	ICGV-36-1	22	BDGV-602-7-4-2	33	BINA-B-4		

Results and Discussions

The following sixteen lines were selected as moderately resistant for rust and leaf spot diseases

Sl. No.	Name of entry	Sl. No.	Name of entry
1	CHOKO-0314	9	BDGV-602-7-4-2
2	ICGV-38-3	10	BDGV-14-103
3	ICGV-87073	11	ISD-2414
4	ICGV-91176	12	NCGV-0107
5	NCGV-0704	13	PK-1
6	ICGV-35-1	14	ISD-0414
7	ICGV-95090	15	NCGV-0207
8	NCGV-02096	16	JALDHAKHA

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EFFICACY OF DIFFERENT GRUOP OF COMMERCIAL FUNGICIDES AGAINST LEAF SPOT AND RUST DISEASES OF GROUNDNUT

M. S. HOSSAIN

Abstract

An experiment was conducted during 2021-2022 cropping season in the field of Oilseed Research Centre, BARI, Joydebpur to evaluate twelve fungicides of different groups in controlling leaf spot and rust diseases of groundnut. All the fungicides significantly reduced the disease as compared to control. Among the fungicides Amistertop, Score, Nativo, Folicur, Infinity Pro, Tip off performed better than the other fungicides in case of both the diseases. Autostin perfrmed good for leaf spot but not for rust.

Introduction

Groundnut (*Arachis hypogaea* L.) is a promising oil legume crop cultivated in Bangladesh. More than 40 fungal diseases have been reported on groundnut (Jackson and Bell 1969); but in Bangladesh, the crop is subjected to attack by more than a dozen of diseases (Talukder 1974, Anon. 1984). Among them, leaf spot caused by *Cercospora arachidicola* Hori.and *Cercosporidium personatum* Berk. and Curt. and rust caused by *Puccinia arachidis* Speg. are serious foliar fungal diseases (Fakir 1980, Khaleque 1985). Losses in nut yield due to the diseases were recorded to be above 70% (Subrahmanyam *et al.* 1980). In addition to direct yield losses, they also lower seed quality by reducing seed size (South 1912, Arthur 1929) and oil content (Castellani 1959). Chemically this disease may control effectively by some chemical fungicide whice is available in the market. To find out more effective fungicids this experiment has been designed.

Materials and Methods

The experiment was conducted at Oilseed Research Centre, BARI, Joydebpur during 2021-2022. Seeds of Groundnut variety Dhaka 1 was sown on 29 December 2021. The experiment was designed in RCB with 3 replications where plot size was 3m x 1.6m with 40 cm row spacing. All intercultural operations were done timely to raise a good crop. Twelve fungicides of different groups namely Rovral 50 WP, (Iprodian), Dithane M- 45(Mancozeb),Secure(Phenamidan 10% and Mancozeb 50%),Ridomil Gold MZ 68 WG(Mancozeb 64% and Metalaxyl 4%) ,Autostin 50 WDG (Carbendazem), Infinity pro(Fluopicolide 6% and Propinabe 66.7%), Nativo75WG(Tebuconazole50% and Tryfloxystrobin 25%) Tilt 250 EC(Propiconazole), Folicur250 EC (Tebuconazole), Score 250EC (Dyfenoconazole), Tipoff 28 SC (Azoxystrobin20% and Cyporoconazole 8 %), Amister Top 325 SC (Azoxytrobin + Difenoconazole), The fungicides were sprayed 3 times at 15 days intervasl. A control treatment was maintained for comparison. Rovral, Dithane, Secure, Redimil Gold, Nativo, Autostnne Infinity Pro were sprayed @ 0.2 % and Amister top, Folicur, Tilt, Score and Tip off, were sprayed @ 0.1% at 15 days intervals beginning from 45 DAS and continued 3 times. Before 5 days of harvest Disease data was recorded as % leaf infection %leaf area infection from randomly selected 25 leaves taking 5 leaves of randomly selected 5 plants from each plots discurding the 25% upper leaves and 25% lower leaves. Seed yield was recorded from middle two rows and converted to t/ha. Recorded data were analyzed statistically.

Results and Discussion

Results are presented in the Table 1.From the table it is revealed that significant variation of disease severity (% leaf infection and%leaf area infection) found among the treatments in case of both the diseases leaf spot and rust.. All the fungicides significantly reduced the disease as compared to control .for both leaf spot and rust disease. In control plot %leaf area infection were 31.67% and 26.67% for leaf spot and rust disease respectively.

Table Effect of fungicides in controlling leaf spot and rust diseases of Groundnut

Sl. No.	Treatment	Leaf spot		Rust		Yield (t/ha)
		%Leaf infection	% leaf area infection	%Leaf infection	% leaf area infection	
1	Rovral	53.33 cde	11.67 b	58.33 bc	12.33 b	1.46 ab
2	Dithane	70.00 b	11.67 b	65.00 b	13.33 b	1.02 fg
3	Secure	60.00 bcd	10.00 bcd	66.67 b	11.67 bc	1.40 abc
4	Ridomil	61.67 bcd	10.00 bcd	70.00 b	11.33 bc	1.33 abcd
5	Tilt	41.67 ef	7.33 bcd	45.00 cd	6.67 cd	1.32 bcd
6	Folicur	41.67 ef	4.67 d	46.67 cd	5.00 d	1.24 de
7	Score	38.33 f	5.00 bd	41.67 d	4.67 d	1.14 ef
8	Nativo	40.00 ef	4.33 d	40.00 d	5.00 d	1.34 abcd
9	Autostin	43.33 ef	5.00 bd	66.67 b	10.00 bcd	1.10 f
10	Tip off	51.67 def	5.00 bd	38.33 d	5.33 d	1.47 a
11	Infinitipro	66.67 bc	10.00 bcd	65.00 b	11.67 bc	1.30 cd
12	Amister	41.67 ef	5.00 bd	43.33 d	5.00 d	1.27 cde
13	Control	90.00 a	31.67 a	91.67 a	26.67 a	0.96 g

Reference

Meah, M.B.,Howlider, M.A.R. Jalaluddin, M. and Rahman, A. 1988. Effect of fungicide spray at different time and frequencies on Alternaria blight of mustard. Thai.J. Agric.Sci. 21:101-107.

Meah, M.B., Begum, H.A., Howlider, M.A.R. and Islam. N. 1995. Development of Alternaria blight on Brassica campestris in relation to crop management practices. Bangladesh J. Pl. Pathol. 11: 29-31

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IV: INSECT PEST MANAGEMENT

DEVELOPMENT OF A MANAGEMENT APPROACH AGAINST FLEA BEETLE ATTACKING MUSTARD

M.A. ISLAM AND R. ISLAM

Abstract

The experiment was conducted during robi season 2021-22 at ORC research field, BARI, Gazipur to develop effective management approach against flea beetle of mustard. The treatments were as follows: T_1= White sticky trap + Antario (Bt+abamectin) @ 1.0 ml/L of water, T_2= White sticky trap + Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water, T_3= White sticky trap+ Spraying of Biotrine (0.5% Matrine) @ 1.5ml/L of water, T_4= White sticky trap+ Spraying of Spinosad (Success 2.5 SC) @ 1.2 ml/ L of water, T_5= Spraying of Nitro 505 EC(Chlorpyriphos+Cypermethrin) @ 1.0 ml/L of water, T_6= Untreated control. The maximum reduction of plant infestation over control was found in T_2 treated plot (67.15%) and. T_5 treated plot (58.12%). The highest yield was found in T_2 treated plot (1.62 t/ha) T_5 treated plot (1.49 t/ha) and the lowest in T_6 control plot (0.92 t/ha). The best MBCR was found in treatment T_2 and treatment T_5 package.

Introduction

Mustard is one of the most important oilseed crop in Bangladesh. Now-a-day's flea beetle (*Phyllotreta s*pp. Coleoptera: Chrysomelidae) is found to damage mustard crop on leaves and pods, respectively flea beetles are small oval-shaped beetles (2-3mm). The common name reflects their habit of jumping or hopping when disturbed flea beetles damage mostly 6 at seeding and early vegetative stages while pod borers damage mostly at pod formation to till maturity of the mustard corp. There is a challenge to manage which is very difficult to forecast and can cause significant crop losses very quickly. Numerous garden plants are also subject to flea beetle feeding. The larvae are known to chew roots. The larvae of most flea beetle species feed on small roots or root hairs which may slightly reduce plant health and vigor, and causes serious economic losses. Adult flea beetles make small circular pits in leaf tissue as they feed. Feeding at the early seedling stage can cause seedling mortality, reduced plant growth, delayed and uneven maturity and lower seed yield or grade. But no detailed information is available on their damage or crop loss especially in mustard crop in this country. Farmers are applying chemical insecticides indiscriminately in an attempt to control this pests. Such pesticide use, besides being costly, detrimental to human health and environment, is degrading the natural resources base by destroying the predators and parasitoids. Over use of chemical insecticide causes resistant of the pest, destruction of beneficial organisms and environmental pollution. Therefore the study has been designed.

Materials and Methods

The experiment was conducted during *robi* season 2021-22 at ORC research field, BARI, Gazipur and to develop effective management approach against flea beetle of mustard. The experiment was laid out in a randomized complete block design with three dispersed replications. Mustard seeds (BARI Sorisha-18) were swon on 22 December 2021 at Gazipur. The unit plot size was 5.0 m x 4.0 m with 1.0 m row to row and 30 cm distance. The normal intercultural operations were done as and when necessary. The treatments were as follows: T_1= White sticky trap + Antario (Bt+abamectin) @ 1.0 ml/L of water, T_2= White sticky trap + Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water, T_3= White sticky trap+ Spraying of Biotrine (0.5% Matrine) @ 1.5ml/L of water, T_4= White sticky trap+ Spraying of Spinosad (Success2.5 SC) @ 1.2 ml/ L of water , T_5= Spraying of Proclaim 5 SG (Emamectin benzoate) @ 2g/L of water, T_6= Untreated control. The whole plant was thoroughly covered by spray emulsion. Number of flea beetle was recorded at 7 days intervals from the five randomly selected plants from middle rows and five leaves from each plant. Number of flea beetle trapped per trap was counted at seven days intervals. Yield data were recorded also.

Results and Discussion

Severe attacking of flea beetle was observed which is summarized in (table 1). The number of flea beetle per five leave ranged from 1.49 to 6.07 and differed significantly among the treatments. However, the highest number of flea beetle per five leaf (6.07) was found in untreated control while the lowest (1.49) was obtained from T_2 treated plots followed by T_4 and T_5 treated plots. On an average 15.17 flea beetle were captured at white sticky trap per week.

Table 1. Effect of different treatments for controlling flea beetle of mustard

Treatments	No. of flea beetle/ 5 leaf / plants	No. of flea beetle trapped/trap/week
T_1	5.23	15.17
T_2	1.49	
T_3	4.39	
T_4	2.68	
T_5	2.19	
T_6	6.07	
LSD(0.05)	2.55	
CV(%)	38.20	

Effect of different treatment packages against flea beetle of mustard:

The effects of treatment packages against flea beetle are presented in table 2. The percent plant infestation highest was found in (T_6) control plot (43.32) and the lowest in T_2 treated plot (14.23) followed by T_4 and T_5. The maximum reduction of plant infestation over control was found in T_2 treated plot (67.15%). The highest yield was found in T_2 treated plot (1.62t/ha) and the lowest in (T_6) control plot (0.92) t/ha.

Table 2. Effect of different treatments for controlling flea beetle and yield of mustard

Treatments	% plant infestation	% reduction plant infestation over control	Yield (tha^{-1})
T_1	28.65	33.86	1.23
T_2	14.23	67.15	1.62
T_3	26.39	39.08	1.30
T_4	20.39	52.93	1.42
T_5	18.05	58.12	1.49
T_6	43.32		0.92
LSD(0.05)	7.92		0.15
CV(%)	17.3		6.40

T_1= White sticky trap + Antario (Bt+abamectin) @ 1.0 ml/L of water, T_2= White sticky trap + Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water, T_3= White sticky trap+ Spraying of Biotrine (0.5% Matrine) @ 1.5ml/L of water, T_4= White sticky trap+ Spraying of Spinosad(Success2.5 SC) @ 1.2 ml/ L of water , T_5= Spraying of Proclaim 5 SG (Emamectin benzoate) @ 2g/L of water, T_6= Untreated control.

Benefit cost analysis:

The marginal cost benefit ratios (MBCR) of different treatments applied against flea beetle of mustard as worked out based on the expenses incurred and value of crop is presented in table 3. It is to be noted here that expenses incurred reffered to those only on pest control. The results revealed the highest MBCR was observed in treatment (White sticky trap + Bio-chamak @ 2.5 ml/litre of water) treated plot with the highest yield (1.62) and gross return (Tk97200).

Table 3: Economic analysis of different management options against flea beetle of mustard

Treatments	Yield of mustard (t/ha)	Gross return (Tk/ha)	Cost of treatments (Tk/ha)	Net return (Tk/ha)	Adjusted net return (Tk/ha)	MBCR
T_1	1.23	73800	6300	67500	12300	1.95
T_2	1.62	97200	6900	90300	35100	5.09
T_3	1.30	78000	6200	72000	16800	2.71
T_4	1.42	85200	8500	79000	23800	3.84
T_5	1.49	89400	5900	80900	25700	3.02
T_6	0.92	55200	_	_	_	_

Cost of relevant materials/activities:
Farmgate price of mustard @ Tk. 60.00 per kg,
[Cost of Antario: @ Tk 3300/L, Cost of Bio-chamak: @ Tk 3900/L, Cost of Biotrine: @ Tk 3200/L; Cost of Success 2.5SC: @ Tk 3200/L; Cost of Proclaim: @ Tk 6000/kg; Cost of White sticky trap: @ 50 Tk/trap with installation; Cost of spray : Two laborers/spray/ha @ Tk 300.00/labour/day; Spray volume required: 500L /ha].

Conclusion

From the experimental results it may be concluded that the treatment T_2 (White sticky trap + Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water) was effective against flea beetle with higher yield and marginal benefit cost ratio. The experiment will be repeated next year for further investigation.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

DEVELOPMENT OF IPM PACKAGE AGAINST THE MAJOR INSECT PESTS OF SESAME

M.A. ISLAM AND R. ISLAM

Abstract

The experiment was conducted during kharif season 2021-22 at ORC research field, BARI, Gazipur to develop effective management approach against major insect pest of sesame. The treatments were as follows: T_1(IPM Package 1) = Hand Picking of larvae + Perching + spraying Spinosad (Success 2.5 SC) @ 1.2 ml/L of water,T_2(IPM Package 2) = Hand Picking of larvae + Perching + spraying Bt-Kurstaki @ 0.5ml/L of water, T_3(IPM Package 3) = Hand picking of larvae + Perching +spraying Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water, T_4 = Farmers practice (Spraying of Nitro 505 EC (Cypermethrin+ Chlorpyriphos)@ 1.0 ml/L of water,) T_5 = Untreated control. The highest number of whitefly, hopper, leaf beetle, green stink bug and hairy caterpillar were found in control plots and the lowest in T_4 followed by IPM package 3. The highest yield was found in T_4 (1.50 t/ha) and the lowest in control plots (0.98 t/ha).The highest MBCR was also calculated from T_4.

Introduction

Sesame (Sesamum indicum L.; Family: Pedaliaceae) is a flowering plant in the genus Sesamum. Numerous wild relatives occur in Africa and a smaller number in Bangladesh. It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds, which grow in pods. Sesame seed is one of the oldest oil seed crops known, domesticated well over 3000 years ago. Sesame is drought-tolerant and is able to grow where other crops fail. Sesame has one of the highest oil contents of any seed. With a rich nutty flavour, it is a common ingredient in cuisines across the world. Like other nuts and foods, it can trigger allergic reactions in some people. It gains importance because of quality edible oil, protein, calcium and phosphorus. Sesame is used as food, edible oil, bio-medicine and health care. Due to the presence of tocopherol and lignins sesame has remarkable antioxidant function also.

The seeds are rich in proteins and essential amino acids, especially methionine which have an anti-ageing property. The seed is rich source of vitamins E, A & B complex including calcium and phosphorus. Sesame oil has reducing effect on cholesterol and prevents coronary heart diseases. Due to excellent nutritional, medicinal, skin care and cooking qualities of sesame oil it is known as “Queen of oils”..It is grown throughout the year and being a short duration crop, fits well in to various cropping systems. The world’s largest exporter of sesame seeds was India, and Japan the largest importer. Insect pests are one of the major constraints in sesame production. Among the pest white fly (*Bemisia tabaci*) , leaf beetle, hawk moth, hairy caterpillar, sting bug, leaf hopper (*Orosius albicinctus*) Webber and capsule borer (*Antigastra catalaunalis*), gall fly (*Asphondylia sesami*) are the most important pests throughout Bangladesh. Insect pests cause yield losses ranging from 10-60% under different climatic conditions contributing to low productivity of the sesame. The sucking pest, leafhopper (*Orosius albicinctus*) is a vector of serious disease viz. phyllody. It is very difficult to manage these pests by using chemical insecticides. Farmers mostly spray toxic chemicals to combat these pests. But indiscriminate use of pesticides has not only complicated the management, but has also created several adverse effects such as pest resistance, outbreak of secondary pests, health hazards and environmental pollution. So, to reduce unwarranted pesticide load in the environment and for sustainable production of this crop, the study was undertaken to develop management package(s) against major insect pests of sesame.

Materials and Methods

The experiment was conducted during *kharif* season 2022 at ORC research field, BARI, Gazipur to develop effective management approach against major insect pest of sesame. The experiment was laid out in a randomized complete block design with three dispersed replications. Sesame seeds (BARI Till-4) were sown on 08 March 2022 at Gazipur. The unit plot size was 3.0 m x 2.0 m with 30 cm row to row and 1 m plot to plot distance. The normal intercultural operations were done as and when necessary. The treatments were as follows: T_1(IPM Package 1) = Hand Picking of larvae + Perching + spraying Spinosad (Success 2.5 SC) @ 1.2 ml/L of water, T_2(IPM Package 2) = Hand Picking of larvae + Perching + spraying Bt-Kurstaki @ 0.5ml/L of water, T_3(IPM Package 3) = Hand picking of larvae + Perching + spraying Bio-chamak (*Celastras angulatas* 1% EW) @ 2.5 ml/litre of water, T_4 = Farmers practice (Spraying of Nitro 505 EC (Cypermethrin+ Chlorpyriphos)@ 1.0 ml/L of water), T_5 = Untreated control. The whole plant was thoroughly covered by spray emulsion. Number of whitefly, hopper, leaf beetle were recorded at 7 days intervals from the five randomly selected plants from middle rows and five leaves from each plant. Number of green stink bug and hairy caterpillar were also recorded from five randomly selected branch per plot at seven days intervals. Yield data were recorded also.

Results and Discussion

The results are summarized in table 1 and 2.

Effect of different treatment packages against whitefly, hopper and leaf beetle of sesame:

The number of whitefly per leaf ranged from 0.92 to 3.39 and differed significantly among the treatments. However, the highest number of whitefly per leaf (3.39) was found in untreated control while the lowest (0.92) was obtained from T_4 treated plots followed by T_3 treated plots. The number of hopper per leaf ranged from 0.69 to 2.87 and differed significantly among the treatments. However, the highest number of hopper leaf (2.87) was found in untreated control while the lowest (0.69) was obtained from T_4 treated plots followed by T_3 treated plots. The number of leaf beetle per five leave ranged from 0.88 to 2.25 and differed significantly among the treatments. The highest number of leaf beetle per five leave (2.25) was recorded in untreated control and the lowest was found from T_4 treated plots (0.88) followed by T_3 treated plot.

Table 1. Effect of different treatments for controlling sucking pest and leaf beetle of of sesame

Treatments	No. of whitefly/leaf	No. of hopper/leaf	No. of leaf beetle/5 leaf
T_1	1.74	1.49	1.34
T_2	2.89	1.93	1.88
T_3	1.12	1.08	1.15
T_4	0.92	0.69	0.88
T_5	3.39	2.87	2.76
LSD(0.05)	1.26	1.25	0.77
CV(%)	33.40	41.30	25.80

Effect of different treatment packages against green stink bug and hairy caterpillar of sesame:
The number of green stink bug per branch ranged from 0.88 to 2.53 and differed significantly among the treatments. The highest number of green stink bug per branch (2.53) was recorded in untreated control and the lowest was found from T_4 treated plots (0.88) followed by T_3 treated plots. The number of hairy caterpillar per branch ranged from 0.88 to 2.53 and differed significantly among the treatments. The highest number of hairy caterpillar per branch (2.53) was recorded in untreated control and the lowest was found from T_4 treated plots (0.88) followed by T_3 treated plot. The highest yield was obtained from T_4 treated plot (1.50 t/ha) followed by T_3(1.41t/ha) treated plots. and the lowest in (T_5) control plot (0.98) t/ha.

Table 2. Effect of different treatments for controlling hairy caterpillar and green stink bug of sesame

Treatments	No. of green stink bug/ branch	No. of hairy caterpillar/ branch	Yield (tha^{-1})
T_1	1.57	2.16	1.26
T_2	1.82	2.38	1.12
T_3	1.23	1.07	1.41
T_4	0.88	0.64	1.50
T_5	2.53	3.87	0.98
LSD(0.05)	0.77	1.60	0.17
CV(%)	25.80	42.20	7.60

T_1(IPM Package 1) = Hand Picking of larvae + Perching + spraying Spinosad (Success 2.5 SC) @ 1.2 ml/L of water
T_2(IPM Package 2) = Hand Picking of larvae + Perching + spraying Bt-Kurstaki @ 0.5ml/L of water
T_3(IPM Package 3) = Hand picking of larvae + Perching + spraying Bio-chamak (*Celastras angulatas* 1% EW) @ 2.5 ml/litre of water
T_4 = Farmers practice (Spraying of Nitro 505 EC (Cypermethrin+ Chlorpyriphos)@ 1.0 ml/L of water
T_5 = Untreated control

Benefit cost analysis:

The marginal cost benefit ratios (MBCR) of different treatments applied against major insect pest of sesame as worked out based on the expenses incurred and value of crop is presented in table 3. It is to be noted here that expenses incurred referred to those only on pest control. The results revealed the highest MBCR was observed in treatment (Nitro 505 EC @1.0 ml/L of water) treated plot (5.82). The highest yield (1.50) and gross return (Tk90000) was obtained from treatment T_4 followed by T_3.

Table 3. Economic analysis of different management options against major insect pest of sesame

Treatments	Yield of sesame (t/ha)	Gross return (Tk/ha)	Cost of treatments (Tk/ha)	Net return (Tk/ha)	Adjusted net return (Tk/ha)	MBCR
T_1	1.26	75600	5840	69760	10960	1.88
T_2	1.12	67200	-	-	-	-
T_3	1.41	84600	5900	78700	19900	3.37
T_4	1.50	90000	4570	85430	26630	5.82
T_5	0.98	58800	-	-	-	-

Cost of relevant materials/activities:
Farmgate price of sesame @ Tk. 60.00 per kg,
[Cost of Success 2.5SC: @ Tk 3200/L; Cost of Bio-chamak: @ Tk 3900/L ; Cost of Nitro: @ Tk 1850/L; Cost of hand picking : Five labour/ha @ Tk 300/labour/day; Cost of perching: Tk 1000/ha; Cost of spray : Two laborers/spray/ha @ Tk 300.00/labour/day; Spray volume required: 500L /ha].

Conclusion

From the experimental results it may be concluded that the treatment T_4 (Nitro 505 EC) @1.0 ml/L of water) and also T_3 (White sticky trap + Perching+ Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water) were more effective against major insect pest of sesame with higher yield and marginal benefit cost ratio. The experiment will be repeated next year for further investigation.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

RELATIVE SUSCEPTIBILITY OF SOYABEAN VARIETIES TO SUCKING PEST, HAIRY CATERPILLAR AND LEAF ROLLER

M.A. ISLAM AND R. ISLAM

Abstract

The experiment was conducted during Rabi 2021-22 season at ORC research field, BARI, Gazipur to determine the relative susceptibility of BARI release soybean varieties against sucking insect pests, leaf roller and hairy caterpillar. It was observed that there was a significant difference in infestation of varieties by the sucking insect pests, leaf roller and hairy caterpillar. The population of whiteflies and thrip were more abundant during early growth stage, while jassids were more abundant during advanced growth stage of crop. The overall means of pest population showed that whitefly (3.81±0.594) and jassid (4.32±0.746) were more abundant followed by thrips (2.81±0.368) per leaf. The highest whitefly (4.19±0.987 per leaf), jassid (6.09±0.981 per leaf) and thrip (3.99±0.115 per leaf) population were found on cultivar BARI Soybean-5. The highest percent plant infestation by leaf roller (61.20%) and the highest percent plant infestation by hairy caterpillar (57.80%) were observed on cultivar BARI Soybean-5. As far as cultivars are concerned, BARI Soybean-5, BARI Soybean-6 were susceptible, while BARI Soybean-7 were comparatively resistant, however, Shohag were moderately resistant.

Introduction

Soybean (*Glycine max* L.) is a unique crop with high nutritional value, providing 40% protein and 20% edible oil, besides minerals and vitamins. It is playing an important role in augmenting both the production of edible oil and protein simultaneously under the circumstances in which the shortage of these commodities are being experienced by people. It also supports many industries; soybean oil is used as raw material in manufacturing of antibiotics, paints, varnishes, adhesives, lubricants etc. Soybean meal is used as protein supplement in human diet, cattle and poultry feed. Soybean is considered as a 'Golden bean', 'Miracle bean', 'Agriculture‟s Cinderella', 'Wonder crop of the 20th Century', due to its qualities such as good amount of carbohydrates (35%), oil (20%) and 40 percent high quality protein. Soybean protein is rich in valuable amino acid lycine (5%) in which most of the cereals are deficient. In addition, it contains a good amount of minerals, salts and vitamins (thiamine and riboflavin). Soybean mixed with other cereals is capable of increasing Protein Efficiency Ratio (PER), a parameter of protein quality. BARI has developed a considerable number of soyabean varieties for both winter and summer seasons. These varieties are resistant to various insect pests and diseases to a certain level. But nowadays, the varieties are showing susceptibility to different sucking pest, Leaf roller (*Lamprosema indicata* Fab.) and Hairy caterpillar (*Spilarctia obliqua* Walk.) etc. in the field level. Due to the attack of those insect pests, the varieties can't produce desirable yield and farmers are losing economically. Therefore, in the present study has been designed to check the relative susceptibility of those BARI released soyabean varieties.

Materials and Methods

The experiment was conducted during *rabi* season 2021-22 at ORC research field of BARI, Gazipur to check the relative susceptibility of the BARI released soyabean varieties. The experiment was laid out in a randomized complete block design with three dispersed replications. Homogenous seeds of soybean cultivars were sown in a well prepared seed bed on 06 January 2022. The unit plot size was 4.0 m x .30 m with 30 cm row to row and 5cm plant to plant distance. The normal intercultural operations were done as and when necessary. Five varieties of soyabean were evaluated against sucking pest, leaf roller and hairy caterpillar infestation. The varieties were as follows: V_1 =Shohag, V_2 =Bangladesh soybean-4, V_3 =BARI Soybean-5, V_4 =BARI Soybean-6, V_5 =BARI Soybean-7. Cultural practices such as fertilizer and irrigation application, inter culturing and weeding were adopted as per the recommendation. However, spray of insecticides of any kind in and around that experimental area was avoided for proper exploitation of insect pests. For recording observation on population buildup of sucking pests, whitefly, Jassid, and Thrips. Five plants were selected randomly from each plot of respective variety and tagged. Three leaves from each selected plant were examined on random basis and population of pests were recorded. The observations were recorded at weekly intervals from January 30 to march 25, 2022. The data on population of sucking insect pests recorded were arranged as mean, standard deviation and standard error, further analysis of variance of data was carried out and the mean values of pests were compared through least significant difference tests, as per the method.

Results and Discussion

Comparative evaluation against sucking pest of soybean varieties:

The results on overall average of three sucking insect pests recorded on five soybean varieties obtained are presented in the Table 1. The results indicated that all varieties evaluated were infested by the three sucking pests. Comparatively the population of whitefly was low on variety BARI soybean-7 (1.89±0.404) followed by Bangladesh Soybean-7 (3.11±0.127). However, the population of jassid were more on variety BARI Soybean-5 (5.19±0.987), followed by BARI Soybean-6 (4.75±0.115), Shohag (4.50±0.260) per leaf. Whereas greater population of thrips was recorded on BARI Soybean-5 (3.99±0.115), followed by BARI Soybean-6 (3.25±0.230), Shohag (2.5±0.109) varieties, per leaf while other varieties were moderately resistant. These differences may be attributed due to change in the morphological characters of varieties. Sucking insect pests cause serious loss to the soybean crop, these not only damage the crop but are also vector of certain viral diseases. The results of study envisaged that all five varieties evaluated infested by the whitefly, jassids and thrips. The population level varied between time interval and within pest species. The results further demonstrated that whitefly and jassid were more abundant on all varieties planted as compared to thrips. It was observed that the insect pest populations on all varieties evaluated increased gradually and was maximum during the vegetative growth period. Jassids and thrips were found more active up to pod filling while whitefly was found active in the middle of crop season and was low during the entire growth period on all varieties. Among the five varieties sown BARI Soybean-5and BARI Soybean-5 were susceptible against sucking insect pests, while BARI soybean-7 were resistant, while Bangladesh soybean-4 varieties were moderately resistant.

Table 1. Overall Mean ± S.E. population of sucking pests/leaf recorded on different varieties of soybean at Gazipur during 2021-22.

Varieties	No. of Whitefly/leaf	No. of Jassid/leaf	No. of Thrips/leaf
V_1 =Shohag	4.11 ±0.121ab	4.50±0.260ab	2.59±0.109c
V_2 =Bangladesh soybean-4	3.11±0.127bc	2.75±0.520bc	2.35±0.139cd
V_3=BARI Soybean-5	5.19±0.987a	6.09±0.981a	3.99±0.115a
V_4 =BARI Soybean-6	4.75±0.115a	5.80±0.398a	3.25±0.230b
V_5 =BARI Soybean-7	1.89±0.404c	2.50±0.213c	1.88±0.127d
Mean	3.81±0.594	4.32±0.746	2.81±0.368
LSD(0.05)	1.50	1.84	0.53
CV(%)	21.0	22.7	10.1

Mean ± S.E. followed by same latter in a column are not significantly **(**P<0.05) different from each other by LSD.

Comparative evaluation against leaf roller and hairy caterpillar of soybean varieties:

The results on overall average of leaf roller and hairy caterpillar were recorded on five soybean varieties obtained are presented in the Table 2. The results indicated that all varieties evaluated were infested by the leaf roller and hairy caterpillar. The leaf roller attacked the soybean crop during early vegetative stage and continued up to pod forming stage of the crop. Infestation of hairy caterpillar started at vegetative stage of the crop after leaf roller infestation. The insects were found most damaging at vegetative, flowering and pod forming stage. Comparatively the highest number of leaf roller per ten plant on variety BARI Soybean-5(3.06) and BARI Soybean-6(2.65) followed by Bangladesh soybean-4 (1.93). The highest percent plant infestation was found on variety BARI Soybean-5(61.20%) and BARI Soybean-6(53%) . And the lowest percent infestation was found on variety BARI soybean-7(24.2%) and Bangladesh Soybean-4(31.60%). On the other hand, the highest number of hairy caterpillar per ten plant on variety BARI Soybean-5(2.89) BARI Soybean-6(2.58) followed by Bangladesh soybean-4(1.79). The highest percent plant infestation was found on variety BARI Soybean-5(57.8%) and BARI Soybean-6(51.6%). And the lowest percent infestation was found on variety BARI Soybean-7(22.2%) and Shohag(25.2%).

Table 2. Effect of different varieties for controlling leaf roller and hairy caterpillar of soybean

Varieties	No. of leaf roller/10 plant	% plant infestation	No. of hairy caterpillar/10 plant	% plant infestation
V_1 =Shohag	1.58	31.60	1.26	25.20
V_2 =Bangladesh soybean-4	1.93	38.60	1.79	35.80
V_3=BARI Soybean-5	3.06	61.20	2.89	57.80
V_4 =BARI Soybean-6	2.65	53.00	2.58	51.60
V_5 =BARI Soybean-7	1.21	24.20	1.11	22.20
LSD(0.05)	0.33		0.79	
CV(%)	8.4		21.8	

Conclusion

From the experimental results it may be concluded that the variety BARI Soybean-7 are less susceptible, variety shohag is moderately susceptible and variety BARI Soybean-5 BARI Soybean-6 are more susceptible. The experiment will be repeated next year for further investigation.

Acknowledgement

‘Enhance Production of Oil crops (BARI Part)’ project.

RELATIVE SUSCEPTIBILITY OF GROUNDNUT CULTIVARS AGAINST SUCKING INSECT PESTS, HAIRY CATERPILLAR AND LEAF ROLLER

M.A. ISLAM AND R. ISLAM

Abstract

The experiment was conducted during Rabi 2021-22 season at ORC research field, BARI, Gazipur to determine the relative susceptibility of BARI release groundnut varieties against sucking insect pests, leaf roller and hairy caterpillar. It was observed that there was a significant difference in infestation of varieties by the sucking insect pests, leaf roller and hairy caterpillar. The population of whiteflies and was more abundant during early growth stage, while jassids and thrips were more abundant during advanced growth stage of crop. The overall means of pest population showed that thrips were more abundant (3.35±0.331) followed by whitefly (2.85±0.554) and jassid (2.51±0.420) per leaf. The lowest amount of whitefly in Basonti Badam (1.36±0.075), BARI Chinabadam-5(1.36±0.075) (), BARI Chinabadam-6(1.06±0.098), BARI Chinabadam-7(0.89±0.077) and BARI Chinabadam-10 (1.32±0.098). The heighest amount of jassid Dhaka-1(4.15±0.450), Tridana Badam (5.19±0.519) and BARI Soybean-11(5.09±0.589) and thrip population were found in higher amount in all cultivers. The highest percent plant infestation by leaf roller (61.20%), (78.40%), (70.60%) were observed in Dhaka-1, Tridana Badam and BARI Soybean-11 respectively. And the highest percent plant infestation by hairy caterpillar (73.40%), (84.60%), (67.80%) were observed on cultivar in Dhaka-1, Tridana Badam Jhinga Badam. As far as cultivars are concerned, Dhaka-1, Tridana Badam and BARI Chinabadam-11 were comparatively susceptible, while Basonti Badam, BARI Chinabadam-5, BARI Chinabadam-6, BARI Chinabadam-7 and BARI Chinabadam-10 were comparatively resistant.

Introduction

BARI has developed a considerable number of groundnut varieties. These varieties are resistant to various insect pests and diseases to a certain level. But nowadays, the varieties are showing susceptibility to different sucking pest, Leaf roller (*Lamprosema indicata* Fab.) and Hairy caterpillar (*Spilarctia obliqua* Walk.) etc. in the field level. Due to the attack of those insect pests, the varieties can't produce desirable yield and farmers are losing economiclly. Therefore, in the present study has been designed to check the relative resistance of those BARI released groundnut varieties.

Materials and Methods

The experiment was conducted during *rabi* season 2021-22 at ORC research field of BARI, Gazipur to check the relative susceptibility of the BARI released groundnut varieties. The experiment was laid out in a randomized complete block design with three dispersed replications. Homogenous seeds of groundnut cultivars were sown in a well prepared seed bed on 02 January 2022. The unit plot size was 4.0 m x .30 m with 30 cm row to row and 5 cm plant to plant distance. The normal intercultural operations were done as and when necessary. Eleven varieties of groundnut were evaluated against sucking pest, leaf roller and hairy caterpillar infestation. The varieties were as follows:V1 =Dhaka-1,V2 =Basonti Badam, V3=Tridana Badam, V4 =Jhinga Badam, V5 =BARI Chinabadam-5, V6 = BARI Chinabadam-6, V7 = BARI Chinabadam-7, V8 = BARI Chinabadam-8, V9 = BARI Chinabadam-9, V10 = BARI Chinabadam-10, V11 = BARI Chinabadam-11. Cultural practices such as fertilizer and irrigation application, inter culturing and weeding were adopted as per the recommendation. However, spray of insecticides of any kind in and around that experimental area was avoided for proper exploitation of insect pests. For recording observation on population buildup of sucking pests, whitefly, Jassid, and Thrips. Five plants were selected randomly from each plot of respective variety and tagged. Three leaves from each selected plant were examined on random basis and population of pests were recorded. The observations were recorded at weekly intervals from February 20 to April 25, 2022. The data on population of sucking insect pests recorded were arranged as mean, standard deviation and standard error, further analysis of variance of data was carried out and the mean values of pests were compared through least significant difference tests, as per the method.

Results and Discussion

Comparative evaluation against sucking pest of soybean varieties:

The results on overall average of three sucking insect pests recorded on five groundnut varieties obtained are presented in the Table 1. The results indicated that all varieties evaluated were infested by the three sucking pests. Comparatively the population of whitefly was low on variety Basonti Badam (1.36±0.075) BARI Chinabadam-5 (1.06±0.098), BARI Chinabadam-6 (0.89 ±0.077), BARI Chinabadam-7 (1.13±0.133) and BARI Chinabadam-10 (1.32±0.098). However, the population of jassid were more on variety Dhaka-1 (4.15±0.450), Tridana Badam (5.19±0.519) and BARI Chinabadam-11 (3.95 ±0.121) per leaf. Whereas greater population of thrips was recorded as more in case of all varieties during the season. These differences of whitefly and jassid may be attributed due to change in the morphological characters of varieties. Sucking insect pests cause serious loss to the groundnut crop, these not only damage the crop but are also vector of certain viral diseases. The results of study envisaged that all five varieties evaluated infested by the whitefly, jassids and thrips. The population level varied between time interval and within pest species. The results further demonstrated that whitefly and jassid were more abundant on all varieties planted as compared to thrips. It was observed that the insect pest populations on all varieties evaluated increased gradually and was maximum during the vegetative growth period. Jassids and thrips were found more active up to peg filling while whitefly was found active in the middle of crop season and was low during the entire growth period on all varieties. Among the eleven varieties sown Dhaka-1, Tridana Badam and BARI Chinabadam-11 were susceptible against sucking insect pests, while Basonti Badam, BARI Chinabadam-5, BARI Chinabadam-6, BARI Chinabadam-7 and BARI Chinabadam-10 were resistant.

Table 1. Overall Mean ± S.E. population of sucking pests/leaf recorded on different varieties of groundnut

Varieties	No. of Whitefly/leaf	No. of Jassid/leaf	No. of Thrips/leaf
V_1 =Dhaka-1	5.27 ±0.473a	4.15±0.450b	4.89±0.139a
V_2 =Basonti Badam	1.36±0.075d	1.48±0.237d	2.29±0.445d
V_3=Tridana Badam	4.15±0.115b	5.19±0.519a	4.53±0.196b
V_4 =Jhinga Badam	2.39±0.155c	2.31±0.242c	2.87±0.214c
V_5 =BARI Chinabadam-5	1.06±0.098d	1.11±0.046d	3.89±0.589d
V_6 = BARI Chinabadam-6	0.89 ±0.077d	1.23 ±0.156d	2.06 ±0.173d
V_7 = BARI Chinabadam-7	1.13±0.133d	1.43±0.127d	2.21±0.242d
V_8 = BARI Chinabadam-8	4.13±0.572b	2.79±0.075c	2.93±0.133b
V_9 = BARI Chinabadam-9	3.87±0.364b	2.69±0.335c	2.65±0.248b
V_{10} = BARI Chinabadam-10	1.32±0.098d	1.29±0.115d	3.43±0.473d
V_{11} = BARI Chinabadam-11	5.81 ±0.185a	3.95 ±0.121b	5.09 ±0.589a
Mean	2.85±0.554	2.51±0.420	3.35±0.331
LSD(0.05)	0.77	0.81	1.02
CV(%)	15.9	19.1	18.0

Mean ± S.E. followed by same latter in a column are not significantly **(**$P<0.05$) different from each other by LSD.

Comparative evaluation against leaf roller and hairy caterpillar of groundnut varieties:

The results on overall average of leaf roller and hairy caterpillar were recorded on five groundnut varieties obtained are presented in the Table 2. The results indicated that all varieties evaluated were infested by the leaf roller and hairy caterpillar. The leaf roller attacked the groundnut crop during early vegetative stage and continued up to peg forming stage of the crop. Infestation of hairy caterpillar started at vegetative stage of the crop after leaf roller infestation. The insects were found most damaging at vegetative, flowering and peg forming stage. Comparatively the highest number of leaf roller per ten plant on variety Basonti Badam(1.13), BARI Chinabadam-5(1.29), BARI Chinabadam-6(1.16), BARI Chinabadam-7(1.06) and BARI Chinabadam-10(0.92). The lowest percent plant infestation was found on variety Basonti Badam(22.6%), BARI Chinabadam-5(25.8%), BARI Chinabadam-6(23.2%), BARI Chinabadam-7(21.2%) and BARI Chinabadam-10(18.4%). And the heighest percent infestation was found on variety Dhaka-1(61.2%), Tridana Badam(78.4%) and BARI Chinabadam-11(70.6%). On the other hand, the highest number of hairy caterpillar per ten plant on variety Basonti Badam(0.96), BARI Chinabadam-5(1.39), BARI Chinabadam-6(1.26), BARI Chinabadam-7(1.32) and BARI Chinabadam-10(1.42). The lowest percent plant infestation was found on variety Basonti Badam(19.2%), BARI Chinabadam-5(27.8%), BARI Chinabadam-6(25.2%), BARI Chinabadam-7(26.4%) and BARI Chinabadam-10(28.4%). And the lowest percent infestation was found on variety Dhaka-1(73.4%), Tridana Badam(84.6%) and BARI Chinabadam-11(82.2%).

Table 2. Effect of different treatments for controlling leaf roller and hairy caterpillar of groundnut

Varieties	No. of leaf roller/10 plant	% plant infestation	No. of hairy caterpillar/10 plant	% plant infestation
V_1 =Dhaka-1	3.06	61.20	3.67	73.40
V_2 =Basonti Badam	1.13	22.60	0.96	19.20
V_3=Tridana Badam	3.92	78.40	4.23	84.60
V_4 =Jhinga Badam	1.89	37.80	3.39	67.80
V_5 =BARI Chinabadam-5	1.29	25.80	1.39	27.80
V_6 = BARI Chinabadam-6	1.16	23.20	1.26	25.20
V_7 = BARI Chinabadam-7	1.06	21.20	1.32	26.40
V_8 = BARI Chinabadam-8	2.11	42.20	2.87	57.40
V_9 = BARI Chinabadam-9	2.51	50.20	2.16	43.20
V_{10} = BARI Chinabadam-10	0.92	18.40	1.42	28.40
V_{11} = BARI Chinabadam-11	4.53	70.60	4.11	82.20
LSD(0.05)	0.63		0.91	
CV(%)	15.40		25.0	

Conclusion

From the experimental results it may be concluded that the variety Basonti Badam, BARI Chinabadam-5, BARI Chinabadam-6, BARI Chinabadam-7 and BARI Chinabadam-10 are less susceptible, variety Dhaka-1, Tridana Badam and BARI Chinabadam-11 are more susceptible. The experiment will be repeated next year for further investigation.

Acknowledgement

‘Enhance Production of Oil crops (BARI Part)’ project.

DEVELOPMENT OF IPM PACKAGE AGAINST THE MAJOR INSECT PESTS OF SUNFLOWER

M.A. ISLAM AND R. ISLAM

Abstract

The experiment was conducted during kharif season 2021-22 at ORC research field, BARI, Gazipur to develop effective management approach against major insect pest of groundnut. The treatments were as follows: T_1(IPM Package-1) = Hand picking of larvae + Sex pheromone mass trapping of Spodoptera litura+ Application of Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water, T_2(IPM Package-2) = Hand picking of larvae + Sex pheromone mass trapping of Spodoptera litura + Application of SNPV @ 2 g/10 litre of water, T_3(IPM Package-3) = Hand picking of larvae + Sex pheromone mass trapping of Spodoptera litura+ Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water, T_4 = Farmers practice (Application of Nitro 505 EC @ 0.1ml/litre of water),T_5 = Untreated control.The highest number of whitefly, aphid, jassid, and hairy caterpillar were found in control plots and the lowest in T_4 followed by IPM package 3. The highest yield was found in T_4 (1.65 t/ha) and the lowest in control plots (1.08 t/ha). The highest MBCR was also calculated from T_4.

Introduction

Sunflower (*Helianthus annuus* L.) is one of the important oilseed crops in the world and ranks third in area after soybean and groundnut. Presently in Bangladesh during sunflower cultivation a variety of insect pests infest sunflower and cause a significant decrease in yield. Vulnerability of the sunflower insect pests and diseases is one of the main hurdles towards its production. Farmers generally spray traditional insecticides to combat these pests often without having desire result. Indiscriminate use of insecticides is leading to the development of pest resistance, resurgence and health hazard. Toxic chemicals also have serious adverse impacts on the natural enemies of insect's pests. Therefore, the present study has been designed to provide the farmers with a management option for major insect pests of sunflower.

Materials and Methods

The experiment was conducted during *rabi* season 2022 at ORC research field, BARI, Gazipur to develop effective management approach against major insect pest of sunflower. The experiment was laid out in a randomized complete block design with three dispersed replications. Sunflower seeds (BARI Surjamukhi-3) were sown on 22 November 2021 at Gazipur. The unit plot size was 4.5 m x 4.0 m with 30 cm row to row and 1 m plot to plot distance. The normal intercultural operations were done as and when necessary. The treatments were as follows: T_1(IPM Package-1) = Hand picking of larvae + Sex pheromone mass trapping of *Spodoptera litura*+ Application of Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water, T_2(IPM Package-2) = Hand picking of larvae + Sex pheromone mass trapping of *Spodoptera litura* + Application of SNPV @ 2 g/10 litre of water, T_3(IPM Package-3) = Hand picking of larvae + Sex pheromone mass trapping of *Spodoptera litura*+ Bio-chamak (*Celastras angulatas* 1% EW) @ 2.5 ml/litre of water, T_4 = Farmers practice (Application of Nitro 505 EC @ 0.1ml/litre of water),T_5 = Untreated control.The whole plant was thoroughly covered by spray emulsion. Number of whitefly, aphid, jassid and thrips were recorded at 7 days intervals from the five randomly selected plants from middle rows and five leaves from each plant. Number of hairy caterpillar were recorded from three randomly selected branch per plot and number of common cutworm adult per trap recorded at seven days intervals. Yield data were recorded also.

Results and Discussion

The results are summarized in table 1 and 2.

Effect of different treatment packages against whitefly, aphid and jassid of sunflower:

The number of whitefly per leaf ranged from 2.37 to 11.39 and differed significantly among the treatments. However, the highest number of whitefly per leaf (11.39) was found in untreated control while the lowest (2.37) was obtained from T_4 treated plots followed by T_3 treated plots. The number of aphid per leaf ranged from 1.89 to 6.92 and differed significantly among the treatments. However, the highest number of aphid per leaf (6.92) was found in untreated control while the lowest (1.89) was obtained from T_4 treated plots followed by T_3 treated plots. The number of jassid per leaf ranged from 2.11 to 9.27 and differed significantly among the treatments. The highest number of jassid per leaf (9.27) was recorded in untreated control and the lowest was found from T_4 treated plots (2.11) followed by T_3 treated plot.

Table 1. Effect of different treatments for controlling sucking pest of sunflower

Treatments	No. of whitefly/leaf	No. of aphid/leaf	No. of jassid/ leaf
T_1	5.23	3.65	4.56
T_2	7.32	4.35	6.27
T_3	3.35	2.87	2.95
T_4	2.37	1.89	2.11
T_5	11.39	6.92	9.27
LSD(0.05)	3.63	2.71	1.94
CV(%)	32.50	36.60	20.50

Effect of different treatment packages against thrips and hairy caterpillar of sunflower:
The number of thrips per head ranged from 5.66 to 9.89. Number of thrips is high in all the treated plot.The number of hairy caterpillar per branch ranged from 1.11 to 4.15 and differed significantly among the treatments. The highest number of hairy caterpillar per branch (4.15) was recorded in untreated control and the lowest was found from T_4 treated plots (1.11) followed by T_3 treated plot. The highest yield was obtained from T_4 treated plot (1.65 t/ha) followed by T_3(1.54 t/ha) treated plots and the lowest in (T_5) control plot (1.08) t/ha.

Table 2. Effect of different treatments for controlling thrips and hairy caterpillar of sunflower

<table>
<tr><th>Treatments</th><th>No. of thrips/head</th><th>No. of hairy caterpillar/ 3 leaf</th><th>No. of Spodoptera litura adult trapped/trap/week</th><th>Yield (tha^{-1})</th></tr>
<tr><td>T_1</td><td>6.93</td><td>2.65</td><td rowspan="5">12.31</td><td>1.31</td></tr>
<tr><td>T_2</td><td>7.32</td><td>3.35</td><td>1.43</td></tr>
<tr><td>T_3</td><td>6.65</td><td>1.89</td><td>1.54</td></tr>
<tr><td>T_4</td><td>5.66</td><td>1.11</td><td>1.65</td></tr>
<tr><td>T_5</td><td>9.89</td><td>4.15</td><td>1.08</td></tr>
<tr><td>LSD(0.05)</td><td>3.11</td><td>1.23</td><td></td><td>0.03</td></tr>
<tr><td>CV(%)</td><td>22.70</td><td>25.0</td><td></td><td>1.40</td></tr>
</table>

Benefit cost analysis:
The marginal cost benefit ratios (MBCR) of different treatments applied against major insect pest of sunflower as worked out based on the expenses incurred and value of crop is presented in table 3. It is to be noted here that expenses incurred referred to those only on pest control. The results revealed the highest MBCR was observed in treatment (Nitro 505 EC @1.0 ml/L of water) treated plot (6.65). The highest yield (1.65) and gross return (Tk99000) was obtained from treatment T_4 followed by T_3.

Table 3. Economic analysis of different management options against major insect pest of sunflower

Treatments	Yield of sunflower (t/ha)	Gross return (Tk/ha)	Cost of treatments (Tk/ha)	Net return (Tk/ha)	Adjusted net return (Tk/ha)	MBCR
T_1	1.31	78600	7500	71100	7100	0.95
T_2	1.43	85800	9300	76500	12500	1.34
T_3	1.54	92400	9200	83200	19200	2.09
T_4	1.65	99000	4570	94430	30430	6.65
T_5	1.08	64000	-	-	-	-

Cost of relevant materials/activities:
Farmgate price of sunflower @ Tk. 60.00 per kg,
[Cost of Success 2.5SC: @ Tk 3200/L; Cost of Bio-chamak: @ Tk 3900/L; Cost of SNPV: @ Tk 3200/L; ost of Nitro: @ Tk 1850/L; Cost of hand picking : Five labour/ha @ Tk 300/labour/day; Cost of spray : Two laborers/spray/ha @ Tk 300.00/labour/day; Spray volume required: 500L /ha].

Conclusion
From the experimental results it may be concluded that the treatment T_4 (Nitro 505 EC) @1.0 ml/L of water) and also T_3 (White sticky trap + Perching+ Bio-chamak (Celastras angulatas 1% EW) @ 2.5 ml/litre of water) were more effective against major insect pest of sunflower with higher yield and marginal benefit cost ratio. The experiment will be repeated next year for further investigation.

Acknowledgement
'Enhance Production of Oil crops (BARI Part)' project.

PROJECT V: TECHNOLOGY TRANSFER ACTIVITIES OF OILCROPS

R.ISLAM, M A LATIF AKANDA, F BEGUM, M M ALI, M KADIR AND CONCERNED SCIENTISTS OF ORC, RARS, ARS AND OFRD, BARI

Abstract

Technology transfer activities includes training, demonstration, field day, workshop publication of booklets, leaflets, posters, broadcasting in radio, TV etc. Training on molecular techniques, oilseed production, processing and preservation technologies and data analysis were given to the Scientists of BARI, Officers of DAE, BADC, NGO, SAAO of DAE, SA/SSA of BARI and farmers. A total of 120 Scientists, Officers and Staff were trained in 5 batches. Farmers' training on production and preservation technologies of oilseed crops was also conducted and 625 farmers were trained in 22 batches. Forty (40) demonstrations of different HYV oilseed crop varieties and technologies were conducted at the farmer's fields in different locations for showing their performance. A total of 23 field days on different HYV oilseed crop varieties and technologies were conducted of in the farmer's fields in different locations for showing their performance. About 1840 participants were present in the field days occasions and showing the performance of the technologies directly in the farmers' fields in different locations.

Introduction

Oilseed Research Centre, BARI is continuously working for developing improved oilseed production technologies to increase the production of oilseed crops. The improved technologies include development of high yielding short duration oilseed crop varieties and production techniques. Most of the varieties have not yet reached to the farmers. They do not apply irrigation, pesticides and fertilizers for oilseeds cultivation. So there exist huge yield gap between farmers field and research plot. There is a wide scope of increasing the total production of oilseed in the country by adopting new varieties and modern technology by the farmers. Therefore, it is urgently needed to transfer modern technologies of oilseed crops to the farmers and all concern agencies through conducting training, field demonstration and arranging of farmers day. For quick dissemination of improved production technologies, a number of technology transfer program were conducted during 2021-22 cropping season. This technology transfer program was undertaken with the following objectives:

Quick dissemination of modern varieties of oilseed crops to extension personnel and farmers
Block demonstration of the latest oilseed technologies
Conduction of field days in the demonstration block for the farmers and Extension personnel to demonstrate directly the performance of the modern technologies.
To improve skill of the farmers and extension personnel to update knowledge by conducting training, field demonstration and arranging of farmers day in the fields.

A. Training

Training is an important method for transfer of technology. It improves skills and update knowledge of the trainee for quick dissemination of technologies. In this connection 3-days training program of one batches (20 persons) on Modern Production Technology and Seed Production of Oilseed Crops were conducted for Scientists of BARI at Gazipur (Table 1). One day training program for DAE, BADC, NGO officers was arranged in one batch (20 persons) at Jamalpur. Training program was also conducted for SAAO of DAE and SA/SSA of BARI at Jamalpur, Jashore and Rangpur locations and they were trained in 03 batch (25 persons/each batch). Training programs were also conducted for farmers on Modern Production Technologies including important diseases and insect pest management of mustard, groundnut, sesame, sunflower and soybean crops. A total of 625 farmers were trained up in 22 batches at different oilseed growing areas (10 locations) of the country (Table 2). Booklets and leaflets on different oilseed crop production technologies were provided them for easily understanding the subject matter of the training class.

Table 1. Training conducted for BARI scientists, DAE, BADC officers, SAAO on production practices of oilseed crops during 2021-22

Type of Trainee	No. batch	Location	Participant
Scientist of BARI	01	Gazipur	20
Officers of DAE, BADC	01	Jamalpur	25
SAAO of DAE and SA/SSA of BARI	03	Jamalpur, Jashore, Rangpur	75
Total =	**05**	**04**	**120**

Table 2. Training conducted for farmers in different locations during 2021-22

Type of Trainee	No. batch	Location	Participants
Farmers' training (Production technology of mustard, groundnut, sesame, soybean & sunflower)	22	Manikganj., Bagura, Jamalpur, Tangail, Netrakona, Rangpur, Gopalganj, Faridpur, Satkhira, Akbarpur, Moulavibazar	625

B. PILOT PRODUCTION PROGRAM

Cropping pattern based Pilot Production Program were conducted in the farmers' field. In cropping pattern, at least one oilseed crop must be included. Popular and recently developed varieties released by ORC of BARI will be included in pilot production program in order to popularize these varieties. OFRD of BARI executed the pilot production program at the following locations (30 locations) and area of each location was at least one hectare.

No. of locations	Name of locations
30	Manikgonj (2), Faridpur (2), Tangail (3), Sherpur (3), Jamalpur (2), Pabna, Gaibandha (2), Bhola (2), Patuakhali (3), Khulna (2), Satkhira (2), Bogura (3), Kushtia (2) & Rajshahi (2)

PRODUCTION PROGRAMME

PRODUCTION PROGRAM OF BARI SHARISHA-14 IN FARIDPUR

S. AHMED, AFM R. QUDDUS AND F..BEGUM

A production program under OFRD, BARI, Faridpur and “Strengthening of oil seed and pulses research and development project in Bangladesh” was conducted at farmer’s field of the MLT site, Rajbari and Madaripur during the rabi season of 2021-22 to popularize BARI Sarisha-14 and to observe the local neighboring farmers, DAE personnel and NGO workers. The program was conducted in about 700 decimal (21 bigha) of land and nine (9) numbers of farmers were involved. Different crop management practices like date of sowing, intercultural operations, date of harvest etc. are stated in Table 1. The crop was fertilized with N-P-K-S-Zn & B ha^{-1} in the form of urea, TSP, MoP, gypsum, zinc sulphate mono hydrate and boric acid, respectively. Two third of N and full amount of P, K, S, Zn and B was applied as basal during final land preparation. The remaining N was applied as top dress at 21-23 days after sowing (DAS) irrespective of farmers followed by irrigation. BARI Sarisha-14 was harvested at 87-92 DAS. Data on yield and economic returns were recorded and presented in Table 2. In Table 6, average yield and economic return was stated on the basis of all locations.

Table 1. Crop management practices of BARI Sarisha-14 at the MLT site, Rajbari and Madaripur during the year of 2021-22.

Location	Variety	Farmer (nos.)	Area (dec)	Date of sowing	Fertilizer dose (N-P-K-S-Zn-B) kg ha^{-1})	Irrigation and Urea top dressing (DAS)	Date and DAS to harvest
MLT site, Rajbari	BARI Sarisha-14	6	400	19-28 Nov2021	120-36-40-15-2-1	Irri: 25 Urea top: 26	15-24 Feb 2022 (87-90 DAS)
	BARI Sarisha-14	2	50	17 Nov 2021	100-40-35-20-2-2		08 Jan 2022 (91 DAS)
MLT site, Madaripur	BARI Sarisha-14	3	100	13-14 Nov 2021	120-36-40-15-2-1	Irri:50 Urea top: 25-28	10-12 Feb 2022 (89-92 DAS)
	Local (Jota)	1	50	17 Nov 2021	100-30-36-12-2-1	Irri:50 Urea top: 27-28	16 February 2022 (91 DAS)

Results

MLT site, Rajbari: The mean seed yield obtained from BARI Sarisha-14 was 1.39 t ha^{-1} whereas 1.30 t ha^{-1} was found from farmers own management variety BARI Sarisha-14. BARI Sarisha-14 provided 7% higher yield over farmers own management variety, BARI Sarisha-14. Gross return (Tk. 125100 ha^{-1}) and gross margin (Tk.74325 ha^{-1}) were found in BARI Sarisha-14. The BCR of BARI Sarisha-14 and local was 2.46 and 2.39, respectively (Table 2).

MLT site, Madaripur: The average seed yield of BARI Sarisha-14 was 1.49 t ha^{-1} which was 15% higher than that of local cultivar (Jota). BARI Sarisha-14 showed higher gross return (Tk.119200 ha^{-1}), gross margin (Tk.69345 ha^{-1}) and BCR (2.39) over the local cultivar. Farmer's stored different amount of seeds for next year cultivation (Table 2).

Table 2. Yield and economic return of BARI Sarisha-14 at the MLT site, Rajbari and Madaripur during the year of 2021-22.

Location	Variety	Seed yield ($t\ ha^{-1}$)		Gross return ($Tk\ ha^{-1}$)	Total cost ($Tk\ ha^{-1}$)	Gross margin ($Tk\ ha^{-1}$)	BCR	Seed stored (kg)
		Range	Average					
MLT site, Rajbari	BARI Sarisha-14	1.28-1.55	1.39	125100	50775	74325	2.46	150
	FP (BARI Sarisha-14)	1.30	1.30	117000	48962	68038	2.39	--
MLT site, Madaripur	BARI Sarisha-14	1.45-1.52	1.49	119200	49855	69345	2.39	50
	Local (Jota)	1.28-1.33	1.30	104000	48265	55735	2.15	--

Output price: Seed ($Tk\ kg^{-1}$): Rajbari: 90.00 and Madaripur: 80.00

BARI Sarisha-14gave 10% higher seed yield (Table 6) over local variety

Table 3. At a glance seed yield and return of BARI Sarisha-14 over local during 2021-22

Variety	Seed yield ($t\ ha^{-1}$)	Gross return ($Tk\ ha^{-1}$)	Variable cost ($Tk\ ha^{-1}$)	Gross margin ($Tk\ ha^{-1}$)	BCR
BARI Sarisha-14	1.43	121550	50315	71235	2.42
Local	1.30	110500	48614	61886	2.27

Output price:($Tkkg^{-1}$): 85:00

Farmers' opinion

Farmers opined positively to variety BARI Sarisha-14 for its higher seed yield and negligible pest infestation. Yield of BARI Sarisha-14 is not satisfactory due to rainfall (Zawad effect, 6-7 Dec, 2021). A good amount of seed has been stored by the farmers for growing in the next year.

Conclusion

BARI Sarisha-14 gave 10% higher seed yield (Table 6) over local variety and negligible pest infestation. For the short duration character, this variety is easily fit in the existing cropping pattern (Mustard-Jute-T. Aman). A good amount of seed has been stored by the farmers for growing in the next year.

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PRODUCTION PROGRAM OF BARI SARISHA-17

M.H. RASHID, M.K. ISLAM, T.S. MUNMUN, M. K. SHAHADAT AND M. RAHMAN

Abstract

The production programme was conducted in the farmer's field at Ramerdanga, Satkhira during the Rabi season of 2021-2022 to popularize and disseminate BARI Sarisha-17 among the farmers and also to increase through increasing yield. BARI Sarisha-17 produced significantly yield (2.43 t ha^{-1}). Economic analysis revealed that BARI Sorisha-17 gave gross return (Tk.14348 3ha^{-1} Tk), gross margin (Tk.78533 ha $^{-1}$) and benefit-cost ratio was (2.20).

Introduction

In Bangladesh coastal areas occupy almost thirty percent of the net cultivable land. Almost 0.84 million hectares of coastal land is affected by salinity of varying degrees (Karim *et al*. 1990). Mustard is one of the most important oil crops in Bangladesh which can be grown in the coastal area. So, it is necessary to select salt tolerant mustard genotype. Keeping this in mind, the experiment will be conducted in saline area to examine the variation in salt tolerance of selected mustard genotypes up to maturity and to select salt tolerant mustard genotypes under salinity condition.

Materials and Methods

The programme was conducted at Ramerdanga, Satkhira during the r*abi* season of 2021-2022 under farmers field condition to popularize BARI new developed high yielding variety. BARI Sorisha-17 was distributed among 7 farmers and having total of 1.33ha. Seeds were sown on 15 to 25 November 2021 in broadcasting method. The land was fertilized with N-P-K-S-Zn-B @ 196-135-120-83-14-7.5kg/ha. Half N and all other fertilizer were applied as basal and remaining N was top dressed at vegetative stage (22 Days after Emergence). All the intercultural operations were done as and when necessary. The crop was harvested at 10 to20 February 2022.

Results and Discussion

The maximum plant m^{-2} was (78) and minimum was (71). The plant height of BARI Shorisha-17was recorded from (81to 86 cm). The highest number of siliqua plant^{-1} was 83 and lowest was 74 and average number of siliqua plant^{-1} was 78.33. Number of seed siliqua^{-1} varied from (22 to 23), average was 22.33. Thousand seed weight was 3.51 g. Seed yield of BARI Shorisha-17 was obtained from (1.58to 1.71 t ha^{-1}). Average yield was 1.66 t ha^{-1} (Table 2).

Table 1. Performance of BARI Sorisha-17 variety at Ramerdanga, Satkhira during the year of 2021-22

Location	Variety(s)	No. of upazila	No. of farmer	Area (ha)	Date of sowing	Date of harvesting
Ramerdanga, Satkhira	BARI Sarisha-17	1	6	1.33	15-25 Nov. 2021	10-20 Feb. 2022

Table 2. Yield and yield contribution characters of mustard lines at Ramerdanga, Satkhira during 2021-22

Variety	Farmers	Plant population (m^2)	Plant height (cm)	No. of siliqua plant^{-1}	No. of seed siliqua^{-1}	1000 Seed weight (g)	Seed yield (t ha^{-1})
BARI Sarisha-17	F1	74.00	85.00	81.00	23.00	3.50	1.69
	F2	75.00	86.00	83.00	22.00	3.55	1.69
	F3	78.00	83.00	81.00	23.00	3.85	1.71
	F4	73	84.00	75.00	22.00	3.50	1.64
	F5	74.00	85.00	76.00	22.00	3.48	1.65
	F6	71.00	81.00	74.00	22.00	3.20	1.58
Mean		**74.17**	**84.00**	**78.33**	**22.33**	**3.51**	**1.66**

Economic analysis

Cost and return analysis of BARI Shorisha-17 presented in Table 2, showed that the mean of 6 farmers gross return was (143483Tk.ha^{-1}), gross margin was (78533Tk.ha^{-1}) and benefit cost ratio was (2.20Tk.ha^{-1}).

Table 3. Cost and return analysis of BARI Sarisha-17at Ramerdanga, Satkhira

Treatment	Farmers	Gross return (Tk.ha^{-1})	Cost of production (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})	BCR
BARI Sorisha-17	F1	145930	64950	80980	2.25
	F2	146790	64950	81840	2.26
	F3	147650	64950	82700	2.27
	F4	141610	64950	76660	2.18
	F5	142470	64950	77520	2.19
	F6	136450	64950	71500	2.10
Mean		143483	64950	78533	2.20

Price: 80 Tk/ Kg

Farmers' opinion

Farmers and the neighbors were encouraged observing the yield BARI Shorisha-17. However, they showed their interest to cultivate the mustard BARI Shorisha-17 for their highest silique plant^{-1}, seed silique^{-1} and higher yield performance in saline of Ramerdanga, Satkhira.

Conclusion

From the study it was revealed that BARI Shorisha-17 gave the better performance in saline soil of Ramerdanga, Satkhira. It was the first year results, for conformation the results further trails to be needed.

Acknowledgement

'Enhance Production of Oil crops (BARI Part)' project.

PRODUCTION PROGRAMME OF MUSTARD VARIETIES AT HAOR AREAS IN KISHOREGANJ

M.MOHIUDDIN AND F.BEGUM

Abstract

A production program under OFRD, BARI, conducted in the farmer's field at Nikli, Mitamoin, Karimganj, Hossainpur and Kishoreganj sadar in Kishoreganj district during the rabi season in 2021-22 to assess the performance of BARI sharisa-17 and BARI sharisa-14 in this area. Yield of BARI sharisa-17 was found 1.64 t/ha and 1.56 t/ha of BARI sharisa-14. The highest gross return (106795Tk/ha), gross margin (65545 Tk/ha) and BCR 2.59 were calculated from BARI sharisa-17 and lowest gross return (101725 Tk/ha), gross margin (60475 Tk/ha) and BCR (2.47) from BARI sharisa-14.

Introduction

Now mustard is ranked as first oil seed crop in Bangladesh. Current oil seed production can't keep peace with the current oil demand of the country. The farmer's of Kishoreganj traditionally used local variety (Tory-7) for mustard seed production which have low yield potential. BARI has developed a good numbers of high yielding varieties (about 18 varieties) and many of the farmer's of haor don't know about these high yielding BARI variety. If short duration and high yielding BARI variety inserted in these area, cropping intensity and farmers' income may increase and reduce oil scarcity of the country. So the present program had been taken to assess the performance and to introduce a new variety in different haor area to meet up the oil scarcity as well as increase productivity.

Materials and methods

An experiment on mustard was conducted at farmer's field of Nikli, Mitamoin, Karimganj, Hossainpur and Kishoreganj sadar in Kishoreganj district during rabi 2021-22 cropping season to know the performance of BARI sharisa-17 and BARI sharisa-14 in this haor areas. The land areas were fifteen acres for BARI sharisa-17 and 30 acres for BARI sharisa-14 in different upazilas of Kishoreganj. Seeds of mustard were sown on 25-30 October 2021. The seeds were sown in broad casting method. The recommended fertilizer doses were applied at the rate of $N_{115}P_{32}K_{40}$ S_{25} Zn_2 and B_2 kg ha^{-1}. Among the fertilizers half of urea and all others fertilizers were applied as basal during final land preparation. The remaining half urea was applied as top dress at 25 DAS. In cultivating time there were no infestations of any insects or disease. Mustard were harvested on 17-27 January 2022. Yield Data has collected and calculated carefully.

Results and discussion

Yield and economic data of BARI sharisa-17 and BARI sharisa-14 has presented in the Table 1. Crop durations were 85-90 days for BARI sharisa-17 and 81-83 days for BARI sharisa-14. Seed yield of BARI sharisa-17 was calculated 1.64 t/ha and 1.56 t/ha of BARI sharisa-14. The highest gross return (106795 Tk/ha), gross margin (65545 Tk/ha) and BCR (2.59) were calculated from BARI sharisa-17 followed by BARI sharisa-14 (101725 Tk/ha, 60475 Tk/ha and 2.47, respectively).

Table 1. Yield performance of BARI sharisa-17 and BARI sharisa-14 during 2021-22

Variety	Area (acres)	Duration (days)	Seed yield (t/ha)	Gross return (Tk/ha)	Total cost of production(Tk/ha)	Gross margin (Tk/ha)	BCR
BARI sharisa-17	15	85-90	1.64	106795	41250	65545	2.59
BARI sharisa-14	30	81-83	1.56	101725	41250	60475	2.47

*TVC includes labour, Land preparation, Seed, fertilizers and Insecticides, Price of Mustard= Tk. 65 kg^{-1}

Farmers' assessment

Farmers are highly interested to grow BARI Mustard variety but timely seed must be available at farmers level.

Conclusion

These are new and good varieties for the farmer of this areas. Though, the plant is tall but capable to give higher yield.

Acknowledgement

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PRODUCTION PROGRAM OF BARI SHARISAH-18 IN FARIDPUR

SELIM AHMED AND AFM RUHUL QUDDUS

A production program under OFRD, BARI, Faridpur and was conducted at farmer's field of the FSRD site, Faridpur, the MLT site, Rajbari and Madaripur during the rabi season of 2021-22 to popularize new canola variety, BARI Sarisha-18 and to observe to the local neighboring farmers, DAE personnel and NGO workers. The program was conducted in about 1346 decimal (41bigha) land. A total of 33 farmers were selected. Different crop management practices like date of sowing, intercultural operations, date of harvest etc. are stated in Table 1. The crop was fertilized with 120-36-40-15-2-1 kg of N-P-K-S-Zn & B ha^{-1} in the form of urea, TSP, MoP, gypsum, zinc sulphate mono hydrate and boric acid, in Rajbari and Madaripur. But, in Faridpur, N rate was 100 kg ha^{-1}. Two third of N and full amount of P, K, S, Zn and B was applied as basal during final land preparation.

The remaining N was applied as top dress at 21-27days after sowing (DAS) irrespective of farmers followed by irrigation. BARI Sarisha-18 was harvested at 97-108 DAS. Data on yield and economic returns were recorded and presented in Table 2. In Table 3, average yield and economic return was stated on the basis of all locations.

Table 1. Crop management practices of BARISarisha-18 under different locations of OFRD, Faridpur during the year of 2021-22

Location	Variety	Farmer (nos.)	Area (dec)	Date of sowing	Fertilizer dose (N-P-K-S-Zn-B) kg ha^{-1})	Irrigation (DAS)	Date and DAS to harvest
FSRD site, Faridpur	BARI Sarisha-18	11	534	08-30 Nov 2021	100-36-40-15-2-1	24-34	24 Feb-12 Mar 22(103-108 DAS)
	BARI Sarisha-14	2	60	25 Nov. 2021	92-30-50-9-2-1		16-18 Jan 2021 (89-90 DAS)
MLT Site, Madaripur	BARI Sarisha-18	2	112	15 Nov to 01 Dec. 21	120-36-40-15-2-1	26	10-12 Feb - 2022 (98-101 DAS)
	Local (Jota)	2	80	17 Nov to 03 Dec. 21	101-30-36-12-2-1	28	16 Feb to 07 March2022 (91-94 DAS)
MLT site, Rajbari	BARI Sarisha-18	20	700	11 Nov to 05 Dec. 2021	120-36-40-15-2-1	22-30	28 Feb –15 Mar 2021 (97-104 DAS)
	BARI Sarisha-14	2	50	25 Nov 20201	100-40-35-20-2.17-2.1	36	24 February 2022 (72 DAS)

Results

FSRD site, Faridpur: The average seed yield obtained from BARI Sarisha-18 was 1.6 t ha^{-1} which was 30% higher than that of BARI Sarisha-14). BARI Sarisha-18 showed higher gross return over the local cultivar (Table 2). The respective as well as neighboring farmers stored different amount of seeds for next year cultivation.

Madaripur: The average seed yields obtained from BARI Sarisha-18 was 1.55 t ha^{-1} whereas 1.30 t ha^{-1} was found from local variety Jota). BARI Sarisha-18 showed higher gross return and BCR (2.91) over the local cultivar. Farmer's stored different amount of seeds for next year cultivation.

Rajbari: The seed yields obtained from BARI Sarisha-18 was 1.49 t ha^{-1} whereas 1.32 t ha^{-1} was found from local variety (BARI Sarisha-14). Sarisha-18 provided 100 % higher yield over local cultivar. The BCR of BARI Sarisha-18 and local was 2.70 and 2.46, respectively.

Table 2. Yield and economic return of BARISarisha-18 under OFRD, Faridpur during the year of 2021-2022

Location	Variety	Seed yield (t ha^{-1})		Gross return (Tk ha^{-1})	Variable cost (Tk ha^{-1})	Gross margin (Tk ha^{-1})	BCR	Seed stored (kg)
		Range	Average					
FSRD site, Faridpur	BARI Sarisha-18	1.41-1.74	1.59	152450	59080	93370	2.58	120
	Local (BARI Sarisha-14)	1.09-1.35	1.23	116985	54080	62905	2.16	---
MLT Site, Madaripur	BARI Sarisha-18	1.45-1.66	1.55	13500	50655	84345	2.67	80
	Local (Jota)	1.28-1.32	1.30	107255	48265	58990	2.22	--
MLT site, Rajbari	BARI Sarisha-18	1.15-1.82	1.49	137375	50775	86600	2.70	120
	BARI Sarisha-18	0.88-1.18	0.90	120800	48962	71836	2.46	--

Output price: -Seed (BARI Variety and local): 90.00 Tk kg^{-1}

Table 3. At a glance yield and return of BARI Sarisha-18 over local during the year of 2020-21

Variety	**Seed yield (t ha^{-1})**	**Gross return (Tk ha^{-1})**	**Variable cost (Tk ha^{-1})**	**Gross margin (Tk ha^{-1})**	**BCR**
BARI Sarisha-18	1.62	145802	53503	92299	2.72
Local	1.28	115013	50436	64577	2.28

Farmers' opinion

Farmers opined positive to the new variety BARI Sarisha-18 for its higher seed yield and negligible pest infestation. A good amount of seed has been stored by the farmers for growing in the next year. Shattering tendency of pod was observed. Plant height was higher than that of BARI Sarisha-18 resulting lodging.

Conclusion

BARI Sarisha-18 performed better than of BARI Shorisha-14. But, most of the plant became lodged due to over growth at the MLT site Madaripur and Rajbari. The lower yield was observed at the FSRD site, Faridpur due to delay sowing and Jawed effect (6-7 Dec. 2021). In Faridpur, lower lodging of plant was happened due to reduced application of N-fertilizer (100 kg ha^{-1}).

Acknowledgement

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SEED PRODUCTION PROGRAM OF BARI DEVELOPED MUSTARD VARIETY

M. M. BASHIR AND S. K. BHOWAL

The production program was carried out in the farmer's field of Muradnagar, Barura,SadarDakkhin, Titas and Meghna upazilla in Cumilla District, Hajigonj in Chandpur and Kosba in Brahmanbaria district during the Rabi season of 2021-22. The soil of the experimental plot was clay loam. Seeds were sown according to the farmer's practice *i.e.* broadcast method. Thirty five farmers were included in this program. Two varieties were used in the demonstration program such as BARI Sarisha-17and BARI Sarisha-18. Seeds of mustard were broadcasted @ 7.0 kg ha^{-1} on 12 Nov- 15 Dec, 2021. Due to Jawad vast area was fully damaged, so re-sowing was done in those plots. Fertilizers were applied at the rate of 120, 90, 60, 33, 13.5 and 1.9 kg ha^{-1} of N, P, K, S, Zn and B in the form of Urea, Triple Super Phosphate, Murate of Potash, Gypsum, Zinc Oxide and Boric acid, respectively in the field. Half of urea and full amount of all other fertilizers were applied during final land preparation. The rest urea was top dressed at 25 Days after Sowing (DAS).Bioferty @ 3ml L^{-1} was sprayed to promote growth of survived plots after Jawad.About no irrigation was applied. Spraying of rovral at the rate of 0.2 % for controlling *Alternaria* leaf spot at 10 days interval from disease iniciation. For controlling aphids, Nimbicidin and Malathion were sprayed @ 0.2 %. The crop was harvested from 08 February-24 March, 2022. Data were collected as per required.

Results and Discussion

Seed yield of BARI Sarisha-17 and BARI Sarisha-18 were presented in Table 1. The average seed yield of BARI Sarisha-17 and BARI Sarisha-18were 1.26and 1.76t ha^{-1} respectively from all location. From the partial economic analysis, it was found that the higher gross margin (Tk. 118000.0ha^{-1}) was found in BARI Sarisha-18.BARI Sarisha-18 takes 10-12 days more to mature than BARI Sarisha-14 &BARI Sarisha-17.

Table 1. Seed yield of BARI Sarisha-17 and BARI Sarisha-18 at different locations under Cumilla region during the Rabi season of 2021-22

SL. No	Variety	No. of farmers	Area (Hectare)	Location	Date of sowing	Seed yield (t ha^{-1})
1.	BARI Sarisha-17	12	2.44	Cumilla & Chandpur	12Nov.- 01 Dec. 2021	1.26
2.	BARI Sarisha-18	23	6.26	Cumilla, Chandpur & B. Baria	30 Nov.- 24 Dec 2021	1.76
Total		35	8.7	-	-	-

Table 2. Cost and return analysis of BARI Sarisha-17 and BARI Sarisha-18at different locations under Cumilla region during the Rabi season of 2021-22

Varieties	Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
BARI Sarisha-17	100800.00	30000.0	70800.00
BARI Sarisha-18	158400.00	30000.0	128400.00

Market price of BARI Sarisha-17 @ Tk. 80 kg^{-1} and BARI Sarisha-18@ Tk. 90 kg^{-1}

Farmer s' reaction

Farmers are satisfied to see the seed yield performance of BARI Sarisha-18 and BARI Sarisha-17 in field level. They cultivate local variety of Sarisha (Tori-7) without proper management practices. They want to cultivate BARI developed short duration Sarisha variety instead of local for its higher seed yield and market price.

Conclusion

This year, several environmental hazards hampered the yield of mustard. If no hazard BARI Sarisha-18 will can give about 2.5 t ha^{-1} yield. So, where BARI Sarisha-18 may be fitted in the pattern, we must suggest the farmers to grow it for safer (low erocic acid and late sowing potential) and higher yielder mustard.

PRODUCTION PROGRAM OF BARI MUSTARD VARIETY (BARI SARISHA-18) IN MANIKGANJ

RUHUL AMIN

The production program of BARI Mustard variety (BARI Sarisha-18) was carried at two locations of Manikganj district. One at Boinna village under Ghior upazila and another at Sharashing village under Shibaloya upazila during Rabi season of 2021-22 in the farmers' field with irrigation facilities. BARI Sarisha-18 was grown at both the locations in 04 farmer's field in 03 bighas of land. The seed was collected from Oilseed Research Centre of BARI, Gazipur. The experimental block was fertilized with N-P-K-S-Zn-B-cowdung @ 96-37.5-56-36-2.5-1.27-5000 kg ha^{-1} in the form of urea, triple super phosphate, muriate of potash and gypsum, zinc sulphate, boric acid, respectively. Sowing time varied in the tested locations depended on the farmers' field condition. Seed was sown as broadcast @ 7.0 kg ha^{-1} on 07 to 15 November,2021 Irrigation was given once at 35 DAS. Other plant protection measures were taken as and when required. The crop was harvested at on 22 to 23 February 2022. Data on seed and stover yield were recorded and converted into kg per hectare.

Results

The seed yield of BARI Sarisha-18 is shown in Table 1. Economic benefit obtained by the farmers is shown in Table 2.

Pest incidence:

Alternaria leaf spot disease was observed in the plots due to prolonged foggy weather during the growing season and Rovral @ 2 gm L^{-1} water was sprayed to control the disease. No other diseases or pest incidence was observed in the experimental fields.

Farmers' opinion

The farmers opined that BARI Sarisha-18 is a new variety of mustard at Manikganj. This variety could fit well in Mustard-Summer maize/Jute-Fallow cropping pattern. They showed interest to grow BARI Sarisha-18 in the next growing season.

Table 1. Yield of BARI mustard varieties grown at Ghior and Shibolaya of Manikganj during Rabi season of 2021-22.

Treatments	Location	Farmers involved	Area (bigha)	Field duration (days)	Average seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
BARI Sarisha-18	Ghior	03	02	107	1800	2830
BARI Sarisha-18	Shibaloya	01	01	107	2300	3550

Table 2: Cost and return of BARI mustard varieties grown at Ghior and Shibaloya of Manikganj during Rabi season of 2021-22

Treatments	Seed yield (kg ha^{-1})	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
BARI Sarisha-18	1800	146830.00	64825	82005.00
BARI Sarisha-18	2300	187550.00	64825	122725.00

Price of mustard @ Tk. 80.00 kg^{-1} and straw @ Tk. 1.00 kg^{-1}

Conclusion

Considering the yield, mustard var. BARI Sarisha-18 was found to be high yielding and could be recommended to cultivate in large scale in the farmers field at Manikganj.

Acknowledgement

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SEED PRODUCTION PROGRAM OF BARI RELEASED SESAME VARIETIES

S. K. BHOWAL AND M. M. BASHIR

The production programme was conducted at Sadar Sadar Dakhin, Titas and Debidwar Upazillas under Cumilla district and Hatila, Haziganj under Chandpur district during the *Kharif* season of 2021 following RCB design with four dispersed replications. BARI Til-3, BARI Til-4 and a local variety was included as check in the experiment. The unit plot size was 320 decimals with broadcast method. Land was prepared by three to four times ploughing followed by laddering. All inputs like seed of BARI Til-4, chemical fertilizers and pesticides were provided to the farmers. Total land area was 300 decimals using seed rate @ 7 kg ha^{-1}. Seeds were sown on 25-30March, 2021. Fertilizers were applied @ 52-27-22.5-19-1.80-1.50 kg ha^{-1} N-P-K-S-Zn-B, respectively. Half of urea and all other fertilizers were applied as basal during final land preparation. One weeding was done at 20- 25 Days after sowing (DAS). Two to three irrigation was done and the rest half of urea was applied at 25-30 DAS. The crop was sprayed by Propiconazol (Tilt 250 EC) @ 0.5 ml L^{-1} 2 to 3 times 7-10 day's interval to control leaf rust diseases. The crop was also sprayed by Cypermethrin (Ripcord 10 EC) @ 1ml L^{-1} to control caterpillars. The crop was harvested on 16-20 June, 2021. Data were recorded and analyzed by using Statistix10 program.

Results and discussions

Yield, area covered and number of farmers involved under BARI Til-3 and BARI Til-4 production was presented in Table 1. Fourfamers were involved in this pilot program covering 320 decimals of land. On an average, the crop duration of BARI Til-4 was84-87 days with an average seed yield was1.45 t ha^{-1} followed by BARI Til-3. Seed yield of local variety was 0.86 t ha$^{-1.}$ The price of local variety was higher than BARI developed variety. The highest gross return and gross margin of Tk. 145000 ha^{-1}and Tk. 84550 ha^{-1}, respectively were obtained from BARI Til-4.

Farmers' opinion

Farmers expressed their satisfaction because of its eight-chamber silique and higher seed yield. So, they have been stored seed for growing in the next year.

Table 1. Number of farmers involved, area covered and seed yield of Sesame

Variety	No. of farmers involved	Total area (Dec.)	Crop duration (day)	Seed yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
BARI Til-3	02	180	80-86	1.25	125000	60450	64550
BARI Til-4	02	140	84-87	1.45	145000	60450	84550
Local (Black)	2	10	80-85	0.86	103200	60450	42750

Price: Tk. 100 kg^{-1}& Local variety 120 kg^{-1}

Conclusion

BARI Til- 4 gave the higher yield and higher cash return. Farmers are interested to cultivate BARI Til-4 as aoil crop if seeds are available.

PRODUCTION PROGRAM OF BARI CHINABADAM-8 VARIETIES IN KUSHTIA

J. A. MAHMUD

Abstract

The production program of groundnut was taken at MLT site, Bheramara during the year ofto2021-22 to observe yield performance of BARI released groundnut varietyt in block approach. Two farmers were involved in the production program covering land area of 1.5 ha. Farmers were benefited to cultivate BARI Badam-8 due to higher seed yield and higher income.

Introduction

Groundnut (*Arachis hypogaea*) is an important leguminous oilseed crop. It is cultivated both in Rabi and Kharif seasons in Bangladesh. This crop is an important source of oil (43-55%) and protein (25-28%), hence used as food and feed. It is a good source of edible oil as it contains about (50% oil good quality. It is excellent source of vitamins and contains high levels of thiamine, riboflavin and niacin. Being highly digestible, the children's food made of groundnut can help in meeting part of the nutritional needs. Groundnut, being a drought tolerant crop, it require low input and produces high output for the farmer. Since it is a leguminous crop it can fix atmospheric nitrogen enhancing soil health by adding nitrogen to soil. Farmer's of charland areas of Bangladesh usually grow Groundnut with local variety which produce lower yield and susceptible to pest and disease. BARI has developed some modern varieties of Groundnut, which are supposed to be higher yielder and less susceptible to pest and disease. The present study was undertaken to observe the yield performance of BARI Chinabadam-8 in block approach.

Materials and Methods

The experiment was conducted at MLT site, Bheramara during the rabi season of 2021-22. OFRD, BARI, Kushtia has supplied all inputs like seed of BARI Badam-8, chemical fertilizers and pesticides to the farmers. Total land area was 1.5 ha. Seeds were sown maintaining a spacing of 30 cm x 15 cm. Before sowing, seeds were treated with provex @ 0.2% to prevent seed and soil borne disease. Seeds were sown on 21 December, 2021. All nutrients were applied following BARI technology handbook (50-50-30-35-2-1.5 kg of NPKSZn and B ha^{-1}). Other intercultural operations were done as when necessary. The crop was harvested on 15 May, 2022. Data on yield and other characters were recorded and analyzed statically. The gross economic return was calculated on the basis of prevailing market price of the commodities.

Results and Discussion

The performance of BARI Chinabadam-8 was presented in table1. The seed yield of BARI Chinabadam-8 was 2.30 t ha^{-1}. Gross return, total variable cost and gross margin were Tk (184000) ha^{-1}, Tk (65940) ha^{-1} and Tk. (118060) ha^{-1} respectively. Satisfactory seed yield and attractive gross margin was achieved might be due to sowing at optimum time and timely proper management practices like weeding and pest management.

Table1. Yield, cost and return analysis of BARI badam-8 during theyear 2021-22

Location	No. of Farmers	Area (ha)	Seed yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
MLT site, Bheramara	02	1.50	2.30	184000	65940	118060

Market price of Chinabadam @ 80 Tk.kg^{-1}

Farmers' opinion

Farmer`s were happy to see the high yielding variety of BARI Chinabadam-8. They have stored seeds of BARI Chinabadam-8 for next year sowing.

Conclusion

Groundnut cultivation is profitable to the farmers. This variety should be expanded among all other farmers.

Acknowledgement
It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

PRODUCTION PROGRAM OF BARI SURJAMUKHI-2 IN FARIDPUR

SELIM AHMED AND AFM RUHUL QUDDUS

A production program was conducted under at farmer's field situation of the FSRD site, Faridpur during the *rabi season of* 2021-22 to observe the performance of BARI Surjamukhi-2 and to observe neighboring farmers, DAE personnel and NGO workers. The program was conducted in about 100 decimals of land. Different crop management practices like date of sowing, intercultural operations, date of harvest, etc. are stated in Table 1. The crop was fertilized with 87-34-80-29-4-2 kg of N-P-K-S-Zn & B ha^{-1} in the form of urea, TSP, MoP, gypsum, zinc sulphate monohydrate and boric acid, respectively. One-third of N and the full amount of P, K, S, Zn and B was applied as basal during final land preparation. The remaining N was applied two times as top-dressing at 26-30 and 48-54 days after sowing (DAS) irrespective of farmers followed by irrigation. Data on yield and economic returns were recorded and presented in Table 2.

Table 1. Crop management practices used in BARI Surjamukhi-2 at the FSRD site, Faridpur during 2020-21

Date of sowing	Fertilizer dose (N-P-K-S-Zn-B) kg ha^{-1})	Irrigation	Top dressing of Urea (DAS)	Date and DAS to harvest
28 Nov-16 Dec 2021	87-34-80-29-4-2	Irrigation: 26-30, 48-54	26-30, 48-54	27 March to 5 April 2022 (110-119 DAS)

Results
The seed yield of BARI Surjamukhi-2 was 1.82 t ha^{-1}. The gross return and gross margin of variety were Tk 182500.00 ha^{-1}, Tk 91502.00 ha^{-1}.

Table 2. Yield and economic return of BARI Surjamukhi-2 at the FSRD site, Faridpur

Range of seed yield (t ha^{-1})	Average seed yield (t ha^{-1})	Gross return (Tk ha^{-1})	VTotal (Tk ha^{-1})	Gross margin (Tk ha^{-1})	BCR
1.7-1.93	1.82	182500	90998	91502	2.00

Output price: Seed- 100.00 Tk kg^{-1-}

Pest and disease incidence
No remarkable disease was observed but hairy caterpillar attacked the leaves and head during pre-mature stage which was tried to prevent manually and sprayed insecticide (Emamectinbenzoet) by the farmers at 90-96 DAS.

Farmers' opinion
Farmers opined, BARI Surjamukhi-2 was higher yield variety. The sunflower was considered as a good source of honey collection.

Conclusion
BARI Surjamukhi-2 was a good variety by the farmers for its higher yield. They will cultivate in next year & preserved seed.

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PRODUCTION PROGRAMME OF SUNFLOWER VARIETY AT HAOR AREAS IN KISHOREGANJ

M.MOHIUDDIN AND F.BEGUM

The production programme on BARI Surjomukhi-3 was conducted at the farmers field of Nikli, Kishoreganj during rabi season 2021-22 to assess the performance and disseminate the variety in the haor area. The land areas were 3 acres Seeds were sown on 31 October 2021. Spacing was 50 cm x 25 cm. The seeds were sown in line sowing method by BARI seeder. Before sowing all seeds were treated with provex @ 2.5 g kg^{-1}. The recommended fertilizer doses were applied at the rate of $N_{90}P_{40}K_{75}\,S_{30}$ Zn_8 and B_7 kg ha^{-1}. Among the fertilizers half of urea and all others fertilizers were applied as basal during final land preparation. The remaining half urea was applied as top dress at 25 DAS. In cultivating time there were infestations of insects and three splitted spraying were done by Karate. Crops were harvested on 10 February 2022. Yield Data has collected and calculated carefully.

Results and discussions

Yield and economics data of BARI Surjomukhi-3 has presented in the Table 1. Crop durations were 102 days. Seed yield was calculated 1578 kg/ha. The gross return (71010 Tk/ha), gross margin (42260 Tk/ha) as well as BCR 2.47 were calculated from the BARI Surjomukhi-3.

Table 1. Yield performance of BARI Surjumukhi-3 in Kishoreganj during 2020-21

Variety	Area (decimal)	Seed yield (t/ha)	Gross return (Tk/ha)	Total cost of production(Tk/ha)	Gross margin (Tk/ha)	BCR
BARI Surjomukhi-3	300	1.578	71010	28750	42260	2.47

*TVC includes land preparation, labour, seed, fertilizers and insecticides, Price of sunflower = 45tk/kg

Farmers' assessment

Since sunflower cultivation was totally new in the haor area thus farmers are highly appreciated to get a new variety and they pleased to observe the dwarf type and yield performance of BARI Surjomukhi-3. Farmers are facing problem to sell their produce. As a result sunflower has to be sold at lower price than mustard.

Conclusion

It's a new practice and a good variety for the haor areas farmer. If they can sell their produce easily in the local market then it would be popular sharply.

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SEED PRODUCTION PROGRAM OF BARI Surjamukhi -3

M. M. BASHIR & S. K. BHOWAL

The production program was conducted at MLT site Barura and Chandina of Cumilla, Kosba of Brahmanbaria and Saharasti of Chandpur district during Rabi season of 2021-22 to show the performance of sunflower variety under farmer's field condition. BARI developed Sunflower variety BARI Surjamukhi-3 was used in this program. The variety was evaluated with four dispersed replications. The experimental land was ploughed by the tiller with four passes then laddered to prepare plot. Chemical fertilizers were applied @ 100-30-60-20-1.5 kg ha-1 N, P, K, S and B in the form of Urea, TSP, Mop, Gypsum, Boric acid in the field. Half of Urea and full doses of all other fertilizers were applied during final land preparation. Rest amount of Urea were top dressed at 25 & 45 days after sowing. Seeds were sown on 23-31 December, 2021 with a spacing of 50 cm × 25 cm, respectively. The seeds were treated with Provax-200 at the rate of 2.5 mg Kg^{-1} of seeds. To control caterpillar (*Admair*and*Cortan Plus*) Nitro 505 EC at the rate of 2ml $L^{-1}$was sprayed twice at flowering and grain filling stage. For controlling blight and root rot diseases of sunflower Autostin 72 Wp and Rovral-50 Wp @ 1 mg $L^{-1}$of water were sprayed at disease initiation stage. The crop was harvested 23 March- 04 April, 2022. Yield and Yield attributes were recorded properly and then statistically analyzed with Statistix10.

Results and Discussion

Average of four demonstrations of different locations of Cumilla region is given in Table 1. BARI Shurjamukhi-3 showed 84.78 cm height which is very much shorter than BARI Shurjamukhi-2 (). It has taken ninety one (91) days to be matured. Head diameter, seeds $head^{-1}$, Thousand seed weight and yield were- 57cm, 570.6, 72g and 2.15t ha^{-1}, respectively. From partial economic analysis it was revealed that it can produce higher gross return (Tk. 172000.00 ha^{-1}) and gross margin (Tk. 131500.00 ha^{-1}).

Table 1. Land area, yield and yield contributing characters of sunflower (BARI Surjamukhi-3) in Cumilla region during 2021-22.

Land area (Decimal)	Farmers Involved (no.)	Plant height (cm)	Head dia (cm)	Seeds/head (no.)	Th seed wt. (g)	Yield (t/ha)	Field duration
185	4	84.78	57	570.6	72	2.15	91.25

Table 2. Cost and Benefit analysis of BARI Surjamukhi-3 at different location of Cumilla region during Rabi season of 2021-22

Variety	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
BARI Surjomukhi-3	172000.00	40500.00	131500.00

Market price of Sunflower @ Tk. 80 kg^{-1}

Farmers reaction

Farmers were very much happy to get shorter sunflower plant with higher yield, which is more tolerant against lodging than the long varieties (eg. BARI Shurjamukhi-2). Farmers can earn extra money in sunflower field as its the new era to open the windows of Agro tourism

Conclusion

Farmers want to cultivate BARI surjomukhi-3 as a new crop, if seed is available. Somewhere oil extraction is a problem. Without refining, the oil can’t be used for a long time.

PILOT PROGRAMME

IMPROVEMENT OF EXISTING CROPPING PATTERN MUSTARD-T. AUS-T. AMAN RICE THROUGH INCLUSION OF MODERN VARIETIES OF MUSTARD AND RICE IN AEZ 20 OF SYLHET REGION

M. I. NAZRUL AND F.BEGUM

Abstract

The study was conducted at the farmer's field in Sylhet under AEZ 20 during the year of 2020-2021 to determine the productivity and profitability of cropping patterns viz. improved pattern (IP): Mustard (BARI Sarisha-18-T. Aus (BRRI dhan48)-T. Aman ric (BRRI dhan75) by introducing high yielding varieties of mustard and rice in existing pattern (EP): Mustard (BARI Sarisha-14-T. Aus (BRRI dhan48)-T. Aman ric (Binadhan-7). The experiment was laid out in randomized complete block design with six dispersed replications. Results showed that the improved pattern with management practices provided 24 % higher rice equivalent yield (REY) than existing pattern. Similarly, the highest mean gross margin (Tk. 224430 ha^{-1}) with marginal benefit cost ratio (1.49) was obtained over existing pattern. Results revealed that 4.41 % extra cost provides an ample scope of considerable improvement of the productivity with the inclusion of modern mustard and T. Aman rice in improved pattern.

Introduction

At present fallow - T. Aus - T. Aman followed by mustard - T. Aus - T. Aman rice cropping sequences are widely followed by farmers under rainfed condition in medium high land to medium low land in Sylhet region. Nazrul (2019) reported that inclusion of short duration mustard in fallow period preceding t. Aus-t. Aman rice cropping can be practice by the farmers for higher crops yield and productivity in Sylhet region. Transplantation of Aus rice is being dependent on rainfall, which sown during early monsoon (early May). This delayed transplantation of T. Aus rice that causes late cultivation and harvesting of T. Aman rice, which hampered timely cultivation of rabi crops. The soils under these cropping pattern areas are generally heavy silty clay loams to clays and the top soil quickly becomes dry and hard after the harvest of T. Aman rice. In Eastern Surma Kushiara Floodplain of Sylhet region, a vast area remains fallow for a long time after the harvest of T. Aman rice due to moisture stress up to next season for cultivation of T. Aus rice following the existing cropping pattern (Fallow-T. Aus-T. Aman rice). However, the yields of rice are very low compared to other regions of the country. Generally, rainfall starts in February and prevails up to November in each year that offers an excellent opportunity for the production of short duration pulse and oilseed crops before T. Aus rice. Shaheb and Nazrul (2012) reported that mustard varieties can be grown well in fallow land of Sylhet where var. BARI Sarisha-14 and BARI Sarisha-17 could be more suitable and produced higher seed yield. To enhance the crop production through utilization of fallow land in Sylhet region, the potato-rice and chickpea - rice based cropping patterns have been developed (Nazrul *et al.,* 2013; Nazrul and Shaheb, 2012; Shaheb *et al.,* 2011). A number of reports on different cropping pattern are available in Bangladesh that an additional crop could be introduced without much changes or replacing the existing ones for considerable increases of productivity as well as profitability of the farmers (Azad *et al.* 1992; Khan *et al.*, 2005 and Nazrul *et al.*, 2013, KamrozzAman *et al*., 2015*).* But, little effort has been made for on-farm evaluation of the improved technologies of Mustard-T. Aus-T. Aman rice cropping pattern in Sylhet area. The present study was therefore, initiated to determine productivity and economic feasibility of an improved package of technologies over the farmer's existing practices.

Materials and Methods

The study was conducted at the farmer's field in Sylhet under AEZ 20 during the year of 2020-2021 at farmer's field, Sylhet (24°54'N latitudes and 91°58' E longitude) located in Agro Ecological Zone (AEZ)-20; under Eastern Surma Kushiyara Floodplain. This trial was conducted to determine the productivity and profitability of cropping patterns viz. improved pattern (IP): Mustard (BARI Sarisha-18-T. Aus (BRRI dhan48)-T. Aman ric (BRRI dhan75) by introducing high yielding varieties of mustard and rice in existing pattern (EP): Mustard (BARI Sarisha-14-T. Aus (BRRI dhan48)-T. Aman ric (Binadhan-7). The experiment was laid out in randomized complete block design with six dispersed replications.

Annual monthly total rainfalls, along with maximum and minimum average temperatures during the study period are presented in Fig. 1. The highest amount of average monthly rainfall occurred in June followed by July and May, whereas lowest amount of rainfall occurred in January followed by November and December. Rainfall increases gradually from the month of January to June and then decreases.

The initial status of N (0.07%), P (7.59 µg/soil), K (0.18 meq/100g soil), S (10.80 µg/soil), B (0.34 µg/soil) and Zn (1.27 µg/soil) was very low, low, low, low, medium and medium, respectively. The trial was laid out in randomized complete block design with six dispersed replications. Two plots of 500 m^2 were selected for each replication. One plot was under the improved pattern and the other farmer's pattern.

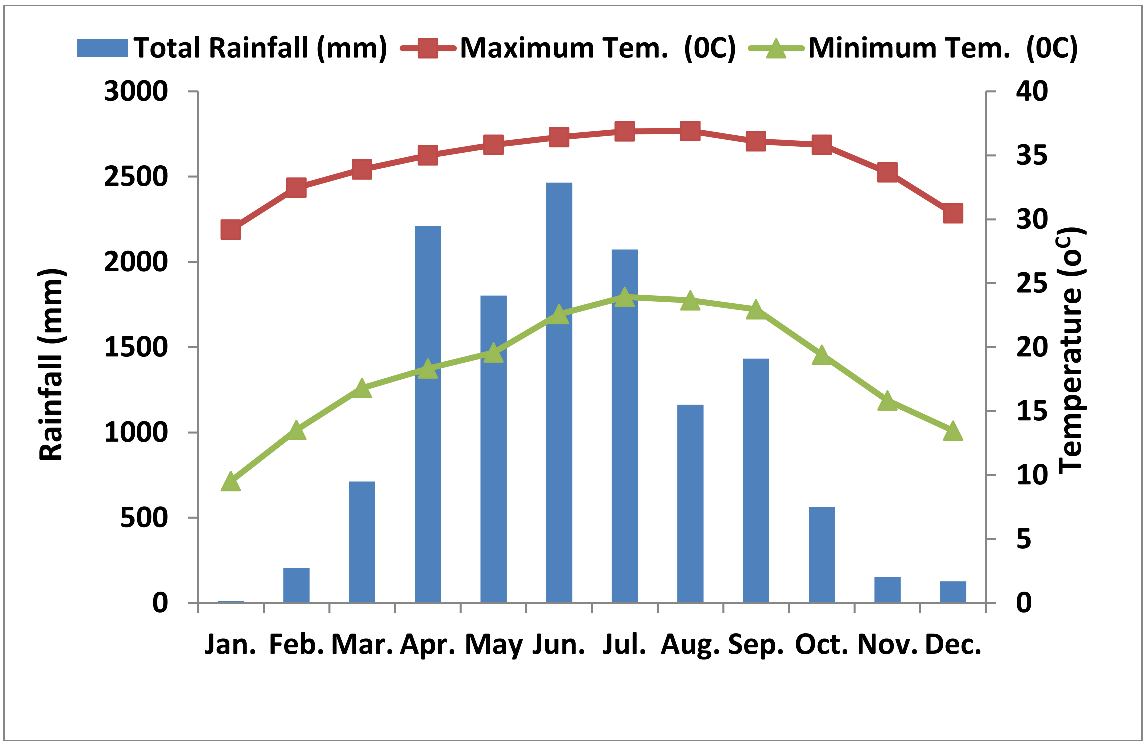

Fig. 1. Average of three years monthly total rainfall (mm), maximum and minimum air temperatures during study period (Source: Metrological Department, Sylhet)

Results and Discussions

Yield of rice and mustard: In rice, the average yield of T. Aus and T. Aman was varied from 3.89-4.65 t ha^{-1}. In mustard, the variety BARI Sarisha-18 was produced 2.10 t ha^{-1} of seed yield in IP whereas 1.39 t ha^{-1} of seed yield was produced by BARI Sarisha-14 in EP. The variety of T. Aus and T. Aman rice was given higher grain yields under the pattern IP it might be due to use of improved rice variety. The highest average yield of T. Aus (4.50 tha^{-1}) and T. Aman (4.65 tha^{-1}) rice was provided by IP.

T. Aman rice equivalent yield: The total productivity of the cropping sequence was ascertained by the rice equivalent yield (REY) it was calculated from the yields of component crops. REY was varied under different cropping sequence. In average of two years revealed that the highest REY (18.61 t ha^{-1}) was recorded from IP as compared to EP (15.02 t ha^{-1}). Inclusion of new mustard variety and modern variety of T. Aman rice in IP increased REY 24 % as compared to EP. Similarly, the highest mean gross margin (Tk. 224430 ha^{-1}) with marginal benefit cost ratio (1.49) was obtained over existing pattern. Results revealed that 4.41 % extra cost provides an ample scope of considerable improvement of the productivity with the inclusion of modern mustard and T. Aman rice in improved pattern.

Farmers' opinion

Farmers opined that the insertion of high yielding short duration new mustard variety BARI Sarisha-18 in improved pattern instead of BARI Sarisha-14 and almost no need of irrigation which can also be cultivated after harvest of T. Aman rice during fallow period. Mustard is also a profitable safe crop for the farmers of Sylhet region.

Table 1. Management practices followed in improved and existing cropping pattern at FSRD site, Kamalbazer, Sylhet during the year of 2020-2022

Observation	Improved cropping pattern			Existing cropping pattern		
Cropping pattern-II						
Crop	Mustard	T.Aus	T. Aman	Mustard	T.Aus	T. Aman
Variety	BARI Sarisha-18	BRRI dhan48	BRRI dhan75	BARI Sarisha-14	BRRI dhan48	Binadhan-7
Date of sowing/ transplanting	15-11-20	23-04-21	02-08-21	29-11-20	16-04-21	01-08-21
Seed rate (kg ha^{-1})	7.5	26	26	7.5	26	26
Spacing (cm)	-	20 x 15	20 x 15	-	20 x 15	20 x 15
Fertilizer dose (N-P-K-S-Zn-B, kgha^{-1})	115-30-43-27-18-1.7	134-53-83-60-0-0	150-53-83-60-0-0	115-30-43-27-18-1.7	134-53-83-60-0-0	165-60-105-86-0-0
Date of harvesting	10-02-21	27-07-20	03-11-21	08-02-21	25-07-21	18-11-21
Field duration (days)	95	90	95	85	90	110
Turnaround time (days)	70	05	10	75	3	2

Table 2: Yield and economic analysis of improved and existing cropping pattern at FSRD site, Kamalbazer, Sylhet during the year of 2020-2022

Observation	Improved cropping pattern			Existing cropping pattern		
Crop	Mustard	T.Aus	T. Aman	Mustard	T.Aus	T. Aman
Variety	BARI Sarisha-18	BRRI dhan48	BRRI dhan75	BARI Sarisha-14	BRRI dhan48	BINA dhan-7
Seed/grain yield (tha^{-1})	2.10	4.50	4.65	1.39	4.49	3.89
Straw yield (tha^{-1})	2.25	5.40	5.5	1.41	5.50	4.8
REY	7.75	5.05	5.61	5.14	5.16	4.72
Total REY	18.61			15.02		
Gross return (Tk ha^{-1})	182850	116150	129030	118220	118680	108560
Total variable cost (Tk ha^{-1})	55600	68000	80000	49000	68000	78000
Gross margin (Tk ha^{-1})	65370	41800	48950	33100	23060	30670
Total Gross return (Tk ha^{-1})	428030			345460		
Total variable cost (Tk ha^{-1})	203600			195000		
Total Gross margin (Tk ha^{-1})	224430			150460		
MBCR	1.49					

Unit price (TK.kg^{-1}) Mustard=85.00, Mustard Straw = 2.00, Rice Straw= 4.00, T.Aus=21.00, T. Aman = 23.00

Conclusion

Two years study revealed that improved pattern is more productive, sustainable and remunerative for medium high land under Eastern Surma Kushiyara Floodplain (AEZ 20). So, farmers of commanding area could follow Mustard (var. BARI Sarisha-18)-T. Aus (var. BRRI dhan48)-T. Aman rice (var. BRRI dhan75) cropping pattern for higher productivity and profitability as well as mustard straw can be utilized as fuel instead of cow dung.

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DEVELOPMENT OF ALTERNATE MUSTARD-BORO-T. AMAN RICE CROPPING PATTERN AGAINST BORO-FALLOW-T. AMAN IN BOGURA REGION

M. S. ALAM AND M. A. ISLAM

Abstract

An on-farm trial on Three crops pattern was conducted under the MLT Site, Sonatola, Bogura, during the year of 2020-22 cropping season with a view to improving the existingBoro-Fallow-T. Aman rice cropping pattern through the inclusion of Mustard in the system andvarietal replacement. Varieties used for the existing cropping pattern Boro (BRRI dhan28)-T. Aman (Swarna) and for alternate cropping pattern (Mustard (BARI Sarisha-14)-Boro(BRRI dhan81)-T. Aman (BRRI dhan75). Higher rice equivalent yield (15.80 t ha^{-1}) and gross margin (Tk. 265765 ha^{-1}) were obtained from the alternate pattern over the existing pattern (equivalent rice yield, 10.60 t ha^{-1} and gross margin, Tk 176392 ha^{-1}) during the year cycle which together contributed to the higher marginal return Tk. 130025 ha^{-1} and marginal benefit-cost ratio of 3.19 against the marginal cost of Tk. 40452 ha^{-1} over the three crops pattern.

Introduction

Bangladesh, with an area of 147570 sq km, is the country of the world's most densely populated (about 843 persons per sq. km). Its present population is about 149 million, which is increasing annually at about 1.37 percent. By 2025 AD, the population will increase to about 178 million ((BBS 2014). The total cultivable land of the country is about 8.44 million hectares. Demographic pressures and increased urbanization have caused the cultivated area to decline at 1 percent per year. The country's food requirementis estimated to be doubled in the next 25 years (Islam and Haq 1999). The demand has to be met from our limited and shrinking land resources. Bangladesh is predominantly a rice-growing country, and rice is the staple food. Rice occupies about 80% of the total cropped area and is cultivated in three seasons a year. Boro-Fallow-T. Aman is a popular cropping pattern in the Bogura region. Farmers are using the Swarna in the existing pattern. But including potential high-yield Mustard and rice varieties (BARI Sarisha-14, BRRI dhan81 and BRRI dhan75) could bring a unique opportunity for increasing system yield and economic return. Therefore, the experiment has been employed to compare the system productivity of the alternate Mustard-Boro-T. Aman rice cropping pattern over the existing Boro-Fallow-T. Aman practice.

Materials and Methods

The trial was conducted in the Multilocation testing site's farmers field, Sonatola, Bogura, from October 2021 to January 2022 cropping to improve the existing Boro-Fallow-T. Aman rice cropping pattern through the inclusion of Mustard as well as modern high-yielding varieties in the pattern. The experiment was carried out as block approach on 1 ha of land. There were two treatments, i.e., T_1: Existing Cropping pattern; Boro rice (var. BRRI dhan28)-Fallow-T. Aman rice (var. Swarna) and T_2: Alternate Cropping pattern; Mustard (var. BARI Sarisha-14)-Boro (var. BRRI dhan81)-T. Aman rice (var. BRRI dhan75). The unit plot size was 1320m^{2,}and the area was 1 ha of land. All agronomic activities, including sowing/transplanting, harvesting, spacing, fertilizer management etc. are presented in Table 1. Recommended fertilizer package (BARC, 2018) and the application methods were done to support the normal growth of the crops. For economic comparison between two crop sequences, the yield of all crops was converted into price equivalent yield based on the prevailing market price of individual crops. The economic indices, i.e., gross return, gross margin, marginal return, marginal cost and marginal benefit-cost ratio, were also calculated based on the prevailing market price of the commodities. Relevant data were taken and analyzed statistically.

Pest incidence

In Boro, T.Aus and T. Aman rice, stem borer and sheath blight were observed in some plots. Folicur @ 0.5 ml/L was sprayed to control sheath blight and Virtako 40 WG @1.5g/10 L for stem borer. In mustard, leaf spot was observed in some plots, Acrobat MZ @ 2 g/L was sprayed to control the disease.

Table 1. Crop management practices of existing and alternate cropping Pattern at Sonatola, Bogura, during the year of 2021-22 cropping season

Parameters	Existing Cropping Pattern			Alternate Cropping Pattern		
Crop	Boro	Fallow	T. Aman	Mustard	Boro	T. Aman
Variety	BRRI dhan28	-	Swarna	BARI Sarisha-14	BRRI dhan81	BRRI dhan75
Spacing	Irregular transplanting	-	Irregular transplanting	Broadcast	20× 15cm	20 x 15cm
Area	1 ha			1 ha		
Fertilizer dose (NPKSZnB kgha-^{1})	120-30-55-10-1-1	-	108-22-37-13-0-0-0	121-36-60-24-2.70-1.27	142-25-74-14-4-0	105-20-25-15-0-0
Date of transplanting/ sowing	15-30 Jan 2021	-	15-30 July 2021	01-7 Nov. 2021	26-30 Jan. 2021	15-20 July 2021
Date of harvesting	25-30 May 2021	-	05-15 Nov. 2021	20-25 Jan. 2022	20-25 May 2021	25-30 Oct. 2021
Fertilizer application	Broadcast	-	Broadcast	Broadcast	Broadcast	Broadcast
Intercultural Operation	Irrigation 15 times and weeding 2 times	-	Weeding 2 times	Irrigation 1 time and weeding 1 time	Irrigation 15 times and weeding 2 times	Weeding 2 times
Field duration (days)	125	-	120	81	115	105
Turnaround time (days)	70	-	50	5	4	55

Results and Discussion

Yield, cost and return of alternate pattern and existing pattern are presented in Table 2. In the alternate cropping pattern, the yield of Mustard, Boro, and T. Aman rice was 1.67, 5.45, and 4.65 t ha$^{-1,}$ while in the existing pattern, the yield of Boro and T. Aman were 5.12 and 4.56 t ha^{-1}, respectively. The improved cropping pattern contributed to a higher Rice Equivalent Yield (15.80 t ha^{-1}) against the existing cropping pattern (10.60 t ha^{-1}).

The total gross margin of the improvedcropping pattern was Tk. 265765 ha^{-1}, whereas, in the existing cropping pattern,it was Tk. 176392 ha^{-1}. After calculating marginal return and marginal cost, the marginal benefit-cost ratio of the whole pattern was recorded as 3.19 (Table 2). Higher rice equivalent yield and the economic return obtained from the alternate cropping pattern over the existing cropping pattern might be due to changes in the crop varieties as well as the inclusion of Mustard in the pattern. So, it can be concluded that alternate cropping patterns were more productive, offering higher economic returns to the farmers.

Table 2. yield and economic return of existing and alternate cropping pattern at Sonatola, Bogura during the year of 2021-22

Parameters	**Existing Cropping Pattern**			**Alternate Cropping Pattern**		
Crop	Boro	Fallow	T. Aman	Mustard	Boro	T. Aman
Economic yield (t ha^{-1})	5.12	-	4.56	1.67	5.45	4.65
Biological yield (t ha^{-1})	5.72	-	5.89	2.35	5.92	5.24
Equivalent yield (t ha^{-1})	10.60			15.80		
Gross Return (Tk.ha^{-1})	139440	-	125780	120425	148090	126730
Total variable cost (Tk. ha^{-1})	48695	-	40133	33550	52690	43240
Gross margin (Tk. ha^{-1})	90745	-	85647	86875	95400	83490
Gross margin (Tk. ha^{-1})	176392			265765		
Marginal return (Tk. ha^{-1})	-			130025		
Marginal cost (Tk. ha^{-1})	-			40452		
MBCR	-			3.19		

Market price: Mustard @ 70 Tk.kg^{-1}, Straw @ 1.5 Tk.kg^{-1}, Boro @ 25 Tk.kg^{-1}, Straw @ 2.0 Tk.kg^{-1}T. Aman @ 25 Tk.kg^{-1}, Straw @ 2.0 Tk.kg^{-1}

Conclusion

Based on the yield and economic analysis, alternate Mustard-Boro-T. Aman cropping pattern is more profitable than the existing cropping pattern. So, the alternate cropping pattern may be recommended for large-scale adaptation.

Acknowledgement

It is acknowledged to the project entitled ‘Enhancement of Oil Seed Crop Production’ for his generous and stimulating financial and logistic support.

DEVELOPMENT OF ALTERNATIVE CROPPING PATTERN MUSTARD- MAIZE- T. AMAN RICE AGAINST FALLOW- BORO- T. AMAN CROPPING PATTERN IN RAJSHAHI REGION

M. S. RAHMAN, M. M. ANWAR, M. N. A. SIDDQUIE, M. J. ISLAM AND M. M. I. CHOWDHURY

Abstract

A field trial was conducted at the farmers' field of Paba, Rajshahi during the year of 2020-2021 to develop Mustard- Maize- T. Aman cropping pattern. There were two treatments i.e, T_1: Existing Cropping Pattern: Fallow- Boro(BRRIdhan 28)-T. Aman (Sharna) andT_2: Alternate Cropping pattern: Mustard (BARI Sarisha-18)- Maize (Laltir Hybrid 339). T. Aman (BRRI dhan75). In Alternate cropping pattern, yield of Mustard, Maizeand T.A man rice were 2.04, 7.4 and 4.8 t ha^{-1} while in existing pattern, yield of Boro and T. Aman rice were 5.81 and 4.76 t ha^{-1}, respectively. Alternate cropping pattern gave higher rice equivalent yield (16.93 t ha^{-1}) against existing cropping pattern (11.03 t ha^{-1}). Total gross return (Tk. 468722 ha^{-1}) and gross margin (Tk. 240417 ha^{-1}) of alternatecropping pattern were found higher than that of existing cropping pattern (GR: Tk. 320298 ha^{-1} and GM: Tk. 153643 ha^{-1}). After inclusion of alternate cropping pattern, MBCR was 2.41.

Introduction

Fallow-Boro rice-T. Aman rice is one of the major existing cropping patterns at Pabaupazila of Rajshahi district. Generally, farmers of the upazila cultivate T. Aman rice (long duration variety) followed by Boro rice and a little period (around 80-90 days) remains fallow after harvesting of T. Aman rice and before transplanting of Boro rice. The area is under level Barind tract areas and water is crisis for irrigating the boro rice crop. So, less water requirement crops are needed to cultivate in the region. In this context, maize might be a promising crop. Besides, BARI Sarisha-18 is a new variety which crop duration is 100 days, potential yield is 2-2.5 t ha-1 and have low erusic acid. This cropping pattern require minimum water and will increase cropping intensity as well as productivity and profitability. With this view in mind, the experiment was undertaken to increase productivity and income of farmers in AEZ-11.

Materials and Methods

The experiment was conducted at Boraipara and Dharmahata, Paba, Rajshahi during 2020-21 in High Ganges River Floodplain (AEZ-11) to develop Mustard- Maize -T. Aman cropping pattern. The experiment was laid out in a randomized complete block design with six replications. There were two treatments i.e, T_1: Existing Cropping Pattern (ECP): Fallow-Boro (BRRIdhan 28)-T. Aman (Swarna) andT_2: Alternate Cropping Pattern (ACP): Mustard (BARI Sarisha-18)-Maize (Laltir Hybrid339) - T. Aman (BRRI dhan75). All agronomic activities including sowing/transplanting, harvesting, spacing, fertilizer management etc. are presented in Table 1. Recommended fertilizer package (BARC, 2018) along with the application methods were done to support the normal growth of the crops. For economic comparison between two crop sequences, the yield of all crops was converted into price equivalent yield on the basis of prevailing market price of individual crops. The economic indices i.e. gross return, gross margin, and benefit cost ratio were also calculated on the basis of prevailing market price of the commodities. Relevant data were taken and computed.

Table 1. Management practices of existing and alternate cropping patterns during the year of 2020-2021

Crop	Cultivar	Seed rate (kg ha^{-1})	Spacing (cm^2)	Date of sowing/ transplantation	Date of harvesting	Fertilizer (kg ha^{-1})					
						N	P	K	S	Zn	B
Alternate CP											
Mustard	BARI Sarisha-18	7	Broadcast	05-10 Nov. 2020	20 -25 Feb.2020	126	35	46	29	2.5	2
Maize	Laltir Hybrid 339	22.5	60 x 20	3-7 March 2021	05-10 July 2021	152	52	74	26	-	1
T. Aman rice	BRRI dhan75	35	20 x 15	25-30 July 2021	25-30 Oct. 2021	90	10	25	12	1	-
Existing CP											
Boro	BRRI dhan28	35	20 x 15	25-30 Jan. 2021	10-12 Apr. 2021	138	15	60	14	1	-
T. Aman rice	Swarna	35	20 x 15	15-20 July 2021	10-15 Nov. 2021	138	15	60	14	1	-

Pest management

In mustard field Rovral@2 gm L^{-1} was applied for controlling alterneria blight of mustard. In Boro and T. Aman, stem borer and sheath blight was observed in some plots. Folicur @ 0.5 ml/L was sprayed to control sheath blight and Virtako 40 WG @ 1.5g/10 L for stem borer.

Results and discussion

Yield, cost and return of improved pattern and existing pattern are presented in Table 2. In alternate cropping pattern, the yield of Mustard, Maizeand T. Aman *rice* were 2.04, 7.4 and 4.8 t ha^{-1}, respectively while in existing cropping pattern, the yield of Boro and T. Aman rice were 5.81 and 4.76 t ha^{-1}, respectively. Alternate cropping pattern gave higher rice equivalent yield (16.93 t ha^{-1}) against existing cropping pattern (11.03 t ha^{-1}). Total gross return and gross margin of alternate cropping pattern were Tk. 468722 ha^{-1} and Tk. 240417 ha^{-1},respectively whereas in existing cropping pattern it was Tk. 320298 ha^{-1} and Tk. 153643 ha^{-1}, respectively. The overall MBCR was 2.41.

Table 2. Yield, cost and return analysis of existing and alternate cropping patterns during the year of 2020-2021

Observation	Alternate cropping pattern			Existing cropping pattern		
Crop	Mustard	Maize	T. Aman	Boro	Fallow	T. Aman
Seed /grain yield (t ha^{-1})	2.04	7.40	4.80	5.81	-	4.76
Straw yield (t ha^{-1})	3.01	-	5.36	6.34	-	5.30
Gross return (Tk ha^{-1})	143402	185000	140320	181170	-	139128
Total variable cost (Tk ha^{-1})	64320	91150	72835	96235	-	70420
Gross margin (Tk ha^{-1})	79082	93850	67485	84935	-	68708
W. Pattern REY (t ha^{-1})	16.93			11.03		
W. Pattern GR (Tk ha^{-1})	468722			320298		
W. Pattern TVC (Tk ha^{-1})	228305			166655		
W. Pattern GM (Tk ha^{-1})	240417			153643		
MBCR	2.41					

Price of output: T. Aman: Tk 27 kg^{-1}, Straw Tk. 2 kg^{-1}, Mustard: Tk. 70 kg^{-1}, Straw :Tk 0.2 kg^{-1}, Maize: Tk 25.00 kg^{-1}, Boro rice: Tk. 29 kg^{-1} and straw : Tk2 kg^{-1}

Farmers opinion

Farmers' showed keen interest in alternate cropping pattern due to higher yield and income.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

DEVELOPMENTOF ALTERNATIVE CROPPING PATTERN MUSTARD- BORO- T. AMAN RICE AGAINST FALLOW- BORO- T. AMAN CROPPING PATTERN IN RAJSHAHI REGION

M. S. RAHMAN, M. M. ANWAR, M. N. A. SIDDQUIE, M. J. ISLAM AND M. M. I. CHOWDHURY

Abstract

A field trial was conducted at the farmers' field of Chanduria, Tanore, Rajshahi during the year of 2020-2021 to develop Mustard- Boro- T. Aman cropping pattern. There were two treatments i.e, T_1: Existing Cropping pattern: Fallow- Boro-(BRRIdhan 28)-T. Aman (Swarna) andT_2: Alternate Cropping pattern: Mustard (BARI Sarisha-18)- Boro (BRRI dhan 81). T. Aman (BRRI dhan87). In alternate cropping pattern, yield of mustard, Boroand T. Aman rice were 1.91, 5.98 and 5.7 t ha^{-1}, respectively while in existing pattern, yield of Boro and T.AAman rice were 5.82 and 4.79t ha^{-1}, respectively. Alternate cropping pattern gave higher rice equivalent yield (17.07 t ha^{-1}) against existing cropping pattern (11.04 t ha^{-1}). Total gross return and gross margin of improved cropping pattern were Tk. 488062 ha^{-1} and Tk.257057 ha^{-1} whereas in existing cropping pattern those were Tk. 321810 ha^{-1} and Tk. 155155 ha^{-1}, respectively and MBCR was 2.48 due to introduction of new crops and varieties.

Introduction

Fallow-Boro rice-T. Aman rice is one of the major existing cropping patterns at Tanoreupazila of Rajshahi district. Generally, farmers of the upazila cultivate T. Aman rice followed by Boro rice and a long period (around 90 days) remains fallow after T. Aman rice harvest which could be utilized by inclusion of a suitable Rabi crop like mustard. Mustard might be a promising crop. Besides, BARI Sarisha-18 is a new variety which crop duration 100 days, yield 2-2.5 t ha-1 and have low erusic acid. This cropping pattern require minimum water and will increase cropping intensity as well as productivity and profitability. With this view in mind, the experiment was undertaken to increase productivity and income of farmers in AEZ-11.

Materials and Methods

The experiment was conducted at Chanduria, Tanore, Rajshahi during the year of 2020-21 in High Ganges River Floodplain (AEZ-11) to develop Mustard- Boro -T. Aman cropping pattern. The experiment was laid out in a randomized complete block design with six replications. There were two treatments i.e, T_1: Existing Cropping pattern: Fallow-Boro (BRRIdhan 28)-T. Aman (Swarna) andT_2: Alternate Cropping pattern: Mustard (BARI Sarisha-18)-Boro (BRRI dhan81) - T. Aman (BRRI dhan87). All agronomic activities including sowing/transplanting, harvesting, spacing, fertilizer management etc. are presented in Table 1. Recommended fertilizer package (BARC, 2018) along with the application methods were done to support the normal growth of the crops. For economic comparison between two crop sequences, the yield of all crops was converted into price equivalent yield on the basis of prevailing market price of individual crops. The economic indices i.e. gross return, gross margin, and benefit cost ratio were also calculated on the basis of prevailing market price of the commodities. Relevant data were taken and computed.

Table 1. Management practices of existing and alternate cropping patterns during 2020-2021

Crop	Cultivar/ varieties	Seed rate (kg ha^{-1})	Spacing (cm^2)	Date of sowing/ transplantation	Date of harvesting	Fertilizer (kg ha^{-1})					
						N	P	K	S	Zn	B
Alternate CP:											
Mustard	BARI Sarisha-18	7	Broadcast	05-10 Nov.2020	20 -28 Feb.2020	126	35	46	29	2.5	2
Boro	BRRI dhan81	35	20 x 15	20-28 Feb. 2021	25-30 Jul 2021	93	12	26	12	1	-
T. Aman rice	BRRI dhan87	35	20 x 15	25-30 July 2021	25-30 Oct. 2021	90	10	25	12	1	-
Existing CP:											
Boro	Jirasail	35	20 x 15	20-25 Jan 2021	10-12 Apr. 2021	138	15	60	14	1	-
T. Aman rice	Swarna	35	20 x 15	10-15 July 2021	05-10 Nov. 2021	138	15	60	14	1	-

Pest management

In Mustard field Rovral@2 gm L^{-1} was applied for controlling alterneria blight of mustard. In Boro and T. Aman, stem borer and sheath blight was observed in some plots. Folicur @ 0.5 ml/L was sprayed to control sheath blight and Virtako 40 WG @ 1.5g/10 L for stem borer.

Results and discussion

Yield, cost and return of improved pattern and existing pattern are presented in Table 2. In alternate cropping pattern, yield ofMustard, Boroand T. Aman *rice* were 1.91, 5.98 and 5.7 t ha^{-1}, respectively while in existing pattern, yield of Boro and T. Aman rice were 5.82 and 4.79 t ha^{-1}, respectively. Alternate cropping pattern gave higher rice equivalent yield (17.07 t ha^{-1}) against existing cropping pattern (11.04 t ha^{-1}). Total gross return and gross margin of improved cropping pattern were Tk. 488062 ha^{-1} and Tk. 257057 ha^{-1} whereas in existing cropping pattern, those were Tk. 321810 ha^{-1} and Tk. 155155 ha^{-1}, respectively and MBCR was 2.48.

Table 2. Yield, cost and return analysis of existing and alternate cropping pattern during 2020-2021

Observation	Alternate cropping pattern			Existing cropping pattern		
Crop	Mustard	Boro	T. Aman	Boro	Fallow	T. Aman
Seed /grain yield (t ha^{-1})	1.91	5.98	5.7	5.82	-	4.79
Straw yield (t ha^{-1})	2.51	6.91	6.36	6.40	-	5.45
Gross return (Tk ha^{-1})	134202	187240	166620	181580	-	140230
Total variable cost (Tk ha^{-1})	64320	96350	72835	96235	-	70420
Gross margin (Tk ha^{-1})	69882	93390	93785	85345	-	69810
W. Pattern REY (t ha^{-1})	17.07			11.04		
W. Pattern gross return (Tk ha^{-1})	488062			321810		
W. Pattern TVC (Tk ha^{-1})	233505			166655		
W. Pattern gross margin (Tk ha^{-1})	257057			155155		
MBCR	2.48					

Price of output: T. Aman: Tk 27 kg^{-1}, straw 2 kg^{-1}, Mustard: Tk70.00 kg^{-1}, straw :Tk 0.2 kg^{-11}, Boro rice: Tk. 29 kg^{-1} and straw : Tk 2 kg^{-1}

Farmers opinion

Farmers' showed keen interest in alternate cropping pattern due to higher yield and income.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

ENHANCE PRODUCTION OF MUSTARD THROUGH INCLUSION IN FALLOW-BORO-T. AMAN RICE CROPPING PATTERN

M.A.H. KHAN, T.TASMIMA, M.M. RAHMAN AND S. ROY

Abstract

An on-farm trial has been conducted at FSRD site Atia, MLT site Ghatail, Madhupur and Dhanbari to increase cropping intensity and productivity through inclusion of Mustard in fallow period at farmers existing practice of Fallow-Boro-T. Aman and variety of each crop were BARI Sarisha-14, BRRI dhan29 and BRRI dhan49 respectively. It was observed that at FSRD site Atia, MLT site Ghatail, Madhupur and Dhanbari three crop patterns produced the higher rice equivalent yield (REY) (14.34, 16.47, 16.61 and 17.46 t ha^{-1}) respectively which was 40, 48, 48 and 52% higher than farmers practice respectively. Cost-benefit analysis over four locations in Tangail district showed that improved pattern gave higher gross return (Tk. 364950ha^{-1}) and gross margin (Tk. 196004 ha^{-1}) were 46.95 and 75.50 % higher, respectively compared to that of existing pattern with only 23.63 % extra cost. The marginal benefit-cost ratio of the three crop patterns over the existing pattern was 2.64, which indicates three crops is a profitable venture.

Introduction

With the increasing population pressure there is no other way to increase food production vertically. Hence, to fulfill Sustainable Development Goal (SDG)-2 Bangladesh Agricultural Research Institute (BARI) is committed to developing technologies for increasing cropping intensity. By keeping the goal in mind, BARI is trying to convert mono crop land into double-crop land, likewise, double crop to triple crop and triple crop to four crop land. The major crop cropping patterns in Tangail district are Fallow-Boro- T. Aman. After harvest of T. Aman and before planting of Boro the land remain fallow around 3 months. Some of the farmers are growing for short duration crops in that time. Mustard is a high value crop which can be easily grown in between two crops. So, the trial was conducted to improve the existing cropping patterns, and thereby increasing cropping intensity and economic return.

Materials and Methods

An On-farm trial of three-crop based crop sequence has been going on at farmers' field of FSRD site, MLT site, Tangail. The three-crop sequence- Mustard-Boro-T. Aman has been introduced against farmers' existing sequence of Fallow- Boro-T. Aman to increase cropping intensity and productivity. The trial was carried out during the year of 2020-'21, involving six cooperative farmers having a unit plot size of 33 decimal land per farmer. All agronomic activities including sowing/transplanting, harvesting, fertilizer, irrigation, weeding etc. were followed according to standard methods (Azad *et al*., 2017). Recommended fertilizer package (BARC, 2012 and BARC, 2018) along with prescribed application methods were followed for all the crops. Pest management and other intercultural management practices were done as and when necessary. For economic comparison between two crop sequences, the yield of all crops was converted into price equivalent yield of Boro rice based on the prevailing market price of individual crops (Ahlawat and Sharma, 1993).

Data on the yield of various crops in sequences were recorded and converted to ton per hectare. The data of farmer's practice was recorded from adjacent farmers' plots. Total system productivity was calculated as the summation of individual (component) crop yield of each cropping cycle. The productivity of crop sequences was compared by calculating their economic rice equivalent yield (REY) using formula given by Ahlawat and Sharma (1993), where

Rice Equivalent Yield (REY) was calculated with following formula (Ahlawat and Sharma, 1993):

Rice equivalent yield (t ha^{-1}) = $$\frac{\text{Yield of individual crop} \times \text{market price of that crop}}{\text{market price of rice}}$$

Marginal benefit cost ratio (MBCR): The economic analysis was done following the method suggested by CIMMYT (1988). The MBCR could be computed as the marginal value product (MVP) over the marginal value cost (MVC). It could be computed as

Marginal benefit cost ratio = $\frac{\text{Gross return (E) - Gross return (F)}}{\text{TVC (E) - TVC (F)}} = \frac{MVP}{MVC}$

Where, TVC=Total variable cost

Results and Discussion

Crop management, field duration and turnover time: Similar agronomic management practices were followed in both farmers practice and improved cropping pattern practices. However, the difference in the improved pattern is the inclusion of Mustard against fallow period. Crop management practices included date of sowing/transplanting, date of harvesting, fertilizer dose used etc. of improved and existing cropping pattern are shown in Table 1. Crop field duration of Mustard, *Boro* and T. *Aman* rice under improved cropping pattern at different location of Tangail, Mustard (BARI Sarisha-14)- *Boro* (BRRI dhan29)-T. *Aman* rice (BRRI dhan49) were 81-85, 100-115 and 113-120 days, respectively while, in existing cropping pattern Fallow- *Boro* (BRRI dhan29)-T. *Aman* rice (BRRI dhan49) were 114-123 and 116-118 days for *Boro* and T. *Aman*, respectively. Turn around times for improved and existing cropping pattern were 35-64 and 93-125 days, respectively.

Table 1. Crop management practices of the crops for existing patterns and improved patterns at different location of Tangail during the year of 2020-21

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	Fallow	Boro	T. Aman	Mustard	Boro	T. Aman
Variety	-	BRRI dhan29	BRRI dhan49	BARI Sarisha-14	BRRI dhan29	BRRI dhan49
Date of transplanting	-	17 Jan-04 Feb. .	10 Jun-24July	01 -20 Nov.	27 Jan-15 Feb.	12 Jun-15 July
Seed rate (kg ha^{-1})	-	40	40	7	40	40
Spacing (cm)	-	20 x15	20 x15	Broadcasting	20 x15	20 x15
Fertilizer dose (kg ha-^{1} N-P-K-S-Zn-B)	-	138-15-30-0-2.6-0	74-12-42-10-3-0	90-34-42-26-1.7-1.7	138-15-60-15-3-0	70-15-35-8-4-0
Date of harvesting (range)	-	15 May-1 June	26 Oct.-22 Nov.	22 Jan.-08 Feb.	18 May -12 June	05 Oct.-14 Nov.
Field duration (days)	-	114-123	116-118	81-85	100-115	113-120
Turn around time (days)	-	68-72	25-53	6-25	5-7	24-32

Grain and by-product yield, rice equivalent yield (REY): Both in existing and improved cropping pattern rice equivalent yield of Mustard, Boro and T. Aman were calculated based on their respective grain/fiber and by-product yield.

At FSRD site, Atia, in the existing pattern rice equivalent yield of Boro and T. Aman were 6.95 and 3.30 t ha^{-1}, respectively. Where, the whole pattern REY was 10.25 t ha^{-1}. On the other hand, in the improved cropping pattern REY of Mustard, Boro and T. Aman were 2.94, 6.60 and 4.80 t ha^{-1}, respectively. Where cumulative REY of the whole pattern were 14.34 t ha^{-1} . (Table 2)

At MLT site, Ghatail, in the existing pattern rice equivalent yield of Boro and T. Aman were 6.75 and 4.40 t ha^{-1}, respectively. Where, the whole pattern REY was 11.15 t ha^{-1}. On the other hand, in the improved cropping pattern REY of Mustard, Boro and T. Aman were 4.82, 6.75 and 4.90 t ha^{-1}, respectively. Where cumulative REY of the whole pattern were 16.47 t ha^{-1} . (Table 3)

At MLT site, Madhupur, in the existing pattern rice equivalent yield of Boro and T. Aman were 6.50 and 4.75 t ha^{-1}, respectively. Where, the whole pattern REY was 11.25 t ha^{-1}. On the other hand, in the improved cropping pattern REY of Mustard, Boro and T. Aman were 4.15, 7.50 and 4.96 t ha^{-1}, respectively. Where cumulative REY of the whole pattern were 16.61 t ha^{-1} . (Table 4)

At MLT site, Dhanbari, in the existing pattern rice equivalent yield of Boro and T. Aman were 6.80 and 4.70 t ha^{-1}, respectively. Where, the whole pattern REY was 11.50 t ha^{-1}. On the other hand, in the improved cropping pattern REY of Mustard, Boro and T. Aman were 5.66, 7.00 and 4.80 t ha^{-1}, respectively. Where cumulative REY of the whole pattern were 17.46 t ha^{-1} . (Table 5).

Table 2. Yield of existing and improved cropping pattern at FSRD site, Atia, Tangail during the year of 2020-21

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	Fallow	Boro	T. Aman	Mustard	Boro	T. Aman
Variety	-	BRRI dhan29	BRRI dhan49	BARI Sarisha-14	BRRI dhan29	BRRI dhan49
Seed/grain yield (t ha^{-1})	-	6.95	3.30	1.47	4.60	4.80
Straw yield (t ha^{-1})	-	4.15	3.20	2.22	5.73	4.15
Rice equivalent yield (t ha^{-1})	-	6.95	3.30	2.94	6.60	4.80
Whole pattern REY (t ha^{-1})	10.25			14.34		

Unit price (Tk. kg^{-1}): Mustard=60, Boro=30, T. Aman=27.5, and stover=2.00, straw=4 and straw=5.00

Table 3. Yield of existing and improved cropping pattern at MLT site, Ghatail, Tangail during the year of 2020-21

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	Fallow	Boro	T. Aman	Mustard	Boro	T. Aman
Variety	-	BRRI dhan29	BRRI dhan49	BARI Sarisha-14	BRRI dhan29	BRRI dhan49
Seed/grain yield (t ha^{-1})	-	6.75	4.40	1.55	6.75	4.90
Straw yield (t ha^{-1})	-	5.75	5.1	3.73	5.84	4.60
Rice equivalent yield (t ha^{-1})	-	6.75	4.40	4.82	6.75	4.90
Whole pattern REY (t ha^{-1})	11.15			16.47		

Unit price (Tk. kg^{-1}): Mustard =70, Boro=22.5, T. Aman =22.5, and stover=2.00, straw=2 and straw=2.00

Table 4. Yield of existing and improved cropping pattern at MLT site, Madhupur, Tangail during the year of 2020-21

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	Fallow	Boro	T. Aman	Mustard	Boro	T. Aman
Variety	-	BRRI dhan29	BRRI dhan49	BARI Sarisha-14	BRRI dhan29	BRRI dhan49
Seed/grain yield (t ha^{-1})	-	6.50	4.75	1.38	7.50	4.96
Straw yield (t ha^{-1})	-	6.20	4.50	2,30	6.00	4.56
Rice equivalent yield (t ha^{-1})	-	6.50	4.75	4.15	7.50	4.96
Whole pattern REY (t ha^{-1})	11.25			16.61		

Unit price (Tk. kg^{-1}): Mustard =70, Boro=18.75, T. Aman =25, and stover=2.00, straw = 4 and straw=5.

Table 5. Yield of existing and improved cropping pattern at MLT site, Dhanbari, Tangail during the year of 2020-21

Parameters	Existing cropping pattern			Improved cropping pattern		
Crop	Fallow	Boro	T. Aman	Mustard	Boro	T. Aman
Variety	-	BRRI dhan29	BRRI dhan49	BARI Sarisha-14	BRRI dhan29	BRRI dhan49
Seed/grain yield (t ha^{-1})	-	5.80	3.70	1.65	7.00	4.00
Straw yield (t ha^{-1})	-	6.40	4.30	2.30	6.80	4.80
Rice equivalent yield (t ha^{-1})	-	6.80	4.70	5.66	7.00	4.80
Whole pattern REY (t ha^{-1})	11.50			17.46		

Unit price (Tk. kg^{-1}): Mustard =70, Boro=18.75, T. Aman =25, and stover=2.00, straw=4 and straw=5.00

Cost and return analysis: In Improved cropping pattern, average gross return, total variable cost and gross margin of three crop pattern were Tk. 364950, Tk. 168945, Tk. 196004 per hectare, respectively while gross return, total variable cost and gross margin of existing cropping pattern were Tk. 248343, Tk. 136659, Tk. 111684 per hectare, respectively (Table 6). The MBCR was found 2.64, which indicates the profitability of three crop-based, improved pattern over the farmers ‘existing patterns.

Table 6. Average rice equivalent yield and cost-return analysis of Existing and Improved cropping patterns at Tangail district during the year of 2020-21

Site	Pattern	Rice equivalent yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	MBCR
FSRD site, Atia	Existing	10.25	230625	124140	139485	2.31
	Improved	14.34	322650	151945	170705	
MLT site, Ghatail	Existing	11.15	250875	153390	97485	3.23
	Improved	16.47	370575	201720	168855	
MLT site, Madhupur	Existing	11.25	253125	134710	118415	2.76
	Improved	16.61	373725	166808	206917	
MLT site, Dhanbari	Existing	11.50	258750	134399	124351	2.28
	Improved	17.46	392850	175310	217540	
Average	Existing	11.04	248343	136659	111684	2.64
	Improved	16.22	364950	168945	196004	

Average Price (Tk. kg^{-1}): Boro=22.5

Pest & disease incidence: In Boro and T. Aman, stem borer and sheath blight was observed in some plots. Folicur @ 0.5 ml/L was sprayed to control sheath blight and Virtako 40 WG @ 1.5g/10 L for stem borer. In Mustard, Alternaria blight was observed in some plots, Rovral @ 2g/L water was sprayed at early stage for controlling the disease at 7 days interval.

Farmers’ opinion: Boro and T. Aman rice yield increased to some extend due to balanced fertilization and management practice and they got additional yield of mustard. Farmer reacted positively and were satisfied with higher seed yield of mustard and economic return than existing pattern. Several amounts of seed have been stored by the farmers for growing mustard in the next year.

Conclusion

Based on the yield, cost and return analysis Mustard-Boro-T. Aman rice cropping pattern is more profitable then existing cropping pattern. The final conclusion can be drowning after completion of the 2nd cycle.

Acknowledgement

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IMPROVEMENT OF EXISTING CROPPING PATTERN GROUNDNUT- T. AUS-T. AMAN OF BHOLA

G. N. HASAN AND R. H. ANIK

Abstract

The study was performed at Daulatkhan upazila under Bhola district during the year of 2021-22 cropping season to introduce new varieties into existing cropping pattern. The experimental design was RCB with three dispersed replications. In improved pattern, the yield of Groundnut (BARI Chinabadam-9 -T. Aus (BRRI dhan82) and T. Aman (BRRI dhan72) rice was 2.20, 4.45 and 5.30 t ha^{-1} where as in existing pattern, the yield of Soybean (Local)-D. Aus (BRRI dhan48) and T. Aman (Sarna) rice were found 1.68, 3.80 and 4.28 t ha^{-1} respectively. The improved cropping pattern gave higher Rice Equivalent Yield (21.28 t ha^{-1}) while existing one recorded 17.00 t ha^{-1}. The whole system Rice Equivalent Yield was 25.20 % higher in improved pattern due to addition of high yielding improved varieties.

Introduction

Bangladesh is the world's eighth densely populated country which is fifty times higher than that of the US and six times higher than even that of China (Ministry of Land, 2016). Its total land area is 14,570 km2 where 60% of the total land area is used as cultivated area (BBS, 2016). The population is still increasing by 1.37% every year (BBS, 2017), however, the cultivated land is decreasing simultaneously. The agricultural land is converted by the uncontrolled urbanization, industrialization as well as with the increasing of human activities (Ahmed, 2013). These land to human ratio decreasing phenomenon is the serious encounters of food security in Bangladesh (Roy *et al*, 2019). The food security can be ensured by adopting new technologies like improved varieties that produce more food than local varieties. In Bhola the cropping intensity is 255% (2020-21, source: DAE, Bhola). Farmers of Bhola generally grow local variety of Groundnut and rice in Groundnut-D.Aus-T. Aman crop sequences. They usually got lower return from their local varieties. Groundnut is a promising crop in Bhola. The crop production can be increased by inclusion of high yielding groundnut and rice variety in the existing cropping system. Growing improved high yielding varieties is only the way to increase crop productivity as well as economic return.

Materials and methods

The study was performed at Daulatkhan, under Bhola district during the year of 2021-22 cropping season. The experimental design was RCB with three dispersed replications in order to increase crop productivity and intensity through inclusion of high yielding groundnut variety in rice based cropping pattern. The improved cropping pattern Groundnut (BARI Chinabadam-9)-T. Aus (BRRIdhan 82)-T. Aman (BRRIdhan 72) was tested against the existing cropping pattern Soybean (Local)-D. Aus (BRRIdhan 48)-T. Aman (Sarna). The average plot size was 600 m^2. All agronomic practices including sowing date/transplanting and harvesting dates, seed rate, plant spacing, fertilizer etc. were mentioned in Table 1. Fertilizer packages (FRG 2018) and the standard application methods were used for all the crops. Irrigation, pest managements and other protective measures were taken as and when necessary. Rice hispa infestation was observed before the tillering stage and Virtako was used as per instruction. In case of soybean common cut warm like insects, yellow mosaic disease infestation was observed. The cost and return analysis also calculated on the basis of prevailing market price of the inputs and outputs (produced). Crop cut was done from two areas of 1 m^2 of each plot for measuring yield. The data on yield cost and return analysis of all the crops were taken plot wise and made up of average and stated in Table 2.

Table 1. Crop management practices used in existing and improved cropping pattern during the year of 2021-22 in Bhola district

Items	Farmers existing cropping pattern (EP)			Improved cropping pattern (IP)		
Crop	Groundnut	D. Aus	T. Aman	Groundnut	T. Aus	T. Aman
Variety	Local	BRRI dhan48	Sarna	BARI Chinabadam9	BRRI dhan82	BRRI dhan72
Date of sowing/ Transplanting	24/01/2022	05/05/2021	28/08/2020	02/01/2022	12/05/2021	20/08/2021
Seedling age (days)	-	Dibbling	35	-	20	25
Seed rate (kg ha^{-1})	120	50	50	100	40	40
Spacing (cm)	20x4	20 x 15	35 x 30	30 x 6	20 x 15	20 x 15
Fertilizer dose (N, P, K, S, Zn kg ha^{-1})	40-200-140-80-0	150-50-75-35-5	150-110-50-30-10	55-175-120-100-0	150-52-75-38-5	180-120-100-68-12
Date of harvesting (range)	19/05/2022	06/08/2021	27/12/2021	2-5/05/2021	07/08/2021	02/12/2021
Field duration (days)	115	90	120	120	85	100

Result and Discussion

The performance of yield, cost and return of improved pattern and existing pattern are presented in Table 2. In improved pattern, the yield of Groundnut (BARI Chinabadam-9) -T. Aus (BRRI dhan82) and T. Aman (BRRI dhan72) rice was 2.20, 4.45 and 5.30 t ha^{-1} where as in existing pattern, the yield of Groundnut (Local)-D. Aus (BRRI dhan48 and T. Aman (Sarna) rice were found 1.68, 3.80 and 4.28 t ha^{-1} respectively. The improved cropping pattern gave higher Rice Equivalent Yield (21.28 t ha^{-1}) while existing one recorded 17.00 t ha^{-1}. The whole system Rice Equivalent Yield was 25.20 % higher in improved pattern due to addition of high yielding improved varieties.

Cost and return

The gross margin of improved cropping pattern was 218600 Tk. ha^{-1} whereas Tk. 151300 ha^{-1} in existing pattern. The MBCR of whole pattern is 4.84.

Table 2. Yield, cost and return analysis of improved and existing cropping pattern in Bhola district during the year of 2021-22 cropping season

Items	Existing cropping pattern (EP)			Improved cropping pattern (IP)		
Crop	Groundnut	D. Aus	T. Aman	Groundnut	T. Aus	T. Aman
Variety	Local	BRRI dhan48	Sarna	BARI Chinabadam-9	BRRI dhan82	BRRI Dhan72
Grain Yield (t ha^{-1})	1.68	3.80	4.28	2.20	4.45	5.30
Straw yield (t ha^{-1})	-	-	5.60	-	-	5.30
Rice Equivalent Yield (t ha-1)	8.40	3.80	4.84	11.00	4.45	5.83
Whole pattern Rice equivalent yield (t ha^{-1})	17.00			21.28		
Gross return (GR) (Tk ha^{-1})	168000	76000	96800	220000	89000	116600
TVC (Tk ha^{-1})	70500	58500	60500	81000	60500	65500
Gross margin (GM) (Tk ha^{-1})	97500	17500	36300	139300	28500	51100
WP GR (Tk. ha^{-1})	340800			425600		
Whole pattern TVC (Tk ha^{-1})	189500			207000		
WP GM (Tk. ha^{-1})	151300			218600		
Whole pattern MBCR	4.84					

Output: Unit price (Tk. kg^{-1}): Groundnut= 100, Rice = 20.00, Rice straw = 2.00

Farmers' opinion

1. Farmers realized that use of high yielding modern varieties instead of local varieties or old HYVs can increase production as well as their income.
2. Farmers like BRRI dhan72 as early maturing variety but rat and bird infestation were high during ripening stage because of non-availability of food in other fields at that time.

Conclusion

Inclusion of groundnut especially BARI Chinabadam-9 than local variety of chinabadam and BRRIdhan 72 gave higher yield and economic benefit.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

IMPROVEMENT OF EXISTING CROPPING PATTERN SOYBEAN- T. AUS-T. AMAN OF BHOLA

G. N. HASAN AND R. H. ANIK

Abstract

The study was performed at Daulatkhan and Bhola sadar under Bhola district during the year of 2021-22 cropping season. The experimental design was RCB with three dispersed replications. In improved pattern, the yield of Soybean (BARI Soybean-6) -T. Aus (BRRI dhan82) and T. Aman (BRRI dhan87) rice was 1.82, 4.43 and 5.26 t ha^{-1} where as in existing pattern, the yield of Soybean-D. Aus (BRRI dhan48) and T. Aman (BRRI dhan52) rice were found 1.24, 3.68 and 4.30 t ha^{-1} respectively. The improved cropping pattern gave higher Rice Equivalent Yield (14.71 t ha^{-1}) while existing one recorded 11.83 t ha^{-1}. The whole system Rice Equivalent Yield was 24.34 % higher in improved pattern due to addition of high yielding improved varieties. The whole pattern MBCR was 3.59.

Introduction

Bangladesh is the world's eighth densely populated country which is fifty times higher than that of the US and six times higher than even that of China (Ministry of Land, 2016). Its total land area is 14,570 km2 where 60% of the total land area is used as cultivated area (BBS, 2016). The population is still increasing by 1.37% every year (BBS, 2017), however, the cultivated land is decreasing simultaneously. The agricultural land is converted by the uncontrolled urbanization, industrialization as well as with the increasing of human activities (Ahmed, 2013). These land to human ratio decreasing phenomenon is the serious encounters of food security in Bangladesh (Roy *et al*.,2019). The food security can be ensured by adopting new technologies like improved varieties that produce more food than local varieties. In Bhola the cropping intensity is 255% (2020-21, source: DAE, Bhola). Last year, 2021 cultivable land under soybean was 9000 ha and area increasing day by day. Still farmers use local varieties or in some cases old HYVs that's yield potentiality is low as well as different pest susceptible. Different research organizations developed high yielding crop varieties which is high yielder and less pest susceptible. The crop production can be increased by inclusion of high yielding variety in the existing cropping system. Farmers of Bhola generally grow local variety of Soybean and rice in Soybean-D.Aus-T. Aman crop sequences. They usually got lower return from their local varieties. So, growing improved high yielding varieties is only the way to increase crop productivity as well as economic return.

Materials and methods

The study was performed at Daulatkhan, Bhola sadar under Bhola district during 2021-22 cropping season. The experimental design was RCB with three dispersed replications. The improved cropping pattern Soybean (BARI Soybean-6)-T. Aus (BRRI dhan82)-T. Aman (BRRI dhan87) was tested against the existing cropping pattern Soybean (Local)-D. Aush (BRRI dhan48)-T. Aman (BRRI dhan52). The average plot size was 600 m^2. All agronomic practices including sowing date/transplanting and harvesting dates, seed rate, plant spacing, fertilizer etc. were mentioned in Table 1. Fertilizer packages (FRG 2018) and the standard application methods were used for all the crops. Irrigation, pest managements and other protective measures were taken as and when necessary. Rice hispa infestation was observed before the tillering stage and Virtako was used as per instruction. In case of soybean common cut warm like insects, yellow mosaic disease infestation was observed. The cost and return analysis also calculated on the basis of prevailing market price of the inputs and outputs (produced). Crop cut was done from two areas of 1 m^2 of each plot for measuring yield. The data on yield cost and return analysis of all the crops were taken plot wise and made up of average and stated in Table 2.

Table 1. Crop management practices used in existing and improved cropping pattern during the year of 2021-22 in Bhola district

Items	Existing cropping pattern (EP)			Improved cropping pattern (IP)		
Crop	Soybean	D. Aus	T. Aman	Soybean	T. Aus	T. Aman
Variety	Local	BRRIdhan 48	BRRIdhan 52	BARI Soybean-6	BRRIdhan 82	BRRIdhan 87
Date of sowing/ Transplanting	18/01/2022	05/05/2021	28/08/2021	10/01/2022	16/05/2021	18/08/2021
Seedling age (days)	-	Dibbling	35	-	20	25
Seed rate (kg ha^{-1})	100	50	50	60	40	40
Spacing (cm)	Broadcast	30 x 20	30 x 25	30 x 6	20 x 15	25 x 15
Fertilizer dose (N, P, K, S, Zn kg ha^{-1})	40-200-140-80-0	150-50-75-35-5	150-110-50-30-10	55-175-120-100-0	150-52-75-38-5	180-120-100-68-12
Date of harvesting (range)	28/04/2022	12/08/2021	23/12/2021	26/04/2022	10/08/2021	03/12/2021
Field duration (days)	100	100	115	106	85	104

Result and Discussion

The performance of yield, cost and return of improved pattern and existing pattern are presented in Table 2. In improved pattern, the yield of Soybean (BARI Soybean-6) -T. Aus (BRRI dhan82) and T. Aman (BRRI dhan87) rice was 1.82, 4.43 and 5.26 t ha^{-1} where as in existing pattern, the yield of Soybean (Local)- D. Aus (BRRI dhan48) and T. Aman (BRRI dhan52) rice were found 1.24, 3.68 and 4.30 t ha^{-1} respectively. The improved cropping pattern gave higher Rice Equivalent Yield (14.71 t ha^{-1}) while existing one recorded 11.83 t ha^{-1}. The whole system Rice Equivalent Yield was 24.34 % higher in improved pattern due to addition of high yielding improved varieties.

Cost and return

The gross margin of improved cropping pattern was 129840 Tk. ha^{-1} whereas Tk. 80900 ha^{-1} in existing pattern. The MBCR of whole pattern is 3.59.

Table 2. Yield, cost and return analysis of improved and existing cropping pattern in Bhola district during 2021-22 cropping season

Items	Existing cropping pattern (EP)			Improved cropping pattern (IP)		
Crop	Soybean	D. Aus	T. Aman	Soybean	T. Aus	T. Aman
Variety	Local	BRRIdhan 48	BRRIdhan 52	BARI Soybean-6	BRRIdhan 82	BRRIdhan 87
Grain Yield (t ha^{-1})	1.24	3.68	4.30	1.82	4.43	5.26
Straw yield (t ha^{-1})	-	-	4.30	-	-	5.26
Rice Equivalent Yield (t ha-1)	3.41	3.68	4.73	4.53	4.43	5.78
Whole pattern Rice equivalent yield (t ha^{-1})	11.83			14.71		
Gross return (Tk ha^{-1})	68200	73600	94600	100100	88600	115600
TVC (Tk ha^{-1})	36500	58500	60500	45460	60500	68500
Gross margin (Tk ha^{-1})	31700	15100	34100	54600	28100	47100
WP GR (Tk. ha^{-1})	236400			304300		
Whole pattern TVC (Tk ha^{-1})	155500			174460		
WP GM (Tk. ha^{-1})	80900			129840		
Whole pattern MBCR	3.59					

Output: Unit price (Tk. kg^{-1}): Soybean =55.00, Rice = 20.00, Rice straw = 2.00

Farmers' opinion

1 Farmers realized that use of high yielding modern varieties instead of local varieties or old HYVs can increase production as well as their income.

2 Farmers like BRRI dhan87 as early maturing variety but rat and bird infestation were high during ripening stage because of non-availability of food in other fields at that time.

Conclusion

Inclusion of BARI Soybean-6 than local variety and BRRI dhan87 gave higher yield and economic benefit.

DEVELOPMENT OF ALTERNATE CROPPING PATTERN SUNFLOWER– T. AUS RICE -T. AMAN RICE AGAINST FARMERS EXISTING PATTERN RELAY COWPEA – FALLOW - T. AMAN RICE

MM ISLAM, KN ISLAM AND MSI KHAN

Abstract

The experiment was conducted at MLT site Kalapara, Patuakhali during the year of 2021-22 to determine the profitability of the alternate cropping pattern Sunflower (BARI Surjomukhi-2)-T. Aus (BRRIdhan 48) - T. Aman rice (BRRI dhan52) against the farmers' existing pattern Cowpea (BARI Felon-1) - Fallow - T. Aman rice (Sarnogota). The alternate cropping pattern found agronomically and economically more profitable than the existing pattern. The highest gross return (Tk. 282420 ha^{-1}), gross margin (Tk. 115970 ha^{-1}) and MBCR (2.56) were obtained from alternate cropping pattern over existing pattern.

Introduction

Patuakhali one of the southern districts of Bangladesh, is a special area for agriculture with various problems, like salinity and charland. The area is characterized by heavy clay soil, heavy rainfall from March to November, cyclone, tidally flooded twice a day during wet season, high soil salinity and scarcity of sweet water for irrigation in the dry season, shorter winter that starts late, late harvesting of T. Aman rice etc. Relay cowpea were major Robi crops in the coastal upazillas. But due to unusual rainfall at November and December sometimes cowpea becomes damaged. In this situation it is needed to select an alternate crop of cowpea. Sunflower is such a crop which can be grown instead of cowpea and after that T. Aus rice could be transplant there in time. After cowpea harvest land remain fallow in the coastal region but there is a scope to cultivate Aus if the farmers are motivated with HYV Aus varieties and the cropping intensity of the region will be increased. For the reason to develop new pattern and to increase farmers' income the trial was undertaken.

Materials and Methods

The experiment was conducted at Kalapara, Patuakhali during the year of 2021-22. The alternate cropping pattern Sunflower (BARI Surjomukhi-2) - T. Aus Rice (BRRI dhan48) - T. Aman rice (BRRI dhan 52) against the farmers' existing pattern Cowpea - Fallow - T. Aman rice (Gutisarna). The unit plot size was 20 decimal. Details of crop management including fertilizer application are presented in Table 1.

Table 1. Management practices of alternate cropping pattern and existing cropping pattern (MLT site, Kuakata, Patuakhali) during the season of 2021-22

Management factors	Improved pattern			Existing pattern		
Season	Kharif-1	Kharif-2	Rabi	Kharif-1	Kharif-2	Rabi
Variety	BRRI dhan 48	BRRI dhan 52	BARI Surjomukhi-2	Fallow	Gutisarna	BARI Felon-1
Date of sowing	25.04.2021	11.08.21	05.01.2022	-	05.08.21	05.12.2020
Transplanting date	18.05.2021	08.09.21	-	--	08.09.21	-
Seedling age (days)	27	35	-	-	38	-
N-P-K-S-Zn-B kg ha^{-1}	70-18-36-10-10	90-20-45-10-10	90-30-75-30-5-5	-	110-40-60-25-0	13-8-15-0-0
Spacing	20cm*15cm	25cm*15cm	50cm*25cm	-	30cm*20cm	Continuous
Basal ((N-P-K-S-Zn kg /ha)	0-18-36-10-10	0-20-45-10-10	45-30-75-30-5-5	-	0-40-60-25-0	13-8-15-0-0
N top dress (DAT)	20 & 40	20 & 40		-	20 & 40	-
Pest control	Curative	Curative	Curative	-	Curative	Curative
Irrigation (DAT)	35 & 60	-	-	-	-	-
Date of harvest	03.09.21	12.12.2021	14.04.2022		21.12.2021	12.04.2021

Results and Discussion

Yield and economic performance of new cropping pattern and existing cropping pattern during the year of 2021-22 were presented in (Table 2). In the existing pattern, farmers used local T. Aman rice variety Gutisarna which produced yield only 3.22 t ha^{-1} which was replaced by modern rice variety BRRI dhan 52 that produced 4.47 t ha^{-1} grain yields. Here 34% yield increased by varietal change in Aman rice. On the contrary, replacement of cowpea by new crop Sunflower gave 4.24 t ha-1 more rice equivalent yield. Introduction of Aus rice in the existing pattern also increase productivity and income of the new pattern. New pattern gave 9.09 t ha-1 additional REY that contributed to the highest gross return (Tk. 282420 ha^{-1}), gross margin (Tk. 115970 ha^{-1}) and MBCR (2.56) over existing pattern.

Table 2. Yield and Economic analysis of alternate cropping pattern and existing cropping pattern (MLT site, Kalapara)

Observations	Improved cropping pattern			Existing cropping pattern		
Crop	Sunflower	T. Aus	T. Aman	Cowpea	Fallow	T. Aman
Seed/grain yield (t ha^{-1}	1.89	3.42	4.47	0.86	-	3.22
Straw yield (t ha^{-1})	-	-	4.01	-	-	4.21
REY (t ha-1)	7.35	3.42	4.92	3.11		3.69
Pattern REY (t ha^{-1})	15.69			6.60		
Gross return (Tk/ha)	132300	61560	88560	55900	-	66420
TVC (Tk/ha)	68300	48650	49500	27500	-	49500
Gross margin (Tk/ha)	64000	12910	39060	28400	-	16920
Pattern Gross return (Tk/ha)	282420			122320		
Pattern TVC (Tk/ha)	166450			77000		
Pattern Gross margin (Tk/ha)	115970			45320		
MBCR (whole pattern)	2.56					

Unit price (Tk. kg^{-1}): T. *Aman* rice= 18/-, Aus rice=18/-, Rice straw = 2/-, Sunflower = 70/-, Cowpea = 65/-

Farmers' opinion

Farmers realized that use of high yielding modern varieties instead of local varieties can increase production as well as their income. Yield of relay cowpea is reducing day by day so they showed their interest to grow sunflower instead of relay cowpea. They also noticed some difficulties like laborious intercultural operations, more labor requirements and bird attack at harvesting stage which hampers sunflower cultivation.

Conclusion

Despite the fact of some difficulties which were noticed by the farmers to grow sunflower, mechanized cultivation could reduce those problems. The results obtained from the study indicated that alternate cropping pattern is more profitable than the farmer's pattern. So, Sunflower - T. Aus - T. Aman rice may be the one of the major pattern in coastal area.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

DEVELOPMENT OF ALTERNATE CROPPING PATTERN THROUGH TAMAN – FALLOW – FALLOW AGAINST T. AMAN-MUSTARD-JUTE

M K SHAHADAT, M. H RASHID, M.K. ISLAM, T. S. MUNMUN AND M. M RAHMAN

Abstract

The experiment was conducted at the MLT site, Satkhira during the year of 2021-2022 for improving the productivity and profitability of an existing cropping pattern T. Aman –Fallow-Fallow by introducing BARI Sharisha-18 variety after T. Aman harvest. Results revealed that improved cropping pattern T. Aman – Mustard - Jute produced the highest total rice equivalent yield (12.74t ha^{-1}) than farmers practice (5.06 t ha^{-1}). As a result, an improved cropping pattern brought the highest gross return (Tk. 764120) and gross margin (Tk. 6488 14ha^{-1}). The overall MBCR of 6.62 from an improved pattern over existing cropping pattern.

Introduction

The existing major cropping pattern under rain fed condition of Satkhira is Fallow-Boro-T. Aman (62250 ha) which accounts about 33% of total cultivable land of Satkhira district. The existing cropping intensity of Satkhira is lower (204 %) compared to other regions of the country. Crop productivity can be increased by improving existing cropping patterns i.e. by introducing new crops and crop varieties suitable for the region. High yielding short duration crop variety along with modern cultivation technologies are the pre-requisite for developing improved cropping pattern. BARI Sharisha 18 is a short duration high value crop which adds nutrients to the soil that improves soil health and soil fertility as well as brings high economic return. The crop could easily be cultivated in the region after harvest of T. Aman rice. Keeping the circumstances in mind, the experiment has been undertaken to develop an alternate cropping pattern through T. Aman – Mustard in south-western coastal area of Bangladesh particularly in Satkhira.

Materials and Methods

The experiment was conducted at seven farmers fields under the MLT site, Satkhira during the year of 2021-'22 and in the medium high land situation to study the suitability of proposed cropping pattern T. Aman –Mustard-Jute against the existing farmers' pattern T. Aman –Fallow- Fallow for improving crop productivity as well as higher economic returns. The alternate cropping pattern was tested across the farmers' field under same land type. The unit plot size was 33 decimal. All agronomic activities including sowing/transplanting, harvesting, spacing, fertilizer management etc. are presented in Table 1. Recommended fertilizer package (BARC, 2012) along with the application methods were used for all the crops. Pest management and other intercultural management practices were done as and when necessary. Relevant data were taken and analyzed statistically. For economic comparison between two crop sequences, the yield of all crops was converted into price equivalent yield of rice on the basis of prevailing market price of individual crops (Ahlawat and Sharma, 1993). Rice Equivalent Yield (REY) was calculated with following formula (Ahlawat and Sharma, 1993).

$$\mathrm{REY}(\mathrm{tha}^{-1}) = \mathrm{Yc} \times \left(\frac{\mathrm{Pc}}{\mathrm{Pr}}\right)$$

Where,

Yc= Yield of component crop (t ha^{-1})

Pc= Price of component crop

Pr= Price of Rice

Production efficiency (PE)

Production efficiency values in terms of Kg ha^{-1} day^{-1} were calculated by total production in a cropping sequence divided by total duration of crops in that sequence (Tomer and Tiwari. 1990).

$$\mathrm{ProductionEfficiency(PE)} = \frac{\mathrm{Y_1 + Y_2 + Y_3}}{\mathrm{D_1 + D_2 + D_3}}$$

Where,
Y_1: Yield of 1st crop
Y_2: Yield of 2nd crop
Y_3: Yield of 3rd crop
d_1= Duration of 1st crop of the pattern
d_2= Duration of 2nd crop of the pattern
d_3= Duration of 3rd crop of the pattern

For Marginal Benefit Cost Ratio the following formula was used:

$$\mathrm{MBCR} = \frac{\mathrm{GrossReturn}(\mathrm{GR}_1) - \mathrm{GrossReturn}\ (\mathrm{GR}_0)}{\mathrm{Variablecost}(\mathrm{VC}_1) - \mathrm{Variablecost}\ (\mathrm{VC}_0)}$$

Where,
GR_1= Gross return of main crop (Tk. ha^{-1})
GR_0= Gross return of component crop (Tk. ha^{-1})
VC_1= Variable cost of main crop (Tk. ha^{-1})
VC_0= Variable cost of component crop (Tk. ha^{-1})

Results and Discussion

Field duration

Field duration of cropping pattern mainly depends on individual duration of component crops in the field. The improved cropping pattern (IP) T. Aman –Mustard-Jute had the longer field duration than farmers' existing pattern (FP) T. Aman -Fallow- Fallow in the study year (Table 1). In 2021-22,, total field duration of improved pattern were 210 days, while in farmers pattern it was 110 days.

Grain yield

In 2021 -2022, yield of both improved practice (IP) and farmers' practice (FP) varied, which may be due differences in management practices. In farmers practice, grain yield of T.Amon rice was 4.48 t ha^{-1}, whereas in improved practices (IP) 4.56 t ha^{-1} and grain yield of Mustard in improved practice it was 1.77 t ha^{-1} (Table 1).

Rice equivalent yield and production efficiency

In 2021-'22, total rice equivalent yield in IP was 12.74 t ha^{-1}, whereas in FP it was 5.05 t ha^{-1} (Table 1). Addition of new crops and high yielding varieties and improved management practices in the IP increased the rice equivalent yield. Production efficiency of FP was 46 kg $ha^{-1}day^{-1}$ (110 days) whereas in IP it was 60 kg $ha^{-1}day^{-1}$ (210 days) (Table 1).

Table 1. Agronomic management practices and rice equivalent yield of the crops for the existing (T. Aman –Fallow -Fallow) and alternate cropping pattern (T. Aman – Mustard -Jute) at the MLT site, Satkhira during 2021-'22

<table>
<tr><td colspan="2">Parameters</td><td colspan="3">Existing cropping pattern</td><td colspan="3">Alternate cropping pattern</td></tr>
<tr><td colspan="2">Crop</td><td>T. Aman</td><td>Fallow</td><td>Fallow</td><td>T. Aman</td><td>Mustard</td><td>Jute</td></tr>
<tr><td colspan="2">Variety</td><td>Binadhan-7</td><td>-</td><td>-</td><td>BRRI Dhan75</td><td>BARI Sharisha-18</td><td>-</td></tr>
<tr><td colspan="2">Spacing</td><td>20 cm x 15 cm</td><td>-</td><td>-</td><td>20 cm x 15 cm</td><td>30cm</td><td>-</td></tr>
<tr><td colspan="2">Unit plot size (decimal)</td><td>33</td><td>-</td><td>-</td><td>33</td><td>33</td><td>-</td></tr>
<tr><td colspan="2">Seedling age (days)</td><td>34</td><td></td><td></td><td>-</td><td>26</td><td></td></tr>
<tr><td colspan="2">Date of sowing/ transplanting</td><td>2 August ,2021</td><td>-</td><td>-</td><td>10-15 august 2021</td><td>28 November - 2 December</td><td>-</td></tr>
<tr><td colspan="2">Fertilizer dose (kg ha^{-1} N-P-K-S-Zn-B)</td><td>167-62-84-56-75-0</td><td>-</td><td>-</td><td>167-62-84-56-75-0</td><td>195-90-33-5-3</td><td>-</td></tr>
<tr><td colspan="2">Fertilizer application</td><td>- Basal and top dress</td><td>-</td><td>-</td><td>Basal & top dress</td><td>Basal</td><td>-</td></tr>
<tr><td colspan="2">Intercultural operation</td><td>Weeding 1</td><td></td><td></td><td>Weeding 1</td><td>Weeding 1</td><td></td></tr>
<tr><td colspan="2">Date of harvesting</td><td>7 November</td><td>-</td><td>-</td><td>15 -25 November 2021</td><td>10 March 2021</td><td>-</td></tr>
<tr><td colspan="2">Field duration (days)</td><td>110</td><td>-</td><td>-</td><td>110</td><td>100</td><td>-</td></tr>
<tr><td colspan="2">Turnaround time (days)</td><td>110</td><td>-</td><td></td><td>110</td><td>100</td><td></td></tr>
<tr><td rowspan="5">2021-22</td><td>Grain Yield (t ha^{-1})</td><td>4.48</td><td></td><td></td><td>4'56</td><td>1.77</td><td></td></tr>
<tr><td>Straw Yield (t ha^{-1})</td><td>5.00</td><td></td><td></td><td>5'01</td><td>3.18</td><td></td></tr>
<tr><td>Rice Equivalent Yield (REY) (t ha^{-1})</td><td>5.05</td><td>-</td><td>-</td><td>5.06</td><td>7'68</td><td>-</td></tr>
<tr><td>Total REY (t ha^{-1})</td><td colspan="3">5.05</td><td colspan="3">12.74</td></tr>
<tr><td>Production efficiency (kg ha^{-1} day^{-1})</td><td colspan="3">46</td><td colspan="3">60</td></tr>
</table>

Price (Tk. kg^{-1}): T. Aman=20.00, Straw = 2.00, Mustard= 85.00,Stover=1.00

Table 2. Rice equivalent yield and cost benefit analysis of farmers and improved cropping patterns (T. Aman – Fallow –Fallow and T.Amon – Mustard -Jute) at the MLT site, Satkhira during 2021-'22

<table>
<tr><td>Pattern</td><td>Pattern</td><td>Rice equivalent yield (t ha-1)</td><td>Gross return (Tk. ha-1)</td><td>Total variable cost (Tk. ha-1)</td><td>Gross margin (Tk. ha-1)</td><td>MBCR</td></tr>
<tr><td rowspan="2">2021-'22</td><td>FP</td><td>5.05</td><td>111,100</td><td>50356</td><td>60744</td><td>2.20</td></tr>
<tr><td>IP</td><td>12.74</td><td>764120</td><td>115306</td><td>648814</td><td>6.62</td></tr>
</table>

Benefit cost analysis

Average benefit cost analysis over three years shows that IP produced highest gross return (Tk764120) and gross margin (Tk. 648814) than FP (Tk. 111,320 and Tk. 60964, respectively). MBCR of improved practice over farmers practice was found 6.62, which indicates improved pattern is profitable than farmers practice (Table 2).

Conclusion

BARI Sharisha18 is a canola variety which is high yielding and highly benefit for health, so system productivity could be improved for single cropped area if adequate and timely seed supply is ensured.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

References

Ahlawat, I. P. S. and Sharma, R. P. 1993. Agronomic terminology. 3rded. New Delhi: Indian Society of Agronomy.

BARC (Bangladesh Agricultural Research Council) (2012). Fertilizer recommendation guide. www.barc.gov.bd

DEVELOPMENT OF ALTERNATE CROPPING PATTERN THROUGH TAMAN – FALLOW – FALLOW AGAINST T. AMAN-MUSTARD-JUTE

M K SHAHADAT, M. H RASHID, M.K. ISLAM, T. S. MUNMUN AND M. M RAHMAN

Abstract

The experiment was conducted at the MLT site, Batiaghata Khulna during the year of 2021-2022 for improving the productivity and profitability of an existing cropping pattern T. Aman – Fallow-Fallow by introducing BARI Sharisha 18 variety then jute after T. Aman harvest. Results revealed that improved cropping pattern T. Aman – Mustard – Jute produced the highest total rice equivalent yield (11.58t ha^{-1}) than farmers practice (5.05t ha^{-1}). As a result, an improved cropping pattern brought the highest gross return (Tk. 672040 ha^{-1}) and gross margin (Tk. 556734 ha^{-1}). The overall MBCR of 5.82 from an improved pattern over existing cropping pattern.

Introduction

The existing major cropping pattern under rain fed condition of Batiaghata Khulna is Fallow-Boro-T. Aman (62250 ha) which accounts about 33% of total cultivable land of Batiaghata Khulna district. The existing cropping intensity of Batiaghata Khulna is lower (204 %) compared to other regions of the country. Crop productivity can be increased by improving existing cropping patterns i.e. by introducing new crops and crop varieties suitable for the region. High yielding short duration crop variety along with modern cultivation technologies are the pre-requisite for developing improved cropping pattern. BARI Sharisha 18 is a short duration high value crop which adds nutrients to the soil that improves soil health and soil fertility as well as brings high economic return. The crop could easily be cultivated in the region after harvest of T. Aman rice. Keeping the circumstances in mind, the experiment has been undertaken to develop an alternate cropping pattern through T. Aman – Mustard in south-western coastal area of Bangladesh particularly in Batiaghata Khulna.

Materials and Methods

The experiment was conducted at seven farmers' fields under the MLT site, Batiaghata Khulna 2021-'22 and in the medium high land situation to study the suitability of proposed cropping pattern T. Aman –Mustard - jute against the existing farmers' pattern T. Aman –Fallow- Fallow for improving crop productivity as well as higher economic returns. The alternate cropping pattern was tested across the farmers' field under same land type. The unit plot size was 33 decimal. All agronomic activities including sowing/transplanting, harvesting, spacing, fertilizer management etc. are presented in Table 1. Recommended fertilizer package (BARC, 2012) along with the application methods were used for all the crops. Pest management and other intercultural management practices were done as and when necessary. Relevant data were taken and analyzed statistically. For economic comparison between two crop sequences, the yield of all crops was converted into price equivalent yield of rice on the basis of prevailing market price of individual crops (Ahlawat and Sharma, 1993). Rice Equivalent Yield (REY) was calculated with following formula (Ahlawat and Sharma, 1993).

$$REY(tha^{-1}) = Yc \times (\frac{Pc}{Pr})$$

Where,
Yc= Yield of component crop (t ha^{-1})
Pc= Price of component crop
Pr= Price of Rice

Production efficiency (PE)

Production efficiency values in terms of Kg ha^{-1} day^{-1} were calculated by total production in a cropping sequence divided by total duration of crops in that sequence (Tomer and Tiwari. 1990).

$$ProductionEfficiency(PE) = \frac{Y_1 + Y_2 + Y_3}{D_1 + D_2 + D_3}$$

Where,
Y_1: Yield of 1st crop
Y_2: Yield of 2nd crop
Y_3: Yield of 3rd crop
d_1= Duration of 1st crop of the pattern
d_2= Duration of 2nd crop of the pattern
d_3= Duration of 3rd crop of the pattern

For Marginal Benefit Cost Ratio the following formula was used:

$$MBCR = \frac{GrossReturn(GR_1) - GrossReturn\ (GR_0)}{Variablecost(VC_1) - Variablecost\ (VC_0)}$$

Where,
GR_1= Gross return of main crop (Tk. ha^{-1})
GR_0= Gross return of component crop (Tk. ha^{-1})
VC_1= Variable cost of main crop (Tk. ha^{-1})
VC_0= Variable cost of component crop (Tk. ha^{-1})

Results and Discussion

Field duration

Field duration of cropping pattern mainly depends on individual duration of component crops in the field. The improved cropping pattern (IP) T. Aman –Mustard - jute had the longer field duration than farmers' existing pattern (FP) T. Aman -Fallow- Fallow in the study year (Table 1). In 2021-22, total field duration of improved pattern were 210 days, while in farmers pattern it was 110 days.

Grain yield

In 2021 -2022, yield of both improved practice (IP) and farmers' practice (FP) varied, which may be due differences in management practices. In farmers practice, grain yield of T. Aman rice was 4.48 t ha^{-1}, whereas in improved practices (IP) 4.56 t ha^{-1} and grain yield of Mustard in improved practice it was 1.49t ha^{-1} (Table 1).

Rice equivalent yield and production efficiency

In 2021-'22, total rice equivalent yield in IP was 12.74 t ha^{-1}, whereas in FP it was 5.05 t ha^{-1} (Table 1). Addition of new crops and high yielding varieties and improved management practices in the IP increased the rice equivalent yield. Production efficiency of FP was 46 kg $ha^{-1}day^{-1}$ (110 days) whereas in IP it was 55.14 kg $ha^{-1}day^{-1}$ (210 days) (Table 1).

Table 1. Agronomic management practices and rice equivalent yield of the crops for the existing (T. Aman –Fallow -Fallow) and alternate cropping pattern (T. Aman – Mustard - Jute) at the MLT site, Batiaghata Khulna during the year of 2021-'22

Parameters		Existing cropping pattern			Alternate cropping pattern		
Crop		T. Aman	Fallow	Fallow	T. Aman	Mustard	Jute
Variety		Binadhan-7	-	-	BRRI Dhan76	BARI Sharisha-18	-
Spacing		20 cm x 15 cm	-	-	20 cm x 15 cm	30cm	-
Unit plot size (decimal)		33	-	-	33	33	-
Seedling age (days)		34			-	26	
Date of sowing/ transplanting		2 August ,2021	-	-	10-17august 2021	15 - 18 November	-
Fertilizer dose (kg ha^{-1} N-P-K-S-Zn-B)		167-62-84-56-75-0	-	-	167-62-84-56-75-0	195-90-33-5-3	-
Fertilizer application		- Basal and top dress	-	-	Basal & top dress	Top dressed	-
Intercultural operation		Weeding 1			Weeding 1	Weeding 1	
Date of harvesting		7 November	-	-	17 -24 November 2021	28 February - 4March 2021	-
Field duration (days)		110	-	-	110	100	-
Turnaround time (days)		110	-		110	100	
2021-22	Grain Yield (t ha^{-1})	4.48			4.56	1.49	
	Straw Yield (t ha^{-1})	5.00			5.01	3.18	
	Rice Equivalent Yield (REY) (t ha^{-1})	5.05	-	-	5.06	6.491	-
	Total REY (t ha^{-1})	5.05			11.58		
	Production efficiency (kg ha^{-1} day^{-1})	46			55.14		

Price (Tk. kg^{-1}): T. Aman=20.00, Straw = 2.00, Mustard= 85.00, Stover=1.00

Table 2. Rice equivalent yield and cost benefit analysis of farmers and improved cropping patterns (T. Aman – Fallow –Fallow and T. Aman – Mustard - Jute) at the MLT site, Batiaghata Khulna during the year of 2021-'22

Pattern	Pattern	Rice equivalent yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha$^{-1)}$	Gross margin (Tk. ha$^{-1)}$	MBCR
2021-'22	FP	5.05	111,100	50356	60744	2.20
	IP	11.58	672040	115306	556734	5.82

Benefit cost analysis

Average benefit cost analysis over three years shows that IP produced highest gross return (Tk672040) and gross margin (Tk. 556734 ha^{-1}) than FP (Tk. 111100 ha^{-1} and Tk. 60744 ha^{-1}, respectively). MBCR of improved practice over farmers practice was found 5.82, which indicates improved pattern is profitable than farmers practice (Table 2).

Conclusion

BARI Sharisha1-18 is a canola variety which is high yielding and highly benefit for health, so system productivity could be improved for single cropped area if adequate and timely seed supply is ensured.

Acknowledgement

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DEVELOPMENT OF OILSEED CROP BASED CROPPING PATTERN SESAME – T. AMAN RICE – MUSTARD IN MANIKGANJ

RUHUL AMIN

Abstract

The field trial was conducted at Mitura village under Sadar Upazila of Manikganj district during the year of 2021-2022 cropping season to develop oilseed based cropping pattern Sesame (BARI Til-4) – T. Aman (BRRI dhan75) – Mustard (BARI Sarisha-14) against farmers existing Sesame (Local variety) – T. Aman (BRRI dhan49) – Mustard (Tori-7) cropping pattern. The objectives of the trial was to increase cropping intensity and productivity through inclusion of high yielding oilseed crops in farmers existing cropping systems. The yield of different crops in alternate cropping pattern of Sesame (BARI Til-4) – T. Aman (BRRI dhan75) – Mustard (BARI Sarisha-14) were 1.36 t ha^{-1} in sesame, 4.52 t ha^{-1}in BRRI dhan75 rice and 1.45 t ha^{-1} BARI Sarisha-14 while that in the existing pattern of Sesame (local variety) – T. Aman (BRRI dhan49) – Mustard (Tori-7) were 0.988 t ha^{-1} in sesame, 4.20 t ha^{-1} in BRRI dhan49 and 0.95 t ha^{-1} in Tori-7, respectively. The higher gross return (Tk. 329490 ha^{-1}) and gross margin (Tk. 167850 ha^{-1}) were obtained in alternative Sesame (BARI Til-4) – T. Aman (BRRI dhan75) – Mustard (BARI Sarisha-14) and in existing pattern gross return (Tk.250855 ha^{-1}) and gross margin (Tk. 83215 ha^{-1}). The BCR of improved cropping pattern (2.03) was 36.24 % higher over existing cropping pattern (1.49).

Introduction

Oilseed crops play an important role in Bangladesh Agriculture. The total oilseed production can meet-up about one-third of the total demand. The remaining part is imported from foreign countries spending a huge amount of foreign exchange on imports of edible oils and oilseeds to meet the increasing demand of its population. Edible oils play vital roles in human nutrition by providing calories and aiding in digestion of several fat soluble vitamins, for example Vitamin A. Some oilseeds are also a source of good quality protein, vitamins, and fuel. Oilcake is also an important manure for crop production and livestock feed. Mustard is the main edible oilseed crops in our country covering about 80% of the total oilseed area and contributing to more than 60% of the total oilseed production in Bangladesh. The acreage of rapeseed and mustard in Manikganj district was 37126 acres and total production was 15216 metric ton during 2018-2019 (Statistical Year Book, 2019). BARI Sarisha-14 is an excellent variety of mustard grown in the farmer's field of Manikganj covering about 65% of the total mustard growing area. The yield of local varieties are very low and 868 kg ha^{-1} on an average while BARI developed improved varieties provide yield ranged from 1500 to 2500 kg ha^{-1} under different agro-ecological zones and climate variations. The production area of BARI sarisha-14 is increasing day by day due to its higher yield potentiality and higher market price of mustard oil as price soaring of soybean oil in the international market including Bangladesh. Sesame ranks the third among the edible oilseed crops in Bangladesh. The acreage of sesame in Manikganj district was 5308 acres and total production was 1461 metric ton during 2017-2018 (Statistical Year Book, 2019). Sesame contains 42-45% oil and 20% protein.

Oilseed Research Centre of BARI released a good number of improved varieties of mustard and several numbers of sesame with high yield potentials. Being a small country, we don't have enough scope to grow oilseed crops as a sole crop but could be fitted in different cropping patterns to sustain the production. Farmers generally choose a crop and its variety considering the field duration of the crop to fit well in the existing cropping pattern to get higher yield and economic return. The rate of adoption of these improved varieties at farm level is encouraging (Miah *et al*., 2015b; Miah *et al.*, 2015c) and have created positive impact and saved foreign exchange for the country (Miah *et al.*, 2015a). Manikganj is one of the important mustard and sesame growing area in Bangladesh. The experiments was therefore undertaken to adopt the BARI released short duration and high yielding mustard and sesame varieties to fit in the existing cropping pattern replacing low yielding local varieties to increase production of oilseed crops and to increase farmers income.

Materials and Methods

The experiment was conducted at in the farmer's field at Mitura village under sadar upazila of Manikganj during the year of 2020-2021. The trial was carried out in three farmer's field in 06 bighas of land. The seeds of BARI Til-4 and BARI sarisha-14 was collected from Oilseed Research Centre of BARI; BRRIdhan 75 and BRRIdhan-49 from BADC, Manikganj and local varieties from the seed traders in Manikganj town. The crop management practices used in existing and alternate cropping pattern is shown in Table 1. The experimental field was fertilized in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. Half of urea and all TSP, MoP, Gypsum, Zinc and Boron were applied during final land preparation. The remaining half of urea was top dressed at 30 DAS during flowering stage of crop. Plant protection measures such as irrigation, weeding and pesticides application were done as and when required. Data on yield and yield contributing characters was recorded and converted into kg ha^{-1}.

Table 1. The crop management practices of existing and alternate cropping pattern at Mitura, Manikganj during the year of 202-2022

Improved CP	**Sesame**	**T. Aman rice**	**Mustard**
Variety	BARI Til-4	BRRI dhan75	BARI Sarisha-14
Spacing	Broadcast	25cm x 15cm	Broadcast
Fertilizer application	55-30-25-20-2-1.7	90-15-35-12-1.79-0.85	104-33-45-20-1.6-1.27
Sowing/planting date	16-22 March, 2021	15-18 July, 2021	07 to 10 November, 2021
Field duration	85	89	88
Harvesting time	8-14 June, 2021	11 to 13 October, 2021	30 January to 06 February, 2022
Intercultural operation	Irrigation: Nil Weeding: 1	Irrigation: 05 Weeding: 2	Irrigation: nil Weeding: Nil
Existing CP	**Sesame**	**T. Aman rice**	**Mustard**
Variety	Local variety	BRRI dhan49	Tori-7
Spacing			
Fertilizer application N-P-K-S-Zn-B (kg ha^{-1})	55-30-25-20-2-1.7	90-15-35-12-1.79-0.85	104-33-45-20-1.6-1.27
Sowing/planting date	15-23 March, 2021	15- 20 July, 2021	07 to 15 November, 2021
Field duration	85	105	80
Harvesting time	10-20 June, 2021	25 October to 05 November, 2021	28 January to 05 February, 2022
Intercultural operation	Irrigation: Nil Weeding:1	Irrigation: 07 Weeding: 2	Irrigation: Nil Weeding: Nil

Results and Discussion

Yield performance:

The results of the present study have been presented in Table 2. The yield performance revealed that Sesame (BARI Til-4) – T. Aman (BRRI dhan75) – Mustard (BARI Sarisha-14) cropping pattern under improved practices gave significantly higher grain yield in sesame (1.36 t ha^{-1}), T. Aman rice (4.52 t ha^{-1}) and Mustard (1.45 t ha^{-1}) than existing pattern of Sesame (Local variety) – T. Aman (BRRI dhan49) – Mustard (Tori-7) were 0.988 t ha^{-1} in sesame, 4.20 t ha^{-1}in BRRI dhan49 rice and 0.95 t ha^{-1} Tori-7, respectively. On an average, the yield of sesame, T. Aman rice and mustard in improved cropping pattern increased by 37.76%, 7.61%, and 52.63 %, respectively over the farmer's existing cropping pattern because of inclusion of high yielding varieties of oilseeds (sesame and mustard) and rice and also for improved management practices.

Field duration

Field duration of cropping pattern mainly depends on individual duration of component crop. Farmers existing cropping pattern Sesame (Local variety) – T. Aman (BRRI dhan49) – Mustard (Tori-7) required on an average 262 days field duration and alternative cropping pattern Sesame (BARI Til-4) – T. Aman (BRRI dhan75) – Mustard (BARI Sarisha-14) required 270 days (excluding seedling age of T. Aman rice grown in separate seedbed) to complete the cycle. Result indicated that high yielding variety of sesame (BARI Til-4) and mustard (BARI Sarisha-14) could easily be fitted in the farmers existing pattern providing higher seed yield of sesame and mustard in a year.

In farmers existing cropping pattern (Sesame – T. Aman rice – Mustard) they used local variety of mustard (Tori-7) which is a short duration variety helps to grow BRRI dhan49 which take longer field duration (105 days). Meanwhile in the improved cropping pattern BARI Sarisha-14 (88 days) required 8 more days to get maturity than Tori-7 (80 days) but T. Aman rice variety BRRIdhan75 (89 days) got maturity 16 days earlier than BRRIdhan49 (105 days). As a result, gross return and gross margin was higher in improved cropping pattern due to higher yield of crops.

Cost and return

The details of economic analysis of cropping pattern are presented in Table 2. Economics of system productivity revealed that the gross return and gross margin was differ between the cropping patterns. The higher gross return (Tk. 329490 ha^{-1}) and gross margin (Tk. 167850 ha^{-1}) were obtained in alternate Sesame (BARI Til-4) – T. Aman (BRRI dhan75) – Mustard (BARI Sarisha-14) cropping pattern while lower gross return (Tk. 250855 ha^{-1}) and gross margin (Tk. 83215 ha^{-1}) was found in existing cropping pattern. Thus, considering the whole pattern analysis, the improved cropping pattern was found economically profitable with higher production of oilseeds in the farmer's field at Manikganj.

Table 2.Yield and economics of alternate and farmer's existing cropping pattern at Manikganj during 2021-22

Parameters	Alternate Cropping Pattern			Existing Cropping Pattern		
Crop	Sesame	T. Aman rice	Mustard	Sesame	T. Aman rice	Mustard
Variety	BARI Til-4	BRRI dhan75	BARI Sarisha-14	Local variety	BRRI dhan49	Tori-7
Grain yield (kg ha^{-1})	1364	4520	1450	988	4200	892
Straw yield (kg ha^{-1})	2520	5110	2500	2045	4450	1800
Gross return (Tk. ha^{-1})	87770	123220	118500	63795	113900	73160
Total variable cost (Tk. ha^{-1})	44325	75240	42075	44325	81240	42075
Gross margin (Tk. ha^{-1})	43445	47980	76425	19470	32660	31085
Gross return (Tk. ha^{-1}) of the pattern	329490			250855		
TVC (Tk. ha^{-1}) of the pattern	161640			167640		
Gross margin (Tk. ha^{-1}) of the pattern	167850			83215		
BCR of the pattern	2.03			1.49		

Price of input (Tk. kg^{-1}): Urea- 16.00, TSP-22.00, MoP-15.00, Gypsum-15.00, Boron-500.00, Zn-230.00, Rovral- 440.00 & Labor cost (Tk. labor $^{-1}$ day^{-1}): 500.00
Price of Sesame: Tk. 62.50 kg^{-1} and straw: Tk. 1.00 kg^{-1}
Price of T. Aman rice: Tk. 25.00 kg^{-1} and straw: Tk. 2.00 kg^{-1}
Price of Mustard: Tk. 80.00 kg^{-1} and straw: Tk. 1.00 kg^{-1}

Pest incidence:
Sesame: The crop was slightly infested by Jute hairy caterpillar and Karate @ 2ml L^{-1} water sprayed to control this insect.

T. Aman rice: Rice stem borer was observed in the field and Desis @ 2ml L^{-1} water sprayed to control this insect at the beginning of infestation.

Mustard: Rovral @ 2 gm L^{-1} water was sprayed to control *Alterneria* leaf spot disease.

Farmers' opinion
Farmers opined that BARI Til-4 is a high yielding variety of sesame having 8 rows of seed in each pod but there is 4 rows of seed in local variety. The colour of seed in BRRI Til-4 is reddish brown and market price is slightly lower than black seed coat of local variety. BRRI dhan75 is a high yielding aromatic rice variety with shorter field duration than BRRI dhan49. BARI Sarisha-14 is an excellent variety of mustard with higher yield potentiality.

Conclusion
In economic point of view, improved cropping pattern including two oilseed crops was suitable and profitable practice than the farmers existing cropping pattern. Therefore, this cropping pattern with high yielding varieties of sesame (BARI Til-4) and mustard (BARI Sarisha-14) could be recommended for large scale extension in the flood free or less flood affected medium highland of Manikganj district.

Acknowledgement
It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

DEVELOPMENT OF OILSEED CROP BASED CROPPING PATTERN BORO – FALLOW – MUSTARD IN MANIKGANJ

RUHUL AMIN

Abstract

The field trial was conducted at Ramnagar village under Shibaloya Upazila of Manikganj district during 2021-2022 cropping season to develop oilseed based cropping pattern Boro rice (BRRI dha-89) – Fallow - Mustard (BARI Sarisha-14) against farmers existing Boro rice (BRRIdhan 29) – Fallow - Mustard (Tori-7) cropping pattern. The objectives of the trial was to increase cropping intensity and productivity through inclusion of oilseed crops in farmers existing cropping systems. The yield of different crops in alternate cropping pattern of Boro rice (BRRI dhan89) – Fallow - Mustard (BARI Sarisha-14) were 7.37 t ha^{-1} in BRRI dhan89, and 1.43 t ha^{-1} BARI Sarisha-14 while that in the existing pattern of 7.09 t ha^{-1} in BRRI dhan29, and 0.87 t ha^{-}1 in Tori-7, respectively. The higher gross return (Tk. 312695 ha^{-1}) and gross margin (Tk. 120105 ha^{-1}) were obtained in alternative Boro rice (BRRI dhan89) – Fallow - Mustard (BARI Sarisha-14) and in existing pattern gross return (Tk.262371 ha^{-1}) and gross margin (Tk. 68036 ha^{-1}). The BCR of improved cropping pattern (1.60) was 18.51% higher over existing cropping pattern (1.35).

Introduction

Oilseed crops play an important role in Bangladesh Agriculture. The total oilseed production can meet-up about one-third of the total demand and the rest amount is imported from foreign countries to meet the increasing demand of its population. Global demand for edible oils is increasing due to the ever increasing population and higher consumption of oils for cooking. Edible oils play vital roles in human nutrition by providing calories and aiding in digestion of several fat soluble vitamins, for example Vitamin A. The per capita recommended dietary allowance of oil is 6 gm/day for a diet with 2700 Kcal. At least 15% (405 kcal) of the total calories must come from visible and invisible oils or fats for maintaining good health. Some oilseeds are also a source of good quality protein, vitamins, and fuel. Oilcake is also an important manure for crop production and livestock feed.

Mustard is leading oilseed crop covered about 80% of the total oilseed area and contributing to more than 60% of the total oilseed production in Bangladesh. The acreage of Rapeseed and Mustard in Manikganj district was 37126 acres and total production was 15216 metric ton during 2018-2019 (Statistical Year Book, 2019). BARI Sarisha-14 is an excellent variety of Mustard grown in the farmer's field of Manikganj covering about 65% of the total mustard growing area. The average yield of this variety is about 1500 kg ha^{-1} under farmer's field condition though the yield was also observed as high as 2000 kg ha^{-1} in different farmers' field. The production area of BARI Sarisha-14 is increasing day by day due to its higher yield potentiality and higher market price of Mustard oil as price soaring of soybean oil in the international market including Bangladesh. Mustard is the main edible oilseed crops in our country covering 2.34 lac hectares of land and 2.03 lac tons of oil is produced from the produces. The yield of local varieties are very low and 868 kg ha^{-1} on an average while BARI developed improved varieties provide yield ranged from 1500 to 2500 kg ha^{-1} under different agro-ecological zones and climate variations.

Oilseed Research Centre of BARI released a good number of improved varieties of Mustard with high yield potential. Being a small country, we don't have enough scope to grow oilseed crops as a sole crop but could be fitted in different cropping patterns to sustain the production. Farmers generally choose a crop and its variety considering the field duration of the crop to fit well in the existing cropping pattern to get higher yield and economic return. The rate of adoption of these improved varieties at farm level is encouraging (Miah *et al.*, 2015b; Miah *et al.*, 2015c) and have created positive impact and saved foreign exchange for the country (Miah *et al.*, 2015a). Manikganj is one of the important Mustard growing areas in Bangladesh. The experiments was therefore undertaken to adopt the BARI released short duration and high yielding Mustard varieties to fit in the existing cropping pattern replacing low yielding local varieties to increase production of oilseed crops and to increase farmers income.

Materials and Methods

The experiment was conducted in the farmer's field at Ramnagar village under Shibaloya upazila of Manikganj during the year of 2020-20212021-2022. The trial was carried out in three famrer's field in 06 bighas of land. The seeds of BARISarisha-14 was collected from Oilseed Division of BARI; BRRI dhan89 and BRRIdhan29 from BADC, Manikganj and local varieties from the seed traders in Manikganj town. The crop management practices used in existing and alternate cropping pattern is shown in Table1. The experimental field was fertilized in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. Half of urea and all TSP, MoP, Gypsum, Zinc and Boron were applied during final land preparation. The remaining half of urea was top dressed at 30 DAS during flowering stage of crop. Plant protection measures such as irrigation, weeding and pesticides application were done as and when required. Data on yield and yield contributing characters was recorded and converted into kg ha^{-1}.

Table 1. The crop management practices of existing and alternate cropping pattern at Shibaloya, Manikganj during the year of 2021-22

Improved CP	**Boro**	**Fallow**	**Mustard**
Variety	BRRI dhan89		BARI Sarisha-14
Spacing	25cm x 15cm		Broadcast
Fertilizer application N-P-K-S-Zn-B (kg ha^{-1})	35-30-112-13-2.68-1.27		104-33-45-20-1.6-1.27
Sowing/planting date	25-27 February 2021		02-08 November 2021
Field duration (days) excluding seedling age)	110		90
Harvesting time	14-18 June 2021		28 January – 04 February 2022
Intercultural operation	Irrigation: 20 Weeding:1		Irrigation: Nil Weeding: Nil
Existing CP	**Boro**	**Fallow**	**Mustrad**
Variety	BRRI dhan29		Tori-7
Spacing	25cm x 15cm		Broadcast
Fertilizer application	35-30-112-13-2.68-1.27		104-33-45-20-1.6-1.27
Sowing/planting date	16-18 July 2021		05-11 November 2021
Field duration (days) (excluding seedling age)	115		85
Harvesting time	14 November 2021		30 January – 6 February 2022
Intercultural operation	Irrigation: 20 Weeding:1		Irrigation: Nil Weeding: Nil

Results and Discussion

Yield performance:

The results of the present study have been presented in Table 2. The yield performance revealed that Boro (BRRI dhan89) – Fallow – Mustard (BARI Sarisha-14) cropping pattern under improved practices gave significantly higher grain yield of Boro rice (7.37 t ha^{-1}) and Mustard (1.43 t ha^{-1}) than existing pattern of Boro rice (BRRI dhan29) – Mustard (Tori-7) were 7.09 t ha^{-1} in BRRI dhan29 rice and 0.87 t ha^{-1} Tori-7, respectively. On an average, the yield of Boro rice and mustard in improved cropping pattern increased by 3.94%, and 64.36%, respectively over the farmer's existing cropping pattern because of inclusion of high yielding varieties of oilseed and rice and also for improved management practices.

Field duration

Field duration of cropping pattern mainly depends on individual duration of component crop. Farmers existing cropping pattern Boro rice (BRRI dhan29) – Fallow – Mustard (Tori-7) required on an average 189 days field duration and alternative cropping pattern Boro rice (BRRI dhan89) – Mustard (BARI Sarisha-14) required similar 200 days (excluding seedling age of Boro rice grown in separate seedbed) to complete the cycle. The rest period of the year the land remain inundated due to flood. Result indicated that high yielding variety of Mustard (BARI Sarisha-14) could easily be fitted in the farmers existing pattern providing higher seed yield of mustard in a year.

In farmers existing cropping pattern (Boro rice – Fallow – Mustard), they used local variety of Mustard (Tori-7) which is a short duration variety helps to grow BRRIdhan29 which takes longer field duration (115 days). Meanwhile in the improved cropping pattern BARI Sarisha-14 (90 days) required 5 more days to get maturity than Tori-7 (85 days) but Boro rice variety BRRIdhan89 (110 days) got maturity 05 days earlier than BRRIdhan29 (115 days). As a result, gross return and gross margin was higher in improved cropping pattern due to higher yield of crops.

Cost and return

The details of economic analysis of cropping pattern are presented in Table 2. Economics of system productivity revealed that the gross return and gross margin was differ between the cropping patterns. The higher gross return (Tk.315240 ha^{-1}) and gross margin (Tk. 120105 ha^{-1}) were obtained in alternate Boro rice (BRRI dhan89) –Fallow- Mustard (BARI Sarisha-14) cropping pattern while lower gross return (Tk. 262371 ha^{-1}) and gross margin (Tk. 68036 ha^{-1}) was found in existing cropping pattern Boro rice (BRRI dhan29) –Fallow- Mustard (Tori-7). Thus, considering the whole pattern analysis, the improved cropping pattern was found economically profitable with higher production of oilseed in the farmer's field at Manikganj.

Table 2. Yield and economics of alternate and farmer's existing cropping pattern at Shibaloya Manikganj during the year of 2021-22

Parameters	Alternate Cropping Pattern			Existing Cropping Pattern		
Crop	Boro rice	Fallow	Mustard	Boro rice	Fallow	Mustard
Variety	BRRI dhan89	-	BARI Sarisha-14	BRRI dhan29	-	Tori-7
Grain yield (t ha^{-1})	7373		1432	7096		875
Straw yield (t ha^{-1})	6905		2545	6674		1623
Gross return (Tk. ha^{-1})	198135		117105	190748		71623
Total variable cost (Tk. ha^{-1})	153060		42075	153060		41275
Gross margin (Tk. ha^{-1})	45075		75030	37688		30348
Gross return (Tk. ha^{-1}) of the pattern	315240			262371		
TVC (Tk. ha^{-1})	195135			194335		
Gross margin (Tk. ha^{-1}) of the pattern	120105			68036		
BCR	1.60			1.35		

Price of input (Tk. kg^{-1}): Urea-16.00, TSP-22.00, MoP-15.00, Gypsum-15.00, Boron-500.00, Zn-230.00, Rovral-4400.00 & Labor cost (Tk. labor $^{-1}$day^{-1}): 400.00

Price of T. Aman rice: Tk. 25.00 kg^{-1} and straw: Tk. 2.00 kg^{-1}

Price of Mustard: Tk. 80.00 kg^{-1} and straw: Tk. 1.00 kg^{-1}

Pest incidence:
Mustard: Rovral @ 2 gm L^{-1} water was sprayed to control *Alterneria* leaf spot disease.
Boro rice: Rice stem borer was observed in the field and Desis @ 2ml L^{-1} water sprayed to control this insect at the beginning of infestation.

Farmers' opinion

Farmers opined that BRRI dhan89 is a high yielding rice variety for Boro season with shorter field duration compared to BRRI dhan29. BARI Sarisha-14 is an excellent variety of mustard with higher yield potentiality.

Conclusion

In economic point of view, improved cropping pattern including oilseed crop was suitable and profitable practice than the farmers existing cropping pattern. Therefore, this cropping pattern with high yielding varieties of Mustard (BARI Sarisha-14) could be recommended for large scale extension in the farmer's field at flood prone areas of Manikganj.

IMPROVEMENT OF T. AMAN - MUSTARD-BORO RICE CROPPING PATTERN

M.S. MOLLAHAND A. RAHMAN

Abstract

The program was carried out at the farmers' field during 2011-22 to improve T. Aman-Mustard-Boro rice cropping pattern comparing with T. Aman-Fallow-Boro rice at FSRD site, Ganggarampur, Pabna. The program was implemented in five farmer's field. Crop yield of T. Aman, Mustard and Boro rice were recorded as 5.65, 1.63 and 6.45 t ha^{-1}, respectively with rice equivalent yield (REY) 21.76 t ha^{-1} in the improved cropping pattern whereas REY 14.25 t ha^{-1} were recorded in the existing cropping pattern. The gross margin was higher in improved cropping pattern than existing pattern due to addition of Mustard.

Introduction

Rice based cropping pattern is the major cropping pattern in Bangladesh agriculture. (Haque, 1998). More than 60% of the total cropped areas covered by T. Aman-Fallow-Boro rice cropping pattern in Bangladesh. About 2.4 mha crop land is occupying by this cropping pattern in Bangladesh (Ladha *et al.*, 2003; Dawe *et al.*, 2004; Bhuiyan *et al.*, 2004). Rice is the staple food and the economy mainly depends on rice production. In self-sufficiency of rice, the dominant cropping pattern T. Aman (wet season rice)-Fallow-Boro (dry season rice) plays an important role which covers about 1.8 million hectares (about 22% of the total land) of land (Elahi *et al.*, 1999). Bangladesh Rice Research Institute (BRRI) has recommended the T. Aman- Mustard-Boro cropping pattern for the irrigated ecosystem (BARC, 2001; Khan *et al.*, 2004) with the inclusion of 70-75 days local mustard variety (Tori 7) in the transition period between T. Aman and Boro rice. But the farmers harvest poor yield from local var. Tori7 that can be increased manifold by introducing high yielding varieties (Alam and Rahman, 2006; Basak *et al.*, 2007). Bangladesh Agricultural Research Institute (BARI) has developed high yielding yellow seeded mustard (Brassica campestris) varieties, BARI Sarisha-17 whose yield potential is higher than Tori-7. T. Aman-Fallow-Boro crop sequence can be shifting easily possible by inclusion of these mustard varieties with higher economic return.

Materials and Methods

The production program was conducted at the farmers' field condition in at FSRD site, Ganggarampur during the year of 2021-22. Mustard BARI Sarisha-17 variety was included in existing cropping pattern T. Aman-Fallow–Boro rice to develop T. Aman-Mustard-Boro rice cropping pattern. The program was implemented in 1 ha land with 5 farmers. Existing patterns data were collected from neighbor farmer's practiced land of each location. Economic analysis was done on the basis of prevailing local market price of the commodities. Productivity of different cropping systems was compared in terms of rice equivalent yield (REY). The REY was calculated on the basis of average market price of T. Aman and Boro rice. The details of the crop management for the cropping pattern have been presented in Table 1.

Table 1. Crop management practices in alternate cropping pattern and existing cropping pattern at FSRD site, Ganggarampur, Pabna during the year of 2021-22

Observation	Existing cropping pattern			Improved cropping pattern		
Crop	T. Aman	Fallow	Boro	T. Aman	Mustard	Boro
Variety	Swarna	-	BRRI dhan29	BRRI dhan49	BARI Sarisha-17	BRRI dhan58
Spacing	20 cm ×15 cm	-	20 cm × 15 cm	20 cm × 15 cm	Broadcast	20 cm × 15 cm
Fertilizer dose (N-P-K-S-Zn-B Kg ha^{-1})	102-62-20-08-0-0	-	136-50-20-08-0-0	90-10-35-12-1-0	80.6-26-23.5-10-1.6-0.5	150-20-65-18-1.3-0
Date of sowing/ transplanting	20-30/07/21	-	20-25/01/22	16-20/07/11	10-15/11/21	1-3/03/22
Harvesting date	10-15/11/21	-	25-30/05/22	25-30/10/19	10-15/02/22	10-15/06/22

Results and discussion

Crop grain yield in the developed cropping pattern were 5.65, 1.63 and 6.45 MT for T. Aman, Mustard and Boro rice, respectively with Rice equivalent yield 21.76 t ha^{-1}. Besides, the yield in the existing pattern were 5.27 and 6.11 for T. Aman and Boro rice, respectively with 14.25 t ha^{-1} REY.

Cost and Return analysis: Total gross margin in the developed pattern were Tk.333100 ha^{-1} whereas in existing pattern it was Tk. 206225 ha^{-1}. Marginal benefit cost ratio in developed cropping pattern was 2.8 over existing pattern (Table 2).

Pest incidence

Some fields were partially infested with aphid and *Alternaria* blight disease. Insecticide Malathoin and fungicide Rovral 50 wp were applied three times at 7 days interval in the infected fields.

Farmers' opinion

Farmers were highly impressed with the high yielding, more oil containing and short duration mustard variety BARI Sarisha-17 that can be easily fitted in between T. Aman and Boro the major cropping pattern in Pabna region. From the cost and return, it is revealed that farmers can earn a good cash before Boro cultivation from their field.

Conclusion

Short duration with high yielding mustard variety BARI Sarisha-17 can easily be grown during the fallow period between T. Aman and Boro. It will help to increase productivity and minimize the shortage of edible oil for the increasing population of Bangladesh.

Table 3. Crop performance of improved cropping pattern (T. Aman-Mustard-Boro) against the existing pattern T. Aman-Fallow-Boro in FSRD site, Ganggarampur, Pabna during the year of 2021-22

Observation	Existing cropping pattern			Improved cropping pattern		
Crop	T. Aman	Fallow	Boro	T. Aman	Mustard	Boro
Variety	Swarna	-	BRRI dhan29	BRRI dhan49 & Swarna	BARI Sarisha-17	BRRI dhan58
Field duration	112-115	-	124-130	102-107	88-92	102-107
Turnaround time	55	-	70	25	15	20
Grain or seed yield (t ha^{-1})	5.27	-	6.11	5.65	1.63	6.45
Straw or stover yield (t ha^{-}	6.74	-	8.31	6.62	2.70	8.55
REY (t ha^{-1})	14.25			21.76		
Gross return (Tk. ha^{-1})	373975			571250		
Total variable cost (Tk. ha^{-1})	167750			238150		
Whole pattern GM (Tk.	206225			333100		
MBCR (Whole pattern)	-			2.8		

Price (Tk kg^{-1}): T. Aman rice=23.75; Boro rice= 28.75; Av. Rice price= 26.25; Rice straw= 5; Mustard seed= 100; Mustard stover= 1.

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IMPROVED CROPPING PATTERN OF MUSTARD-SESAME-T. AMAN RICE IN BARIND AREA

M.S. HOSSAIN AND J.C. BARMAN

Abstract

A validation program was carried out in the farmers' field of FSRD site, Basantapur, Godagari, Rajshahi during the year of 2021-22 to verify the performance of Mustard-Sesame-T. Aman rice cropping pattern in High Barind Tract. The rice equivalent yield (REY) was the (12.09 t ha^{-1}). The gross margin was Tk.232037 ha^{-1} and BCR was 3.00.

Introduction

Sustainable crop production in Bangladesh through improvement of cropping pattern in rice-based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and creation of job opportunity. The main challenge of the new millennium is to increase per unit yield by at least 50% through manipulating the limited land resource. In this regard, the challenges for the agriculturists are to understand crop production problems and process to develop the best ways of production technologies for the management of problems and sustain production. In case of production agronomy, targeting high yield with high cropping intensity and productivity are the most logical way to raise the total production. In order to produce more food within a limited area, two most important options to be adopted firstly to increase the cropping intensity producing three or more crops over the same piece of land in a year and secondly to increase the production efficiency of the individual crop by using optimum management practices. Oil seeds are the important group of crops which are mostly grown in *Rabi* season. The areas of oilseeds in *Rabi* season are decreased because of increasing cultivation of irrigated *Boro* rice. Recently with the development of short duration rice, oil seeds and pulse opportunities have been created to accommodate three/four crops in same piece of land in a year

Mustard is an important edible oilseed crops in Bangladesh. It has been widely cultivating in this country and top of the list in respect of area and production. The area under mustard is decaling due to increasing of *Boro* rice cultivation and winter vegetables. This has become a serious problem. More over the area and production of mustard declined due to heat stress as well as late planting. But recently, market price of mustard grain is more than rice and farmers are interested to grow mustard timely.

Sesame is one of the most ancient oil seed crops, and it is grown widely in tropical and subtropical areas (Ashri 2010; Bedigian and Harlan 1986). Sesame (*Sesamum indicum* L.) is one of the important oil crops in Bangladesh. It contains 5.3% water, 5.2% minerals, 2.9% fiber, 18.3% protein, 43.3% fat and 25% carbohydrate per 100g edible portion and this crop is drought tolerant crop. It is mainly grown in Kharif-I season which is the dry-wet transition period due to start of monsoon rain. Sesame is extremely susceptible to water logging but this crop is drought tolerant crop. So planting of sesame is another option to increase production of oilseed. Large-scale Sesame farming on the fallow lands can be the effective means of mitigating the existing drought condition alongside the adverse impact of climate change in the vast Barind tract. Droughts in May and June destroy broadcast Aman, Aus and jute. Farmers grow local variety of Sesame with traditional management practices resulting in very low yield. If we can replace their variety by BARI developed HYV, the farmers as well as the country will be benefited. So planting of Sesame is another option to increase total oilseeds production. T. Aman –Fallow- Fallow is one of the major cropping patterns in Barind tract, Rajshahi. Farmers can easily be grown there three crops in this (Mustard-Sesame-T. Aman rice) pattern. After harvesting sesame T. Aman will be planted on timely. To meet up the edible oil requirement of the country this (Mustard-Sesame-T. Aman rice) pattern plays an important role. This pattern was suitable and economically profitable for the farmers of High Barind Tract. The experiment was undertaken for

i) to increase productivity and income of farmers in High Barind Tract and

ii) to verify the developed technology in farmers' field.

Materials and Methods

The validation program was conducted at the farmer's field of FSRD site, Basantapur, Godagari, Rajshahi; during 2021-22 to increase productivity and thereby income generation to the farmers in High Barind Tract. The crop cultivars were grown on a fixed land area. Mustard (BARI Sharisha-17), Sesame (BARI Til-4) and T. Aman rice (BRRIdhan51) were used as test crop. Mustard was sown in 12-15 November 2021, Sesame in 04-05 April 2021 and rice was transplanted in 01 July 2021. For rice, all fertilizers except N was broadcast and incorporated at the time of final land preparation. Nitrogen was broadcast in three equal splits at 15, 30 and 45 days after transplanting. For the Mustard and Sesame, all fertilizers were applied at sowing time and before sowing light irrigation (about 50 mm) was given to the field for providing necessary soil moisture. Crop management, including weeding and pesticide was given to support the normal growth of crops. Mustard was harvested on 13-14 February 2022, Sesame on 1 July 2021 and T. Aman rice on 3-5 November 2021. Yield of main and by-product of each crop were measured in each plot (6 m^2) at physiological maturity. The economic part of individual crops was separated manually after harvesting. Grain yield for Mustard and Sesame was adjusted at 10 % moisture while for rice at 14% moisture from the harvested area. Cultural practices of different crops presented in Table 1.

Results and discussion

The Agro-economic performance of Mustard-Sesame-T. Aman Rice cropping pattern during the year of 2021-22 at HBT were presented in Table 2. Mustard yield was found 1.75 t ha^{-1}. (Table 2) BARI Sharisha-17 is a high yielding variety and it has been accepted well in farmers' level. Sesame yield was found 1.21 t ha^{-1} (Table 2). BARI Til-4 is a high yielding variety and farmers were satisfied about its yield. But farmers are reluctant to cultivate Sesame due to sudden rain of its harvesting and threshing period. T. Aman rice gave 4.88 and 6.12 t ha^{-1} grain yield and straw yield, respectively. In case of rice equivalent yield (REY), it was recorded (11.09 t ha^{-1}). The gross margin was Tk.232037 ha^{-1} and BCR was 3.00.

Table 1. Details of cultural practices adopted for different crops in field experiments

Crop	Cultivar	Seed rate (kg ha^{-1})	Spacing (cm^2)	Date of planting	Date of harvesting	Rate of fertilizer application (kg ha^{-1})					
						N	P	K	S	Zn	B
Sesame	BRRI Til-4	7.5	Broadcast	4-5 April 2021	1 July 2021	46	25	20	16	1.5	-
T. Aman	BRRIdhan51	40	20 x 15	12-14 July 2021	3-5 November 2021	80	15	30	12	2	-
Mustard	BARI Sharisha-17	7.5	Broadcast	12-15 November 2021	13-14 February 2022	115	35	40	24	1.5	1.5

Table 2. Agro-economic performance of Mustard-Sesame-T. Aman Rice cropping pattern during 2021-22 at HBT

Mustard (t ha^{-1})	Sesame (t ha^{-1})	T. Aman		REY (t ha^{-})	GR (Tk ha^{-1})	TVC (Tk ha^{-1})	GM (Tk ha^{-1})	BCR
		Grain (tha^{-})	straw (tha^{-1})					
1.75	1.21	4.88	6.12	12.09	347587	115550	232037	3.0

Mustard -Tk. 80.00 kg^{-1}, Sesame - Tk. 62.50 kg^{-1} BRRIdhan51- Tk. 28.75 kg^{-1}

Farmers' reaction

1. Farmers of High Barind area cordially accepted the Mustard variety BARI Sharisha-11 for its higher yield potentiality.
2. Sesame is a chance crop and farmers are reluctant to cultivate it.

DEVELOPMENT OF MUSTARD-SESAME-T. AMAN CROPPING PATTERN AGAINST BORO-FALLOW-T. AMAN IN ACTIVE BRAHMAPUTRA JAMUNA FLOODPLAIN OF GAIBANDHA

MD JAHANGIR ALAM AND ABDULLAH-AL-MAHMUD

Abstract

The experiment was conducted at Kamolpur, Saghata, Gaibandha under On-Farm Research Division during the year of 2021-22 to increase the cropping intensity and productivity by integrating short-term mustard in rice-based cropping patterns. Alternate cropping patterns were agronomically and economically more profitable than the existing patterns. The system productivity based on rice equivalent yield (RYE) in the alternate cropping pattern was 18.18 t ha^{-1}, which was 58% higher than that of the existing cropping pattern (11.51 t ha^{-1}). The gross return from the alternate cropping pattern was Tk. 363600 ha^{-1}, 58% more compared to the existing cropping pattern with a value of Tk. 230200 ha^{-1}. Similarly, the higher gross margin was recorded from the alternate cropping pattern (Tk. 123600 ha^{-1}) or 70% higher than the existing cropping pattern (Tk. 72700 ha^{-1}). Finally, the marginal benefit-cost ratio (MBCR) of the whole cropping pattern was 1.62 over the existing cropping pattern. Replacement of Boro rice, as well as the inclusion of oilseed crops (sesame and mustard) in the existing cropping system using modern improved varieties, has resulted in increased productivity and profitability.

Introduction

Bangladesh is a small country of 0.148 million km^{-2} but surprisingly it has to feed some 150 million people (BBS 2020). In the past few decades, high food production growth rates have kept pace with population growth. Although rice production increased more than three folds in the last few decades, the country still could not attain sustainable self-sufficiency in food. Currently, about 36.6 million ton (Mt) of rice is being produced from an area of 11.4 million hectares (Mha) with an average of 3.20 t ha^{-1} (BBS, 2020). With the population increasing at 1.37% per annum (BBS, 2020), the gradual decrease (0.08 million hectares, Mha or 1% per annum) in the area of cultivable land due to increasing industrialization and urbanization (Planning Commission, 2009), and a competitive world market, the challenge of ensuring future food security is daunting. Moreover, the frequent occurrence of devastating floods, droughts, cyclones, etc., results from disruption to the overall supply of food grains (Alam and Islam, 2013). The population of Bangladesh is projected to be 192 million by 2030, with cereals (rice and wheat) requirements of 38.2 million tons (Mt), but with no scope for increasing the area under production (IFPRI, 2012).

Bangladesh consumes about 3.0 million tons of oil and fat per year, including both edible and inedible. At present Bangladesh produces about 1 million tons of oilseeds (BBS, 2020). In contrast to production, about 2.0 million tons have to be imported from abroad every year. Per capita consumption of edible oil in Bangladesh has increased by 20% in the last five years and reached 16.4 kg in 2020 (Financial Express, 2021). Meanwhile, overall consumption of edible oil increased by 36% in five years to 3.03 million tonnes in 2020 from 2.22 million tonnes in 2015. Bangladesh has to spend a huge amount of foreign exchange on the import of edible oil and oilseeds to meet the growing demand of the population. A report published shows that among the developing countries, Bangladesh has the highest oil consumption trend (Oil World, 2019). The use of oil has increased in tandem with growing population growth, economic development, and increasing consumer purchasing power. Due to inadequate domestic production in recent times, Bangladesh is dependent on imports to meet the demand for oil. About 90 to 92 percent of the annual demand for oil is met through imports (Financial Express, 2021). Due to various reasons, the area under oilseed cultivation is declining year after year (BBS, 2020) due to economic and technical reasons. However, the area under rapeseed and mustard has started increasing since 2010 (Miah *et al*., 2014). Recently, the Government of Bangladesh has given due importance to the research and development of oilseed crops to achieve self-sufficiency in edible oil. Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture

(BINA) have released several improved varieties of different oil crops (mustard, groundnut, sesame, soybean, linseed) and the adoption rate of these improved varieties at the field level is more encouraging (Miah et al., 2015b; Miah et al., 2015c) and positive effects as well as saving foreign exchange for the country (Miah et al., 2015a).

Therefore, there is a need to increase per unit production by increasing yield and cropping system intensification. These could be achieved by improving the existing cropping pattern/system, including the short duration of Aman rice, mustard, sesame etc. in the existing cropping pattern. Sustainable crop production in Bangladesh is regarded as increasingly important in national issues such as food security, poverty alleviation and the creation of job opportunities. Targeting high yield with high cropping intensity and productivity is the most logical way to raise the total production. In order to produce more food within a limited area, the two most important options to be adopted are i) to increase the cropping intensity by producing three or more crops over the same piece of land in a year and ii) to increase the production efficiency of the individual crop by using high yielding modern cultivars as well as optimum management practices. Considering this, the existing crop cropping pattern (Boro-Fallow-T. Aman) was improved with an alternate cropping pattern (Mustard-Sesame-T. Aman) with the following objective:

- to increase the cropping intensity and productivity by integrating short-term mustard in rice-based cropping patterns.

Materials and Methods

The experiment was conducted at Kamolpur, Saghata, Gaibandha under the supervision of the On-Farm Research Division (OFRD), BARI, Gaibandha during the year of 2021-22. A three crop-based alternative cropping pattern Mustrad-Sesame-T. Aman cropping pattern with their existing Boro-Fallow-T. Aman cropping pattern was tested. The plot size was 1 ha. Recommended fertilizer package (FRG, 2018) along with the application methods were done to support the normal growth of the crops. An agronomic performance like field duration and rice equivalent yield of cropping patterns was calculated. Economic analysis was done on the basis of the prevailing market price of the commodities.

Rice Equivalent Yield (REY): Rice equivalent yield (REY) was calculated to compare system performance by converting the yield of each crop into equivalent rice yield on a price basis, using the formula: REY (of crop $_x$) = Y_x (P_x /P_r)

where, Y_x is the yield of crop ‘x‘(tons harvested product ha^{-1}), P_x is the price of crop, ‘x' and P_r is the price of rice (Biswas et al., 2006). The price of the rice grain, rice straw, sesame and mustard was 20, 1, 100 and 75 Tk kg^{-1}, respectively.

The cost and return analysis included gross return, gross margin and marginal benefit-cost ratio (MBCR). The output and inputs were valued at existing market prices. The MBCR of the farmer’s prevalent pattern and any replacement for it can be computed as the marginal value product (MVP) over the marginal value cost (MVC). The Marginal of the prevalent pattern (F) and any potential replacement (E) for it was computed as (CIMMYT, 1988).

$$\text{Marginal Benefit-Cost Ratio (MBCR)} = \frac{\text{Gross return (AP)} - \text{Gross return (EP)}}{\text{TVC (AP)} - \text{TVC (EP)}}$$

Results and Discussion

Yield and System productivity: In 2021-22, the boro and T. Aman rice yield were 5.51 and 5.29 t ha^{-1} in the existing (Boro-Fallow-T. Aman) cropping pattern. On the contrary, the yield of Sesame, T. Aman, and Mustard was 1.35, 4.79, and 1.87 t ha^{-1} in, respectively in the alternate (Sesame-T. Aman-Mustard) cropping pattern. In terms of system rice equivalent yield (REY) the higher value was observed in the alternate cropping pattern (18.18 t ha^{-1}), 58% more than that of the existing cropping pattern (11.51 t ha^{-1}). The reason was mainly due to the inclusion of sesame and mustard in the existing cropping pattern instead of Boro rice which plays a crucial role in increasing the total system yield.

Table 1. Details of the crop management of existing and alternate cropping patterns at Kamolpur, Saghata, Gaibandha during the year of 2021-2022

Pattern	Existing cropping pattern			Alternate cropping pattern		
Crop	Boro	Fallow	T. Aman	Sesame	T. Aman	Mustard
Variety	BRRI dhan28	-	Guti Swarna	BARI Til-4	BRRIdhan87	BARI Sarisha-14
Spacing (cm^2)	20 x 15	-	20 x 15	30 x5	20 x 15	Row to row 30 cm
Unit plot size (m^2)	-	-	-	1ha	1ha	1 ha
Fertilizer dose (N-P-K-S-Zn-B kg ha^{-1})	120-20-45-15-1-0	-	135-25-20-8-0-0	50-30-25-20-1-1	80-20-50-10-1-1	100-30-40-25-1-1
Date of sowing/ transplanting	20-25 January	-	15-20 July	15-20 February 2021	15-20 July 2021	2-4 November 2021
Harvesting date	1-5 May	-	18-23 November	20-25 May 2021	25-26 October 2021	20-25 January 2022

Table 2. Crop performance of existing and alternate cropping patterns at Kamolpur, Saghata, Gaibandha during 2021-2022

Pattern	Existing cropping pattern			Alternate cropping pattern		
Crop	Boro	Fallow	T. Aman	Sesame	T. Aman	Mustard
Variety	BRRI dhan28	-	Guti Swarna	BARI Til-4	BRRIdhan87	BARI Sarisha-14
Field duration	100	-	125	98	102	80
Turnaround time	75	-	65	50	8	27
Grain or seed yield (t ha^{-1})	5.51	-	5.29	1.35	4.79	1.87
Straw or stover yield (t ha^{-1})	7.55	-	6.65	-	6.11	-
REY (t ha^{-1})	11.51			18.18		
Gross return (Tk. ha^{-1})	230200			363600		
Total variable cost (Tk. ha^{-1})	157500			240000		
Gross margin (Tk. ha^{-1})	72700			123600		
MBCR (Whole pattern)	-			1.62		

*Price (Tk. kg^{-1}): Urea- 16, TSP- 25, MP- 15, Gypsum- 9, Zinc Sulphate- 130, Boric acid- 140, Rice grain- 20, Rice straw- 1.0, Sesame-100 and Mustard -75; REY: rice equivalent yield, MBCR: marginal benefit cost ratio.

Cost and return analysis: The gross return from the alternative cropping pattern was Tk. 363600 ha^{-1}, 58% higher than the existing cropping pattern which is worth Tk. 230200 ha^{-1}. Similarly, a higher gross margin has been recorded from the alternative cropping pattern (Tk. 123600 ha^{-1}) or 70% more than the existing cropping pattern (Tk. 72700 ha^{-1}). Finally, the marginal benefit-cost ratio (MBCR) of the entire cropping pattern was 1.62 over the existing cropping pattern. Due to high market prices of Sesame and Mustard, gross return, as well as gross margins, were revealed higher in the alternative crop pattern.

Farmers' opinion: At first the farmers were confused, how is it possible to grow three crops a year on their land? However, now they are very optimistic and fascinated about the three crop based patterns. This will help encourage them to increase productivity and profitability.

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DEVELOPMENT OF EXISTING CROPPING PATTERN MUSTARD-SESAME- T. AMAN AT FARIDPUR

AFM RUHUL QUDDUS AND SELIM AHMED

Abstract

A trial was conducted at the FSRD site, Faridpur started during Kharif I 2021 with sesame to improve the existing cropping pattern Mustard-Sesame-T. Aman to increase yield and economic return through rice based cropping system. The trial field belongs to the agro-ecological zone of Low Ganges River Floodplain Soil (AEZ # 12). Mustard-Sesame -T. Aman cv. BARI Sarisha-18, BARI Til-4 and BRRI dhan75 were given as the improved variety whereas, the varieties of the same cropping pattern are BARI Sarisha-14, local and Binadhan-7. The crop cycle was started with the sesame at Kharif I season. The product yield of different three crops in improved cropping pattern of sesame, T. Aman and Mustard was 1.59, 5.21 and 1.83 t ha^{-1} while in existing pattern 1.41, 4.29, 1.37 t ha^{-1}, respectively. REY was found to increase 21% over existing cropping sequence. Existing cropping pattern required in an average 283 days field duration and improved cropping pattern required 292 days (excluding seedling age of rice) to complete the cycle. The production efficiency was increased near about 18.29 % over existing cropping sequence. The higher gross return (Tk. 443372 ha^{-1}) and gross margin (Tk. 220412 ha^{-1}) were obtained in improved Mustard-Sesame-T. Aman cropping pattern and lower gross return (Tk 151443 ha^{-1}) was found in existing cropping pattern. The MBCR of improved cropping pattern was 8.20 over existing cropping pattern.

Introduction

In Faridpur district, about 13.5 thousand hectares of land comprising 9% of cultivable area is under oil based cropping pattern like Mustard-Jute-Fallow and Groundnut-Fallow-Fallow. In recent years, price of oil is increasing resulting oil crop area is increasing. During 2019-20, 2020-21 and 2021-22 mustard area was 8300 ha, 8800 ha and 8900 ha, respectively. Farmers normally cultivate Mustard, sesame and T. Aman with their local variety/cultivar like BARI Sarisha-14, local black coated seed of sesame and Binadhan-7, respectively. BARI and BRRI has developed BARI Sarisha-18 & BARI Til-4 and BRRIdhan75 can be easily fit in the farmers existing cropping pattern Mustard-Sesame-T. Aman cropping pattern. This improved pattern is undoubtedly be highly productive and economically profitable. Hence, the trial was conducted to improve the existing cropping pattern, increase yield and economic return through rice-based cropping system.

Materials and Methods

The On-farm trial was conducted at the FSRD site, Faridpur started during Kharif I 2021 with sesame to improve the existing cropping pattern Mustard-Sesame-T. Aman to increase yield and economic return through rice based cropping system. The trial field belongs to the agro-ecological zone of Low Ganges River Floodplain Soil (AEZ # 12). Mustard-Sesame -T. Aman cv. BARI Sarisha-18, BARI Til-4 and BRRI dhan75 were given as the improved variety whereas, the varieties of the same cropping pattern are BARI Sarisha-14, local and Binadhan-7. Three farmers have been selected as dispersed replications covering a total of 100 decimals of land. The improved cropping pattern and neighboring existing cropping pattern were cultivated. The crop cycle was started with the sesame at Kharif I season.

The crop management practices from first cycle of improved cropping pattern are stated below:

Sesame: BARI Til-4 was used as first crop in the cropping pattern of Mustard-Sesame-T. Aman (Table 1). The crop was fertilized with 100-40-40-20-3-2 kg ha^{-1} N-P-K-S-Zn-B in the field. All the fertilizers except N were provided at final land preparation. The urea was top dressed at 33-34 DAS. The seeds were sown on 22-23 March 2021. One hand weeding at 32-33 DAS was done. The crop was harvested during 17-21 June 2021 (87-90 DAS).

T. Aman:. The crop rice (var. BRRI Dhan75) was used in the cropping pattern. The 21 days old seedlings were transplanted during 12 Aug 2021. The crop was fertilized with 80-16-40-9-1-0 kg ha^{-1} N-P-K-S-Zn-B in the plot. All the phosphorus, potassium, Sulphur and zinc were applied as broadcast and incorporated during final land preparation. The full nitrogen was applied in three equal splits and top dressed at seedling stage (10 DAT), rapid tillering stage (24 DAT) and at panicle initiation stage (50 DAT). One hand weeding was done at 22 DAT. Four times irrigation was applied. Carbofuran (Carbofuran 3G @ ACI Formulations Limited) Thiamethoxam (20%) + Chloraniliprole (20%) group (Virtako 40 WG @ Syngenta Bangladesh Limited) was applied at 22 and 52 DAT. The crop was harvested on 16 Nov 2021 (96 DAT).

Mustard: Long durated HYV BARI Sarisha-18 was used in the improved cropping pattern of Mustard-Sesame-T. Aman. The crop was fertilized with 120-36-40-15-2-1 kg ha^{-1} N-P-K-S-Zn-B in the field. Half of nitrogen and all the phosphorus, potassium, sulphur, zinc and boron was applied as broadcast and incorporated during final land preparation. Remaining half nitrogen was applied before flower initiation (35 DAS) as top dress followed by irrigation. The seeds were sown on 25 November 2021. One hand weeding at 29 DAS was done. Two-time irrigations were applied at immediately after sowing and 26-28 DAS. The crop was harvested during 8 March 2022 at field duration of 104 days.

Existing cropping pattern:

Data on crop management practices of existing cropping pattern (Mustard-Sesame-T. Aman) were recorded (Table 1) from nearby growing field. Most of the management practices were same from the existing farmer's practice except fertilizer dose and weed management.

Data on yield along with other parameters were collected and subjected to mathematical analysis. Agronomic performance like field duration, production efficiency and rice equivalent yield of cropping patterns were calculated. Cost and return analysis was done on the basis of prevailing market price of the commodities for gross return and marginal benefit cost ratio (MBCR). Production efficiency value in terms of kg/ha/day was calculated by total main product in a cropping pattern divided by total duration of crops in that pattern (Tomar and Tiwari, 1990).

Production Efficiency (kg/ha/day) $= \dfrac{\sum Y_i}{\sum d_i}$

Where, Y_i= Yield (kg) of ith crop and d_i= Duration (day) of ith crop of the pattern

i= 1, 2, 3, 4

Rice Equivalent Yield (REY): For comparison between crop sequences, the yield of every crop was converted into rice equivalent on the basis of prevailing market price of individual crop (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by market price of that crop divided by market price of rice.

Rice equivalent yield (t ha-1/yr) = $\dfrac{\text{Yield of individual crop} \times \text{market price of that crop}}{\text{Market price of rice}}$

The economic analysis was calculated on the basis of prevailing market price of the produces. Economic analysis involved collection of data on prices and quantities of inputs used and output produced. The inputs used included seed, fertilizer, labour and insecticides. The output and inputs were valued at market prices. The MBCR of the farmer's prevalent pattern and any replacement for it can be computed as the marginal value product ((MVP) over the marginal value cost (MVC). The Marginal of prevalent pattern (F) and any potential replacement (E) for it was computed as (CIMMYT, 1988).

Marginal Benefit Cost Ratio (MBCR) = $\dfrac{\text{Gross return (E) - Gross return (F)}}{\text{TVC (E) - TVC (F)}} = \dfrac{MVP}{MVC}$

Table 1. Management practices followed in Mustard-Sesame- T. Aman cropping pattern at the FSRD site, Faridpur during the year of 2021-22

Parameters	**Improved Cropping Pattern**			**Existing Cropping Pattern**		
Crop	**Sesame**	**T. Aman**	**Mustard**	**Sesame**	**T. Aman**	**Mustard**
Variety	BARI Til-4	BRRI Dhan75	BARI Sarisha-18	Local (black coated)	BRRI Dhan39	BARI Sarisha-14
Seed rate (kg ha^{-1})	5	50	5	5	50	5
Spacing	Broadcast	20 cm x 15 cm	Broadcast	Broadcast	20 cm x 20 cm	Broadcast
Fertilizer dose (kg ha^{-1})	$N_{100}P_{40}K_{40}S_{20}Zn_3B_2$	$N_{80}P_{16}K_{40}S_9Zn_1B_0$	$N_{120}P_{36}K_{40}S_{15}Zn_2B_1$	$N_{37}P_{20}K_{25}S_{15}Zn_0B_{1.7}$	$N_{120}P_{25}$K40$S_{22}Zn_2B_1$	$N_{120}P_{36}K_{40}S_{15}Zn_2B_1$
N Top dress (DAT/DAS)	33-34 DAS	10, 24, 50 DAT	35 DAS	33 DAS	12, 28 DAT	27 DAS
Date of sowing	22-23 March 2021	22 July 2021	25 Nov 2021	22 March 2021	22 July 2021	25 Nov 2021
Date of planting	--	12 Aug 2021	--	--	11 Aug 2021	--
Seedling age (days)	--	21	--	--	22	--
Irrigation (no.)	2 (32-33, 54-55 DAS)	4 (1, 10, 24, 50 DAT)	2 (1, 26-28 DAS)	2 (32-33, 54-55 DAS)	4 (1, 12, 28, 55 DAT)	2 (1, 26-28 DAS)
Weeding (no.)	1Time (32-33 DAS)	1 Time (22 DAT)	1 (29 DAS)	--	1 Time (24 DAT)	--
Pest control (no.)	--	2 (Carbofuran-22 DAT and Virtako-52 DAT)	--	--	2 (Carbofuran-22 DAT and Virtako-52 DAT)	--
Date of harvesting	17-21 June 2021 (87-90 DAS)	16 Nov 2021 (96 DAT)	8 March 2022 (103 DAS)	21 June 2021 (91 DAS)	17 Nov 2021 (98 DAT)	24 Feb 2022 (91 DAS)
Field duration in main field (days)	88-91	97	104	92	99	92
Turnaround time (days)	--	51-55	8	--	50	7

Result and Discussions

Yield performance: Yield performance in improved cropping pattern and existing pattern were presented in Table 2. The product yield of different three crops in improved cropping pattern of sesame, T. Aman and Mustard was 1.59, 5.21 and 1.83 t ha^{-1} while in existing pattern 1.41, 4.29, 1.37 t ha^{-1}, respectively (Table 2). Improved cropping pattern gave higher rice equivalent yield (REY) (17.73 tha^{-1}yr^{-1}) against existing cropping pattern (14.60 tha^{-1}yr^{-1}). Higher rice equivalent yield was obtained in improved cropping pattern due to introduction of new varieties. REY was found to increase 21% over existing cropping sequence. Existing cropping pattern required in an average 283 days field duration and improved cropping pattern required 292 days (excluding seedling age of rice) to complete the cycle. The production efficiency was increased near about 18.30 % over existing cropping sequence. Result indicated that long durated Mustard (BARI Sarisha-18) could easily be fitted in the existing cropping pattern.

Cost and return: The details of economic analysis of cropping patters are presented in Table 2. Economics of system productivity of three crop sequences revealed that the gross return was different for different cropping patterns. The higher gross return (Tk. 443372 ha^{-1}) and gross margin (Tk. 220412 ha^{-1}) were obtained in improved Mustard-Sesame-T. Aman cropping pattern and lower gross return (Tk. 151443 ha^{-1}) was found in existing cropping pattern. The MBCR of improved cropping pattern was 8.20 over existing cropping pattern.

Table 2. Yield and economics of improved and farmer's existing cropping pattern at Faridpur during 2021-22

Parameters	improved cropping pattern			Existing cropping pattern		
Crop	Sesame	T. Aman	Mustard	Sesame	T. Aman	Mustard
Variety	BARI Til-4	BRRI Dhan75	BARI Sarisha-18	Local (Black coated)	BRRI Dhan39	BARI Sarisha-14
Grain yield (t ha^{-1})	1.59	5.21	1.83	1.41	4.29	1.37
Straw/Stover yield/(t ha^{-1})	--	4.34	3.02	--	3.61	1.64
GR (Tk ha^{-1})	111860	156290	175222	105900	128910	130013
TVC (Tk ha^{-1})	64470	99410	59080	58640	100660	54080
GM (Tk ha^{-1})	47390	56880	116142	47260	28250	75933
BCR	1.74	1.57	2.96	1.81	1.28	2.40
REY for individual crop	4.47	6.25	7.01	4.24	5.16	5.2
Rice equivalent yield (t $ha^{-1}yr^{-1}$)	17.73			14.6		
Production efficiency (kg $ha^{-1}day^{-1}$)	29.55			24.98		
Gross return (Tk/ha)	443372			364823		
TVC (Tk/ha)	222960			213380		
Gross margin (Tk/ha)	220412			151443		
MBCR	8.20					

Price of output (Tk kg^{-1}): Improved cropping pattern: Sesame: 70.00, rice: 25.00, rice straw: 6.00, Mustard: 92.50, stover: 2.00

Existing cropping pattern: Sesame: 75.00, rice: 25.00, rice straw: 6.00, Mustard: 92.50, stover: 2.00
Price of input (Tk kg^{-1}): Urea- 16.00, TSP-22.00, MoP-15.00, Gypsum-10.00, Boron-240.00, Zn-220.00

Farmer's opinion

Farmers were happy to get higher income from improved cropping pattern over existing cropping pattern.

Conclusion

The rice equivalent yield and production efficiency was increased 21% and 18% from the Mustard-Sesame-T. Aman cropping pattern through inclusion of new varieties. The MBCR (8.20) of improved pattern over existing cropping pattern was also promising. However, it is the results of one year (one cycle), for concrete decisions, the trial is needed to be repeated for next one year/cycle.

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DEVELOPMENT OF ALTERNATE CROPPING PATTERN SUNFLOWER-JUTE-T. AMAN AGAINST EXISTING CROPPING PATTERN LENTIL-JUTE-T. AMAN AT FARIDPUR

SELIM AHMED AND AFM RUHUL QUDDUS

Abstract

A trial was conducted at the FSRD site, Faridpur started during Kharif I 2021 with alternate cropping pattern Sunflower-Jute-T. Aman against existing cropping pattern Lentil-Jute-T. Aman to increase yield and economic return through rice based cropping system. The trial field belongs to the agro-ecological zone of Low Ganges River Floodplain Soil (AEZ # 12). Sunflower-Jute -T. Aman cv. BARI Surjomukhi-2, JRO 524 and BRRI dhan75 were given as the improved variety in the alternate pattern whereas, the varieties of the existing cropping pattern were BARI Masur-8, JRO 524 and Binadhan-7. The crop cycle was started with the jute at Kharif I season. The product yield in alternate cropping pattern of jute, T. Aman and sunflower was 2.96, 5.30, 2.15 t ha^{-1} while in existing pattern 2.80, 4.65, 1.58 t ha^{-1}, respectively. REY was found to increase 20% over existing cropping sequence. Existing cropping pattern required in an average 323 days field duration and alternate cropping pattern required 325 days (excluding seedling age of rice) to complete the cycle. The production efficiency was increased near about 15% % over existing cropping pattern. The higher gross return (Tk.609790ha^{-1}) and gross margin (Tk.281712 ha^{-1}) were obtained in alternate Sunflower-Jute-T. Aman cropping pattern and lower gross return (Tk509690 ha^{-1}) was found in existing cropping pattern Lentil-Jute-T. Aman. The MBCR of alternate cropping pattern was 3.35 over existing cropping pattern.

Introduction

In Faridpur district, about 13.5 thousand hectares of land comprising 9% of cultivable area is under oil based cropping pattern like Mustard-Jute-Fallow and Groundnut-Fallow-Fallow. In recent years, price of oil is increasing resulting oil crop area is increasing .About 23% area is under pulse based cropping pattern (grass pea, black gram and lentil). In some places of Faridpur, Sunflower is cultivating instead of pulse and about 32 ha of land during 2021-22 is under Sunflower-Jute-T. Aman cropping pattern. Farmers normally cultivate lentil, jute and T. Aman with their local HYV variety/cultivar like BARI Masur-3, JRO-524 and Binadhan-7. BARI and BRRI developed BARI Surjomukhi-2 and BRRI dhan75 can be easily fit in the farmers existing cropping pattern Lentil-Jute-T. Aman cropping pattern. This alternate pattern is undoubtedly be highly productive and economically profitable. Hence, the trial was conducted with alternate cropping pattern Sunflower-Jute-T .Aman against existing cropping pattern Lentil-Jute-T. Aman to increase yield and economic return through rice based cropping system.

Materials and Methods

The On-farm trial was conducted at the FSRD site, Faridpur started during Kharif I season of 2021with alternate cropping pattern Sunflower-Jute-T. Aman against existing cropping pattern Lentil-Jute-T. Aman to increase yield and economic return through rice based cropping system. The trial field belongs to the agro-ecological zone of Low Ganges River Floodplain Soil (AEZ # 12). Sunflower-Jute-T. Aman cv. BARI Surjomukhi-2, JRO 524 and BRRI dhan75 were given as the improved variety in the alternate pattern whereas, the varieties of the existing cropping pattern were BARI Masur-3, JRO 524 and Binadhan-7. Three farmers have been selected as dispersed replications covering a total of 100 decimals of land. The crop cycle was started with the jute for alternate and existing cropping pattern at Kharif I season. In rabi season, lentil was alternated with sunflower crop.

The crop management practices from first cycle of alternate cropping pattern are stated below:

Jute: Indian cultivar JRO-524 was used as first crop in the cropping pattern of Sunflower-Jute-T. Aman (Table 1). The crop was fertilized with 50-30-50 kg ha^{-1} N-P-K in the field. All the fertilizers with half N were provided at final land preparation. The urea was top dressed at 33DAS. The seeds were sown on 2 April 2021. Two hand weeding at 16, 43 DAS was done. One time Emamectin Benzoate (proclaim @ Syngenta Bangladesh Limited) on 10 DAS was sprayed. The crop was harvested during 20 July 2021

T. Aman:.The crop rice (var. BRRI dhan75) was used in the alternate cropping pattern. The 20days old seedlings were transplanted during 08 Aug 2021. The crop was fertilized with 80-16-40-9-1-0 kg ha^{-1} N-P-K-S-Zn-B in the plot. All the phosphorus, potassium, Sulphur and zinc were applied as broadcast and incorporated during final land preparation. The full nitrogen was applied in three equal splits and top dressed at seedling stage (9 DAT), rapid tillering stage (24 DAT) and at panicle initiation stage (49 DAT). One hand weeding was done at 22 DAT. Four times irrigation was applied. Carbofuran (Carbofuran 3G @ ACI Formulations Limited) at 24 DAT,Thiamethoxam (20%) + Chloraniliprole (20%) group (Virtako 40 WG @ Syngenta Bangladesh Limited) at 47 DAT and Azoxystobin (20%) + Difenoconazole (12.5%) group (Amistar Top @ Syngenta Bangladesh Limited) at 55 DAT were applied. The crop was harvested on 6Nov2021 (90 DAT).

Sunflower: BARI Surjamukhi-2 was used in the alternate cropping pattern of Sunflower-Jute-T. Aman. The crop was fertilized with 87-34-80-29-4-2 kg ha^{-1} N-P-K-S-Zn-B in the field. One-third of nitrogen and all the phosphorus, potassium, sulphur, zinc and boron was applied as broadcast and incorporated during final land preparation. Remaining nitrogen was applied at 33 and 54DAS as top dress followed by irrigation. The seeds were sown on 27November 2021. One hand weeding at 30-32 DAS was done. Two-time irrigations were applied at 33, 54 DAS. One time Emamectin Benzoate (Guilder @Aama Green Care) at 97 DAS was sprayed. The crop was harvested during27 March 2022 at field duration of 123days.

Existing cropping pattern:

Data on crop management practices of existing cropping pattern (Lentil-Jute-T. Aman) were recorded (Table 1) from nearby growing field. Most of the management practices were same from the recommended practices except fertilizer dose.

Data on yield along with other parameters were collected and subjected to mathematical analysis. Agronomic performance like field duration, production efficiency and rice equivalent yield of cropping patterns were calculated. Cost and return analysis were done on the basis of prevailing market price of the commodities for gross return and marginal benefit cost ratio (MBCR).Production efficiency value in terms of kg/ha/day was calculated by total main product in a cropping pattern divided by total duration of crops in that pattern (Tomar and Tiwari, 1990).

Production Efficiency (kg/ha/day) = $\frac{\sum Y_i}{\sum d_i}$ Where, Y_i= Yield (kg) of ith crop and d_i= Duration (day) of

crop of the pattern. i= 1, 2, 3, 4

Rice Equivalent Yield (REY): For comparison between crop sequences, the yield of every crop was converted into rice equivalent on the basis of prevailing market price of individual crop (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by market price of that crop divided by market price of rice.

Rice equivalent yield (t ha-1/yr) = $\frac{\text{Yield of individual crop} \times \text{market price of that crop}}{\text{Market price of rice}}$

The economic analysis was done for gross return, gross margin and marginal benefit cost ratio was calculated on the basis of prevailing market price of the produces. Economic analysis involved collection of data on prices and quantities of inputs used and output produced. The inputs used included seed, fertilizer, labour and insecticides. The output and inputs were valued at market prices. The MBCR of the farmer's prevalent pattern and any replacement for it can be computed as the marginal value product ((MVP) over the marginal value cost (MVC). The Marginal of prevalent pattern (F) and any potential replacement (E) for it was computed as (CIMMYT, 1988).

$$\textbf{Marginal Benefit Cost Ratio (MBCR)} = \frac{\text{Gross return (E) - Gross return (F)}}{\text{TVC (E) - TVC (F)}} = \frac{MVP}{MVC}$$

Table1. Management practices followed in alternate and existing cropping pattern at the FSRD site, Faridpur during 2021-22

Parameters	**Alternate cropping Pattern**			**Existing cropping pattern**		
Crop	Jute	T. Aman	Sunflower	Jute	T. Aman	Lentil
Variety	JRO-524	BRRI dhan75	BARI Surjomukhi-2	JRO-524	Binadhan-7	BARI Masur-3
Seed rate (kg ha^{-1})	7	50	10	7	50	40
Spacing	Broadcast	20 cm x 15 cm	50 cm x 25 cm	Broadcast	20 cm x 20 cm	Broadcast
Fertilizer dose (kg ha^{-1})	$N_{50}P_{30}K_{50}$	$N_{80}P_{16}K_{40}S_9Zn_1B_0$	$N_{87}P_{34}K_{80}S_{29}Zn_4B_2$	$N_{95}P_{20}K_{50}$	$N_{120}P_{25}K_{40}S_{22}Zn_2B_1$	$N_{36}P_{20}K_{35}S_0Zn_{1.8}B_1$
N Top dress (DAT/DAS)	33 DAS	9, 24, 49 DAT	33, 54 DAS	33 DAS	10, 26 DAT	--
Date of sowing	02 April 2021	19 July 2021	27 November 2021	02 April 2021	19 July 2021	24 November 2021
Date of planting	--	08 August 2021	--	--	07 August 2021	--
Seedling age (days)	--	20	--	--	19	--
Irrigation (no.)	3 (1, 32-33, 54-55 DAS)	4 (1, 9, 24, 49 DAT)	2 (33, 54 DAS)	3 (1, 32-33, 54-55 DAS)	4 (1, 10, 26, 55 DAT)	1 (1DAS)
Weeding (no.)	2 Time (16, 43 DAS)	1 Time (22 DAT)	1 (30-32 DAS)	2 Time (16, 43 DAS)	1 Time (24 DAT)	--
Pest control (no.)	1 (Proclaim-10 DAS)	3 (Carbofuran-24 DAT, Virtako-47 DAT, Amistar Top-55 DAT)	1(Guilder-97 DAS)	1 (Proclaim-10 DAS)	2 (Carbofuran-24 DAT and Virtako-47 DAT)	2 (Amistar Top-75, 92 DAS)
Date of harvesting	20 July 2021 (109 DAS)	06 November 2021 (90 DAT)	27 March 2022 (123 DAS)	17 July 2021 (106 DAS)	14 November 2021 (98 DAT)	20 February 2022 (116 |DAS)
Field duration in main field (days)	110	91	124	107	99	117
Turnaround time (days)	--	18	20	--	20	9

Result and Discussions

Yield performance: Yield performance in alternate cropping pattern and existing pattern were presented in Table 2. The product yield of different three crops in alternate cropping pattern of jute, T. Aman and Sunflower was2.96, 5.30, 2.15t ha^{-1} while in existing pattern 2.80, 4.65, 1.58 t ha^{-1}, respectively (Table 2). Alternatecropping pattern gave higher rice equivalent yield (REY) (24.39t ha-1/yr) against existing cropping pattern (20.39t ha-1/yr). Higher rice equivalent yield was obtained in alternate cropping pattern due to introduction of new crop (sunflower) and varieties. REY was found to increase 20% over existing cropping sequence. Existing cropping pattern required in an average 323 days field duration and alternate cropping pattern required 325 days (excluding seedling age of rice) to complete the cycle. The production efficiency was increased near about 15%%over existing cropping pattern. Result indicated that long durated Sunflower (BARI Surjamukhi) could easily be fitted in the existing cropping pattern.

Cost and return: The details of economic analysis of cropping patters are presented in Table 2. Economics of system productivity of three crop sequences revealed that the gross return was different for different cropping patterns. The higher gross return (Tk.609790ha^{-1}) and gross margin (Tk.281712ha^{-1}) were obtained in alternate Sunflower-Jute-T. Aman cropping pattern and lower gross return (Tk509690ha^{-1}) was found in existing cropping pattern Lentil-Jute-T. Aman. The MBCR of alternate cropping pattern was 3.35 over existing cropping pattern.

Table 2. Yield and economics of improved and farmer's existing cropping pattern at Faridpur during 2021-22

Parameters	Alternate cropping pattern			Existing cropping pattern		
Crop	Jute	T. Aman	Sunflower	Jute	T. Aman	Lentil
Variety	JRO-524	BRRI dhan75	BARI Surjomukhi-2	JRO-524	Binadhan-7	BARI Masur-3
Grain/Fibre yield (t ha^{-1})	2.96	5.3	2.15	2.80	4.65	1.58
Straw/Stover/stick yield/(t ha^{-1})	4.67	4.33	--	4.58	3.97	0.92
GR (Tk ha^{-1})	236010	158480	215300	223740	140070	145880
TVC (Tk ha^{-1})	137670	99410	90998	138406	100660	59158
GM (Tk ha^{-1})	98340	59070	124302	85334	39410	86722
BCR	1.71	1.59	2.37	1.62	1.39	2.47
REY for individual crop	9.44	6.34	8.61	8.95	5.60	5.84
Rice equivalent yield (t ha^{-1}yr^{-1})	24.39			20.39		
Production efficiency (kgha^{-1}day^{-1})	32.04			27.96		
Gross return (Tk/ha)	609790			509690		
TVC (Tk/ha)	328078			298224		
Gross margin (Tk/ha)	281712			211466		
MBCR	3.35					

Price of output (Tk kg^{-1}): Improved cropping pattern: Jute: 75.00, stick: 3.00, rice: 25.00, rice straw: 6.00, Sunflower: 100

Existing cropping pattern: Jute: 75.00, stick: 3.00, rice: 25.00, rice straw: 6.00, lentil: 90.00, stover: 4.00Price of input (Tk kg^{-1}): Urea- 16.00, TSP-22.00, MoP-15.00, Gypsum-10.00, Boron-240.00, Zn-220.00

Farmer's opinion

Farmers were happy to get higher income from alternate cropping pattern over existing cropping pattern.

Conclusion

The rice equivalent yield and production efficiency was increased 20% and 15%, respectively in Sunflower-Jute-T. Aman cropping pattern over existing pattern through inclusion of new crop and varieties. The MBCR (3.35) of alternate pattern over existing cropping pattern was also promising. However, it is the results of one year (one cycle), for concrete decisions, the trial is needed to be repeated for next one year/cycle.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

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DEVELOPED ALTERNATE CROPPING PATTERN MUSTARD- BORO-T. AMAN AGAINST EXISTING CROPPING PATTERN BORO-FALLOW-T. AMAN AT SHERPUR

M.S. RAHMAN, M. M. RAHAMAN AND A.K.M.Z. NOOR

Abstract

The experiment was conducted at FSRD, Tarakandi, Sherpur of On-Farm Research Division, BAR1, Sherpur during the year of 2021-2022 to study the comparative agronomic performance of existing cropping pattern Fallow- Boro-T. Aman rice and improved cropping pattern Mustard- Boro-T. Aman rice by introducing a short duration mustard (BARI Sarisha-14) after T. Aman rice harvest. The higher rice equivalent yield (17.47 t ha-1) was obtained from improved cropping pattern which was 58.81% higher over farmers existing pattern. At the same time improved cropping pattern Mustard- Boro-T. Aman rice gave higher gross return (Tk. 4,25,878/- ha^{-1}) and gross margin (Tk. 1,76,976/- ha^{-1}) which was (59.86%) and (108%) higher over farmers pattern. Farmers practice gave the lower gross return (Tk. 2,66,400/-ha^{-1}) and gross margin (Tk 85,048/- ha^{-1}) .

Introduction

Farmers at Sherpur followed different types of cropping pattern. Fallow-Boro-T. Aman rice is one of the important cropping Patterns. Oilseed Research Centre, BARI has developed a number of short duration high yielding mustard varieties. It needs to popularize among the farmers by fitting mustard in the existing cropping pattern Fallow-Boro-T. Aman rice. The alternate cropping pattern was Mustard - Boro-T. Aman rice. On-farm trial will help to popularize and evaluate the new cropping pattern among the farmers. With this view in mind, the trial was undertaken.

Materials and Methods

The experiment was conducted at FSRD site Tarakandi, Sherpur under On-Farm Research Division, Bangladesh Agricultural Research Institute, Sherpur during the year of 2021-22 to study the comparative agronomic performance of existing cropping pattern Fallow-Boro-T. Aman rice and improved cropping pattern Mustard- Boro-T. Aman rice by introducing a new crop Mustard (BARI Sarisha-14) after T. Aman rice harvest. The experiment was laid out in a randomized complete block design with two dispersed replications. The unit plot size was 1.5 ha. Two cropping pattern viz. alternate cropping pattern (Mustard-Boro-T. Aman rice) and farmers' cropping pattern (Fallow-Boro-T. Aman rice) were the treatment of the experiment. Recommended fertilizer package (BARC, 2018) along with the application methods were done to support the normal growth of the crops. All field operations and management practices were closely monitored and data were recorded and presented in Table 1. The collected data were averaged and presented in tabular form. Agronomic performance like field duration, and rice equivalent yield of cropping patterns were calculated. For comparison between crop sequences the yield of every crop was converted into rice equivalent on the basis of prevailing market price of individual crop (Ahlawat and Sharma, 1993). Rice Equivalent Yield (REY) was calculated with the following formula and Production Efficiency (kg ha^{-1} day^{-1}) was also calculated. The economic analysis was done for gross return, gross margin and marginal benefit cost ratio and it was done on the basis of prevailing market price of the commodities. The Marginal Benefit Cost Ratio (MBCR) was computed as CIMMYT, 1988.

Results and Discussion

FSRD, Tarakandi, Sherpur

Crop management and yield performance of the pattern: The details of crop management under improved cropping pattern and farmers existing pattern are shown in Table 1. Field duration of cropping pattern comprises on the individual crop duration. Farmers' cropping pattern Fallow- Boro-T. Aman rice has needed 200 days field duration. The newly introduced crop in the farmers existing pattern was Mustard (BARI Sarisha-14). A short duration T. Aman rice variety Dhanigold was also introduced for timely sowing of mustard crop. Total field duration of three crops pattern Mustard- Boro-T. Aman rice has needed 277 days (excluding seedling age of rice) to complete the cycle (Table1). Result indicated that mustard could be easily fitted in Rice-Rice cropping pattern. Average grain yield of BARI Sarisha-14 in the alternate cropping pattern was 1.72 t ha^{-1}. The grain yield of Tej and Dhani gold was 6.10 and 6.14 t ha^{-1}, respectively from the alternate cropping pattern. The grain yield of BRRI dhan28 and Dhani Gold (hybrid) was 5.20 and 5.8 t ha^{-1} in existing pattern.

Rice equivalent yield: Improved cropping pattern produced higher rice equivalent yield (17.47 t $ha^{-1}yr^{-1}$) over farmers' existing cropping pattern (11.0 t $ha^{-1}yr^{-1}$) Inclusion of mustard in existing cropping pattern increased REY 58 % compared to farmers' practice (Table 1).

Table-1. Agronomic parameters of alternate cropping pattern and existing cropping pattern at Tarakandi, Sherpur during the year of 2021-22

Parameter	Alternate cropping pattern Tarakandi, Sherpur			Existing cropping pattern		
	Boro	T. Aman	Mustard	Fallow	Boro	T. Aman
Variety	Tej gold (Hybrid)	Dhani gold (Hybrid)	BARI sarisha-14	-	BRRIdhan 28	Dhani gold (Hybrid)
Sowing/transplanting	04-06 Feb., 2021	30-31 July, 2021	8-13 Nov., 2021	-	20-30 Jan., 2021	25-30 July, 2021
Seed rate (kg ha^{-1})	40	40	40	-	40	40
Planting method	Line	Line	Broadcast	-	Line	Line
Spacing (Row x hill)	20 cm x 15 cm	20cm x 15cm	-	-	20cm x 15cm	20cm x 15cm
Seedling age (days)	35	30	-	-	35-40	30
Seedling $hill^{-1}$	2	2	-	-	-	2
Fertilizer dose (kg N-P-K-S-Zn-B ha^{-1})	139-21-75-20-2.5-2.5	139-21-75-20-0-2.5	103-32-40-24-1.6-1.7	-	139-21-75-20-2.5-2.5	139-21-75-20-0-2.5
Fertilizer application	Basal & top dress	Basal & top dress	Basal & top dress	-	Basal & top dress	Basal & top dress
Weeding (no.)	Once at 25 DAS	Once at 30 DAS	Once at 22 DAS	-	Once at 25 DAS	Once at 30 DAS
Irrigation (no.)	40	3	-	-	40	3
Insect and disease control	Chemical	Chemical	Chemical	-	Chemical	Chemical
Harvesting time	16-18 May, 2021	31 Oct.-3 Nov.,2021	26-29 Jan., 2022	-	10-15 May, 2021	31 Oct.-3 Nov.,2021
Grain yield (t ha^{-1})	6.10	6.14	1.72	-	5.20	5.80
By product yield (t ha^{-1})	6.79	6.27	1.95	-	6.5	6.27
Field duration (days)	105	92	80	-	105	95
REY (t $ha^{-1}yr^{-1}$)	17.47			11.0		
Gross return (Tk. ha^{-1})	4,25,878/-			2,66,400/-		
TVC (Tk. ha^{-1})	2,48,902/-			1,81,352/-		
Gross Margin(Tk. ha^{-1})	1,76,976/-			85,048/-		
BCR	1.71			1.46		

Cost and return: Gross return of improved cropping pattern was Tk. 4,25,878/- ha $^{-1}$ which was more than 59.86% higher over farmers' pattern. Farmers' pattern gave the lower gross return Tk. 2,66,400 ha $^{-1}$. Total variable cost was higher in improved pattern (Tk. 2,48,902/- ha $^{-1}$) might be due to inclusion of mustard in the pattern. The gross margin was substantially higher in the alternate pattern Tk. 1,76,976/- ha $^{-1}$ than farmers' pattern (Tk.85,048/- ha $^{-1}$). The higher gross margin of the alternate pattern was achieved mainly due to inclusion of mustard as a component crop

Table-2. Cost and return analysis of alternate and existing cropping pattern at Tarakandi, Sherpur during 2021-22

Parameter	Alternate cropping pattern Tarakandi, Sherpur			Existing cropping pattern		
	Boro	T. Aman	Mustard	fallow	Boro	T. Aman
Grain yield (t ha^{-1})	6.1	6.14	1.72	-	5.20	5.8
By product yield (t ha^{-1})	6.79	6.27	1.95	-	6.50	6.27
Field duration (days)	140	122	80	-	150	122
REY (t $ha^{-1}yr^{-1}$)	17.47			11.0		
Gross return (Tk. ha^{-1})	1,46,693/-	1,80,960/-	98,225/-	-	1,14,400/-	1,52,000/-
Total variable cost (Tk. ha^{-1})	89,462/-	91,890/-	67,550/-	-	89,462/-	91,890/-
Gross Margin(Tk. ha^{-1})	57,231/-	89,070/-	30,675/-	-	24,938/-	60.110/-

Unit price (Tk/Kg): Boro rice=22.00, T. Aman rice=26.00, Mustard=55.00, Rice straw Boro=1.50, Rice straw Aman=3.00, Mustard straw=2.0

Farmers opinion

Farmers were highly satisfied to see the higher returns of alternate cropping pattern Mustard-Boro-T. Aman rice against existing pattern Fallow-Boro-T. Aman rice due to higher yield as well as gross return of the improved pattern. They also opined that this pattern would be expanded in this area.

Conclusion

From the above result it should be concluded that improved cropping patter was more productive and remunerative compared to existing pattern so, it could be suggested for large scale production in medium high land of Sherpur.

Acknowledgement

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DEVELOPED ALTERNATE CROPPING PATTERN MUSTARD- BORO-T. AMAN AGAINST EXISTING CROPPING PATTERN BORO-FALLOW-T. AMAN AT JAMALPUR

M.S. RAHMAN, M. M. RAHAMAN AND A.K.M.Z. NOOR

Abstract

The experiment was conducted at Multilocation Testing site (MLT), Boushi, Sarishabari, Jamalpur under On-Farm Research Division, BAR1, Sherpur during the year of 2021-2022 to study the comparative agronomic performance of existing cropping pattern Fallow- Boro-T. Aman rice and improved cropping pattern Mustard- Boro-T. Aman rice by introducing a short duration mustard (BARI Sarisha-14) after T. Aman rice harvest. The higher rice equivalent yield (14.85 t ha^{-1}) was obtained from improved cropping pattern which was 48.5% higher over farmers existing pattern. At the same time improved cropping pattern Mustard- Boro-T. Aman rice gave higher gross return (Tk. 4,13,400ha^{-1}) and gross margin (Tk. 1,36,018 ha^{-1}) .Farmers practice gave the lower gross return (Tk. 2,49,400 ha^{-1}) and gross margin (Tk 44,326 ha^{-1}) .

Introduction

Farmers at Jamalpur region followed different types of cropping pattern. Fallow-Boro-T. Aman rice is one of the important cropping Patterns. Oilseed Research Centre, BARI has developed a number of short duration high yielding mustard varieties. It needs to popularize among the farmers by fitting mustard in the existing cropping pattern Fallow-Boro-T. Aman rice. The alternate cropping pattern was Mustard -Boro-T. Aman rice. On-farm trial will help to popularize and evaluate the new cropping pattern among the farmers. With this view in mind, the trial was undertaken.

Materials and Methods

The experiment was conducted at Multilocation Testing site (MLT), Boushi, Sarishabari, Jamalpur under On-Farm Research Division, Bangladesh Agricultural Research Institute, Sherpur during the year of 2021-22 to study the comparative agronomic performance of existing cropping pattern Fallow-Boro-T. Aman rice and improved cropping pattern Mustard- Boro-T. Aman rice by introducing a new crop Mustard (BARI Sarisha-14) after T. Aman rice harvest. The experiment was laid out in a randomized complete block design with two dispersed replications. The unit plot size was 1.5 ha. Two cropping pattern viz. alternate cropping pattern (Mustard-Boro-T. Aman rice) and farmers' cropping pattern (Fallow-Boro-T. Aman rice) were the treatment of the experiment. Recommended fertilizer package (BARC, 2018) along with the application methods were done to support the normal growth of the crops. All field operations and management practices were closely monitored and data were recorded and presented in Table 1. The collected data were averaged and presented in tabular form. Agronomic performance like field duration, and rice equivalent yield of cropping patterns were calculated. For comparison between crop sequences the yield of every crop was converted into rice equivalent on the basis of prevailing market price of individual crop (Ahlawat and Sharma, 1993). Rice Equivalent Yield (REY) was calculated with the following formula and Production Efficiency (kg ha^{-1} day^{-1}) was also calculated. The economic analysis was done for gross return, gross margin and marginal benefit cost ratio and it was done on the basis of prevailing market price of the commodities. The Marginal Benefit Cost Ratio (MBCR) was computed as CIMMYT, 1988.

Results and Discussion

Crop management and yield performance of the pattern: The details of crop management under improved cropping pattern and farmers existing pattern are shown in Table 1. Field duration of cropping pattern comprises on the individual crop duration. Farmers' cropping pattern Fallow- Boro-T. Aman rice has needed 201 days field duration. The newly introduced crop in the farmers existing pattern was Mustard (BARI Sarisha-14). A short duration T. Aman rice variety BRRI dhan 49 was also introduced for timely sowing of mustard crop. Total field duration of three crops pattern Mustard- Boro-T. Aman rice has needed 284 days (excluding seedling age of rice) to complete the cycle (Table1). Result indicated that Mustard could be easily fitted in Rice-Rice cropping pattern. Average grain yield of BARI Sarisha-14 in the alternate cropping pattern was 1.59 t ha^{-1}. The grain yield of BRRIdhan 89 and BRRIdhan 49 was 5.6 and 4.8 t $ha^{-1}$from the alternate cropping pattern in Tarakandi ,Sherpur and Boushi, Jamalpur. The grain yield of BRRIdhan 28 and Hori dhan was 5.20 and 4.8 t ha^{-1} in existing pattern.

Rice equivalent yield: Improved cropping pattern produced higher rice equivalent yield (14.85 t $ha^{-1}yr^{-1}$) over farmers' existing cropping pattern (10.0 t $ha^{-1}yr^{-1}$) Inclusion of Mustard in existing cropping pattern increased REY 48.5 % compared to farmers' practice (Table 1).

Table-1. Agronomic parameters of alternate cropping pattern and existing cropping pattern at Boushi, Jamalpur during the year of 2021-22

Parameter	Alternate cropping pattern Boushi, sarishabari, Sherpur			Existing cropping pattern		
	Boro	T. Aman	Mustard	Fallow	Boro	T. Aman
Variety	BRRI dhan89	BRRI dhan49	BARI Sarisha-14	-	BRRI dhan28	Hori dhan
Sowing/transplanting	20 Jan.2021	30- July 2021	8-13 Nov. 2021	-	20-30 Jan. 2021	25-30 July 2021
Seed rate (kg ha^{-1})	40	40	40	-	40	40
Planting method	Line	Line	Broadcast	-	Line	Line
Spacing (Row x hill)	20 cm x 15 cm	20cm x 15cm	-	-	20cm x 15cm	20cm x 15cm
Seedling age (days)	35	30	-	-	35-40	30
Seedling hill^{-1}	2	2	-	-	-	2
Fertilizer dose (kg N-P-K-S-Zn-B ha^{-1})	139-21-75-20-2.5-2.5	79-17-50-18-3.5-0	103-32-40-24-1.6-1.7	-	139-21-75-20-2.5-2.5	139-21-75-20-0-2.5
Fertilizer application	Basal & top dress	Basal & top dress	Basal & top dress	-	Basal & top dress	Basal & top dress
Weeding (no.)	Once at 25 DAS	Once at 30 DAS	Once at 22 DAS	-	Once at 25 DAS	Once at 30 DAS
Irrigation (no.)	40	3	-	-	40	3
Insect and disease control	Chemical	Chemical	Chemical	-	Chemical	Chemical
Harvesting time	10 May 2021	31 Oct.-3 Nov.2021	26-29 Jan. 2022	-	10-15 May 2021	31 Oct.-3 Nov. 2021
Grain yield (t ha^{-1})	5.6	4.8	1.59	-	5.20	4.8
By product yield (t ha^{-1})	7.9	6.9	2.8	-	6.5	6.20
Field duration (days)	110	90	84	-	105	96
REY (t ha^{-1}yr^{-1})	14.85			10.0		
Gross return (Tk. ha^{-1})	4,13,400			2,49,400		
TVC (Tk. ha^{-1})	2,77,382			2,05,074		
Gross Margin(Tk. ha^{-1})	1,36,018			44,326		
BCR	1.49			1.21		

Cost and return: Gross return of improved cropping pattern was Tk. 4,13,400/-ha $^{-1}$ which was more than 65.75% higher over farmers' pattern. Farmers' pattern gave the lower gross return Tk.2,49,400ha $^{-1}$. Total variable cost was higher in improved pattern (Tk. 2,77,382 ha $^{-1}$) might be due to inclusion of Mustard in the pattern. The gross margin was substantially higher in the alternate pattern Tk. 1,36,018 ha $^{-1}$ than farmers' pattern (Tk. 44,326ha $^{-1}$). The higher gross margin of the alternate pattern was achieved mainly due to inclusion of Mustard as a component crop

Table-2. Cost and return analysis of alternate and existing cropping pattern at Boushi, Jamalpur during the year of 2021-22

Parameter	Alternate cropping pattern Boushi, sarishabari, Jamalpur			Existing cropping pattern		
	Boro	T. Aman	Mustard	fallow	Boro	T. Aman
Grain yield (t ha^{-1})	5.6	4.8	1.59	-	5.20	4.8
By product yield (t ha^{-1})	7.9	6.9	2.8	-	6.5	6.20
Field duration (days)	154	126	84	-	150	122
REY (t $ha^{-1}yr^{-1}$)	13.77			11.0		
Gross return (Tk. ha^{-1})	1,55,800	1,40,700	1,16,900	-	1,17,000	1,32,400
Total variable cost (Tk ha^{-1})	1,09,271	95,803	72,308	-	1,09,271	95,803
Gross Margin(Tk. ha^{-1})	46,529	44,897	44592	-	7,729	36,597

Unit price (Tk/Kg): Boro rice=25.00, T. Aman rice=25.00, Mustard=70.00, Rice straw Boro=2.0, Rice straw Aman=3.00, Mustard=2.00.

Farmers opinion

Farmers were highly satisfied to see the higher returns of alternate cropping pattern Mustard-Boro-T. Aman rice against existing pattern Fallow-Boro-T. Aman rice due to higher yield as well as gross return of the improved pattern. They also opined that this pattern would be expanded in this area.

Conclusion

From the above result it should be concluded that improved cropping patter was more productive and remunerative compared to existing pattern so, it could be suggested for large scale production in medium high land of Jamalpur.

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IMPROVEMENT OF LENTIL-SESAME-T. AMAN CROPPING PATTERN IN KUSHTIA

J. A. MAHMUD

Abstract

An experiment was conducted at Kushtia sadar upazila during 2021-2022 to improved cropping pattern Lentil-Sesame-T. Aman with latest varieties. The varieties Lentil (BARI Masur-6)-Sesame (local)-T. Aman (BRRIdhan 39) were replaced by Lentil (BARI Masur-8)-Sesame (BARI Til-4)-T. Aman (BRRIdhan 75) rice. Gross return and gross margin (Tk. 409663 ha^{-1} and Tk. 244013 ha^{-1}) were higher in ICS where existing cropping pattern were Tk. 354413 ha^{-1} and Tk. 197863 ha^{-1}.

Introduction

Lentil-Sesame -T. Aman is one of the important cropping patterns in Kushtia. Most of the farmers cultivate BARI Masur-3/6 of lentil, local/BARI Til-3 of sesame and BRRIdhan 39 of T. Aman variety which are not high yielding. These varieties are comparative lower yielder and susceptible to pests. Recently BARI and BRRI developed new lentil, sesame and T. Aman variety. Replacing the local cultivars with the modern varieties such as BARI Masur-8 for lentil, BARI Til-4 for sesame and BRRIdhan75 for T. Aman may contribute to 10-20% higher yield the existing pattern. Hence, the experiment has been taken under in this consideration.

Materials and Methods

The experiment was conducted at the farmer's field of Kushtia during 2021-22. The experiment was laid out in RCB design with 6 dispersed replications. Here the varieties Lentil (BARI Masur-6)-Sesame (Local)-T. Aman (BRRIdhan39) were replaced by Lentil (BARI Masur-8)-Sesame (BARI Til-4)-T. Aman (BRRIdhan75) rice. All the materials used and methods followed during impletion of this experiment were stated in table-1 intercultural operation were done when necessary. At maturity different data were collected accordingly and subjected to statistical analysis.

Results and Discussion

Yield, cost and return of alternative cropping pattern with recent varieties Lentil-Sesame-T. Aman were shown in Table 2. Gross return and gross margin of improvement cropping pattern were Tk. 409663 ha^{-1} and Tk. 244013 ha^{-1} whereas in existing cropping these were Tk. 354413 ha^{-1} and Tk. 197863 ha^{-1}, respectively. The MBCR was 1.23. Rice equivalent yield was also higher (12.20 t ha^{-1}) in improved cropping pattern where as existing pattern was (10.52 t ha^{-1}).

Table 1. Crop management of Improved and existing cropping pattern at Kushtia during the year of 2021-22

Parameters	**Improved Cropping Pattern**			**Existing Cropping Pattern**		
Crop	Lentil	Sesame	T. Aman	Lentil	Sesame	T. Aman
Variety	BARI Masur-8	BARI Til-4	BRRI dhan75	BARI Masur-6	Local	BRRI dhan39
Spacing (cm)	Broadcast	Broadcast	Line sowing	Broadcast	Broadcast	Line sowing
Fertilizer dose (NPKSZn&B kg /ha)	21-17-17.5-9.36-0-1	55-28-22.5-19-1.8-1.7-0	115-27-44-13-1-0	20-17-17.5-9-0-1	50-25-20-15-0-0	115-27-44-13-1-0
Date of planting/ sowing	23-25 Nov, 2021	22-25 March 2022	3-4 Aug. 2021	20-24 Nov. 2021	12-15 March 2022	25-30 July 2021
Weeding (no.)	1	1	2	1	1	2
Date of harvesting	15-17 March 2022	16-18 June 2022	30 Oct. 2021	7-9 March 2022	15-17 June 2022	03-05 Nov. 2021

Table 2. Performance of Improved and existing cropping pattern at Kushtia during the year of 2021-22

Parameters	Improved Cropping Pattern			Existing Cropping Pattern		
Crop	Lentil	Sesame	T. Aman	Lentil	Sesame	T. Aman
Variety	BARI Masur-8	BARI Til-4	BRRI dhan75	BARI Masur-6	Local	BRRIdhan 39
Grain/seed (t ha^{-1})	1.90	1.20	4.85	1.60	1.05	4.25
Straw yield (t ha^{-1})	1.75	1.15	3.87	1.62	1.12	3.45
Rice equivalent yield(t ha^{-1}	12.20			10.52		
Gross return (Tk. ha^{-1})	409663			354413		
Total variable cost (Tk. ha^{-1})	165650			156550		
Gross margin (Tk. ha^{-1})	244013			197863		
MBCR	1.23					

Price (Tk/kg): Lentil 80 Tk/kg, Till 65 Tk/kg, Dhan 31.25Tk/kg, Straw 5.00 Tk/kg,

Farmer`s opinion

Farmers who involve in this experiment were satisfied with new improved crop varieties. Gross returns of improved varieties were more profitable than that of existing varieties. Farmers are interested to grow these new crop varieties instead of older as it gives higher return.

Conclusion

Based on findings, it may be concluded that improved cropping pattern in which mordern crop varieties were used is profitable to the farmers. It may contribute to 10-20% higher yield the existing pattern.

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DEVELOPMENT OF RICE BASED CROPPING PATTERN BY ADOPTION OF SHORT DURATION MUSTARD VARIETIES FOR INCREASING CROPPING INTENSITY AND PRODUCTIVITY IN JAMALPUR

M K ALAM, M. M. KADIR AND F.BEGUM

Abstract

The experiment was conducted at Ghoradap union,Jamalpur sadar, Jamalpur under Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Jamalpur during the year of 2021-2022 to study the comparative agronomic performance of existing cropping pattern Fallow- Boro-T. Aman rice and improved cropping pattern Mustard- Boro-T. Aman rice by introducing short duration mustard (BARI Sarisha-14) after T. Aman rice harvest. The higher rice equivalent yield (23.83 t ha-1) was obtained from improved cropping pattern which was 62.45% higher over farmers existing pattern. At the same time improved cropping pattern Mustard- Boro-T. Aman rice gave higher gross return (Tk. 469005 ha^{-1}) and gross margin (Tk. 220013 ha^{-1}) which was (62.45%) and (50.72%) higher over farmers pattern. Farmers practice gave the lower gross return (Tk. 292900/-ha^{-1}) and gross margin (Tk 111598 ha^{-1}).

Introduction

Bangladesh with an area of 1, 47, 570 sq km is the most densely populated (about 1008 persons per km) country of the world. Its present population is about 149 million, which is increasing annually at the rate of about 1.37 per cent (BBS 2020). By the year 2025 AD, the population will increase to about 198 million (en.wikipedia.org/ wiki/world population). On the other hand the cultivable land is decreasing by 1% every year. So, Bangladesh has to produce additional food for millions of people every year. Bangladesh is predominantly a rice growing country and rice is the staple food. Rice occupies about 80% of the total cropped area and is cultivated in three seasons a year. In rice based cropping system T. Aman-Fallow-Boro-Fallow is a dominant cropping pattern where cropping intensity is 200%. In the pace of per capita land availability decrease and production shortage the existence of fallow land in rice based cropping system is very inconsistent to national perspective. Though it is late, however the recent attention to these lands may open new era to rational development initiative, and can add new dimension to agricultural development. Intensive and diversify use of these lands will help to increase production, ease market pressure on commodities, its availability, farmers income generation, employment opportunity and livelihood improvement.

The government of Bangladesh recently prepared the Country Investment Plan (CIP), which provides guidance on investments in agriculture. The CIP has put strong emphasis on regional issues to address food security. Food security involves food availability, food access and food utilization. Acute shortage of edible oil has been prevailing in Bangladesh during last several decades. This shortage has inherited from the past. Bangladesh is producing about 0.17 million tons of edible oil per year as against the requirement of 1.9 million tons. There has been big gap between supply and demand of edible oils, which has been meeting through imports incurring a big amount of foreign exchange every year. In this context, the increase of production of oilseeds has been given priority from government of Bangladesh. T. Aman -Mustard- Boro is the major cropping pattern in some areas of our country. In this land, farmers are being cultivated traditional mustard variety Tori-7 for a long time due to short duration in spite of low yield, lodging tendency and susceptibility to *Alternaria* disease, aphid, even responding poorly to fertilizers and irrigation. Farmers cultivate short duration variety Tori-7 after T. Aman to fit Boro rice. Yield potentiality of Tori-7 is very low which is only 700-800 kgha^{-1}. For vertical expansion, yield per unit area has to be increased. Rapeseed-mustard production can be increased 20-25% only replacing traditional variety by high yielding short duration varieties like BARI Sarisha-14 and BARI Sarisha-15 in the existing rice based cropping system.

Farmers at Jamalpur followed different types of cropping pattern. Fallow-Boro-T. Aman rice is one of the important cropping Patterns. Oilseed Research Centre, BARI has developed a number of short duration high yielding mustard varieties. It needs to popularize among the farmers by fitting mustard in the existing cropping pattern Fallow-Boro-T. Aman rice. The alternate cropping pattern was Mustard -Boro-T. Aman rice. Adaptation trial will help to popularize and evaluate the new cropping pattern among the farmers. With this view in mind, the trial was undertaken.

Materials and Methods

The experiment was conducted at Ghoradap union,Jamalpur sadar, Jamalpur under Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Jamalpur during the year of 2021-22 to study the comparative agronomic performance of existing cropping pattern Fallow-Boro-T. Aman rice and improved cropping pattern Mustard- Boro-T. Aman rice by introducing a new crop Mustard (BARI Sarisha-14) after T. Aman rice harvest. The experiment was laid out in a randomized complete block design with two dispersed replications. The unit plot size was 1.5 ha. Two cropping pattern viz. alternate cropping pattern (Mustard- Boro-T. Aman rice) and farmers' cropping pattern (Fallow-Boro-T. Aman rice) were the treatment of the experiment. Recommended fertilizer package (FRG, 2018) along with the application methods were done to support the normal growth of the crops. All field operations and management practices were closely monitored and data were recorded and presented in Table 1. The collected data were averaged and presented in tabular form. Agronomic performance like field duration, and rice equivalent yield of cropping patterns were calculated. For comparison between crop sequences the yield of every crop was converted into rice equivalent on the basis of prevailing market price of individual crop the economic analysis was done for gross return, gross margin and marginal benefit cost ratio and it was done on the basis of prevailing market price of the commodities.

Results and Discussion

Crop management and yield performance of the pattern

The details of crop management under improved cropping pattern and farmers existing pattern are shown in Table 1. Field duration of cropping pattern comprises on the individual crop duration. Farmers' cropping pattern Fallow- Boro-T. Aman rice has needed 200 days field duration. The newly introduced crop in the farmers existing pattern was mustard (BARI Sarisha-14). A short duration T. Aman rice variety Dhanigold was also introduced for timely sowing of mustard crop. Total field duration of three crops pattern Mustard- Boro-T. Aman rice has needed 277 days (excluding seedling age of rice) to complete the cycle (Table1). Result indicated that mustard could be easily fitted in Rice-Rice cropping pattern. Average grain yield of BARI Sarisha-14 in the alternate cropping pattern was 1.78 t ha^{-1}. The grain yield of Tej and Dhani gold was 6.15 and 6.10 t ha^{-1} respectively from the alternate cropping pattern. The grain yield of BRRIdhan 28 and Dhani Gold (hybrid) was 5.19 and 5.78 t ha^{-1} in existing pattern.

Rice equivalent yield: Improved cropping pattern produced higher rice equivalent yield (23.83 t $ha^{-1}yr^{-1}$) over farmers' existing cropping pattern (10.97 t $ha^{-1}yr^{-1}$) Inclusion of mustard in existing cropping pattern increased REY 62.45 % compared to farmers' practice (Table 1).

Table 1. Agronomic parameters and cost return analysis of alternate and existing cropping pattern at Ghoradap union, Jamalpur during the year of 2021-2022

Parameter	Alternate cropping pattern Ghoradap union, Jamalpur			Existing cropping pattern		
	Boro	T. Aman	Mustard	Fallow	Boro	T. Aman
Variety	Tej gold (Hybrid)	Dhani gold (Hybrid)	BARI Sarisha-14	-	BRRIdhan 28	Dhani gold (Hybrid)
Sowing/transplanting	04-06 Feb. 2021	30-31 July2021	8-13 Nov. 2021	-	20-30 Jan.2021	25-30 July 2021
Seed rate (kg ha^{-1})	40	40	40	-	40	40
Planting method	Line	Line	Broadcast	-	Line	Line
Spacing (Row x hill)	20 cm × 15 cm	20cm × 15cm	-	-	20cm × 15cm	20cm × 15cm
Seedling age (days)	35	30	-	-	35-40	30
Seedling $hill^{-1}$	2	2	-	-	-	2
Fertilizer dose (kg N-P-K-S-Zn-B ha^{-1})	139-21-75-20-2.5-2.5	139-21-75-20-0-2.5	103-32-40-24-1.6-1.7	-	139-21-75-20-2.5-2.5	139-21-75-20-0-2.5
Fertilizer application	Basal & top dress	Basal & top dress	Basal & top dress	-	Basal & top dress	Basal & top dress
Weeding (no.)	Once at 25 DAS	Once at 30 DAS	Once at 22 DAS	-	Once at 25 DAS	Once at 30 DAS
Irrigation (no.)	40	3	-	-	40	3
Insect and disease control	Chemical	Chemical	Chemical	-	Chemical	Chemical
Harvesting time	16-18 May 2021	31 Oct.-3 Nov.2021	26-29 Jan. 2022	-	10-15 May2021	31 Oct.-3 Nov.2021
Grain yield (t ha^{-1})	6.15	6.10	1.78	-	5.19	5.78
By product yield (t ha^{-1})	6.91	6.12	1.99	-	6.3	6.33
Field duration (days)	105	92	80	-	105	95
REY (t $ha^{-1}yr^{-1}$)	23.83			10.97		
Gross return (Tk. ha^{-1})	469005			292900		
TVC (Tk. ha^{-1})	248992			181302		
Gross Margin(Tk. ha^{-1})	220013			111598		
BCR	1.88			1.62		

Unit price (Tk/Kg): Boro rice=22.00, T. Aman rice=26.00, Mustard=80.00, Rice straw Boro=1.50, Rice straw Aman=3.00, Mustard straw=2.0

Cost and return

Gross return of improved cropping pattern was Tk. 469005ha $^{-1}$ which was more than 62.45 % higher over farmers' pattern. Farmers' pattern gave the lower gross return Tk. 292900 ha $^{-1}$. Total variable cost was higher in improved pattern (248992 ha $^{-1}$) due to inclusion of mustard in the pattern. The gross margin was substantially higher in the alternate pattern Tk. 220013 ha $^{-1}$ than farmers' pattern (111598 ha $^{-1}$). The higher gross margin of the alternate pattern was achieved mainly due to inclusion of mustard as a component crop

Farmers opinion

Farmers were highly satisfied to see the higher returns of alternate cropping pattern Mustard-Boro-T. Aman rice against existing pattern Fallow-Boro-T. Aman rice due to higher yield as well as gross return of the improved pattern. They also opined that this pattern would be expanded in this area.

Conclusion

From the above result it should be concluded that improved cropping patter was more productive and remunerative compared to existing pattern so, it could be suggested for large scale production in medium high land of Jamalpur.

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PILOT PRODUCTION PROGRAM OF OIL SEED BASED CROPPING PATTERN MUSTARD-JUTE-T. AMAN RICE

S.M.A.H. M. KAMAL, M. Z. FERDOUS, M. S. H. MOLLA AND M. A. H. TALUKDER

Abstract

The pilot production program of oil seed based cropping pattern Mustard-Jute-T. Aman rice was conducted at char Bongram, Ranigonj, Chilmari, Kurigram, OFRD, Rangpur during Rabi season 2021-22 to observe the cropping pattern performance at char areas and to popularize and disseminate to the farmers of char areas. The yield was recorded of cropping pattern 1730 Kg of mustard, 2250 Kg of Jute and 4700 Kg of T. Aman rice. The gross return and gross margin of each crop were given 117640 and 76710 of Mustard, 157500 and 90110 of Jute and 117500 and 91021 of T. Aman rice.

Introduction

Mustard is the most important and popular oil seed crop, which is mainly grown in winter season in Bangladesh. The area under mustard is declining due to competition with other *rabi* crops as well as late harvesting of long duration T. Aman rice. Though the production of edible oil is being decreased, but the demand is increasing day by day with the increasing population. To fulfill this demand, Bangladesh has to import a large quantity of edible oil every year at the cost of huge amount of foreign exchange. Cultivation of low yielder local varieties with poor fertilizer management is the major cause for poor yield of mustard in the country (Alam and Rahman 2006). High yield potential of a variety is the prerequisite for increasing the production of a crop. In the recent years, Bangladesh Agricultural Research Institute (BARI) has developed a number of high yielding varieties of mustard with yield potential up to 2.5 t ha-1. The present national average yield of mustard is only 1.1 t ha-1 (Anon. 2015). In those patterns, the farmers are using local variety of mustard (Tori-7) with poor fertilizer management and harvest poor yield of mustard. By introducing the high yielding varieties with better management packages the yield of mustard can be increased at satisfactory level. Therefore the production program of oilseed based cropping pattern was carried out at farmers field.

Materials and Methods

The pilot production program of oil seed based cropping pattern Mustard-Jute-T. Aman rice was conducted at char Bongram, Ranigonj, Chilmari, Kurigram, OFRD, Rangpur during Rabi season 2021-22 to observe the cropping pattern performance at char areas and to popularize and disseminate to the farmers of char areas. Six farmers were cultivated 1 Bigha of each farmer in this area. The sowing date of cropping pattern of farmers was started 6-11 November 2021of Mustard, 2-6 April 2021 of Jute & 2-5 September 2021of T. Aman rice and crop was harvested on 15-17 February 2021 of Mustard, 7-18 August 2021 of Jute & 18-21 December 2021of T. Aman rice. The variety was BARI Sharisha-18, Robi-1, BRRIdhan 87 accordingly mustard, Jute and T. Aman rice. Weeding, irrigation and spraying were done as required. Fertilizers were followed at the Krishi Projukti Hand Book, 2019. Data were taken on different growth parameters like plant height, tuber/plant, tuber weight/plant, and yield only showing yield and economic data.

Results

The yield was recorded of cropping pattern 1730 Kg of mustard, 2250 Kg of jute and 4700 Kg of T. Aman rice. The gross return and gross margin of each crop were given 117640 &76710 of mustard, 157500 & 90110 of jute and 117500 & 91021 of T. Aman rice. The mustard variety BARI Sharisha-18 was good variety due to less disease and pest attack but low yield. Jute variety was also good but the jute sticks break in middle due to wash of farmer's opinions.

Table 1.Yield, cost and return of Mustard – Jute - T. Aman rice cropping pattern crop wise at char Bongram, Ranigonj, Chilmari, Kurigram, OFRD, Rangpur during Rabi season 2021-22

Crops	Variety	Area (dec.)	Yield (Kg/ha)	GR (Tk./ha)	TVC (Tk./ha)	GM (Tk./ha)
Mustard	BARI Sharisha-18	200	1730	117640	40930	76710
Jute	Robi-1	200	2250	157500	67390	90110
T. Aman rice	BRRIdhan 87	200	4700	117500	26479	91021

Price (Tk./Kg) : Mustard:68 /-, Jute : 70/- and T. Aman rice:25/-

Farmer's opinion

Farmers opined that BARI Sarisha-18 is high yielder which encourages them to grow as profitable crop in the existing cropping pattern. They preserved seeds with a view to grow this variety in the next season and showed willingness to distribute quality seeds among the community farmers. Though the duration of BARI Sarisha-18 is quite long, they also preferred this variety due to its higher seed yield and stover yield and suitable for Mustard-Jute-T. Aman cropping pattern. Neighboring farmers and relatives of co-operator farmers frequently visited the block and impressed to see the field performance of the varieties. However, they requested the scientists to improve its lodging tendency.

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PILOT PRODUCTION PROGRAM OF OIL SEED BASED CROPPING PATTERN POTATO-GROUNDNUT-T. AMAN RICE

M. Z. FERDOUS, M. S. H. MOLLA, S.M.A.H. M. KAMAL AND M. A. H. TALUKDER

Abstract

The pilot production program of oil seed based cropping pattern Potato-Groundnut-T. Aman rice was conducted at char Char Jagotber, lalmonirhat under OFRD, Rangpur during Rabi season 2021-22 to observe the cropping pattern performance at char areas and to popularize and disseminate to the farmers of char areas. Rice crop-based cropping pattern Potato (var. BARI Alu-25)-Groundnut (var. BARI Chinabadam-9)-T. Aman (BRRI dhan87) was tested this oilseed based cropping pattern at char Char Jagotber, lalmonirhat under OFRD, Rangpur. The yield was recorded of cropping pattern 27.8 t ha^{-1} of potato, 2350 kg of groundnut and 3600 kg of T. Aman rice. The gross return and gross margin of each crop were given 222400 and 86500 of potato, 141000 and 70200 of groundnut and 90000 and 60500 of T. Aman rice.

Introduction

Agriculture is the main livelihood for *char* dwellers in Bangladesh. Most of the *char* inhabitants are directly or indirectly involved in agricultural operations (World-Bank, 2013). *Char* livelihood largely depends on agricultural production. Cropping systems in *char* are quite different from the other land areas because of sandy soil texture and environmental variability (Kabir, 2006). Only a few specific crops are grown in the *char* area such as maize, groundnut, seasonal paddy, and some vegetables. Most of the *char* farmers keep their lands fallow during the main cropping season: Kharif (May to October) because of high evaporation which is renders cultivation impossible without irrigation. Instead, the Rabi season (November to April) is the main cropping season in the *char* area, when temperatures are lower which is best for vegetable cultivation (Lahiri-Dutt and SAmanta, 2007). Groundnut is the most important and popular oil seed crop, which is mainly grown in char areas of Bangladesh. Though the production of edible oil is being decreased, but the demand is increasing day by day with the increasing population. To fulfill this demand, Bangladesh has to import a large quantity of edible oil every year at the cost of huge amount of foreign exchange. Cultivation of low yielder local varieties with poor fertilizer management is the major cause for poor yield of oilseed crops in the country (Alam and Rahman 2006). High yield potential of a variety is the prerequisite for increasing the production of a crop. In the recent years, Bangladesh Agricultural Research Institute (BARI) has developed a number of high yielding varieties of groundnut with yield potential up to 3 t ha-1. By introducing the high yielding varieties with better management packages the yield of oilseed crops can be increased at satisfactory level. Therefore the production program of potato-groundnut-T. Aman cropping pattern was carried out at farmers field.

Materials and Methods

The pilot production program of oil seed based cropping pattern Potato-Groundnut-T. Aman rice was conducted at Char Jagotber, Lalmonirhat under OFRD, Rangpur during Rabi season 2021-22 to observe the cropping pattern performance at char areas and to popularize and disseminate to the farmers of char areas. Six farmers were cultivated 1 Bigha of each farmer in this area. The planting date of cropping pattern of Groundtnut-T. Aman-Potato was started 22-23 February 2021of Groundnut, 10-16 July 2021 of T. Aman & 15-21 November 2021of Potato and crop was harvested on 25-27 June 2021 of Groundnut, 10-12 November 2021 of T. Aman & 18-21 February 2022 of Potato. The variety was BARI Chinabadam-9, BRRIdhan 87 and BARI Alu-25 accordingly groundnut, T. Aman rice and potato. Weeding, irrigation and spraying were done as required. Fertilizers were followed at the Krishi Projukti Hand Book, 2019. Data were taken on different growth parameters like plant height, tuber/plant, tuber weight/plant, and yield only showing yield and economic data.

Table 1. Yield, cost and return of Potato – Groundnut - T. Aman rice cropping pattern crop wise at char jagotber, Rajpur, Lalmonirhat, under OFRD, Rangpur during Rabi season 2021-22

Crops	Variety	Area (ha)	Yield (t ha-1)	GR (Tk./ha)	TVC (Tk./ha)	GM (Tk./ha)
Potato	BARI Alu-25	1	27.8	222400	135900	86500
Groundnut	BARI Chinabadam-9	1	2.35	141000	70800	70200
T. Aman rice	BRRIdhan 87	1	3.6	90000	29500	60500

Price (Tk./Kg) : Potato:8 Groundnut : 60 and T. Aman rice:25

Results

The yield was recorded of cropping pattern 27.8 t ha-1 of potato, 2350 kg of groundnut and 3600 kg of T. Aman rice. The gross return and gross margin of each crop were given 222400 & 86500 of potato, 141000 & 70200 of groundnut and 90000 & 60500 of T. Aman rice. The potato variety BARI Alu-25 was good variety due to higher yield. The groundnut variety BARI Chinabadam-9 was very good variety due to higher yield and higher market price.

Acknowledgement

It is acknowledged to the project entitled 'Enhancement of Oil Seed Crop Production' for his generous and stimulating financial and logistic support.

DEVELOPMENT OF RICE BASED CROPPING PATTERN BY ADOPTION OF SHORT DURATION MUSTARD VARIETIES FOR INCREASING CROPPING INTENSITY AND PRODUCTIVITY IN MYMENSINGH DISTRICT

M. A. ISLAM, M.M. ZAMAN AND F. BEGUM

Abstract

The trial was conducted at multi-location testing (MLT) site at Trishal under On-Farm Research Division (OFRD), Mymensingh during 2021-22 to study the comparative agronomic performances of existing cropping pattern (T. Aman-Fallow-Boro) and improved cropping pattern (T. Aman-Mustard-Boro) by inclusion of short duration high yielding mustard varieties i.e. BARI Sarisha-14 after harvesting of high yielding short duration T. Aman varieties i.e. BRRI dhan71 & BRRI dhan75 harvest. In Boro season, improved pattern has used high yielding modern varieties i.e. BRRI dhan88 and BRRI dhan92. The inclusion of mustard in between two rice- rice crops and replaced with high yielding rice varieties the higher rice equivalent yield (17.35 t ha-1) was found from improved cropping pattern which was 64.76% higher over farmer existing pattern. The gross return was increased by 64.73% in T. Aman-Mustard-Boro rice sequences compared to existing rice-rice cropping pattern. The marginal benefit cost ratio, land utilization index and production efficiency indicated the superiority of the improved pattern over the farmers' existing pattern. The experimental evidence reveals that there is an ample scope of substantial improvement of the productivity of the double rice cropping sequence with the inclusion of high yielding short duration mustard varieties.

Introduction

Bangladesh is the world's most densely populated country, with an annual population growth rate of about 1.37% (BBS, 2019). On the other hand, agricultural land is decreased by 0.73% each year owing to the development of houses, roads, and industrial infrastructure (BBS, 2019). Because decreasing agricultural land makes it impossible to meet the issue of providing food security by horizontal expansion, an increase in crop production might be achieved through vertical expansion by improving crop yield per unit area and minimizing production losses. In near future, the main challenge is to increase 50% yield per unit land by manipulating limited resources. The most essential choices for producing more food within a confined area are to increase cropping intensity and individual crop production efficiency by applying best management practices (Mondal *et al.*, 2015). With the use of short-duration high yielding rice varieties in transplanted Aman season, an opportunity has increased to grow mustard. In this regard, improved cropping pattern with short duration varieties and better management practices are crucial to boost agriculture productivity. Oilseeds crops are mostly grown in rabi (winter) season in Bangladesh. The area of oilseeds in rabi season is decreasing because of increasing cultivation of irrigated boro rice (Wahhab *et al*., 2002). Rapeseed-mustard can be increased by 20-25% only replacing traditional variety by high yielding short duration ones, like BARI Sarisha-14 and BARI Sarisha-17 in existing rice-based cropping system (OFRD, 2014). However, the benefit of incorporation of extra crops in the rice-based cropping pattern will largely depend on the selection of suitable crop varieties and adoption of sustainable agronomic practices. The late harvest of medium to high duration *T. Aman* rice might causes the decline of mustard area and lower yield. Farmers of Trishal followed different types cropping pattern. T. Aman-Fallow-Boro rice is one of the major cropping patterns in Mymensingh district which covered 65.85% of total pattern. So there has a huge scope to increase cropping intensity by inclusion mustard after T. Aman harvest. Oilseed Research Centre has developed a number of short duration high yielding mustard varieties. It needs to popularize among the farmers by fitting mustard at their fallow land of existing cropping pattern (T. Aman- Fallow-Boro) and increase oilseed production as well as farmer income. Therefore, the present experiment was undertaken with this view in mind.

Materials and Methods

The experiment was conducted at the farmers' field of multi-location testing (MLT) site at Trishal under On-Farm Research Division (OFRD), Mymensingh during 2021-22 to study the comparative agronomic performances of existing cropping pattern (T. Aman-Fallow-Boro) and improved cropping pattern (T. Aman-Mustard-Boro) by introducing short duration high yielding mustard varieties *i.e.* BARI Sarisha-14 after short duration high yielding T. Aman varieties *i.e. i.e.* BRRI dhan71 & BRRI dhan75 harvest. In Boro season, improved pattern has used high yielding modern varieties *i.e.* BRRI dhan88 and BRRI dhan92. The experiment was laid out in a randomized complete block design with two dispersed replications. The unit plot size was 1.0 acre. Two cropping pattern viz. improved cropping pattern (T. Aman-Mustard-Boro) and farmers existing cropping pattern (T. Aman-Fallow-Boro) were included of the experiment. The agronomic practices and intercultural operations for crop production under improved and farmers' practices are presented in Table 1. All field operations and management practices of both improved and farmers' patterns were closely monitored and data were recorded for agro-economic performances. Agronomic performances like field duration, rice equivalent yield, production efficiency and land utilization index were calculated. For comparison between crop sequences, the yield of all crops were converted into rice equivalent on the basis of prevailing market prices of individual crop (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by prevailing market price of that crop divided by market price of rice.

Rice equivalent yield (t ha^{-1}yr^{-1}) = $\dfrac{\text{Yield of individual crop} \times \text{market price of that crop}}{\text{market price of rice}}$

Production efficiency value in terms of kgha^{-1}day^{-1} was calculated by total main product in a cropping pattern divided by total duration of crops in that pattern (Tomar and Tiwari, 1990).

Production Efficiency= $\dfrac{Y_1 + Y_2 + Y_3}{d_1 + d_2 + d_3}$

Where, Y_1= Yield of 1st crop and d_1= Duration of 1st crop of the pattern
Y_2= Yield of 2nd crop and d_2= Duration of 2nd crop of the pattern
Y_3= Yield of 3rd crop and d_3= Duration of 3rd crop of the pattern

Land utilization index (LUI) was worked-out by taking total duration of crops in an individual cropping pattern divided by 365 days (Rahman *et al.* 1989). It was calculated by the following formula:

Land utilization index (LUI) = $\dfrac{d_1 + d_2 + d_3}{365} \times 100$

Where d_1, d_2 and d_3 the duration of 1st, 2nd and 3rd crop of the pattern

The economic indices like gross return, gross margin and marginal benefit cost ratio were also calculated on the basis of prevailing market price of the product. Economic analysis involved collection of data on prices and quantities of inputs used and output produced. The inputs used included seed, fertilizer, labour and insecticides. The MBCR of the farmer's prevalent pattern and any replacement for it can be computed as the marginal value product ((MVP) over the marginal value cost (MVC). The Marginal of prevalent pattern (F) and any potential replacement (E) for it was computed as (CIMMYT, 1988).

Marginal Benefit Cost Ratio (MBCR) $= \frac{\text{Gross return (E) - Gross return (F)}}{\text{TVC (E) - TVC (F)}} = \frac{MVP}{MVC}$

Results and Discussion

Crop management and yield performance of the pattern

The details of crop management under improved cropping pattern and farmers existing pattern are shown in table 1. Field duration of cropping pattern comprises on the individual crop duration. Farmers existing pattern T. Aman-Fallow-Boro has needed 217 days field duration. The improved cropping pattern has needed 267 days field duration (excluding seedling age) where newly introduced oilseed crop was mustard (BARI sharisha-14). Two short duration Aman rice varieties *i.e.* BRRI dhan71 & BRRI dhan75 were also used for timely sowing of mustard crop. Result indicated that mustard could be easily fitted in rice-rice cropping pattern due to use of short duration Aman rice varieties.

Incase of improved pattern, the yield of BRRI dhan71 was 3.45 t ha^{-1} and BRRI dhan75 was 3.30 t ha^{-1}. Mean grain yield two varieties Aman rice were 3.38 t ha^{-1}. The byproduct yield of BRRI dhan71 was 3.80 t ha^{-1} and BRRI dhan75 was 3.60 t ha^{-1}. Mean byproduct yield two varieties Aman rice were 3.70 t ha^{-1}. The yield of BARI Sarisha-14 was 1.70 t ha^{-1}. The byproduct yield of BARI Sarisha-14 was 3.4 t ha^{-1}. The yield of BRRI dhan88 was 5.5 t ha^{-1} and BRRI dhan92 was 6.5 t ha^{-1}. Mean grain yield two varieties were 6.0 t ha^{-1}. The byproduct yield of BRRI dhan88 was 5.8 t ha^{-1} and BRRI dhan92 was 6.9 t ha^{-1}. Mean byproduct yield two varieties at boro season were 6.35 t ha^{-1}.

Incase of existing pattern, the yield of BRRI dhan49 was 3.15 t ha^{-1}. The byproduct yield of BRRI dhan49 was 3.80 t ha^{-1}. The yield of BRRI dhan29 was 5.35 t ha^{-1}. The byproduct yield of BRRI dhan29 was 5.6 t ha^{-1}.

From the study it has been observed that the improved pattern under *T. Aman*- Mustard-*Boro* cropping pattern gave higher grain and by-product yield (Table 1). Rice in improved pattern produced higher grain yield over farmers' practice due to change of variety with improved production technologies. The lower yield of grain and straw of rice in farmers' practice influenced also the use of imbalanced fertilizer and poor management practice. Similar results in higher productivity were also obtained by Nazrul *et al*. (2013), Khan *et al*. (2006), Khan *et al*. (2005) and Hossain and Wahhab (1992).

Rice equivalent yield

The mean rice equivalent yield revealed that improved cropping pattern produced higher rice equivalent yield (17.35 t $ha^{-1}yr^{-1}$) over farmers' (10.53 t $ha^{-1}yr^{-1}$) pattern (Table 2). Inclusion of high yielding mustard varieties, high yielding rice varieties and modern production technology in the improved pattern influenced increased the rice equivalent yield and total productivity increased by 64.76% compared to farmers' practice. Lower rice equivalent yield was obtained in the farmers' pattern due to variety and traditional management practices.

Production efficiency

Maximum production efficiency (41.50) in terms of $kgha^{-1}day^{-1}$ was obtained from improved cropping pattern (Table 2). The higher production efficiency of improved cropping pattern might be due to the modern varieties and management practices. The lower production efficiency (39.17) $kgha^{-1}day^{-1}$ was found in farmers' pattern due to traditional management practices. Similar trend were noted by Nazrul *et al*. (2013), Khan *et al*. (2006), Khan *et al*. (2005) and Krrishna and Reddy (1997).

Land utilization index (LUI)

Land utilization index (LUI) is an effective way of using land in a cropping year which depends on individual crop duration. The LUI indicated that improved pattern used the land for 73.15% period of the year, whereas farmers' pattern used the land for 59.45% period of the year (Table 2). The higher land utilization index in improved pattern because this pattern occupied the field for longest duration (267 days), whereas farmers' pattern occupied the field for 217 days of the year.

Cost and return analysis

The marginal benefit cost ratio of improved pattern and rice based farmers' existing pattern are presented in Table 3. From the economic point of view, the gross return of improved cropping pattern (Tk. 401050 ha^{-1}) showed its superiority by 64.73% over farmers' existing pattern (Tk.243450 ha^{-1}). The production cost of the improved pattern (Tk.260775 ha^{-1}) was higher than farmers' pattern (Tk.179495 ha^{-1}) due to inclusion of mustard which takes extra labour for production and as well as taking money for buying mustard seed, fertilizer and pesticide etc. The gross margin was substantially higher in the improved pattern (Tk. 140275 ha^{-1}) than farmers' pattern (Tk. 63955 ha^{-1}). The higher gross return & margin of the improved pattern was achieved mainly higher yield advantages of the component crops and replacement of high yielding modern rice varieties. The mean marginal benefit cost ratio (MBCR) was found 2.94 which indicated the superiority of the improved cropping pattern over the farmers' pattern. The marginal benefit cost ratio (MBCR) also showed that inclusion of mustard in the existing pattern might be profitable and acceptable to the farmers.

Table 1. Agronomic parameters of improved cropping pattern and farmers' existing pattern at Bir Rampur under Trishal upazila of Mymensingh during the year of 2021-2022

Parameter	Improved Pattern (IP)			Farmers' Pattern (FP)		
	T. Aman	Mustard	Boro	T. Aman	F.	Boro
Varieties	BRRI dhan71 BRRI dhan75	BARI Sarisha-14	BRRI dhan89 BRRI dhan92	BRRI dhan49	-	BRRI dhan29
Sowing/ transplanting	Seed bed 09 July, 2021 TP 08 Aug. 2021	14-16 Nov. 2021	Seed bed 28 Dec, 2021 TP 06-07 Feb. 2022	Seed bed 03 July, 2021 TP 12-16 Aug. 2021	-	Seed bed 22 Dec, 2021 TP 04 Feb. 2021
Seedling age (days)	30 days	-	40	40-45	-	43
Seed rate (kg ha^{-1})	40	6	40	50-60	-	50-60
Planting	Line	Broadcast	Line	Line		Line
Spacing (Row×hill)	20cm × 15cm	Continuous	20cm × 15cm	20cm × 15cm		20cm × 15cm
Seedling hill^{-1}	3	-	3	3-4		3-4
Fertilizer dose (kg NPKSZnB ha^{-1})	85-18-60-15-4-0	120-34-45-28-2-2	140-20-75-20-4-0	90-12-40-0-0-0		150-15-50-15-0-0
Fertilizer application method	Basal and top dress.	Basal and top dress.	Basal and top dress.	Basal and top dress.	-	Basal and top dress.
Weeding (no)	Once at 30 DAT	none	Once at 25 DAT	Once at 25-30 DAT		Once at 25-30 DAT
Irrigation	N/A	none	Several times	N/A		Several times
Insect/ Rodent control	IPM	IPM	IPM	Chemical		Chemical
Harvesting time	31 Oct.,2021 (BRRI dhan75) 03 Nov., 2021 (BRRI dhan71)	03 Feb. 2022	10 May, 2022 (BRRI dhan88) 20 May, 2022 (BRRI dhan92)	20-30 Nov. 2021		27 May, 2022
Seed/Grain Yield (t ha^{-1})	3.45 (BRRI dhan71) 3.30 (BRRI dhan75)	1.70 (BARI Sarisha-14)	5.5 (BRRI dhan88) 6.5 (BRRI dhan92)	3.15 (BRRI dhan49)		5.35 (BRRI dhan29)
By product yield (t ha^{-1})	3.8 (BRRI dhan71) 3.6 (BRRI dhan75)	3.4 (BARI Sarisha-14)	5.8 (BRRI dhan88) 6.9 (BRRI dhan92)	3.8 (BRRI dhan49)		5.6 (BRRI dhan29)
TAT (days)	80	12	6	75		73
Field duration (days)	BRRI dhan71 88 BRRI dhan75 85 Mean 87	BARI Sarisha-14 80	BRRI dhan88 96 BRRI dhan92 103 Mean 100	BRRI dhan49 104		BRRI dhan29 113

Table 2. Productivity of improved and existing cropping patterns at Bir Rampur under Trishal upazila of Mymensingh during 2021-2022

Productivity	Improved Pattern (IP)						Farmers' Pattern (FP)				
	T. Aman		Mustard		Boro		T. Aman		F.	Boro	
Seed/Grain yield ($t\ ha^{-1}$)	BRRI dhan71	3.45	BARI Sarisha-14	1.70	BRRI dhan88	5.5	BRRI dhan49	3.15	-	BRRI dhan29	5.35
	BRRI dhan75	3.30			BRRI dhan92	6.5			-		
	Mean	3.38			Mean	6.0			-		
By product yield ($t\ ha^{-1}$)	BRRI dhan71	3.8	BARI Sarisha-14	3.4	BRRI dhan88	5.8	BRRI dhan49	3.80	-	BRRI dhan29	5.6
	BRRI dhan75	3.6			BRRI dhan92	6.9			-		
	Mean	3.7			Mean	6.35			-		
REY ($tha^{-1}yr^{-1}$)	17.35						10.53				
PE ($kgha^{-1}day^{-1}$)	41.50						39.17				
LUI (%)	73.15						59.45				

REY=Rice equivalent yield, PE=production efficiency, LUI= land utilization index and F= fallow

Table 3. Cost and return analysis of improved and existing cropping pattern at Trishal during 2021-22

Parameters	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	MBCR
Improved pattern	401050	260775	140275	1.94
Farmers' pattern	243450	179495	63955	-

Price of input and output: Urea: 16.00 Tk. kg^{-1}, TSP: 22.00 Tk. kg^{-1}, MOP: 15.00 Tk. kg^{-1}, Gypsum: 12.00 Tk. kg^{-1}, Zinc sulphate: 150.00 Tk. kg^{-1}, Boric acid: 240.00 Tk. kg^{-1}, mustard seed: 85, rice seed: 40

Selling price (Tk. kg^{-1})**:** Mustard**:** 75/-, Boro: 22/-, T. Aman:25/-, Rice straw: 5/- and mustard straw: 2/-

Farmers' opinion

All the farmers under the present study expressed their satisfaction to see the higher returns of improved cropping pattern. They are willing in growing mustard in between fallow time of Aman and Boro rice in future. They also opined that this pattern would be expanded in Mymensingh district through producing quality mustard seeds by them.

Conclusion

From above result it should be concluded that T. Aman-Mustard-Boro cropping pattern is more productive than existing pattern and also applicable in major areas of Mymensingh district. Improved pattern is easily be fitted in the existing pattern with higher benefit. Inclusion of mustard in the pattern will increase oilseed production of the country as well as increase cropping intensity and productivity oil also.

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Acknowledgement

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DEVELOPMENT OF RICE BASED CROPPING PATTERN BY ADOPTION OF SHORT DURATION MUSTARD VARIETIES FOR INCREASING CROPPING INTENSITY AND PRODUCTIVITY IN NETRAKONA DISTRICT

M. A. ISLAM, M.M. ZAMAN AND F. BEGUM

Abstract

The trial was conducted at multi-location testing (MLT) site at Karli, Challisha, Netrakona under On-Farm Research Division (OFRD), Mymensingh during the year of 2021-22 to study the comparative performances of existing cropping pattern (T. Aman-Fallow-Boro) and improved cropping pattern (T. Aman-Mustard-Boro) by inclusion of short duration high yielding mustard varieties i.e. BARI Sarisha-14 and BARI Sarisha-17 after harvesting of high yielding short duration T. Aman varieties i.e. BRRI dhan71 & BRRI dhan75 harvest. In Boro season, improved pattern has used high yielding modern varieties i.e. BRRI dhan89 and BRRI dhan92. The inclusion of mustard in between two rice- rice crops and replaced with high yielding rice varieties the higher rice equivalent yield (18.81 t ha-1) was found from improved cropping pattern which was 82.09% higher over farmer existing pattern. The gross return was increased by 94% in T. Aman-Mustard-Boro rice sequences compared to existing rice-rice cropping pattern. The marginal benefit cost ratio, land utilization index and production efficiency indicated the superiority of the improved pattern over the farmers’ existing pattern. The experimental evidence reveals that there is an ample scope of substantial improvement of the productivity of the double rice cropping sequence with the inclusion of high yielding short duration mustard varieties.

Introduction

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Materials and Methods

The experiment was conducted at the farmers' field of multi-location testing (MLT) site at Karli, Challisha, Netrakona under On-Farm Research Division (OFRD), Mymensingh during 2021-22 to study the comparative performances of existing cropping pattern (T. Aman-Fallow-Boro) and improved cropping pattern (T. Aman-Mustard-Boro) by introducing short duration high yielding mustard varieties *i.e.* BARI Sarisha-14 and BARI Sarisha-17 after short duration high yielding T. Aman varieties *i.e. i.e.* BRRI dhan71 & BRRI dhan75 harvest. In Boro season, improved pattern has used high yielding modern varieties *i.e.* BRRI dhan89 and BRRI dhan92. The experiment was laid out in a randomized complete block design with two dispersed replications. The unit plot size was 1.0 ha. Two cropping pattern viz. improved cropping pattern (T. Aman-Mustard-Boro) and farmers existing cropping pattern (T. Aman-Fallow-Boro) were included of the experiment. The agronomic practices and intercultural operations for crop production under improved and farmers' existing pattern are presented in Table 1. All field operations and management practices of both improved and farmers' patterns were closely monitored and data were recorded for agro-economic performances. Agronomic performances like field duration, rice equivalent yield, production efficiency and land utilization index were calculated. For comparison between crop sequences, the yield of all crops were converted into rice equivalent on the basis of prevailing market prices of individual crop (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by prevailing market price of that crop divided by market price of rice.

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Production efficiency value in terms of kgha^{-1}day^{-1} was calculated by total main product in a cropping pattern divided by total duration of crops in that pattern (Tomar and Tiwari, 1990).

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Where, Y_1= Yield of 1st crop and d_1= Duration of 1st crop of the pattern
Y_2= Yield of 2nd crop and d_2= Duration of 2nd crop of the pattern
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Land utilization index (LUI) was worked-out by taking total duration of crops in an individual cropping pattern divided by 365 days (Rahman *et al.* 1989). It was calculated by the following formula:

Land utilization index (LUI) = $\frac{d_1 + d_2 + d_3}{365} \times 100$

Where d_1, d_2 and d_3 the duration of 1st, 2nd and 3rd crop of the pattern

The economic indices like gross return, gross margin and marginal benefit cost ratio were also calculated on the basis of prevailing market price of the product. Economic analysis involved collection of data on prices and quantities of inputs used and output produced. The inputs used included seed, fertilizer, labour and insecticides. The MBCR of the farmer's prevalent pattern and any replacement for it can be computed as the marginal value product ((MVP) over the marginal value cost (MVC). The Marginal of prevalent pattern (F) and any potential replacement (E) for it was computed as (CIMMYT, 1988).

Marginal Benefit Cost Ratio (MBCR) = $\frac{\text{Gross return (E) - Gross return (F)}}{\text{TVC (E) - TVC (F)}} = \frac{MVP}{MVC}$

Results and Discussion

Crop management and yield performance of the pattern

The details of crop management under improved cropping pattern and farmers existing pattern are shown in table 1. Field duration of cropping pattern comprises on the individual crop duration. Farmers existing pattern T. Aman-Fallow-Boro has needed 215 days field duration. The improved cropping pattern has needed 278 days field duration (excluding seedling age) where newly introduced oilseed crop was mustard (BARI sharisha-14 and BARI sharisha-17). Two short duration Aman rice varieties *i.e.* BRRI dhan71 & BRRI dhan75 were used for timely sowing of mustard crop. Result indicated that mustard could be easily fitted in rice-rice cropping pattern due to use of short duration Aman rice varieties.

In case of improved pattern, the yield of BRRI dhan71 was 3.95 t ha^{-1} and BRRI dhan75 was 4.10 t ha^{-1}. Mean grain yield two varieties Aman rice were 4.03 t ha^{-1}. The byproduct yield of BRRI dhan71 was 4.60 t ha^{-1} and BRRI dhan75 was 4.85 t ha^{-1}. Mean byproduct yield two varieties Aman rice were 4.73 t ha^{-1}. The yield of BARI Sarisha-14 was 1.65 t ha^{-1} and BARI Sarisha-17 was 1.82 t ha^{-1}. Mean seed yield two varieties were 1.74 t ha^{-1}. The byproduct yield of BARI Sarisha-14 was 3.6 t ha^{-1} and BARI Sarisha-17 was 3.8 t ha^{-1}. Mean byproduct yield two varieties of Mustard were 3.7 t ha^{-1}. The yield of BRRI dhan89 was 7.2 t ha^{-1} and BRRI dhan92 was 6.9 t ha^{-1}. Mean grain yield two varieties were 7.1 t ha^{-1}. The byproduct yield of BRRI dhan89 was 7.4 t ha^{-1} and BRRI dhan92 was 7.1 t ha^{-1}. Mean byproduct yield two varieties at boro season were 7.3 t ha^{-1}.

In case of existing pattern, the yield of BRRI dhan32 was 3.10 t ha^{-1} and BRRI dhan49 was 3.45 t ha^{-1}. Mean grain yield two Aman varieties were 3.30 t ha^{-1}. The byproduct yield of BRRI dhan32 was 3.75 t ha^{-1} and BRRI dhan49 was 3.95 t ha^{-1}. Mean byproduct yield two varieties Aman rice were 3.85 t ha^{-1}. The yield of BRRI dhan28 was 4.3 t ha^{-1} and BRRI dhan29 was 5.79 t ha^{-1}. Mean grain yield two boro varieties were 5.0 t ha^{-1}. The byproduct yield of BRRI dhan28 was 4.8 t ha^{-1} and BRRI dhan29 was 6.1 t ha^{-1}. Mean byproduct yield two varieties at boro season were 5.45 t ha^{-1}.

From the study it has been observed that the improved pattern under Mustard-*Boro-T. Aman* cropping pattern gave higher grain and by-product yield (Table 1). Rice in improved pattern produced higher grain yield over farmers' practice due to change of variety with improved production technologies. The lower yield of grain and straw of rice in farmers' practice influenced also the use of imbalanced fertilizer and poor management practice. Similar results in higher productivity were also obtained by Nazrul *et al*. (2013), Khan *et al*. (2006), Khan *et al*. (2005) and Hossain and Wahhab (1992).

Rice equivalent yield

The mean rice equivalent yield revealed that improved cropping pattern produced higher rice equivalent yield (18.81 t $ha^{-1}yr^{-1}$) over farmers' (10.33 t $ha^{-1}yr^{-1}$) pattern (Table 2). Inclusion of high yielding mustard varieties, high yielding rice varieties and modern production technology in the improved pattern influenced increased the rice equivalent yield and total productivity increased by 82.09% compared to farmers' practice. Lower rice equivalent yield was obtained in the farmers' pattern due to variety and traditional management practices.

Production efficiency

Maximum production efficiency (46.29) in terms of $kgha^{-1}day^{-1}$ was obtained from improved cropping pattern (Table 2). The higher production efficiency of improved cropping pattern might be due to the modern varieties and management practices. The lower production efficiency (38.09) $kgha^{-1}day^{-1}$ was found in farmers' pattern due to traditional management practices. Similar trend were noted by Nazrul *et al*. (2013), Khan *et al*. (2006), Khan *et al*. (2005) and Krrishna and Reddy (1997).

Land utilization index (LUI)

Land utilization index (LUI) is an effective way of using land in a cropping year which depends on individual crop duration. The LUI indicated that improved pattern used the land for 76.16% period of the year, whereas farmers' pattern used the land for 58.90% period of the year (Table 2). The higher land utilization index in improved pattern because this pattern occupied the field for 278 days, whereas farmers' pattern occupied the field for 215 days of the year.

Cost and return analysis

The benefit cost ratio of improved pattern and rice based farmers' existing pattern are presented in Table 3. From the economic point of view, the gross return of improved cropping pattern (Tk. 463700.00 ha^{-1}) showed its superiority by 82% over farmers' existing pattern (Tk.239000.00 ha^{-1}). The production cost of the improved pattern (Tk.262325.00 ha^{-1}) was higher than farmers' pattern (Tk.178455 ha^{-1}) due to inclusion of mustard which takes extra labour for production and as well as taking money for buying mustard seed, fertilizer and pesticides etc. The gross margin was substantially higher in the improved pattern (Tk. 201375.00 ha^{-1}) than farmers' pattern (Tk. 60545.00 ha^{-1}). The higher gross return & margin of the improved pattern was achieved mainly higher yield advantages of the component crops and replacement of high yielding modern rice varieties. The mean marginal benefit cost ratio (MBCR) was found 2.67 which indicated the superiority of the improved cropping pattern over the farmers' pattern. The marginal benefit cost ratio (MBCR) also showed that inclusion of mustard in the existing pattern might be profitable and acceptable to the farmers.

Table 1. Agronomic parameters of improved cropping pattern and farmers' existing pattern at Karli, Challisha under sadar upazila of Netrakona district during the season of 2021-2022

Parameter	Improved Pattern (IP)			Farmers' Pattern (FP)		
	T. Aman	Mustard	Boro	T. Aman	F.	Boro
Variety	BRRI dhan71 BRRI dhan75	BARI Sarisha-14 BARI Sarisha-17	BRRI dhan89 BRRI dhan92	BRRI dhan32 BRRI dhan49	-	BRRI dhan28 BRRI dhan29
Sowing/ transplanting	Seed bed 07 July, 2021 TP 04-06 Aug. 2021	04-09 Nov. 2021	Seed bed 25 Dec, 2021 TP 05-06 Feb. 2022	Seed bed 01 July, 2021 TP 10-15 Aug. 2021	-	Seed bed 20 Dec, 2021 TP 05-10 Feb. 2021
Seedling age (days)	28-30 days	-	40-45	40-45	-	40-50
Seed rate (kg ha^{-1})	40	6	40	45-50	-	50-60
Planting method	Line	Broadcast	Line	Line	-	Line
Spacing (Row×hill)	20cm × 15cm	Continuous	20cm × 15cm	20cm × 15cm	-	20cm × 15cm
Seedling $hill^{-1}$	2-3	-	2-3	3-4	-	3-4
Fertilizer dose (kg NPKSZnBha^{-1})	85-18-60-15-4-0	120-34-45-28-2-2	140-20-75-20-4-0	80-25-35-10-0-0	-	140-20-45-15-0-0
Fertilizer application method	Basal and top dress.	Basal and top dress.	Basal and top dress.	Basal and top dress.	-	Basal and top dress.
Weeding (no)	Once at 30 DAT	none	Once at 25 DAT	Once at 25-30 DAT	-	Once at 25-30 DAT
Irrigation (no)	N/A	none	Several times	N/A	-	Several times
Insect/ Rodent control	IPM	IPM	IPM	Chemical	-	Chemical
Harvesting time	28 Oct.,2021 (BRRI dhan75) 31 Oct. 2021 (BRRI dhan71)	26-31 Jan. 2022	25-29 May 2022	20-30 Nov. 2021	-	17-31 May 2022
Seed/Grain yield (t ha^{-1})	3.95 (BRRI dhan71) 4.10 (BRRI dhan75)	1.65 (BARI Sarisha-14) 1.82 (BARI Sarisha-17)	7.2 (BRRI dhan89) 6.9 (BRRI dhan92)	3.10 (BRRI dhan32) 3.45 (BRRI dhan49)	-	4.0-4.5 (BRRI dhan28) 5.5-6.0 (BRRI dhan29)
By product yield (t ha^{-1})	4.60 (BRRI dhan71) 4.85 (BRRI dhan75)	3.6 (BARI Sarisha-14) 3.8 (BARI Sarisha-17)	7.4 (BRRI dhan89) 7.1 (BRRI dhan92)	3.75 (BRRI dhan32) 3.95 (BRRI dhan49)	-	4.8 (BRRI dhan28) 6.1 (BRRI dhan29)
TAT (days)	71	7	9	74	-	76
Field duration (days)	BRRI dhan71 86	BARI Sarisha-14 82	BRRI dhan89 109	BRRI dhan32 102	-	BRRI dhan28 105
	BRRI dhan75 84	BARI Sarisha-17 85	BRRI dhan92 111	BRRI dhan49 106	-	BRRI dhan29 116
	Mean 85	Mean 83	Mean 110	Mean 104	-	Mean 111

Table 2. Productivity of improved and existing cropping patterns at Karli, Challisha under sadar upazila of Netrakona district during 2021-2022

Productivity	Improved Pattern (IP)						Farmers' Pattern (FP)				
	T. Aman		Mustard		Boro		T. Aman		F.	Boro	
Seed/Grain yield ($t\ ha^{-1}$)	BRRI dhan71	3.95	BARI Sarisha-14	1.65	BRRI dhan89	7.2	BRRI dhan32	3.10	-	BRRI dhan28	4.3
	BRRI dhan75	4.10	BARI Sarisha-17	1.82	BRRI dhan92	6.9	BRRI dhan49	3.45	-	BRRI dhan29	5.7
	Mean	4.03	Mean	1.74	Mean	7.1	Mean	3.3	-	Mean	5.0
By product yield ($t\ ha^{-1}$)	BRRI dhan71	4.60	BARI Sarisha-14	3.6	BRRI dhan89	7.4	BRRI dhan32	3.75	-	BRRI dhan28	4.8
	BRRI dhan75	4.85	BARI Sarisha-17	3.8	BRRI dhan92	7.1	BRRI dhan49	3.95	-	BRRI dhan29	6.1
	Mean	4.73	Mean	3.7	Mean	7.3	Mean	3.85	-	Mean	5.45
REY ($tha^{-1}yr^{-1}$)	18.81						10.33				
PE ($kgha^{-1}day^{-1}$)	46.29						38.06				
LUI (%)	76.16						58.90				

REY=Rice equivalent yield, PE=production efficiency, LUI= land utilization index and F= fallow

Table 3. Cost and return analysis of improved and farmers' existing cropping pattern in Netrakona during the year of 2021-22

Parameters	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	MBCR
Improved pattern	463700	262325	201375	2.67
Farmers' pattern	239000	178455	60545	-

Price of input and output: Urea: 16.00 Tk. kg^{-1}, TSP: 22.00 Tk. kg^{-1}, MOP: 15.00 Tk. kg^{-1}, Gypsum: 12.00 Tk. kg^{-1}, Zinc sulphate: 150.00 Tk. kg^{-1}, Boric acid: 240.00 Tk. kg^{-1}, mustard seed: 85, rice seed: 40

Selling price (Tk. kg^{-1})**:** Mustard**:** 80, Boro: 22, T. Aman:25, Rice straw: 5 and mustard straw: 2

Farmers' opinion

All the farmers under the present study expressed their satisfaction to see the higher returns of improved cropping pattern. They are willing in growing mustard in between fallow time of Aman and Boro rice in future. They also opined that this pattern would be expanded in Netrakona district through producing quality mustard seeds by them.

Conclusion

From above result it should be concluded that T. Aman-Mustard-Boro cropping pattern is more productive than existing pattern and also applicable in major areas of Netrakona. Improved pattern is easily be fitted in the existing pattern with higher benefit. Inclusion of mustard in the pattern will increase oilseed production of the country as well as increase cropping intensity and productivity oil also.

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C. ADAPTIVE TRIAL/VALIDATION TRIAL

Cropping pattern based Adaptive Trials and Validation Trials were conducted in the farmers' field. Advanced lines and technologies of different oilseed crops developed by ORC of BARI included in Adaptive and Validation Trials in order to release variety and technology. In addition, released varieties and technologies of ORC of BARI and other research organizations and institutions included in Validation Trials to see the performance of varieties and technologies. ORC and OFRD of BARI executed the Adaptive and Validation Trials at the following locations (15 locations) and area of each location was be 0.5 hectare depending on trial size.

No. of locations	Name of locations
15	Jamalpur, Pabna, Sylhet, Rangpur, Jashore, Kumilla, Hathazari, Rajshahi (Barind), Faridpur, Netrakona, Patuakhali, Khulna, Noakhali, Satkhira & Kushtia

D. Field Days /Farmers' days

A total of 23 field days/farmers' days were arranged on improve production technologies of mustard, groundnut, sesame, soybean and sunflower crops for directly showing the performance of high yielding varieties and modern production technologies of different oilseed crops in different locations (Table 4). The farmers of these locations were very much impressed and pleased to see the performance directly in the fields on modern technologies of the recent improved high yielding oilseed varieties with other crop protection technologies.

Table 4. Field/Farmers' day arranged in different locations during 2021-22

Title	Number	Location	No. of Participants
Mustard Performance of BARI Sharisha-14, Sharisha-15, 17 and 18, BARI Sharisha-11 and 16 at farmers field	17	Jashore, Kishoreganj, Sirajganj, Gaibanda, Netrokona, Satkhira, Gazipur, Tangail, Sherpur, Jamalpur, Mymensingh, Kumilla, Manikganj, Rajshahi, Bogura, Pabna Faridpur	1360
Groundnut Performance of BARI Chinabadam- 8 and BARI Chinabadam- 9 BARI Chinabadam- 10 at farmers field	02	Bhola & Jamalpur	160
Soybean Performance of BARI Soybean-5 and 6 at farmers field	01	Bhola	80
Sunflower Performance of BARI Surjamukhi-3 at farmers field	03	Faridpur, Sylhet & Patuakhali	240
Total	**23**	**20**	**1840**

Results and Discussion

BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17 are short duration (about 80-85 days) modern varieties. In T. Aman-Mustard-Boro cropping pattern, T. Aman variety BINA dhan-7 or BRRI Dhan - 39 is grown timely and the crops were harvested at the end of October. After harvesting T. Aman, BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17 could be grown easily before Boro cultivation. These varieties are well fitted in between T. Aman and Boro rice in place of old variety Tori-7. BARI Sarisha-11 and BARI Sarisha-16 could be grown in non- Boro areas, especially under late planting condition. Canola variety BARI Sarisha-18 could also be grown in non- Boro areas. This variety has already been popularized among the farmers specially in Faridpur, Barind of Rajshahi, Khulna, Pabna. Cultivation of these varieties could be extended, the total production of mustard will substantially increase in the country. Among groundnut varieties, BARI Chinabadam-8, BARI Chinabadam-9 and BARI Chinabadam-10 could be cultivated in char areas. Farmers showed very interest to cultivate recently developed sunflower dwarf variety BARI Surjamukhi-3 in all over the country.

Impact

i) Increase efficiency

a) Farmers enriched their knowledge about HYV and improved production technologies of oilseed crops through training and field demonstration, which will help to increase yield in per unit area.

b) DAE /BADC/NGO personnel gained knowledge of different oilseed crops through training which will help to disseminate improved technologies of oilseed crops to the farmers.

ii) Employment opportunity

a) To get higher yield, farmers adopted improved technologies of different oilcrops. For utilization the production technologies, farmers employed more number of labours.

b) A good number of labours have been involved in post harvest processing (threshing & drying, winnowing, marketing, extraction of oil etc.)

Recommendation

- BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-17 are recommended in between T.Aman - Boro rice cropping pattern in place of Tori-7.
- BARI Sarisha-11, BARI Sarisha-16 and BARI Sarisha-18 (Canola variety) are high yielding varieties and suitable for cultivation where Boro cultivation was not possible.
- BARI Chinabadam-8, BARI Chinabadam-9 are recommended for growing in char areas instead of existing local variety Dhaka-1.
- BARI Soybean-6 is high yielding and is recommended in major soybean growing areas Noakhali Laxmipur, Chandpur and Kumilla regions.
- BARI Surjamukhi-3 is high yielding dwarf variety and is recommended in all over the country specially in Faridpur, Patuakhali and Sylhet regions.
- This technology transfer program of oilseeds may be undertaken in other major oilseed growing areas in future to expand oilseeds area as well as to increase production.

Acknowledgement

'Enhance Production of Oilseed Crops (EPOC)' Project (BARI Part)

Project VI: SEED PRODUCTION AND DISTRIBUTION OF OILSEEDS

R. ISLAM, M A LATIF AKANDA, F BEGUM, M M ALI, M KADIR AND CONCERNED SCIENTISTS OF ORC, RARS, ARS AND OFRD, BARI

Production of Breeder's seed and Truthfully Labeled Seed (TLS) of different varieties of rapeseed, mustard, sesame, groundnut, sunflower soybean in every year is mandatory of ORC, BARI. This was done at headquarter, regional and sub stations of BARI, both in Rabi and Kharif. The quantities of seed of the individual varieties produced during 2021-22 are presented in Table-1. A total of 15393 kg of different oilseeds were produced during 2021-22 at Joydebpur and different regional and sub stations of BARI. Among these, Mustard 8060 kg, Groundnut 3000 kg, Soybean 1978 kg, Sesame 650 kg, Sunflower 1680 kg, Linseed 21 kg, Safflower 2 kg and Niger 2 kg were produced during this year. A total of 11722 kg oilseeds were distributed during 2021-22 (Produced in 2020-21 cropping season). Among these 6530 kg Mustard, 1916 kg Groundnut, 1269 kg Soybean, 1141 kg Sunflower, 833 kg Sesame and 33kg Linseed were distributed to BADC, DAE, NGO, research and farmers during this year (Table 2).

Acknowledgement
Enhance Production of Oilseed Crops (EPOC)' Project (BARI Part)

Table 1. Breeder's seed and TLS production of oilseeds during 2021-22

Seed production (kg)			
Crop/ variety	**Breeder's seed**	**TLS**	**Total**
Rapeseed and Mustard			
BARI Sarisha-9			
BARI Sarisha-11			
BARI Sarisha-13			
BARI Sarisha-14	1559	2540	4099.00
BARI Sarisha-15	114.00		114.00
BARI Sarisha-16	19.00	-	19.00
BARI Sarisha-17	402.00	500	902.00
BARI Sarisha-18	846.00	2080	2926.00
Sub total	**2940**	**5120**	**8060.00**

Groundnut	**Breeder's seed**	**TLS**	**Total**
BARI Chinabadam-8	1000	500	1500
BARI Chinabadam-9	1000.00	500	1500
BARI Chinabadam-10			
Jhingha badam			
Sub total	**2000.00**	**-**	**3000.00**

Soybean	**Breeder's seed**	**TLS**	**Total**
Shohag	-	-	-
BARI Soybean-5	1012.00	100	1112.00
BARI Soybean-6	616.00	250	616.00
Sub total	**1628.00**	**350**	**1978.00**

Sesame	**Breeder's seed**	**TLS**	**Total**
BARI Til-3	200	100	300
BARI Til-4	200	150	350
Sub total	**400**	**250**	**650**

Sunflower	**Breeder's seed**	**TLS**	**Total**
BARI Surjamukhi-2	75	72	117
BARI Surjamukhi-3	276	1170	1446
Sub total	468	**1212**	1680

Linseed	**Breeder's seed**	**TLS**	**Total**
Nila	10	5	15
BARI Tishi-2	5	1	6
Sub total	**15**	**6**	**21**

Safflower	**Breeder's seed**	**TLS**	**Total**
Saff -1	2		2
Sub total	**2**		**2**

Niger	**Breeder's seed**	**TLS**	**Total**
Shova	2		2
Sub total	**2**		**2**
Grand Total			**15393**

Table 2. Distribution of Breeder's seed and TLS of oilseeds during 2021-22

Seed distribution during 2021-22 (kg) (Production in 2020-21 and Kharif 2022)						
Crop/ variety	**BADC**	**DAE**	**NGO**	**Res.**	**Farmer**	**Total**
Rapeseed and Mustard						
BARI Sarisha-9						
BARI Sarisha-11			52.00			52.00
BARI Sarisha-13						
BARI Sarisha-14	535.00	106	145.00	3285.00	168.00	4239.00
BARI Sarisha-15			1.00	69.00	9.00	79.00
BARI Sarisha-16			2.00	5.25		7.25
BARI Sarisha-17	167.00		36.00	474.70	20.00	697.70
BARI Sarisha-18	38.00	118	18.00	1258.40	24.00	1456.40
Sub total	**740**		**254**	**5315**	**221**	**6530**

Groundnut	**BADC**	**DAE**	**NGO**	**Res.**	**Farmer**	**Total**
BARI Chinabadam-8	200.00			105.00		305.00
BARI Chinabadam-9	875.00	100		349.00	**287.00**	1611.00
BARI Chinabadam-10						
Sub total	**1075**			**554**	**287**	**1916**

Soybean	**BADC**	**DAE**	**NGO**	**Res.**	**Farmer**	**Total**
Sohag						
BARI Soybean-5						
BARI Soybean-6	300		40.00	883.00	25.00	1248
BARI Soybean-7				21.00		21.00
Sub total	**300**		**40**	**904**	**25**	**1269**
Sunflower	**BADC**	**DAE**	**NGO**	**Res**	**Farmer**	**Total**
BARI Surjamukhi-2		85		35.00	18.00	138.00
BARI Surjamukhi-3	29.00	226	1.00	719	28.00	1003
Sub total	**29**		**1**	**1065**	**46**	**1141**

Sesame/Til	**BADC**	**DAE**	**NGO**	**Res.**	**Farmer**	**Total**
BARI Til-3	120.00		**100.00**	59.00		279.00
BARI Til-4	120.00		**100.00**	334.17		554.17
Sub total	**240**		**200**	**393**		**833**

Linseed	**BADC**	**DAE**	**NGO**	**Res**	**Farmer**	**Total**
Nila				16.00	7.00	23.00
BARI Tishi-2				10.00		10.00
Sub total				**26**	**7**	**33**

Safflower	**BADC**	**DAE**	**NGO**	**Res**	**Farmer**	**Total**
Saff-1						
Sub total						

Niger	**BADC**	**DAE**	**NGO**	**Res**	**Far**	**Total**
Shova						
Sub total						
Grand Total						**11722**

Appendix I (a): LIST OF SOYBEAN GERMPLASM

Sl No.	Name of Germplasm	Sl No.	Name of Germplasm	Sl No.	Name of Germplasm
1.	ASG-191	37.	NS-1	76.	86017-66-6
2.	ASSET-93-19-13	38.	i. PL-4174-75 ii. PL-4174-75	77.	20965477
3.	ASoMEM	39.	ST-1	78.	B2
4.	AGS-95	40.	SHOLV	79.	401
5.	AGS-205	41.	BARI Soybean-7	80.	Australia 2016
6.	ASSET-95	42.	SHOHAG	81.	USDA-44
7.	BS-13	43.	TAS-4	82.	Unknown
8.	i.BS-29 ii.BS-29	44.	USDA-3	83.	Thailand-1
		45.	USDA-4	84.	Thailand-2
9.	BS-32	46.	USDA-44	85.	BD 2332
10.	BS-33	47.	USDA-11	86.	BD 2333
11.	BG-60	48.	USDA-15	87.	BD 2337
12.	BR-14	49.	Boss	88.	BD 2340
13.	BR-33	50.	USDA-22	89.	BD 2341
14.	BARI Soybean-5	51.	USDA 29	90.	BD 2342
15.	BARI Soybean-6	52.	USDA 30	91.	BD 2348
16.	CS-2	53.	USDA 37	92.	BD 2351
17.	COLOMBUS	54.	USDA 40	93.	BD 2354
18.	DJS-9207	55.	USDA 41	94.	A6785
19.	FV-4PLNICE 7	56.	USDA 42	95.	Santarose (L)
20.	Galarsing	57.	USDA 46	96.	Shohag
21.	GC 83001-16	58.	USDA 47	97.	Brag
22.	GMOT-13	59.	USDA 50	98.	Davis
23.	i. GMOT-95 ii. GMOT-95	60.	USDA 51	99.	Goo-382
		61.	USDA 53	100.	G00-390
24.	GMOT-43	62.	USDA 66	101.	BINA soybean -1
25	GOVRAL	63.	USDA 69	102.	Hayman
26.	GC-335	64.	USDA 70	103.	Ricmond
27.	Joya Waya	65.	USDA 79	104.	ASG-79
28.	JS-9207	66.	USDA 80	105.	KUSH-2004
29.	KADSING	67.	USDA 90	106.	Hayman
30.	KANH	68.	USDA 92	107.	Richmond
31.	K-16	69.	USDA 93	108.	USDA-72
32.	i. LG-92P-1176 ii.LG-92P-1176	70.	USDA 95	109.	USDA-85
		71.	USDA 96		
33.	LG-92P-1825	72.	Australia(i)		
34.	MTD-453	73.	USDA 107		
35.	MTD-16	74.	USDA 110		
36.	NAMVAUC	75	i.VIETKHAI ii.VIETKHAI		

Appendix 1 (b): List of Publications

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Habib SH, MAL Akanda, P Roy, H Kausar. Effect of different dosage of EMS on germination, survivability and morpho-physiological characteristics of sunflower seedling. Helia 44 (75), 167-180. 2021

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Kumar, S., Ali, B., Khaldun, A. B. M., Islam, S. S., Uddin, M. S., Akanda, M. A. L., & Miah, M. S. Genetic Diversity, Correlations and Path Coefficient Analysis among the F5 Populations of Brassica Species. Asian *Journal of Advances in Agricultural Research* 2021, 16(2), 20. https://doi.org/10.9734/ajaar/2021/v16i230170

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Uddin, M.S.; Billah, M.; Afroz, R.; Rahman, S.; Jahan, N.; Hossain, M.G.; Bagum, S.A.; Uddin, M.S.; Khaldun, A.B.M.; Azam, M.G.; Hossain, N.; Akanda, M.A.L.; Alhomrani, M.; Gaber, A.; Hossain, A. Evaluation of 130 Eggplant (*Solanum melongena* L.) Genotypes for Future Breeding Program Based on Qualitative and Quantitative Traits, and Various Genetic Parameters. *Horticulturae* 2021, *7*, 376. doi: 10.3390/horticulturae7100376**.**

Appendix 1(c). METEOROLOGICAL INFORMATION

Month & week	Year	Temperature (0C)		Relative humidity (%)		Total Rainfall (mm)	Sunshine (hrs)
		Max.	Min.	Mor.	Ev.		
July	**2021**						
1st week		29.64	25.94	95.42	85.85	249.00	0.37
2nd week		31.64	27.60	92.71	74.28	8.00	6.44
3rd week		29.31	26.17	89.85	76.14	39.00	4.04
4th week		28.87	23.72	91.50	82.50	39.00	3.05
August	**2021**						
1st week		29.60	26.77	96.00	80.85	102.00	4.55
2nd week		29.08	27.22	94.71	86.28	158.00	2.47
3rd week		28.52	26.98	22.42	81.00	53.00	2.05
4th week		29.49	26.39	95.50	81.50	198.00	3.32
September	**2021**						
1st week		29.32	27.01	90.57	80.00	33.00	4.30
2nd week		30.00	26.81	91.28	77.71	20.00	5.60
3rd week		28.91	26.61	94.28	82.71	15.00	3.90
4th week		28.90	26.21	93.33	81.88	19.00	7.24
October	**2021**						
1st week		29.21	26.30	94.28	81.00	36.00	8.25
2nd week		30.00	26.61	94.00	77.42	0.00	7.00
3rd week		28.81	25.74	94.28	83.14	57.00	5.83
4th week		27.41	23.14	93.40	76.10	0.00	7.84
November	**2021**						
1st week		25.28	19.91	22.57	68.14	0.00	8.61
2nd week		24.81	19.07	94.57	74.42	13.00	4.86
3rd week		23.41	18.27	94.42	82.14	1.00	6.95
4th week		23.13	16.94	94.20	71.89	0.00	7.25
December	**2021**						
1st week		22.37	18.34	94.28	81.00	78.00	3.36
2nd week		21.95	17.44	92.00	77.28	0.00	7.01
3rd week		21.74	15.60	85.28	71.00	0.00	7.07
4th week		20.92	14.46	95.70	81.20	0.00	5.67
January	**2022**						
1st week		18.47	13.94	95.14	81.42	0.00	6.04
2nd week		22.01	16.07	93.42	68.57	0.00	4.88
3rd week		20.01	12.11	91.28	68.28	0.00	5.44
4th week		18.89	13.86	93.70	71.10	3.00	2.97
February	**2022**						
1st week		19.82	13.61	94.71	72.14	36.00	6.15
2nd week		19.85	13.81	91.42	68.14	0.00	6.75
3rd week		21.48	13.95	89.57	53.57	0.00	7.76
4th week		25.71	16.91	88.85	60.85	0.00	7.82
March	**2022**						
1st week		26.01	16.37	88.14	43.85	0.00	9.65
2nd week		28.31	18.64	87.28	43.28	0.00	6.04
3rd week		31.11	20.48	86.42	41.28	0.00	8.62

Month & week	Year	Temperature (0C)		Relative humidity (%)		Total Rainfall (mm)	Sunshine (hrs)
		Max.	Min.	Mor.	Ev.		
4th week		29.60	23.57	89.80	65.50	11.00	6.44
April	**2022**						
1st week		30.98	26.28	88.28	61.71	0.00	6.67
2nd week		31.18	26.31	81.57	66.28	0.00	5.42
3rd week		29.72	28.30	92.42	80.71	65.00	4.80
4th week		29.84	26.96	91.55	94.22	15.00	7.57
May	**2022**						
1st week		28.57	25.47	88.14	74.14	32.00	6.60
2nd week		28.28	26.14	92.00	81.85	113.00	2.26
3rd week		29.78	26.21	89.14	77.57	63.00	5.60
4th week		29.87	25.65	90.80	75.20	90.00	4.43
June	**2022**						
1st week		28.85	27.40	93.00	85.14	119.00	2.62
2nd week		31.00	26.65	92.14	78.00	30.00	3.55
3rd week		28.04	26.47	22.85	83.85	156.60	0.92
4th week		29.53	27.24	90.44	78.33	1.11	5.21

Appendix II. SCIENTIFIC PERSONNELS

SL.No.	Location/ scientific personnel	Designation
	Joydebpur	
1	Dr. Md. Abdul Latif Akanda	Director
2	Dr. Ferdousi Begum	CSO
3	Dr. M. Shalim Uddin	PSO
4	Dr. Mohammed Harun or Rashid	SSO
5	Dr. Sheikh Hasna Habib	SSO
6	Dr. Rabiul Islam	SSO
7	Md. Masud Karim	SSO
8	Hosna Kohinoor (On Deputation)	SSO
9	Nazneen Ara Sultana (On Deputation)	SSO
10	Dr. Mohammad Quamrul Islam Matin	SSO
11	Pryanka Roy	SO
12	Krisna Chandra Saha	SO
13	Mahbub Ul Islam (On Deputation)	SO
14	Towhidi Almas Mujahidi	SO
15	Dr. Debi Rani Datta	SO
16	Asfakun Siddika (On Deputation)	SO
17	Md. Ariful Islam	SO
18	Ummy Kulsum Mukta	SO
	Jashore	
19	Dr. Mohammad Anwarul Monim	SSO
	Ishurdi	
20	Md. Razib Humauan	SSO
	Jamalpur	
21	Dr. Md. Monjurul Kadir	CSO
22	Dr. Muhammad Khorshed Alam	SSO
23	Mukaddasul Islam Riad	SSO
	Rahmatpur, Barishal	
24	Dr. Md. Alimur Rahman	SSO
25	Dr. MD Mahmudul Hasan Khan	
	Burirhat, Rangpur	
26	Md. Bikash Sarker	SSO
27	Dr. Suprio Ghosh	
	Hathazari, Chattogram	
28	Dr. Md. Muktadir Alam	PSO
	Cumilla	
29	Dr. Mia Md. Bashir	SSO

Appendix III: NAME OF FIELD STAFFS

SL. No.	Name of field staffs	Designation
1.	Md. Shoriful Islam	SSA
2.	Md. Mahbubur Rahman	SA
3.	Md. Bozlur Rahman	SA
4.	Md. Abdul Baten Mollah	SA
5.	Md. Rakibuzzaman	SA
6.	Md. Shoriful Islam	SA
7.	Sajeda Akter	SA
8.	Md. Khayrul Islam	SA
9.	Niger Sultana	SA
10.	Md. Moniruzzaman	SSA
11.	Md. Mamunor Rashid	SA
12.	Md. Abdul Karim	Preparer
13.	Shahnaj Begum	F. A.
14.	Md. Asadur Rahman	F. A.

Appendix IV: বার্ষিক কর্মসম্পাদন সূচক অনুযায়ী ২০২১-২২ এর লক্ষ্যমাত্রা ও অর্জন

ক্রমিক নং	কর্মসম্পাদন সূচক	একক	২০২০-২১	
			লক্ষ্যমাত্রা	অর্জন
১	নিবন্ধিত জাত	সংখ্যা	৩	৩
২	উদ্ভাবিত প্রযুক্তি (জাত সম্পর্কিত)	সংখ্যা	১	১
৩	জাতের লাইন উন্নয়নকৃত	সংখ্যা	৬	৬
৪	প্রশিক্ষিত কৃষক	সংখ্যা	৩৩০	৩৩০
৫	স্থাপিত প্রদর্শনী	সংখ্যা	৩০	৩০
৬	আয়োজিত সেমিনার/ওয়ার্কশপ	সংখ্যা	১	১
৭	মাঠ দিবস/ রেলী	সংখ্যা	১৯	১৯
৮	হস্তান্তরিত জাত	সংখ্যা	১	১
৯	হস্তান্তরিত প্রযুক্তি	সংখ্যা	১	১
১০	বার্ষিক গবেষণা রিপোর্ট	সংখ্যা	১	১
১১	লিফলেট, বুকলেট, নিউজ রেটার, জার্নাল, বুলেটিন, ইত্যাদি প্রকাশনা	সংখ্যা	৩	৩
১২	উদ্ভাবিত প্রযুক্তি (নিরাপদ খাদ্য)	সংখ্যা	১	১
১৩	সচেতনতা বৃদ্ধি (লিফলেট, বুকলেট/ফ্যাক্টশীট ইত্যাদি)	সংখ্যা	১	১
১৪	উৎপাদিত ব্রিডার বীজ	টন	৩	৩
১৫	উৎপাদিত মানঘোষিত বীজ	টন	৩	৩
১৬	বিতরণকৃত ব্রিডার বীজ	টন	২.৫০	৪.১৯
১৭	বিতরণকৃত মানঘোষিত বীজ	টন	২.৫০	৩.০০
১৮	কর্মকর্তাদের পরিদর্শনকৃত উন্নয়ন প্রকল্প, কর্মসূচির কার্যক্রম	সংখ্যা	৪	৪
১৯	মহাপরিচালক/ পরিচালক কর্তৃক পরিদর্শনকৃত জাত / প্রযুক্তি/ বীজ উৎপাদন / অবকাঠামো ইত্যাদি কার্যক্রম	সংখ্যা	৪	৪
২০	প্রশিক্ষিত জনবল (বিজ্ঞানী/কর্মকর্তা/কর্মচারী)	সংখ্যা	১১৫	১২৫