

Research Highlights

2021-2022

Research Progress

Plant breeding division of Bangladesh Agricultural Research Institute (BARI) works on varietal improvement of barley, millets, sorghum, oat, chia, quinoa and buckwheat. Crop improvement includes for collection and characterization of germplasm, hybridization and conformation of barley, evaluation of barley, millets, sorghum, oat, quinoa and buckwheat, population development with variation, breeder seed production and technology transfer to farmers. The endmost objective is to develop and improve varieties and fitting technologies for the development of these field crops to the benefit of the farmers in all around Bangladesh particularly in saline, char, barind and marginal areas. Therefore, development of stress tolerant (drought, salt and waterlogging) varieties have been strengthened. Emphasis is also given for location specific variety development. The urgency is given to popularize and disseminate released varieties and developed technologies among farmers and private agencies through demonstration, training, workshop, field days, publications, electronic media etc.

A. COLLECTION AND CHARACTERIZATION

➤ Six Chia lines were previously screened received from different sources were evaluated at BARI, Gazipur, during rabi 2021-22 to select better performing early, dwarf and high yielding lines. Significant variation was observed for the trait days to heading, days to maturity and plant height among the tested lines. Considering short stature, days to heading and days to maturity, Chia-3 being a suitable candidate to release as early and dwarf variety.

B. BARLEY VARIETY DEVELOPMENT

Hybridization of Barley

➤ Nine selected parental genotypes of barley including advance lines, BHL-25 (P₁), BHL-27 (P₂), INBON/L-21/15 (P₃), INBON/L-40/15 (P₄), INBON/L-53/17 (P₅) and IBYT-17/E4 (P₆), Atalpha/12(P₇), Esmarlda (M104/12) (P₈) and BARI Barley-9 (BB-9, P₉) were crossed in half diallel fashion in this experiment. Among 36 cross combinations, 34 successfully produced seeds which have been preserved and will be grown for confirmation trial in the next year.

Growing of F₁ generation of barley (2 Sets)

➤ In set-I, ten Parents IBON-HI-19 E3 (P₁), IBON-HI-19 E24 (P₂), IBON-HI-19 E43 (P₃), IBON-HI-19 E75 (P₄), IBON-HI-19 E100 (P₅), IBON-HI-19 E47 (P₆), IBON-HI-19 E20 (P₇), IBON-HI-19 E34 (P₈), BB-7 (P₉) and BB-9 (P₁₀) and their 34 F₁s progenies were grown in single row in family block during rabi 2021-2022. From the produced F₁s based on yield and earliness, eight (08) crosses i.e. P₅×P₆, P₇×P₁₀, P₂×P₄, P₅×P₇, P₃×P₁₀, P₈×P₉, P₄×P₆ and P₄×P₉ were selected for next generation evaluation.

➤ In set-II, 10 parents BHL-25 (P₁), BHL-27 (P₂), INBYT-19-E4 (P₃), INBYT-19-E5 (P₄), INBYT-18-E9 (P₅), INBYT-20-E85 (P₆), BB-7 (P₇) and BB-9 (P₈) their 28 F₁'s progenies grown in single row in family block during rabi 2021-2022. From the produced F₁s, based on yield, 11 crosses, P₃×P₇, P₁×P₅, P₃×P₈, P₇×P₈, P₅×P₈, P₂×P₃, P₁×P₄, P₁×P₈, P₄×P₈, P₁×P₂ and P₆×P₈, were selected for next generation evaluation.

Growing of (F₂ – F₆) generation of barley

➤ In F₂, based on earliness, tillering and yield, 30 individual plants were selected. In F₃ generation, 135 plants, in F₄ generation 55 families, in F₅ generation 5 families and in F₆ generation, 3 lines were selected for future breeding program.

Advancing OF F₁, F₂ and F₃ generations for developing saline tolerant barley line

➤ Twenty eight F₁s from an 8×8 diallel cross of barley were screened hydroponically against 8-10 dS/m equivalent salinity in Hoagland media for one month to select F₂ seeds for further advancing.

Eight saline tolerant F₂, 35 F₃ and 35 F₄ selected from green house condition will be advanced in normal soil to increase seeds for next year evaluation in native saline soil. On the other hand, 14 F₃ and 58 F₄ including 43 from native saline soil will be advanced in native saline soil.

Evaluation of barley

- Twenty seven barley lines including three check varieties BARI Barley-7, BARI Barley-8 and BARI Barley-9 were evaluated to investigate the performance of the selected lines and identify short duration and high yielding barley lines. Considering yield potentiality yield and yield contributing characters, genotypes E69, E84, E96, E22, E28 and E4 were found promising and selected for future breeding programme.
- Ten hulls-less barley lines including three check varieties BARI Barley-7, BARI Barley-8 and BARI Barley-9 were evaluated in Gazipur, Rangpur and Jashore. The genotypes E7, E17, E21, E111 and E119 found high yielder and stable across locations.
- Nine barley advanced lines including two check varieties, BARI Barley 7 and BARI Barley 9 were evaluated across 4 locations namely Gazipur, Panchagarh, Jashore and Satkhira. Based on the AMMI stability parameter, earliness and yield potentiality IBON-HI-19 E24 was the most stable high yielding lines across the environments.
- Twenty-five barley entries received from ICARDA along with two standard checks BARI Barley-7 and BARI Barley-9 were evaluated at BARI, Gazipur. Considering short stature, yield and yield contributing characters four lines were selected from the 25 barley entries for next year trial.
- Twenty-five barley entries received from ICARDA were evaluated with one standard check variety BARI Barley-8 at BARI, Gazipur. Considering short stature, yield and yield contributing characters lines were selected from the 25 barley entries for next year trial.
- One hundred and twelve barley entries received from ICARDA along with three standard checks BARI Barley-7, BARI Barley-8 and BARI Barley-9 were evaluated at BARI, Gazipur. Considering short stature, yield and yield contributing characters six lines were selected from the 112 barley entries for future breeding program.
- Ten genotypes of barley were screened for spot blotch disease caused by *Bipolaris* under natural condition to find out resistance genotype. Among the 10 tested genotypes only one genotype i.e. Atalpha showed resistant reaction against barley spot blotch. One genotype (E3) showed moderately resistant reaction, two genotypes (Esmardala and INBON) showed moderately susceptible and rest of genotypes showed highly susceptible to spot blotch disease during crop season

C. MILLETS VARIETY DEVELOPMENT

- Two foxtail millet varieties namely BARI Kaon-1 and BARI Kaon-2 were chemically treated by EthylMethane sulphonate (EMS) to create variability in two varieties. EMS treatments alone have been proved to be more efficient for most of the character in M₁ generation. There are some mutagenic effects showed in some of the treatment i.e. short plant height, early to late flowering, and highest number of seed per plant. M₂ seeds of different treatments were harvested and kept separately for future breeding program.
- Six genotypes along with two check varieties of foxtail millets viz. BARI kaon-2 and BARI kaon-4 were evaluated at four locations namely Gazipur, Jamalpur, Burirhut and Jashore. Among the tested Foxtail millet lines E1 showed high yield and E4 and E5 were more stable and selected for further evaluation and commercialization.

- Twenty two proso millet lines along with one check variety (BARI Cheena-1) were evaluated at BARI, Gazipur. Among the studied lines, the lines BD-1405, BD-1408, BD-1413 can be selected for earliness, BD-1408 for short stature, BD-764, BD-1379 and BARI Cheena-1 for higher tiller production, for high yield BARI Cheena-1 and BD-777 (4.5 g). Highest 1000 grain weight was found in the genotype BD-1442, BARI Cheena-1 and BD-777. These lines can be selected and advance to next breeding cycle in a PYT.
- Eight proso millet lines (BD-1399, BD-1447, BD-777, BD-1411, BD-791, BD-1448, BD-1402 and BD-1446) including check BC-1 (BARI Cheena-1) were evaluated at Gazipur, Jamalpur, Burirhat and Jashore. The lines BD-1399, BD-1447 and BD-777 (1.8 t/ha) found more promising for yield. Moreover, three lines consist better yield contributing characters. Considering yield and yield contributing characters three lines i.e., BD-1399, BD-1447 and BD-777 were may be selected for the next year trial.
- Five finger millets genotypes were evaluated at Gazipur. Considering overall performance of the genotypes with days to heading, maturity and plant height, all tested germplasm (IE 3392, IE 3077, IE 2043, IE 501 and IE 2619) may be selected for advance yield trial in the next year.
- The experiment was conducted with balanced bulk pearl millet seeds of first cycle selection of random mated plants at BARI, Gazipur. For the purpose of next generation of selection, 50 panicles were selected separately and preserved carefully. The balanced bulked seeds of these populations would be grown in the next coming season.

D. SORGHUM, OAT, BUCKWHEAT AND QUINOA VARIETY DEVELOPMENT

- Balanced bulk 2th cycle sorghum seeds of two groups, each contained 50 selected panicles based on (i) medium height and high yield goal and (ii) dwarf and earliness were planted and random mated in isolation at BARI, Joydebpur. For next cycle of selection, finally 125 panicles were selected separately from the two groups and preserved carefully. The balanced bulked seeds of these two populations would be grown separately in isolation for final selection of the two desirable source populations in the coming rabi season.
- Forty one sorghum genotypes were evaluated at Plant Breeding Field lab, Joydebpur, Gazipur using pod culture method in water house. Genotypes were exposed in excess water stress after germination in different waterlogging stages, including five leaf stage (stage 2), Flag leaf visible (stage 4), and boot stage (stage 5) stages. Sorghum was most sensitive to waterlogging stress imposed at the stage 5 stage, followed by the stage 2 and stage 4. By considering all the above-mentioned results, it can be concluded that waterlogging remarkably reduced the growth and yield of all the sorghum genotypes when compared with their respective control plants. Among the 41 genotypes, G12, G15, G20, G27, G30, G35 and G39 performed better than other genotypes under waterlogging. The genotypes, G1, G3, G5, G7, G9, G11, G14, G18, G21, G26, G29, G31, G33, G36 and G38 were more susceptible under waterlogged conditions.
- Two oat genotypes *i.e.*, BOL-1 and BOL-2 were treated to physical (Gamma rays), chemical (Ethyl methane sulphonate; EMS) and combined treatments (Gamma rays + EMS). 447 morphological mutants characterized in 10 categories were identified with a frequency of 12.9% in M₂ generation. The selected morphological mutants suggest the further evaluation and confirmation of these variants in the next generations. Broad leaf, spreading type, tall, flowering, narrow leaf, dwarf and semi-dwarf mutants and late maturity mutants could be indirectly useful in recombination breeding programme for developing high yielding lines particularly dual purpose.
- Two buckwheat genotypes (Bogura-1 and BD-4272) were treated chemically with EMS to induce variability. The doses of 0.1% and 0.3% EMS treatments have been proved to be more efficient for most of the characters in M₀ generation in both genotypes. Conversely, 0.5% EMS treated plants showed short plant height, low yield and yield contributing characters. M₁ seeds of different treatments were harvested and kept separately for future breeding program.

- Four genotypes (E2, E3, E4 and E5) along with one local check (E6: Bog-1) of buckwheat were assessed for genotype environment interaction (GEI) and stability to select the best buckwheat lines in three different locations namely Gazipur, Jamalpur and Debiganj. Considering earliness, yield potentiality and stability parameter, genotype E2 (0.8 t/ha) and E3 (1.0 t/ha) exhibited higher yield whereas E3 is stable in favorable environment.

E. BIOTECHNOLOGY AND STRESS RESPONSE

- Twelve barley genotypes were used for polymorphism study through seven SSR markers at the Molecular Breeding Lab of Plant Breeding Division, Bangladesh Agricultural Research Institute (BARI) to assessment of genetic variation in barley genotypes. The molecular characterization study found that the 12 barley genotypes are in harmony with clustering approaches using the SSR genotypic data and principal components analysis, which identified three cluster group. These results demonstrated genetic diversity among the genotypes.
- Five treatment, control (C), drought (D), D+Tre (1 mM), D+J (100 μ M) and D+ Tre (0.5mM)+J(50 μ M), were applied either as seed treatment or foliar application at 15 days, 22 day and 29 days after emergence (DAE) to examine drought induced oxidative stress and its manipulation by Trelahose (Tre) and Methyl jasmonate (J). Drought stress increased $O_2^{\cdot -}$ and H_2O_2 contents and LOX activity strongly over control in both genotypes. Although SOD activity changed and varied with genotypes and application methods, CAT played important role in H_2O_2 metabolism by induced activity in drought in presence or absence of Tre and J while APX had vital role in drought. Both MDHAR and DHAR were induced by Tre and J. They also restored GR activity. However, higher GST activity in foliar spray might be associated in leaf senescence or injury for foliar spray. Although drought induced MG concentration, it decreased by Tre and J. However, there was no harmony in the activity of glyoxalases. Importantly, Gly-I activity increased in drought with Tre and J, but the regulation pattern of Gly-II activity had no harmony, and thus, it needs more research to fix the problem
- Protein, moisture, fat, fiber, ash, starch and amylose were measured in BARI released important varieties and advanced lines. Barley varieties contain almost similar amount of protein, fiber and ash (10.54 to 10.82% protein, 12.14 to 13.38% fiber and 2.05-2.10% ash). However, BARI barley-8 has higher amylose content. Fiber content in foxtail millet ranged 9.24 to 10.85% and ash 2.44-2.46%. Fat content is higher in BD-777. Sorghum contained the highest amylose than other cereals. BARI oat contains $13.01 \pm 0.20\%$ protein and $9.24 \pm 0.03\%$ fiber. Buckwheat has higher fiber. In contrast, quinoa line contains higher protein $14.10 \pm 0.13\%$ and but fiber content $5.54 \pm 0.03\%$.
- Thirty five barley accessions from ICARDA and nine BARI released barley varieties were evaluated to determine variability of starch traits, such as, amylose and amylopectin. . Our results indicated that the barley genotypes had considerable variation for amylose and amylopectin which not only provided some useful information about the difference in the amount of amylose and amylopectin content among these barley genotypes, but also offered some prospects of using selected germplasm for barley quality improvement in respect of preferred amylose and amylopectin content.
- The leaves of available nine kinds minor of cereal (Barley, Foxtail millet, Proso millet, Finger millet, Pearl millet, Buckwheat. Oat, Quinoa, and BARI Sorghum-1) were collected from BARI experimental field to their total arsenic accumulation. The biochemical analysis of these nine kinds of minor cereal was found free of arsenic.

F. BREEDER SEED PRODUCTION

- A Total of 1,252 kg breeder seed of nine barley varieties viz. BARI Barley-1, BARI Barley-2, BARI Barley-3, BARI Barley-4, BARI Barley-5, BARI Barley-6, BARI Barley-7, BARI Barley-8, and BARI Barley-9 were produced at four (Gazipur, Burirhat, Debigonj and Ishwardi) different locations and stored for further use.

- A total 1,257 kg seeds from BARI Kaon-1, BARI Kaon-2, BARI Kaon-3, BARI Kaon-4, BARI Cheena-1 and BARI Sorghum-1 were produced at four (Gazipur, Burirhat, Debigonj and Ishwardi) different locations which were collected and stored for further use.

G. MAINTENANCE BREEDING

- Total 7.76 kg seeds were obtained from 25 advanced lines and stored to use in the breeding program
- Total 3.67 kg seeds were obtained from 12 exotic and locally developed foxtail millet lines
- Total 19.21 kg seeds were produced from 100 Proso millet germplasm and stored to use in the breeding program
- Total 2.5 kg seeds were produced from 12 pearl millet germplasm and stored to use in the breeding program
- Total of 95 kg seed were produced from BARI released oat variety (BARI Oat-1) and preserved for future breeding program
- Total of 1.95 kg breeder seed were produced from three buckwheat lines namely BD4272, BD 4273, BD 4275 and stored to use in the breeding program
- A total of 1.36 kg, 0.66kg, 0.605 kg and 0.78 kg seeds were produced from BARI Quinoa Line-1, BARI Quinoa Line-2, BARI Quinoa Line-3 and SAU Quinoa 1, respectively, and preserved for future breeding program.

H. TECHNOLOGY TRANSFER

Two varieties, BARI Oat-1 and BARI Raghi-1 have been released as in July 2022

Salient features of BARI Oat-1

- Yield: 1.0-1.2 t/ha
- 10-14 erect panicle per plant
- Grains are long and brown in color
- Plant height: 110-115 cm
- Maturity: 125-130 days

Salient feature BARI raghi -1:

- High Ca enriched 320 mg/100g (>2x of milk)
- Yield: 3.0-3.2 ton/ha
- Maturity: 126-139 days
- Suitable for char and poor fertile area

- Training: Five (05) training program on minor cereals were conducted for SA/SSA, farmers (145 participants).
- Field days: Four (04) field days of minor cereals were conducted.
- Demonstration/adaptive trial: Forty two (42) demonstration and adaptive trial were conducted in collaboration of OFRD.
- One (01) seminar workshop was executed.
- One (01) annual report and 01 leaflet on BARI Oat-1 were published.