Annual Research Report 2020-2021

VERTEBRATE PEST RESEARCH

Program Leader
Dr. Md. Shah Alam
Principal Scientific Officer

Vertebrate Pest Division
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701

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Vertebrate Pest Division
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PREFACE

Vertebrate Pest Division is one of the unique divisions not only in Bangladesh Agricultural Research Institute but also in the country which deals research about vertebrate pest management. Animals having backbones that cause considerable amount of damage to crops and other commodities are called vertebrate pests. Vertebrate pests are the major problems both in the field and in storage. Every year, a huge amount of cereal crops especially rice and wheat, fruits and vegetables, storage products and other household things are damaged by different kinds of vertebrate pests. Vertebrate Pest Division was established in 1998 under BARI. The major research mandates of the division are; i) to identify different vertebrate pest species in Bangladesh and to determine their pest status, ii) to quantify the losses caused by them and iii) to develop appropriate methods or techniques to reduce losses. To meet the Sustainable Development Goal (SDG) by 2030, scientists of this division are trying to accelerate their research activities to develop sustainable and ecofriendly technologies to solve the vertebrate pest problems as well as to reduce the crop losses from 10 percent to 5 percent due to vertebrate pests' attack.

Vertebrate pests are generally categorized into three groups - rodents, birds, and jackals including other pest mammals. About 18 species of rats are found in Bangladesh. The lesser bandicoot (*Bandicota bengalensis*) and the greater bandicoot rat (*B. indica*), are found to be the major pests of rice and wheat. The roof rat (*Rattus rattus*) damages different fruits and vegetables specially coconut, guava etc. The house mice (*Mus musculus*) are found in the houses and cause damage to household things. It is reported that rat causes about 4-5% losses to rice (about 150000 ton), 8% in wheat (about 77000 ton), 4-6% in potato, 6-9% in pineapple, and about Tk.75,000 losses in post-harvest condition. Rats are also major problem in the poultry sector cause about Tk. 18000.00 losses per farm family per year. A total of crop damaged by the rats was estimated about Tk. 724 crore per year. Another pest is jackal that mostly damages sugarcane, water melon, maize etc. Squirrel is another rodent pest which is voracious eaters and diggers also. Generally, Eight species of squirrels are found in Bangladesh of them brown squirrel (*Callosciurus phygerythrus*), five striped squirrel (*Funumbulus pennanti*), three striped squirrel (*F. palmarum*), and Malayan giant squirrel (*Rolufa bicolor*) are dominant. Squirrel mainly damage the fruits and vegetable crops but it also damages the cereals and household materials. The major bird species are the Indian myna (*Acridotheres tristis*), Pied myna (*Sturmus contra*), House crow (*Corvus splendens*), Jungle crow (*C. macrorhynchos*), Blue rock pigeon (*Columba livia*) etc. Bat is also an important vertebrate pest. About 3 species of bats are found in Bangladesh which cause extensive damage to banana, guava plantation, mango, litchi, and other fruits.

Scientists of Vertebrate Pest Division have developed different types of traps for controlling rat both in the fields and storage. They have also formulated a 2% zinc phosphide bait materials that has been recommended by the Government. This formulation of zinc phosphide is being successfully and widely used by the farmers. For repelling birds, different fungicides and insecticides can be used in the crop fields. Reflective ribbon is another technology to repel birds from the crop field. For protecting fruits from rats and squirrels, application of metal sheets around the tree trunk is very effective technology. We can also repel squirrel by spraying onion, green chilli and chilli dust upto 4-5 days. Sequential application of trapping followed by poison baiting more than 80 percent success can be achieved.

I am grateful to Almighty Allah and very much pleased to publish the Annual Research Report 2020-21 of Vertebrate Pest Division in time. This report covers the research activities that we conducted last in 2020- 21. Last year we conducted seven experiments and all the research activities have been printed in this report.

Finally, I would like to acknowledge all the scientists, scientific assistants, laboratory assistants and office staffs for their great contribution for conducting the experiments and preparing this annual research report successfully and timely.

Dr. Md. Shah Alam
Principal Scientific Officer

Research Highlights (2020-2021)

- Three plant oil i.e. eucalyptus, neem and karanja as rodent repellant. Food was offered to rats at different distance from the oil odor source and their consumption was recorded. All plant oils showed the similar repellence against rat feeding where those can repel rat up to 3 days from their food. Rat consumed significantly lower amount of food from within 1m distance (0-2.63 g/rat/day) of oil source compared to 6 m distance (5.76-12.09 g/rat/day). At up to 1m distance of eucalyptus oil source, rat consumed 1.26-2.25 g food per day where as it was 1.32-1.58 g for neem oil and 1.47-2.63g for karanja oil.

- Comparative efficacy of newly designed kill trap and commonly used live and kill trap were evaluated. The efficacy of newly designed snap trap and commonly used live and snap trap were statistically similar in both enclosure and field-test. In enclosure test, the average success of newly designed snap trap and commonly used live trap was 40.00% whereas commonly used kill trap showed only 24.00% success. In field, the average success of newly designed snap trap and live trap was 44.09% and 43.90% respectively whereas commonly used kill trap showed 37.71% success.

- Four different wrapping materials were evaluated for poison baiting inside the wet burrow and rodent control success was recorded. Highest success was observed with paper (61.33%) wrapped poison baiting which was statistically similar with wax paper wrapping (48%). Lowest success was found in case of banana leaf (31.33%) that was similar with parafilm (35.67%) and wax paper.

- Comparative efficacy of three types of traps such as live trap, kill trap, and Gopher trap were evaluated at potatoes and tomatoes fields. The study revealed that success rate of live traps was higher than the kill traps and Gopher traps. Average success rate of live trap was 51.49% whereas success rate of kill/snap trap was 39.75% and 41.63% in case of gopher trap.

- A survey was conducted among the farmers on squirrel problem in Rajbari and Cox's Bazar districts of Bangladesh. Both of the Rajbari and Cox's Bazar district farmers reported two types of squirrels which were brown and striped whereas striped squirrel was pre dominant in Rajbari and Brown squirrel was pre dominant in Cox's Bazar. Most affected vegetable crops were bottle gourd (60%) followed by pumpkin (46.67%), cole crop (40%) and carrot (21.67%). Among the fruit crops maximum damage was found in Guava (46.7%) followed by coconut (35%), litchi (33.3%), Jamun, jackfruit and mango (33.3%) and ber (26.6%). Farmers reported that average Tk. 500-1000 per family per year was lost in case of vegetables damaged by squirrel while it was more than Tk. 1000 in case of fruits. Maximum damage was occurred at full grown stage (51.67%) followed by ripening stage (43.33%) of the crop in all the season. Farmers were unknown about the breeding frequency, breeding season and number of young per parturition. Most popular control method used by the farmers was cage Trapping (50%) followed by snap trapping (21.6%) poison (11.6%).

- Efficacy of different combination of netting against pest birds on sunflower were studied. It was revealed that significantly maximum damage of sunflower caused by the pest birds were in the control plots compared to netting treated plots. In control plots maximum 36.06% head damage and 49.58% plant were affected by the birds whereas the lowest damage was happened in treatment where whole plot covered by net (0%) treated plots and two side netting treated plot (2.5%). Seventeen birds species were recorded in sunflower belonging to 15 families and 7 orders during the study periods from dawn to dusk. Passeroformes was the most dominant order (53%) represented 8 families and 9 species followed by order Collumbiformes (2 families 2 species) and order Coraciiformes (2 families 2 species). However, the species richness and Diversity of bird species were obtained higher in morning (17) and afternoon (9) than noon (7).

- Five management techniques namely Hanging red ribbon, Making scarecrow, Plastic bottle windmill, Bird repellent mechanical device and Control were evaluated. Among the different repellent tools, the maximum seed yield of sunflower was obtained from (1.91 t ha^{-1}) Plastic bottle windmill as repellent tool which was followed by (1.90 t ha^{-1}) Bird repellent mechanical

device, (1.82 t ha^{-1}) Hanging red ribbon and (1.80 t ha^{-1}) Making scarecrow while the minimum was in (1.50 t ha^{-1}) control. Similarly, different repellent tools showed increase in yield of sunflower over control using different repellent tools. Maximum BCR was obtained from (1.50) Plastic bottle windmill used plot followed by (1.46) Hanging red ribbon, (1.40) Bird repellent mechanical device, (1.40) Making scarecrow while the minimum (1.23) was in control.

- A survey work has been done on three district of Bangladesh to understand the local people perception, knowledge about owls and their conservation. Most of farmers (77.22 %) replied that they had seen only one species whereas 23.33% farmers reported on two species, 3.33% farmers reported on three species. Half of the farmers (50%) mentioned available owl species as Vutum pecha whereas 43.33% farmers mentioned it as Hutum pecha and only 32.22% farmers mentioned it as Laxmi pecha i.e. Burn owl. Most of the farmers (71.11%) respond that they liked owl as bird but 28.89% farmers did not like owl. Majority of the farmers (87.77%) thought that owl had no harmful effect on human and the environment. Most of the farmers (81.11%) thought that owl had no scary effect on human being as well as the environment. Only 18.89% farmer mentioned that it is a dangerous thing. About 85% farmers replied that owl has a beneficial effect on the nature. Only 14.44% farmers thought it has not affected on nature. Majority of the farmers (85.55%) treated owl as a rat feeder whereas 11.11% farmers considered it as environmental protector.
- The study was conducted in three districts of Bangladesh to know the available owls species, their distribution and locality. During the study of the project period 14 species of owl have been recorded and documented. Among them Barn owl, Spotted owlet, Brown Hawk owl, Brown fish owl, Collard scops owl etc were the most abundant species in different zone. All other owl species also presented in different but their density was comparatively lower than others owl species.
- The diet of the Barn Owl and the Spotted Owlet were studied in the habitat of Gazipur and Rajshahi district, Bangladesh. Regurgitated pellets of these two owl species were analyzed to understand their dietary composition The average weight, length, breadth and thickness to be 5.82g, 47.95 mm, 30.43 mm and 20.29 mm, and 2.33g,26.14 mm, 15.66 mm and 11.94 mm in barn owl and spotted owlet respectively. The diet of barn owl mainly comprised small mammals such as rat, (47.85%), Shrew (27.27%) and insect coleoptera (4.88%), crab (1.73%). Spotted owlet pellets contained small mammals only mice (32.29%), followed by insect (38.72%) of them coleoptera (23.92%), Orthoptera (9.29), Hemiptera (3.28%), Odonata (2.23%), snail (2.14%) and crab (6.75%) and unidentified (15.74%). The remains of insect and crab in the pellets comprised of wing, legs, heads, shell etc.
- Rat damage around the watching tower and the effectiveness of nest box for owl occupation at Rajshahi and Gazipur district were assessed. Percent rat damage in different growth stage of wheat and barley differed significantly in active burrow count methods and cut uncut methods around the owl watching tower areas. Significantly the lowest number of active burrow (0.6) was recorded in 0-25-meter distance around the watching tower followed by 25-50m distance and the highest number of active burrows was observed in 50-75 m distance from watching tower both in Rajshahi and Gazipur. Rat damaged and number of active burrows were higher as increase the distance from the watch tower areas. In Rajshahi 55 % nest boxes were occupied by owl whereas 50 % nest boxes were occupied by ow. In Gazipur maximum nest box were occupied by spotted owlet (*Athena brama*) and in Rajshahi most of the nest box occupied by barn owl (*Tyto alba*).
- Field efficacy of three rodenticide viz.,'Zero phosphide, Commando and Zill phosphide all were evaluated. In field trial test all the rodenticide showed more than 80% rodent control success was recorded. The average poison bait consumption was 0.81, 1.17 and 1.83 g/rat/day in Zero phosphide, Commando and Zill phosphide treated bait respectively.

Table l. List of Vertebrate Pest species and crops damaged in Bangladesh

Common Name	Scientific name	Crops damaged
Rodents		
Lesser bandicoot rat	*Bandicota bengalensis*	Most crops rice, wheat, barley, poultry
Greater bandicoot rat	*Bandicota indica*	Deepwater and boro rice
House/Roof/Black rat	*Rattus rattus*	Stored food, coconut
Norway rat	*Rattus norvegicus*	Stored food
Short-tailed mole rat	*Nesokia indica*	Sugarcane, other crops
House mouse	*Mus musculus*	Stored food and goods
Field mouse	*Mus booduga*	Grain crops, etc.
Soft-furred field rat	*Millardia meltada*	Rice, wheat, barley, etc.
Squirrels Five striped squirrel Three striped squirrel Brown squirrel	 *Funambulus pennanti* *Funambulus palmarum* *Callosciurus pygerythrus*.	 Coconut, ber, mango, betel nut, guava, other fruits
Porcupine Brush tailed porcupine Indian porcupine	 *Atherurus macrourus* *Hystrix indica*	 Pineapple, root and tuber crops, bark of trees.
Birds		
Blue rock pigeon	*Columba livia*	Wheat and other seeds in seed beds/sown fields
Jungle crow	*Corvus macrorhynchos*	Wheat, sprouts, maize cobs, ripened jackfruit and other fruits
House crow	*Corvus splendens*	Wheat sprouts, maize cobs, ripened fruits
Common myna	*Acridotheres tristis*	Wheat sprouts
Jungle myna	*Acridotheres fuscus*	Wheat sprouts
Pied myna	*Sturnus contra*	Wheat sprouts
Rose-ringed parakeet	*Psittacula krameria*	Maize cobs, matured rice, sunflower
Munia	*Lonchura spp*.	Millet, rice, etc.
Baya weaver	*Ploceus philippinus*	Millet, rice, etc.
House sparrow	*Passer domesticus*	Wheat, rice, etc.
Bulbul	*Pycnonotus* spp.	Vegetable of fruits
Bats		
Short-nosed fruit bat	*Cynopterus sphinx*	Most fruits
Flying fox	*Pteropus* sp.	Most fruits
Other wild vertebrate pest		
Golden jackal	*Canis aureus*	Sugarcane, maize, water melon, melon, jackfruit, poultry, etc.
Bengal fox	*Vulpes bengalensis*	Sugarcane, maize, water melon, melon, jackfruit, poultry, etc.
Wild pig/boar	*Sus scrofa*	Root crops, tubers, other plantations in hilly areas.
Asian elephant	*Elephas maximus*	Field crop, vegetables, rubber
Rabbit	*Lepus nigricollis*	Vegetables and grain crops, etc.

C O N T E N T S

Research Report 2020-2021

EVALUATION OF SOME PLANT OILS AS REPELLENT AGAINST RODENTS

A T M Hasanuzzaman and M S Alam

Abstract

The experiment was conducted in outdoor rat enclosure at vertebrate pest division in BARI, Joydebpur, Gazipur during 2020-21 to evaluate three plant oil i.e. eucalyptus, neem and karanja as rodent repellant. Food was offered to rats at different distance from the oil odor source and their consumption was recorded. All plant oils showed the similar repellence against rat feeding where those can repel rat up to 3 days from their food. Rat consumed significantly lower amount of food from within 1m distance (0-2.63 g/rat/day) of oil source compared to 6 m distance (5.76-12.09 g/rat/day). At up to 1m distance of eucalyptus oil source, rat consumed 1.26-2.25 g food per day where as it was 1.32-1.58 g for neem oil and 1.47-2.63g for karanja oil.

Introduction

There is no doubt that rat is a deadly enemy for the agriculture of Bangladesh. Rodents are often a serious threat of different crops and household materials throughout Southern Asia causing damage from 3.5 to 6.8%, depending on crop species. Especially it can damage huge amount of grain crops. The damage cause in the rain-fed deep water rice was assessed as high as 6.8% in 1987 and 3.2% in 1988 (Islam et al., 1993). In wheat, damage ranged from 3.5 to 12% (Bindra and Sagar, 1968; Sood and Guraya, 1976; Poche et al., 1979; Ahmad, 1986). Poison baiting and trapping are the most common rat control methods in Bangladesh. Farmers commonly used zinc phosphide and bromadiolone as poison bait for controlling rodent. Locally available snap trap (kachi kall) and live trap are also used for trapping rodents. Trapping alone is not very effective method for controlling rodent. Sometimes farmers use their indigenous techniques to combat the rat attack but success is not as expected. Some tribal people take rat as a food but it can't be a common rodent controlling option in Bangladesh due to religious restriction.

In Bangladesh farmers generally prefer zinc phosphide baiting for controlling rodent compared to anticoagulant as it is costly. But it induces bait shyness making the bait less acceptable to rodents (Barnett and Prakash, 1975). Others researchers have also reported bait acceptance problems related to bitter taste of zinc phosphide or sub-lethal illness and subsequent conditioned aversion after rodents ingest minimal level of bait (Sridhara 1983, Prakash and Ghosh 1992, Reidinger 1995). Effect of bait shyness may persist more than a year even zinc phosphide removed from the bait. Rodents have extreme or irrational fear or dislike of anything new or unfamiliar due to its neophobic character. Rodents generally avoid consuming some rodenticide bait with an appropriate dose due to its unpleasant taste and smell. Natural products represent one of the most important alternatives to control pests and diseases that affect plants and animals without deleteriously affecting environmental safety (Islam 1997, Men and Hall 1999, Tripathi et al., 2008). Plants with strong smells act as repellents and can protect the crops nearby (Firouzi et al. 1998, Khater 2011, Dubey et al. 2011). Singla and Parshad (2007) studied the antifeeding effects of neem-based formulation against *R. rattus*. Kalandakanond-Thongsong et al. (2010) evaluated the efficacy of chilli, wintergreen oil, bergamot oil, peppermint oil, and geranium oil as repellents in the circular open field against adult male Wistar rats. Pine needle oil inhibits feeding in vertebrate species through sensory cues (Wager-Page et al., 1995). Some botanicals also have anti-reproductive effects against pests (Singla and Garg, 2013) while some have positive effects on growth (Djakalia et al., 2012).

Among the plant families with promising essential oils used as repellents include Cymbopogon spp., *Ocimum* spp., Thymus spp., and Eucalyptus spp. (Koul et al., 2008). Among essential oils, eucalyptus oil, in particular, is more useful as it is easily extractable commercially (industrial value) and possesses a wide range of desirable properties worth exploiting for pest management (Barton,

2000). Rodent repellents are chemicals which by taste or odor or possibly by both will prevent animal from feeding or gnawing. Such substances may be used in protecting an area as well as a tree from rodent infestation or in protecting packaged food, packing materials, electric cables, and other important vulnerable materials. Relatively little work has been carried out on plant-derived repellents compared to other aspects of rodent control. For management purposes, it could be helpful to find repellents that are species-specific and do not affect non-target species. The objective of the study was to find out an effective rodent repellent to minimize crop losses due to rodents.

Materials and Method

The experiment was conducted at the laboratory and inside the rodent enclosure of Vertebrate Pest Division. BARI, Gazipur. Lesser Bandicoot rat, *Bandicota bengalensis* was used as test animal. The animals were kept under the laboratory condition for at least 3 weeks for acclimatization before starting the experiment. All animals were starved for 6 hours before applying the treatment. The trials were conducted in September 2020 to April 2021 at four outdoor rat enclosures in vertebrate pest division.

The source of repellent and baiting:

Three plant oil viz. eucalyptus, neem and karanj were evaluated as rodent repellent. Three outdoor rodent enclosures, were considered as three observations were used for each plan oil. A twig of cotton was put in a metallic food cup that was placed at one corner of enclosure. One drop of plant oil was provided on the cotton twig which was considered as repellent odor source. Four more food cups were placed at 1 cm, 50 cm, 1 m and 6 m distances from the odor source. Wheat grain was used as rat bait. Rodent repellency of specific plant oil at several distances was tested in each enclosure in a multi-choice situation. The positions of the bait stations in each set were changed every day to avoid rodents developing place preferences and to control for any effect of position on choice of bait station but the distances from the odor source were maintained strictly. Three mature male rats were released in to the enclosure. Hundred grams of bait was placed in each bait station each evening and the amount removed was measured by weighing the amount of bait left over in each bait station on the day of observation. Bait stations were refilled for 6 consecutive days. Repellency effect of the oils was assessed based on food consumption.

To correct the day to day effect of air humidity and moisture contents on the weight of grains, a measured amount of bait was placed in separate bait boxes kept out of reach of rodents, as control samples. This bait was weighed daily to check any gain or loss of weight due the air humidity. This correction was applied calculating the actual consumption of bait by rodent from each bait station.

Result and Discussion

Eucalyptus oil: The daily food taken by rat from different bait station at different distances from the odor source were differed significantly for up to three days (1st day: $F_{3,8} = 70.802$, $P < 0.001$; 2nd day: $F_{3,8} = 41.081$, $P < 0.001$; 3rd day: $F_{3,8} = 27.888$, $P < 0.001$) but no significant differences were found for the consumptions of remaining days (4th day: $F_{3,8} = 4.072$, $P = 0.51$; 5th day: $F_{3,8} = 1.297$, $P = 0.340$; 6th day: $F_{3,8} = 3.164$, $P = 0.86$). The average amounts of daily food taken by rat at different distances from the odor source are shown in Fig. 1. At 1st observation day, no food was taken from 1cm distance that was statistically similar with 50 cm distance (0.93 g/rat/day) and 1 m distance (1.26 g/rat/day). Highest amount of food (11.37 g/rat/day) was consumed from 6 m distance from the odor source. Similarly, at 2nd and 3rd observational days, the highest amount of food was consumed by rat from the 6 m distance (2nd day: 12.03 g/rat/day, 3rd day: 10.02 g/rat/day). The lowest amount of food was taken from 1 cm distance (2nd day: 0.07 g/rat/day, 3rd day: 0.71 g/rat/day) of odor source which was statistically similar with 50 cm (2nd day: 1.02 g/rat/day, 3rd day: 1.92 g/rat/day) and 1m (2nd day: 1.43 g/rat/day, 3rd day: 2.23 g/rat/day) distance. At 4th and 5th observation day, comparatively lower amount of food was taken from 1m than 6m distance but the different was not significant. On 6th observation day, the amount of food consumption by rat was more or less similar at all distance from the odor

source. In another experiment Singla *et al*. (2014) found 5 % eucalyptus oil as potential repellent of male *Rattus rattus* in India. On the other hand, the daily total food consumption by rat did not differ significantly ($F_{5,12}$ = 0.492, $P = 0.776$) without considering the food distance from the odor source (Fig. 2).

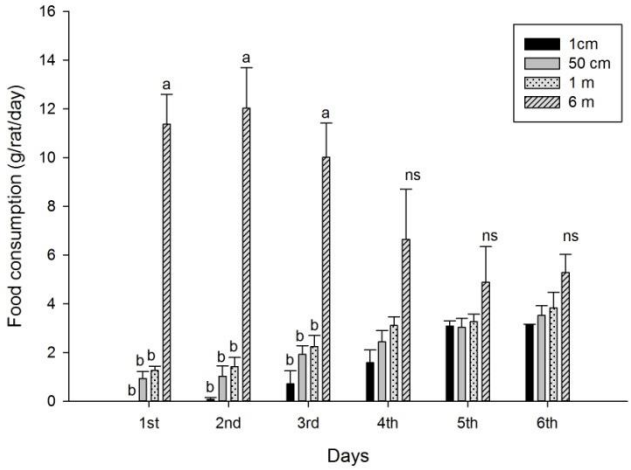

Fig. 1. Average daily food consumption by rat at different distances from eucalyptus oil odor source for six consecutive days in vertebrate pest division, BARI, Gazipur.

Similar letters show non-significant difference to each other.

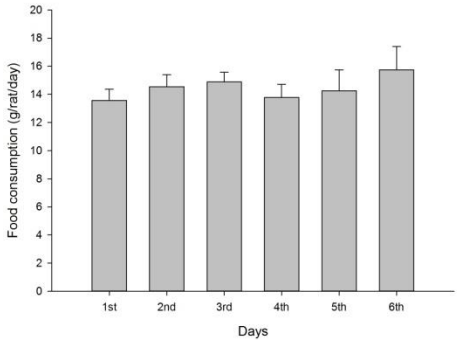

Fig. 2. Average daily total food consumption by rat with eucalyptus oil odor source for six consecutive days in vertebrate pest division, BARI, Gazipur.

Neem oil: The daily food taken by rat from different bait station at different distances from the odor source were differed significantly for up to three days (1st day: $F_{3,8}$ = 394.431, $P < 0.001$; 2nd day: $F_{3,8}$ = 69.798, $P < 0.001$; 3rd day: $F_{3,8}$ = 436.715, $P < 0.001$; 4th day: $F_{3,8}$ = 12.366, $P < 0.002$) but no significant differences were found for the consumptions of remaining days (5th day: $F_{3,8}$ = 0.837, $P = 0.510$; 6th day: $F_{3,8}$ = 0.738, $P = 0.559$). The average amounts of daily food taken by rat at different distances from the odor source are shown in Fig. 3. At 1st observation day, no food was consumed from 1cm distance and very small amount of food (0.70 g/rat/day) was taken from 50 cm distance that was statistically similar with 1m distance (1.23 g/rat/day). Highest amount of food (12.09 g/rat/day) was consumed from 6 m distance from the odor source. Similarly, at 2nd and 3rd observational days, the highest amount of food was consumed by rat from the 6 m distance (2nd day: 11.24 g/rat/day, 3rd day: 10.35 g/rat/day). The lowest amount of food was taken from 1 cm distance (2nd day: 0.10 g/rat/day, 3rd day: 0.53 g/rat/day) of odor source which was statistically similar with 50 cm (2nd day: 0.89 g/rat/day,

3rd day: 1.4 g/rat/day) and 1m (2nd day: 1.56 g/rat/day, 3rd day: 1.58 g/rat/day) distance. Although significantly higher amount of food was taken by rat at 6 m distance on 4th from the odor source but the difference is not so high compare to other distances. From 5th observation day, the amount of food consumption by rat was more or less similar at all distance from the odor source. On the other hand, the daily total food consumption by rat did not differ significantly ($F_{5,12}$ = 0.994, P = *0.461*) without considering the food distance from the odor source (Fig. 4).

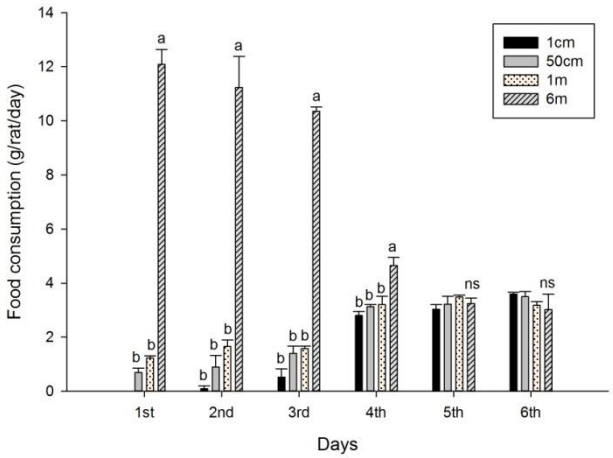

Fig. 3. Average daily food consumption by rat at different distances from neem oil odor source for six consecutive days in vertebrate pest division, BARI, Gazipur.

Similar letters show non-significant difference to each other.

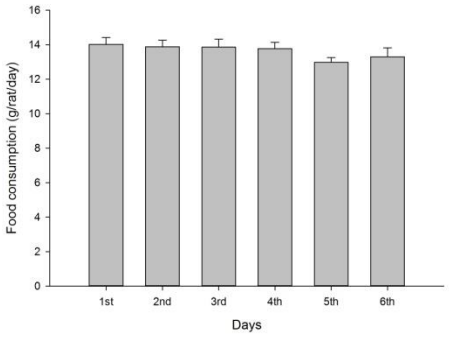

Fig. 4. Average daily total food consumption by rat with neem oil odor source for six consecutive days in vertebrate pest division, BARI, Gazipur.

Karanja oil: The daily food taken by rat from different bait station at different distances from the odor source were differed significantly for up to three days (1st day: $F_{3,8}$ = 149.574, P < *0.001*; 2nd day: $F_{3,8}$ = 38.024, P < *0.001*; 3rd day: $F_{3,8}$ = 22.189, P < *0.001*) but no significant differences were found for the consumptions of remaining days (4th day: $F_{3,8}$ = 3.948, P = *0.53*; 5th day: $F_{3,8}$ = 0.189, P = *0.901*; 6th day: $F_{3,8}$ = 4.106, P = *0.046*). The average amounts of daily food taken by rat at different distances from the odor source are shown in Fig. 5. At 1st observation day, the lowest amount of food (0.267 g/rat/day) was taken from 1cm distance that was statistically similar with 50 cm distance (0.71 g/rat/day) and 1 m distance (1.47 g/rat/day). Highest amount of food (11.32 g/rat/day) was consumed from 6 m distance from the odor source. Similarly, at 2nd and 3rd observational days, the highest amount of food was consumed by rat from the 6 m distance (2nd day: 8.36 g/rat/day, 3rd day: 5.67 g/rat/day). The lowest

amount of food was taken from 1 cm distance (2nd day: 1.02 g/rat/day, 3rd day: 2.41 g/rat/day) of odor source which was statistically similar with 50 cm (2nd day: 1 .62g/rat/day, 3rd day: 2.49 g/rat/day) and 1m (2nd day: 1.89 g/rat/day, 3rd day: 2.63 g/rat/day) distance. From 4th to 6th observation day, the amount of food consumption by rat was more or less similar at all distance from the odor source. On the other hand, the daily total food consumption by rat did not differ significantly ($F_{5,120}$ = 1.616, *P = 0.229*) without considering the food distance from the odor source (Fig. 6).

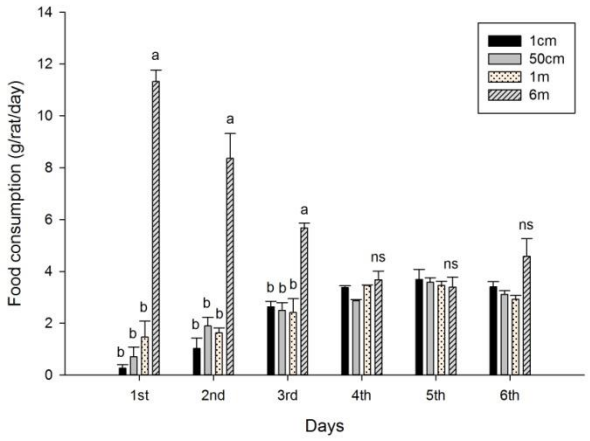

Fig. 5. Average daily food consumption by rat at different distances from Karanja oil odor source for six consecutive days in vertebrate pest division, BARI, Gazipur.

Similar letters show non-significant difference to each other.

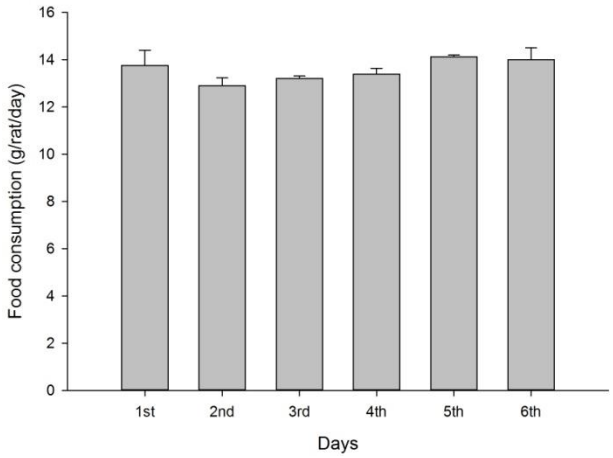

Fig. 6. Average daily total food consumption by rat with karanja oil odor source for ten consecutive days in vertebrate pest division, BARI, Gazipur

Conclusion

During the present studies, significant differences were found in mean daily food consumption at up to 1m and 6m distance of three oil sources for three days only. The three plant oil viz. eucalyptus, neem and karanja oil can repel rat from their food for up to three days. Highest repellency was observed in shortest distance of oil source. Further study is needed to confirm this result. Sex specific response of specific oil should be studied in future.

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MODIFICATION AND EVALUATION OF INDIGENOUS TRAP FOR CONTROLLING FIELD RAT

A T M Hasanuzzaman and M S Alam

Abstract

The experiment was conducted in outdoor rat enclosure at vertebrate pest division and different experimental fields in BARI, Joydebpur, Gazipur during 2020-21 to evaluate the comparative efficacy of newly designed kill trap and commonly used live and kill trap. The efficacy of newly designed snap trap and commonly used live and snap trap were statistically similar in both enclosure and field-test. In enclosure test, the average success of newly designed snap trap and commonly used live trap was 40.00% whereas commonly used kill trap showed only 24.00% success. In field, the average success of newly designed snap trap and live trap was 44.09% and 43.90% respectively whereas commonly used kill trap showed 37.71% success.

Introduction

People are very concern about rodent control. Several rodent pests cause serious damage to our agricultural crops in the field and in storage. Rodents consume and contaminate food with their fur, urine and feces. Their constant gnawing damages property. Rodent damages building, household's good and electrical wire etc. They also are potential threats to both human and animal health through transmission of diseases (Wang, 1996).

The use of rodenticides, in the form of poison bait, is the most common means of rat control in Bangladesh. However, especially in rural areas there are several constraints to their use. Primarily, rodenticides are not affordable to the rural poor who are most affected by the rodent pests. Even when rodenticides are widely available, they are often used inappropriately, leading to low efficacy by developing bait shyness in rodent population. In some cases, rodenticides created serious health hazards to human beings and their pet animals and created environment pollution. After continued use of poison baiting, rodents try to avoid bait, which are popularly known as bait-shyness. This shyness creates a serious problem in rodent control by developing a residual population. Changing control techniques with trapping can solve this problem. On the other hand, by constant and indiscriminate use of anticoagulant rodenticides, rodents can develop resistance on it (Buckle, 1999).

Recently, there has been an increased effort to apply our understanding of rodent population dynamics to develop more ecologically sound methods of rodent management. Non-chemical device - such as trapping rodents is an age old method for rodent population management. Some scientists have shown that trapping can, under some circumstances, be an effective method of rodent management (Gebauer, et al. 1992, Tobin et al. 1993, Ahmed et al. 1995). Two types of traps i.e., live trap and snap (kill) trap are commonly used for controlling rodents in Bangladesh. Farmers' often use some indigenous traps for controlling rodent and get considerable success. In this experiment we shall try to evaluate and modify some indigenous rat trap to increase its effectiveness for controlling rodents. The objective of the study was to develop highly effective eco-friendly device to control the rodent pest.

Materials and methods

One indigenous trap was collected from the farmers of Dinajpur region and this trap was modified in the lab of vertebrate pest division, BARI and then the efficacy of newly designed trap for capturing rodent was evaluated. The experiment was conducted at inside the rodent enclosure of vertebrate pest

Division, BARI and research field of BARI, Joydebpur, Gazipur during November, 2020 to May 2021. Two types of test vis. enclosure test and field test was conducted for this experiment.

Enclosure test: This test was conducted inside the rat enclosure (6m X 4m) during Rabi 2020 -2021. Lesser bandicoot rat *Bandicota bengalensis* was used as test animal. The animals were kept under the laboratory condition for at least 3 weeks for acclimatization before starting the experiment. All animals were starved for 6 hours before applying the treatment. Five rats were released into the enclosure. Five newly designed snap traps and five local kill traps and five live trap were set inside the enclosure. Bread was used as bait material for all types of traps. Traps were randomly set inside the enclosure. All the traps were set in every evening and the data were recorded in the following morning. This test was conducted up to 5 days. Percent trap success for different traps were calculated.

Field test: Field test was conducted in different research field of BARI. For this experiment, up to seven active burrows were selected for each type of trap. The burrows with rat inside and having fresh soil at the opening including some symptoms of new activities were identified and marked as the "active burrows". The presence of rat inside the burrow was ensured by using tracking tiles. One trap was set near the active burrow openings of each burrow system. Bread was used as bait material for all types of trap. Traps were randomly set near the burrow opening. All the traps were set in every evening and the data were recorded in the following morning. This test was conducted up to 5 days. Per cent trap success for different traps were calculated.

Result and discussion

Enclosure test: The result of enclosure test was presented in figure 1. The per cent trap success of newly designed snap trap and commonly used live and kill traps were statistically similar ($F_{2,12} = 2.667$, $P = 0.110$). The newly designed snap trap and commonly used live trap showed 40% success for trapping rodents where commonly used kill trap showed only 24% success. The locally available kill traps used in this experiment, were very good quality traps but in this experiment sometimes this trap was found as sprung without capturing rodents due to its over sensitivity which might have contributed to lower success of this trap.

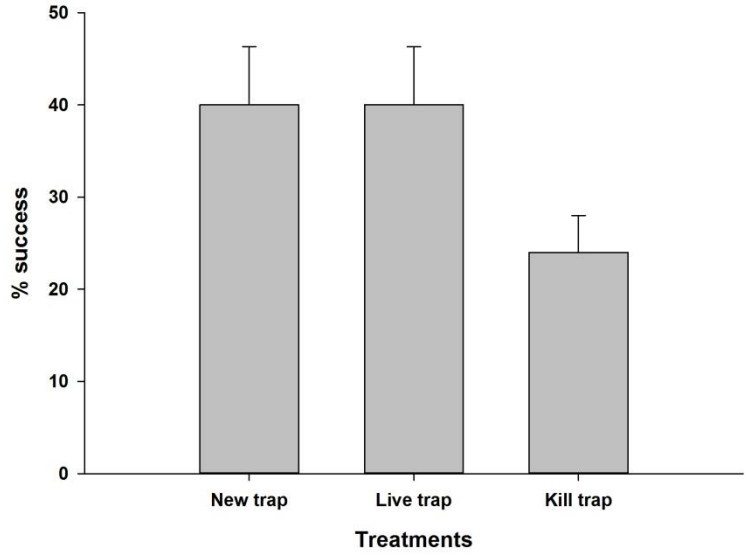

Fig 1. Comparative efficacies of newly designed snap trap and commonly used live and kill traps for trapping rodent in rat enclosure.

Field test: In field test, all the three types of traps showed the similar performance for controlling rodents ($F_{2,12} = 0.287$, $P = 0.753$). The newly designed snap trap showed 44.09% success; on the other hand, commonly used live and snap trap showed 43.90% and 37.71% success respectively. In another experiment, Alam *et at*., (2005) found that, kill trap showed 7.66 % success. Farmers of that area used kill trap in their poultry farm for controlling rodents. Though, newly designed snap trap did not perform better result compared to the commonly used live and snap traps but it has some good effect like: - a) trap sensitivity is the main factor for setting trap to get good result but it is not a matter in case of newly designed trap, b) it can be set easily, c) trapped rat can be removed easily, d) comparatively safer than the local snap trap. There is a limitation of this trap i.e. the trigger rope of this trap has to be changed in every setting time. Considering all these things it can be conclude that farmers can use the new designed snap trap in crop field, godown, poultry farm, houses etc. Further evaluation is needed to confirm this result and this experiment should be continued to further improvement of the newly designed trap.

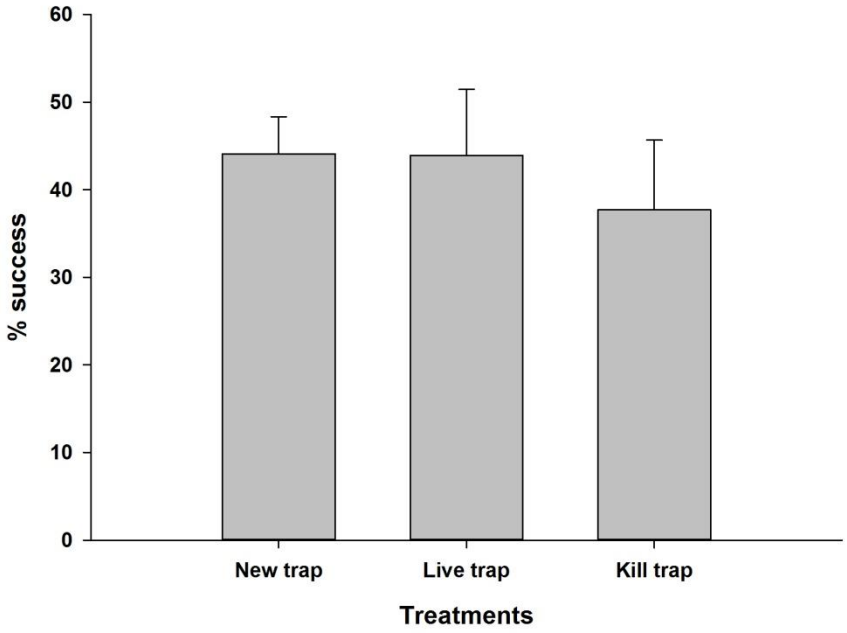

Fig 2. Comparative efficacies of newly designed snap trap and commonly used live and kill traps for trapping rodent in field.

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EVALUATION OF SOME WRAPPING MATERIALS FOR POISON BAITING INSIDE THE BURROW

A T M Hasanuzzaman and M S Alam

Abstract

The experiment was conducted in the experimental field of Bangladesh Agricultural Research Institute (BARI) in 2020-2021. Four different wrapping materials were evaluated for poison baiting inside the wet burrow and rodent control success was recorded. Highest success was observed with paper (61.33%) wrapped poison baiting which was statistically similar with wax paper wrapping (48%). Lowest success was found in case of banana leaf (31.33%) that was similar with parafilm (35.67%) and wax paper.

Introduction

Rodent pests cause serious damage to our agricultural crops and in stores. Rodents are serious pest to wheat crop throughout southern Asia causing a damage of 3.5-12% (Bindra and Sagar, 1968; Sood and Guraya, 1976; Poche et al., 1979; Ahmad *et al*, 1986). Rodents damage buildings, households goods and electrical wire etc. and they are also involved in the transmission of human diseases. According to Ahmed (1986) rat cause 5.7% losses to deep water rice. Rats are major problem in the poultry sector too. In Bangladesh, farmers commonly use zinc phosphide, aluminiun phosphide and lanirat (Bromadiolone) to control rodents. In developing countries, acute rodenticide, zinc phosphide in commonly used to control rodents. But it induces bait shyness making the bait less acceptable to rodents (Barnett and Prakash, 1975).

Others researchers have also reported bait acceptance problems related to bitter taste of zinc phosphide and /or sub-lethal illness and subsequent conditioned aversion after rodents ingest minimal level of bait (Sridhara 1983, Prakash and Ghosh 1992, Reidinger 1995).

In Bangladesh, farmers generally used zinc phosphide poison bait for controlling burrowing rodents. Inside burrow baiting where zinc phosphide poison bait wrapped with paper and placed inside burrow is an effective method for controlling burrowing rodent. In aman rice field, rat burrows remain water inside that wet the wrapping paper and damage the quality of poison bait. The experiment was planned to evaluate some wrapping material for poison baiting inside the wet burrow. The objective of the study was to find out the highly effective wrapping material for poison baiting inside the burrow so that rodent pest can be controlled successfully in aman rice.

Materials and Methods

The experiment was conducted in research field of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. In this experiment, four wrapping materials viz. wax paper, parafilm, banana leaf and plain paper were used for poison baiting inside the burrow where paper was used as a control treatment. Twenty five to thirty wet burrows that placed in the drain side were used for each treatment. Before applying treatments all the active burrows were identified properly. The burrows with rats inside and having fresh soil at the opening including some symptoms of new activities were identified and marked as the “active burrows”. Only active burrows were used for applying the treatments. The pre and post-treatments rodent population index was taken by using tracking tiles. Two tiles (20 cm x 20

cm) were used for each treatment. Tile index were taken for two nights for both pre and post treatment operation. The activities of rat were determined on the basis of active tiles.

For applying the treatment, opening of active burrow was cleaned properly with a bamboo stick. About 1 gm of Zn_3P_2 poison bait (8-10 grains) wrapped with a treatment material and placed inside the burrow in one foot depth. Then the burrow opening was sealed with soil ball. After 24 hours, if no rodent activity was found at burrow opening, then the treatment was considered as a successful treatment. The result was verified with tracking tile index.

Result and discussion

The results of different treatment were presented in figure 1. The rodent control success was varied significantly among the treatments ($F_{3,16} = 4.769, P<0.05$). Rodent control success of poison wrapped with wax paper, parafilm, banana leaf and paper was 48.00%, 35.67%, 31.33% and 61.33% respectively. The highest success of rat control was achieved with paper wrapped poison which was statistically similar with wax paper. Lowest success was achieved by banana leaf wrapping poison that was similar with poison wrapped with parafilm. In another experiment Hasanuzzaman and Mian (2005) found more than 80% success in rodent control using paper wrapped poison inside the burrow. In this experiment the success was not satisfactory because the burrows were in wet condition that damaged the paper as well as degraded the quality of poison bait. Besides, rat may be dislike banana leaf, wax paper and parafilm that can be the reason of lower success in rodent control when these materials were used for wrapping the poison. Further evaluation is needed to confirm this result and this experiment should be continued to find out the suitable wrapping material for poison baiting inside the burrow especially in wet condition.

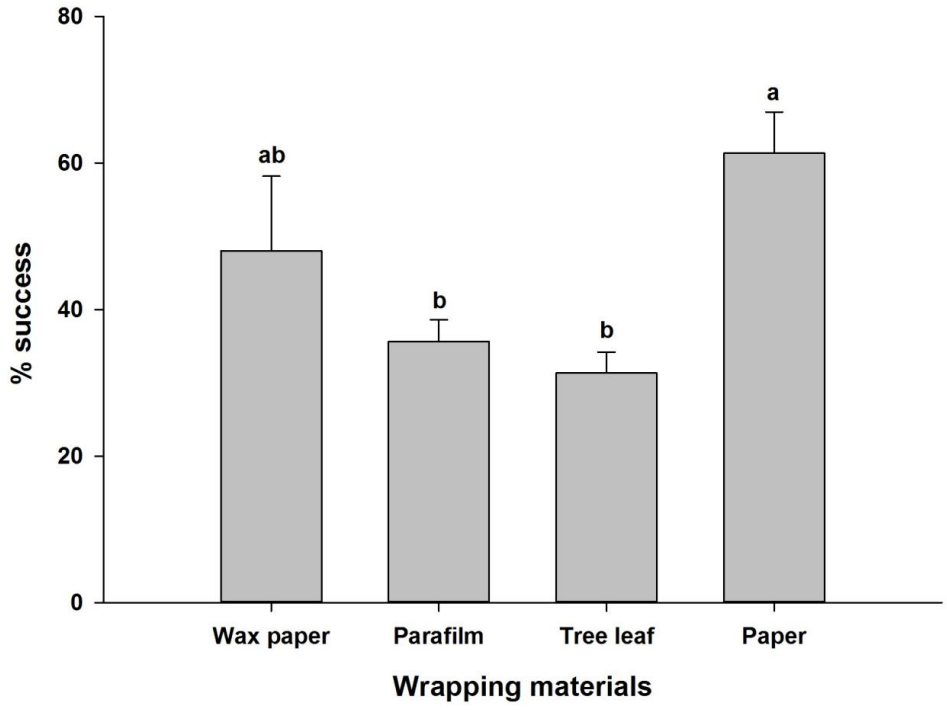

Fig 1. Comparative efficacies of different wrapping materials for effective poison baiting inside the burrow.

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Sood, M. L. and S.S. Guraya, 1976. Rats and Their Control. Punjab Agricultural University, Ludhiana: press Publication.

Sridhara, S. 1983. Rodenticide induced bait aversion and neophobia in *Tatera indica cuviere.* Zeitshrift Fur Angewandte Zoologic 10:429-440.

COMPARATIVE EFFICACY OF DIFFERENT TRAPS (LIVE, KILL AND GOPHER) FOR CONTROLLING RODENTS

M.S. Alam and ATM Hasanuzzaman

Abstract

Comparative efficacy of different traps was evaluated at ARS, Rajbari, Dinajpur research fields during rabi season, 2020-21 to find out the most suitable trap for capturing rats. Three types of traps such as live trap, kill trap, and Gopher trap were used at different potatoes and tomatoes fields for this study. The experiment was conducted in potato and tomato fields for seven trap nights. In each wheat field 5 live traps, 5 kill traps, and 5 Gopher traps were set. Each active burrow was treated with one trap per night. Therefore, total 180 trap nights were used for this study. So, each type of trap was used for 60 trap nights. Live traps and kill traps were set near the burrow opening while Gopher traps were set inside the burrow opening. All traps were set in every evening and the data were recorded in the following morning. From this experiment, it was revealed that success rate of live traps was higher than the kill traps and Gopher traps. Average success rate of live trap was 51.49% whereas success rate of kill/snap trap was 39.75% and 41.63% in case of gopher trap.

Introduction

People are very much concern about rodent control. Several rodent pests cause serious damage to our agricultural crops in the field and in storage. Rodents consume and contaminate food with their fur, urine and faeces. Due to their constant gnawing nature, rodent damages building, household goods and electrical wires etc. They are also potential threats to both human and animal health through transmission of diseases (Wang, 1996). The use of rodenticides, in the form of poison bait, is the most common means of rat control in Bangladesh. However, especially in rural areas there are several constraints to their use. Primarily, rodenticides are not affordable to the rural poor who are most affected by the rodent pests. Even when rodenticides are widely available, they are often used inappropriately, leading to low efficacy by developing bait shyness in rodent population. In some cases, rodenticides create serious health hazards to human beings and their pet animals and make environment pollution. After continuous use of poison baits, rodents try to avoid bait, which are popularly known as bait-shyness. This shyness creates a serious problem in rodent control by developing a residual population. On the other hand, by constant and indiscriminate use of anticoagulant rodenticides, rodents can develop resistance against it. Changing control techniques with trapping can solve this problem (Buckle, 1999).

Non-chemical device such as trapping rodents is an age-old method for rodent population management. Some scientists have shown that trapping can, under some circumstances, be an effective method of rodent management (Gebauer, et. al. 1992, Tobin et. al. 1993, Ahmed et. al. 1995). Two types of traps i.e., live trap and snap trap are commonly used for controlling rodents in Bangladesh. Gopher traps are rarely used by the farmers due to its less availability and farmers are unknown about its effectiveness for controlling burrowing rodents. Therefore, comparative efficacy different traps (live, snap, and Gopher trap) was evaluated to find out the best trap for capturing rats in wheat field.

Materials and methods

The experiment was conducted at Agricultural Research Station, Rajbari, Dinajpur during rabi season, 2020-21. Only field test was conducted for this experiment. For field experiment, total four heavily infested wheat, pulses and oilseed fields were selected. Three types of traps viz. Live trap, Gopher trap and Snap/kill trap were set. In each wheat field 5 live traps, 5 snap traps, and 5 Gopher traps were set. Each active burrow opening was treated with one trap. Before setting the trap, active burrows were identified properly and only active burrow opening was treated with traps. The experiment was conducted for 180 trap nights during the study. Each type of trap was used in 60 trap nights. Snap and live traps were set near the burrow opening and Gopher traps were set inside the burrow opening. Before and after the application of control techniques pre and post treatment population index were taken by

setting tiles for two consecutive nights. Population index was recorded in the following morning. All the traps were set in every evening and the data were recorded in the following morning. Number of rats captured by different traps in the wheat and barley fields was recorded. Each trapped animal was examined and identified to species level. Percent trap success for different species were calculated. Data was analyzed by SPSS software and presented as graphical form. Efficacy of trapping was evaluated by population index.

Result and Discussion

Both on-farm and farmers field live trap gave the better result compared to the Gopher and kill trap. Number of pre-treatment burrows in each treatment were 30. In figure 1. it is revealed that number of post-treatment burrows has been reduced in all treatments. The lowest number of active burrows 12.75 (±1.44)) were observed in live trap treated burrows while it was 17.0 (±1.58) in snap trap and the highest 17.5 (±0.65) were in gopher trap treated burrows (Fig. 1) and there were no significant differences among the treatments. Consequently, the highest trap success (51.49%) was obtained from burrows treated with live trap and this result was numerically identical with Gopher trap treated burrows (41.63%). The lowest success was obtained from burrows treated with snap/kill trap (39.75%) (Fig 2.). Over all rodent control success by active burrow count method over pre-treatment index was 57.5%, 43.33 and 41.66% in live trap, kill trap and Gopher trap respectively (Fig. 2). Alam et al. (2007) reported that live trap was more effective than the kill trap for capturing rats in different poultry farms of Gazipur district in Bangladesh. Hasanuzzaman et al. (2009) evaluated different type of traps viz. cage type live trap made by iron net, box type live trap made by tin, wooden live trap, snap trap made by tin, and wooden snap trap in the wheat field of Dinajpur district in Bangladesh and found cage type live trap made by iron net more successful compared to other type of traps.

The trap success of live trap and kill/snap were significantly higher compared to gopher trap because live trap and kill trap are more sensitive than the gopher trap. For this reason, gopher traps were sprung out but rats were not captured that means they were able to escape. Another thing is that when we set the Gopher trap inside the burrow openings, some soils around the burrow openings are broken down. Rodents have a tendency to repair their burrow system when it is damaged by somehow. So, when they try to mend their burrow opening, they have a chance in contact with the Gopher trap and captured due to its sensitiveness.

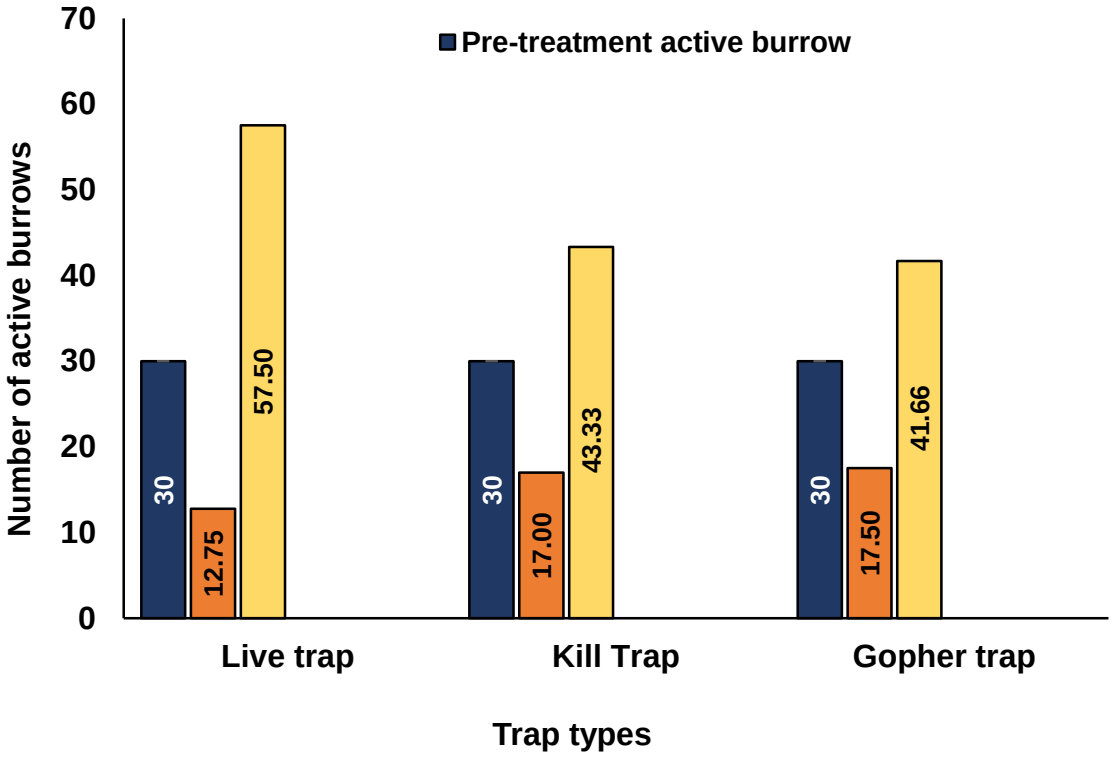

Fig. 1 Number of post-treatment active burrows after treating different types of traps during rabi season 2020-21 at ARS, Rajbari, Dinajpur.

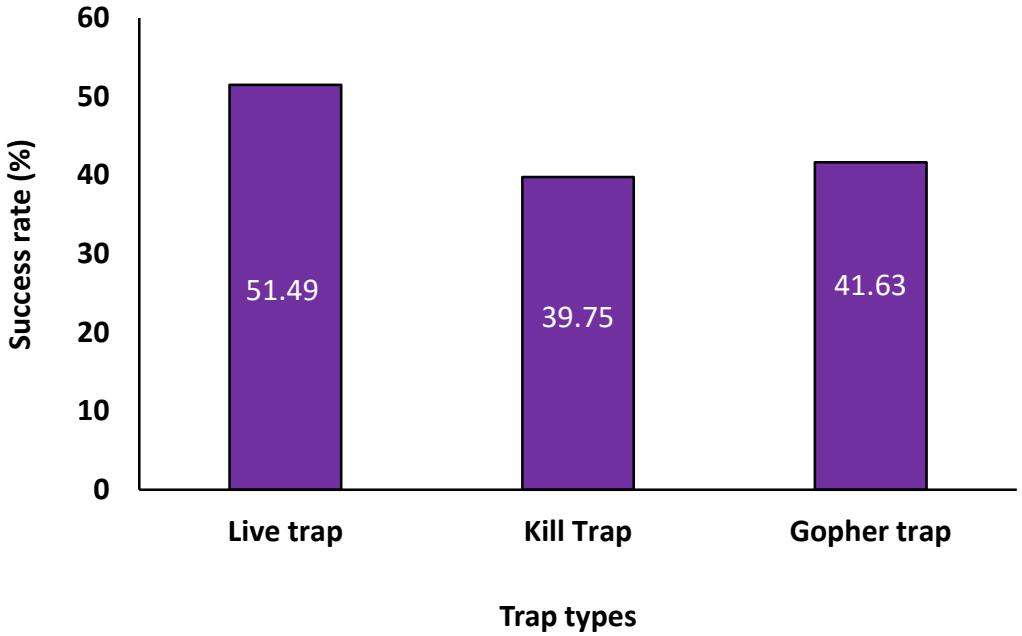

Fig 2. Trap success (%) of different traps against rat during rabi season 2020-21 at ARS, Rajbari, Dinajpur.

Species Composition

During the trapping season total 80 rats were trapped from the wheat and barley fields (Table 2). Out of them, 76 were Black field rat, *Bandicota bengalenses*, 4 were house shrew *Suncus murinus.* It is obvious that *B. bengalensis* was the dominant rat species in the wheat and barley field in Gazipur central farm other species occupied only a minor part of the population. Out of 80 rats, 31 rats were captured by live trap whereas 25 rats were captured by Gopher trap and 24 rats were captured by Snap trap (Table 2). Roy et al. (1987) reported that *Bandicota bengalenses* was the most dominant species in the poultry farm of Monipur, India. This species is also a major species in deep water rice (Islam and Karim 1995; Catling and Islam 1999).

Table 1. Rodent species trapped in the wheat fields during rabi season at ARS, Rajbari, Dinajpur during rabi 2020-21.

Name of the species	Number of captured rats			Total
	Live trap	Gopher trap	Snap trap	
Black field rat, *Bandicota bengalensis*	28	25	23	76
House shrew, *Suncus muricus*	3		1	4
Total	31	25	24	80

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SURVEY ON SQUIRREL DAMAGE IN DIFFERENT FRUITS AND VEGETABLES IN SELECTED AREAS OF BANGLADESH

Md. S. Alam and A.T.M. Hasanuzzaman

Abstract

A study was conducted among the farmers on squirrel problem in different crops in Rajbari and Cox's Bazar districts of Bangladesh during 2020-21. Both of the Rajbari and Cox's Bazar district farmers reported two types of squirrels which were brown and striped whereas striped squirrel was pre dominant in Rajbari and Brown squirrel was pre dominant in Cox's Bazar. According to the farmers' opinion, vegetables and fruit crops were frequently damaged by the squirrels. Most affected vegetable crops were bottle gourd (60%) followed by pumpkin (46.67%), cole crop (40%) and carrot (21.67%). Among the fruit crops maximum damage was found in Guava (46.7%) followed by coconut (35%), litchi (33.3%), Jamun, jackfruit and mango (33.3%) and ber (26.6%). Farmers reported that average Tk. 500-1000 per family per year was lost in case of vegetables damaged by squirrel while it was more than Tk. 1000 in case of fruits. Maximum damage was occurred at full grown stage (51.67%) followed by ripening stage (43.33%) of the crop in all the season. Farmers were unknown about the breeding frequency, breeding season and number of young per parturition. Most popular control method used by the farmers was cage Trapping (50%) followed by snap trapping (21.6%) poison (11.6%).

Introduction

Squirrels belongs to the order Rodentia. Several species of squirrels have been reported to occur in Bangladesh. These are Brown squirrel (*Callos ciurus phygery thrus*), five striped plum squirrel *(Funumbulus pennanti),* three striped plam squirrel, *(F. palmarum)* and malayan giant Squirrel, *(Rolufa bicolor)* (Khan, 1987). Brown squirrels are generally found in the districts of Dhaka and Chottogram division. Five stripped and three stripped squirrels are found in north west and south western districts of Bangladesh. Malayan giant squirrel is reported to occur in evergreen forests of Sylhet and Chottogram hill-tracts. Another group of squirrels are also found in Bangladesh. They are called flying squirrels. They are arboreal species and live mostly on trees in the forest but now also have adapted to human environments. They do not actually fly, they simply glide. They have developed a broad parachute like flap of skin which extends on either side of the body between the limbs and that enables them to glide through the air for a considerable distance. They are reported to inhabit in the forests of Chottogram. They are diurnal animals. So, they are usually seen during day time. All these species especially first three species cause damage to our fruits and vegetables crops. But intensity of damage and status of squirrel as an agricultural pest is yet unknown. This experiment was planned to understand the status of squirrel as a pest, their damage severity, to gain some basic knowledge about their habitat, control measures taken by farmers and the crop losses due to squirrel infestation through a questionnaire survey among the farmers in different districts of Bangladesh.

Materials and methods

The study was conducted in the squirrel infested area of Rajbari and Cox's Bazar regions during 2020-21. One upazillas of Rajbari and one uapzilla of Cox's Bazar district were selected for this study. The questionnaire survey was conducted in four villages from Pangsha upazilla of Rajbari district and five villages from Cox's bazar sadar upazila of Cox's Bazar district. Questionnaire survey on squirrel damage in fruit and vegetables was conducted amongst fruit and vegetables growing farmers. The study was conducted among randomly selected 30 farmers from each upazilla of Rajbari and Cox's Bazar district. Scientists of Vertebrate Pest Division took the framers interview with a prescribed questionnaire sheet. It included different questions such as on species composition, crops damaged by the squirrels, intensity of damage, amount of loss, breeding season, number of parturitions per year, control method used by the farmers etc. The farmers who actually worked in the farms during these seasons were selected for the questionnaire. It is also an important tool for understanding the extent of awareness about squirrel as part of the agro eco-system. Learning the traditional and modern techniques used by farmers and workers will surely be great experience in order to avoid the loss and their

effectiveness. All questionnaire sheets were carefully filled up, compiled, summarized and presented in tabular form. Direct visual observation of squirrel damage was done in the farmers' fields/houses.

Results and Discussion

Types of squirrels

Different species of squirrel caused damage in different fruits, vegetables and grain crops. All the species were not available in all the location. Squirrel problems in fruits and vegetables were severe and most of the farmer opined that squirrel is serious problem. All most all the farmers (100%) opined that squirrel is the most serious pest in vegetables and fruits. In this study, farmers were asked about how many kinds of squirrel they had seen in their locality, The farmers reported two types of squirrels were seen in both Rajbari and Cox's Bazar district and it were striped and brown types squirrel. Striped squirrel was dominant (60% farmer reported) at Pangsha upazilla of Rajbari district and brown squirrel locally also known as Irrawaddy squirrel was dominant (73.33% farmers reportred) at Cox's Bazar sadar upazilla of Cox's Bazar district (Table 1).

Affected crops and economic loss

Squirrels usually damage fruits and vegetables crops. According to farmers' opinion, maximum vegetable crops were attacked by squirrel in bottle gourd (70%), followed by pumpkin (50%), Cole crop (36.67%), brinjal (33.33%) and carrot (26.67%) in Pangsha upazillas of Rajbari and bottle gourd (50%), followed by pumpkin (43.33%) cole ceop (43.33%) and lettuce (23.33%) in Coz's Bazar sadar, Cox's Bazar district (Table 2). Among the fruit crops, maximum damage was found in Guava (53.3%) followed by Jackfruit (43.3%) coconut (40%), Jamun (40%) litchi (36.67%), mango (36.67%), ber (30%) and banana (26.7%) at Pangsha upazilla of Rajbari and guave 40%) followed by papaya (36.7%) coconut (30%), Mango (30%), litchi (30%) jamun (26.67%), jackfruit (23.3%) and ber (23.3%) at Cox's Bazar sadar upazilla of Cox's Bazar district (Table 3).

Crop stage & Damage period

Forty six percent farmers of Pangsha, Rajbari opined that squirrel caused damage at ripening stages of crop whereas 43.33 % farmers opined full grown stages crop followed by all stage of crop (10%) at Pangsha upazilla of Rajbari district (Table 4). Farmers reported that during the day maximum squirrel activity was observed at afternoon (66.67%) followed by morning and noon (16.67% at Pangsha, Rajbari and Cox's Bazar sadar upazilla of Cox's Bazar district farmers also opined same trends of squirrel activity at afternoon (70%) followed by morning (16.67%) and rnoon (15%) (Table 5).

Squirrel beneficial role or aesthetic value and their seasonal activities

Farmers were asked about the beneficial role of squirrel. Eighty six percent farmers of Pangsha upazilla of Rajbari district reported that they have no beneficial effect at all and 13.33% farmers said they have beneficial role whereas at Cox's Bazar sadar upazilla of Cox's Bazar district, 93.33% opined that they have no beneficial effect and only 6.67% farmers said their beneficial effect in the nature. About 66.67% farmers opined that squirrel activity was observed at summer season followed by rainy season (20%) at Pangsha, Rajbari and at the same time squirrel activity was observed at summer (56.67%) followed by rainy season (20%) and winter (13.3%) at Cox's Bazar sadar upazilla of Cox's Bazar,s farmers (Table 6).

Intensity of squirrel activity

To understand the depth of the problem, farmers were asked whether they have seen squirrel or squirrel damage symptom during last one week or one month. About 40% farmers had seen 5-10 squirrels, 16.67% had seen 10-15 squirrels during last one week whereas 20% farmers observed 30-40 squirrels, 33.33% farmers observed 20-30 squirrels and 43.33-46.67% farmers had not seen any squirrel during last one month at Pangsha upazilla of Rajbari district. At Cox's Bazar sadar upazilla of Cox's Bazar district 33.33% farmers had seen 5-10 squirrels and 26.67% seen 10-21 squirrels during last one

week as well as 40% farmer had seen 20-30 squirrels and 26.67% farmers seen 30-40 squirrels during last one month and 33.33% farmers did not see any squirrel (Table 7). These indicate that squirrel problem was severe in the study areas.

Reproduction

Farmers were asked about the breeding habit of squirrel. According to the farmers' opinion, 100% farmers ofboth upazillas Pangsha, Rajbari district and at Cox's Bazar sadar upazilla of Cox's Bazar district. did not know the breeding habitat procedure of squirrels (Table 8).

About 98-100% farmers had no knowledge or unknown about breeding frequency per year and the breeding season of squirrel at Pangsha upazilla of Rajbari district. Twenty six percent farmers opined April- May were the breeding season of squirrel and 73.33% farmers did not know the breeding season of squirrel at Cox's Bazar sadar upazilla of Cox's Bazar. About 16.67% farmers opined squirrel give birth about one time per year while 66.67% farmer did not know the breeding frequency per year at Cox's Bazar sadar upazilla of Cox's Bazar district. They also opined that breeding frequencies depend on the availability of food (Table 9).

To guess the economic impact and loss caused by squirrel in Bangladesh, farmers were also asked how much losses caused by squirrel during last one year. According to the farmers' opinion about average fruits losses,50% and 26.067% farmers opined 300-500 taka loss, 33.33% and 43.33% farmers reported 500-1000 Taka loss and 16.67% and 30% farmers opined more than 1000 Taka loss per farmer per year caused by squirrel in fruit crops at Pangsha and Cox;s Bazar sadar upazilla respectively (Table 10). In case of vegetables, 36.67% and 40% farmers reported Taka 500-1000 loss per year whereas 16.675 and 33.33% farmers opined about more than 1000 Taka vegetables loss per year per family caused by squirrel (Table 11) Pangsha and Cox;s Bazar sadar upazilla respectively.

Squirrel control Technique

Farmers were asked about the control techniques they applied against squirrel. All the farmers (100%) opined that action needed to take against squirrel at Cox's bazar. Eighty-six percent farmers of Pangsha took action against squirrel and 113.3% did not take any action. Farmers reported, they used several control techniques against squirrel. Such as use of trap, shooting, use of poison bait and other type of control measures such as beating by stick, use of catapul gulti, and netting. Among these, 50% farmers used cage trapping, 21.7% used snap trapping, 5% used repelling squirrel and 11.6% farmers used poison bait. About 10% of them were not satisfied about the traditional control techniques of squirrel and 31.67% opined these control techniques were very good, 26.67% good whereas 31.7% farmers were satisfied using these techniques to control the squirrels (Table 12).

Conclusion

This experiment is part of a nation-wide survey on squirrel damage in different crops. In this experiment only two upazillas of two districts were covered. The results showed that in economic point of view, the crop losses by squirrels are not negligible. So other areas of the country should be surveyed later on.

Table 1. Types of squirrels in crop fields in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)							
	squirrel problem		Type and colour of squirrel species observed in study area					
	Yes	No	Type			Colour		
			1	2	3	Striped	Brown	Both
Pangsha, Rajbari (n=30)	30 (100)	-	26 (86.67)	4 (13.33)	-	18(60)	8 (26.67)	4(13.33)
Cox's Bazar sadar, Cox's Bazar (n=30)	30 (100)	-	27 (90)	3 (10)		5 (16.67)	22 (73.33)	3 (10)
Average (n= 30)	30 (100)		26.5 (88.33)	3.5 (11.67)		11.50 (38.33)	15 (50)	3.5 (11.67)

n= Number of respondent (farmers)

Table 2. Vegetable crops damaged by squirrels in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)											
	Vegetables											
	Bean	Brinjal	Pumpkin	Bottle gourd	Ridge gourd	Cucumber	Melon	tomato	Lettuce	Carrot/ Raddish	Cole crop	Okra
Pangsha, Rajbari (n=30)	4 (13.3)	10 (33.3)	15 (50.0)	21 (70.0)	4 (13.3)	5 (16.67)	6 (20.0)	5 (16.67)	0	8 (26.67)	11 (36.7)	2 (6.67)
Cox's Bazar sadar, Cox's Bazar (n=30)	4 (13.3)	0	13 (43.33)	15 (50.0)	0	5 (16,67)	0	3 (10.0)	7 (23.33)	5 (16.67)	13 (43.3)	2 (6.67)
Average (n= 30)	4 (13.3)	5 (16.67)	14 (46.67)	18 (60.0)	2 (6.67)	5 (16.67)	3 (10.0)	4 (13.3)	3.5 (11.67)	6.5 (21.67)	12 (40.0)	2 (6.67)

Table 3. Fruit's crop damaged by squirrels in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)													
	Coco nut	Jack-fruit	Guava	Mango	Ber	Betel nut	Sapota	Banana	Litchi	Papaya	Pumello	Jamun	Date	Pineapple
Pangsha, Rajbari (n=30)	12 (40.0)	13 (43.3)	16 (53.3)	11 (36.7)	9 (30)	3 (10)	2 (6.7)	8 (26.7)	11 (36.7)	3 (10)	2 (6.7)	12 (40)	5 (16.67)	3 (10)
Cox's Bazar sadar, Cox's Bazar (n=30)	9 (30.0)	7 (23.3)	12 (40)	9 (30)	7 (23.3)	4 (13.3)	5 (16.7)	7 (23.3)	9 (30)	11 (36.7)	6 (20)	8 (26.67)	4 (13.33)	6 (20)
Average (n= 30)	10.5 (35.0)	10 (33.3)	14 (46.7)	10 (33.3)	8 (26.7)	3.5 (11.7)	3.5 (11.7)	7.5 (25)	10 (33.3)	7 (23.3)	4 (13.3)	10 (33.33)	4.5 (15)	4.5 (15)

Table 4. Crop stage affected by squirrels in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)			
	Immature	Full grown	Ripening stage	All stages
Pangsha, Rajbari (n=30)		13 (43.33)	14 (46.67)	3 (10)
Cox's Bazar sadar, Cox's Bazar (n=30)		18 (60)	12 (40)	0
Average (n= 30)		15.5 (51.67)	13 (43.33)	1.5 (5.0)

Table 5. Time of squirrel activity during day and night in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)				
	Day	Night	Day time when		
			Morning	Noon	Afternoon
Pangsha, Rajbari (n=30)	30 (100)	0	5 (16.67)	5 (16.67)	20 (66.67)
Cox's Bazar sadar, Cox's Bazar (n=30)	24 (80)	6 (20.0)	5 (16.67)	4 (13.33)	21 (70.0)
Average (n= 30)	27 (90)	3 (10)	5 (16.67)	41 (15)	20.5 (68.33)

Table 6. Beneficial role or aesthetic value of squirrel and seasonal activities of squirrels in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)					
	Beneficial or not		Seasonal of Activity			
	No	Yes	Summer	Rainy	Winter	All time
		Beauty of nature				
Pangsha, Rajbari (n=30)	26 (86.67)	4 (13.33)	20 (66.67)	6 (20)	2 (6.67)	2 (6.67)
Cox's Bazar sadar, Cox's Bazar (n=30)	28 (93.33)	2 (6.67)	17 (56.67)	6 (20)	7 (13.33)	0
Average (n= 30)	27 (90.0)	3 (10.0)	18.5 (61.67)	6 (20)	4.5 (15.0)	1 (3.33)

Table 7. Squirrel seen during last one week and one month in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)									
	During last one week					During last one month				
	Yes				No	Yes				No
	5-10	10-15	30-40	>40		20-30	30-40			
Pangsha, Rajbari (n=30)	12 (40)	5 (16.67)			13 (43.33)	10 (33.33)	6 (20)			14 (46.67)
Cox's Bazar sadar, Cox's Bazar (n=30)	10 (33.33)	8 (26.67)			12 (40.0)	12 (40)	8 (26.67)			10 (33.33)
Average (n= 30)	11 (36.67)	6.5 (21.67)			12.5 (41.67)	11 (36.67)	7 (23.33)			12 (40.0)

Table 8. Breeding habitat and number of young squirrels per parturition of squirrels in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)							
	Breeding habit				No. of youngs/per partuation			
	Un-Known	Tree hole			Un-known	2-3	3-4	5-6
Pangsha, Rajbari (n=30)	30 (100)				30 (100)			
Cox's Bazar sadar, Cox's Bazar (n=30)	30 (100)				30 (100)			
Average (n= 30)	30 (100)				30 (100)			

Table 9. Breeding frequency & breeding season of squirrel in in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Place	Number of respondent (%)									
	Breeding frequency per year					Breeding season i.e month				
	Un-known	1	2	3	4	Un-known	Year round	April - May	June-July	Octo-Dec	Jan-March
Pangsha, Rajbari (n=30)	30 (100)	0				30 (100)				-	-
Cox's Bazar sadar, Cox's Bazar (n=30)	20 (66.67)	10 (33.3)				22 (73.3)		8 (26.7)			
Average (n= 30)	25 (83.3)	5 (16.7)				26 (86.7)		4 (13.3)			-

Table 10. Fruit loss caused by Squirrel in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Places	Number of respondent (%)					
	Loss (%)			Loss in Taka		
	40-50	60-70	80-100	300-500	500-1000	>1000
Pangsha, Rajbari (n=30)				15 (50.0)	10 (33.33)	5 (16.67)
Cox's Bazar sadar, Cox's Bazar (n=30)				8 (26.67)	13 (43.33)	9 (30)
Average (n= 30)				11.5 (38.33)	11.5 (38.33)	7 (23.33)

Table 11. Vegetable loss caused by Squirrel in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Places	Number of respondent (%)					
	Loss (%)			Loss in Taka		
	40-50	60-70	80-100	300-500	500-1000	>1000
Pangsha, Rajbari (n=30)				14 (46.67)	11 (36.67)	5 (16.67)
Cox's Bazar sadar, Cox's Bazar (n=30)				8 (26.67)	12 (40)	10 (33.33)
Average (n= 30)				11 (36.67)	11.5 (38.33)	7.5 (25)

Table 12. Control measure taken by the farmers in the study area of Rajbari and Cox's Bazar districts during 2020-21.

Places	Number of respondent (%)											
	Action taken Needed		Control techniques use by farmers (%)						Control efficacy			
	Yes	No	Cage Trapping	Snap Trapping	Repel (Net)	Repel (Tin)	Poison	No action	Very good	Good	as usual	not satisfactory
Pangsha, Rajbari (n=30)	26 (86.7)	4 (13.3)	19 (63.33)	4 (13.3)	0	0	3 (10)	4 (13.3)	9 (30)	8 (26.7)	11 (36.7)	2 (6.67)
Cox's Bazar sadar, Cox's Bazar (n=30)	30 (100)	0	11 (36.67)	9 (30)	3 (10)	3 (10)	4 (13.3)		10 (33.33)	8 (26.7)	8 (26.7)	4 (13.33)
Average (n= 30)	28 (93.3)	2 (6.67)	15 (50)	6.5 (21.7)	1.5 (5)	1.5 (5)	3.5 (11.6)	2 (6.67)	9.5 (31.67)	8 (26.67)	9.5 (31.7)	3 (10)

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EFFICACY OF NETTING AGAINST PEST BIRDS MANAGEMENT AND BIRD DIVERSITY IN SUNFLOWER

M. S. Alam and ATM Hasanuzzaman

Abstract

The experiment was conducted at BARI central research field, Gazipur during rabi season in 2020-21 to find out the efficacy of different combination of netting on sunflower against pest birds. Six treatments viz., One side netting, Two side netting, Four side netting, Whole crop cover by net, Only top of the crop cover by net and Untreated control (without netting) were used in this experiment. The experiment was laid out in RCB design with four replications. From this experiment, it was revealed that significantly maximum damage of sunflower caused by the pest birds were in the control plots compared to netting treated plots. In control plots maximum 36.06% head damage and 49.58% plant were affected by the birds whereas the lowest damage was happened in treatment where whole plot covered by net (0%) treated plots and two side netting treated plot (2.5%). Seventeen birds species were recorded in sunflower belonging to 15 families and 7 orders during the study periods from dawn to dusk. Passeroformes was the most dominant order (53%) represented 8 families and 9 species followed by order Collumbiformes (2 family 2 species) and order Coraciiformes (2 families 2 species). However, the species richness and Diversity of bird species were obtained higher in morning (17) and afternoon (9) than noon (7).

Introduction

Sunflower (*Helianthus annuus* L.) is a globally important oilseed and a high-value crop. It is very susceptible to birds. Birds cause economic losses in a variety of crops like wheat, maize, sun flower, groundnut and citrus etc. It is stated that crows and parakeet are very destructive to sunflower. So susceptible, in fact, that bird damage can lead to the entire crop being destroyed and abandoned. Bird damage to sunflower is recognized as an international economic problem for sunflower producers. Bird attacks on sunflower crops occur from the sowing stage. Sometimes they occur later - in almost cases - affecting the flower head. Attacks can be very frequent and cause substantial damage to the sunflower crop.

Regional surveys of bird damage to sunflowers conducted outside the United States are practically nonexistent, but localized damage of up to 25% of a field has been reported in various countries (Linz and Hanzel 1997, Khaleghizadeh 2011). In South America, members of the parakeet (Psittacidae) and dove (Columbidae) families can form roosts numbering in the millions and cause significant damage to nearby sunflowers (Bucher 1992, Rodgriguez et al. 1995). In Australia, cockatoos (Cacatuidae) and parrots (Psittacidae) are the main culprits (Bomford 1992). Sparrows (Emberizidae, Passeridae), doves, and crows (Corvidae) cause most of the damage in Europe, whereas parakeets and parrots do so on the Indian subcontinent (De Grazio 1989). However, in order to limit the damage caused by these birds, measures have to be taken to protect the sunflower crop from its inception. Trapping, netting and scaring is common means of bird control techniques in maize and sunflower field where, scaring of bird with reflecting ribbon is considered as an effective and eco-friendly bird control option. Different repellents options may reduce the attacking of bird pests which may help in crop production.

Bird survey is the best method to understand the different species distribution, abundance and diversity of wild bird in a specific area or a crop land (Issa, 2019). About 816 bird's species occurred in Bangladesh of which 388 are resident, and the rest are migratory (Lepage, 2021; Anonymous, 2012). Population density and species diversity of birds is differing, increasing or decreasing according to habitat type and richness. The avian diversity in agricultural landscapes has been studied by different authors in different states of India. Work has been done on bird composition and diversity in the agricultural fields , Agronomy field, Paddy fields of different part of India (Abdar 2014; Hossain & Aditya 2016; Elsen et al. 2016, Mukhopadhyay & Mazumdar 2017, Narayana et al. 2019; Kumar & Sahu 2020; Jayasimhan & Pramod 2019; Sundar & Kittur, 2013).

However, in Bangladesh there is no systematic and detailed research work has yet been done for protecting birds using netting and bird species diversity in sunflower field. In this context, the present study is designed to document the bird species composition and diversity in sunflower field and also planned for protecting sunflower from pest birds using nylon netting.

Materials and Methods

The experiment was conducted at BARI central research field, Gazipur during robi season of 2020-21. In this study different type of netting were used as mechanical repellent against bird pests. Six treatments were used viz. T_1 = One side netting, T_2 = Two side netting, T_3 = Four side netting, T_4 = Whole crop cover by net, T_5 = Only top of the crop cover by net and T_6 = Untreated control (without netting). The experiment was laid out in RCB design with four replications. BARI Surjomukhi-2 was used as test crop. The unit plot size was 5 X 4 meter. Seeds were sown on 17 December 2020, 50 cm x 25 cm spacing was maintained. The plot was fertilized with 180-150-120-120-10 kg ha^{-1} in the form of Urea, TSP, MoP, Gypsum, Boric acid, respectively in the field. Half of 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 DAS and 45 DAS in the growing season. All intercultural operations were done in proper time for better growth of the crop. Nilon Nettings were tied up over the crops longitudinally and were supported by Bamboo stick and plastic rope. The nylon nets were tie up at the milking stage of the crop. Height of the netting were given special consideration because too high and too low reflectors had no significant effect on visiting bird pests. The netting erected about one foot above the crop was found to give better results. Number of healthy sunflowers, number of damaged flowers, and percentage of damaged flowers caused by pest birds were recorded. The number and types of birds were also recorded. Bird survey data were attained using the point count and direct observations methods which is count from a fixed location for a fixed time period at flowering to maturity of the sunflower crop. This method is suitable for studying highly visible and/or local bird species in a wide variety of habitation. In this study birds were counted from a fixed raising point within a circle of 60 meter distances for a specific period of time (12 hours) every day. After 5 minutes settling period all birds seen and heard within 60 m distance were recorded during the 12 hours periods. Bird counts were started early in the morning from 6 am to 6 pm. Bird counts were divided into three recorded time of the days viz., Morning (6 am 11 am), Noon (11 am – 2 pm) and Afternoon (2 pm to 6 pm). Windy and rainy condition during the day of the study were avoided. A Digital camera and attention were done to confirm species identity. Proofs of identifications were done using Collins Birds Guide (Svensson et al., 2009). Species were assigned to families and order (Lepage, 2021: Clements et al 2019).

The data was analyzed by SPSS verson 26 software and presented as table form. Descriptive statistics (mean and SE) were used to illustrated different Treatment's. To assess and compare the diversity of birds species visited in sunflower field in morning, noon and afternoon by using Margalef species richness (d), Shannon's-Weiner Diversity index (H), Peilou's evenness (E) indices and Simson dominance index (C) (Magurran, 1988; Ferdous et al, 2015; Ulfah et al, 2019).

Margalef species richness (d)

The total number of birds species present in the sunflower field

$$d = \frac{(S-1)}{\text{Log } (N)}$$

Where,
S = Total species,
N = Total individuals
The higher the index greater the richness

Shannon-Weiner Diversity Index (H)

Diversity index (H) states the circumstances of the organism's population mathematically to analyze

the number of individuals in each growth step or genus in a habitat community. The most commonly used diversity index is the Shannon-Weiner index (Odum, 1971)

$H = -\sum(Pi \times \ln Pi)$

Where H = Shannon-Weiner index, $Pi = \frac{ni}{N}$

ni = Number of individuals of a species, N =Total individuals of all species

The diversity index criteria are as follows:'

$H \leq 1$ = Low diversity

$1 < H \leq 3$ = Moderate diversity

$H \geq 3$ = high diversity

Simpson's Index of Diversity (D)

$D = 1 - D'$

$D' = \frac{\sum n(n-1)}{N(N-1)}$

n = Number of individuals of a species, N =Total individuals of all species

The value of this index also ranges between 0 and 1, but now, the higher the index value greater the sample diversity.

Evenness Index

The evenness index (E) describes how evenly represent the number of bird species in sunflower field. The more evenly distributed among bird species, the more balanced the ecosystem will be. The formula used is (Odum, 1971):

$$J = \frac{H}{Hmax}$$

Where E = Evenness index, H = Diversity index, H_{max} = ln S, S = Number of species found The evenness index value ranges from 0 -1. Furthermore, the evenness index based on Kreb, 1989 is categorized as follows:

$0 < E \leq 0.5$ = Depressed community

$0.5 < E \leq 0.75$ = Unstable community

$0.75 < E \leq 1$ = Stable community

The smaller the evenness index, the population uniformity smaller as well. It shows the distribution of the number of individuals of each species is not similar so there is a tendency for one species to dominate. The greater the uniformity value describes the number of biotas in each species the same or not much different.

Simpson dominance Index (C)

An uniformity index and small diversity indicates a high dominance of a species against other species. The dominance index formula as follows (Odum, 1971):

$$C = \sum_{i=1}^{s} \left(\frac{ni}{N}\right)^2$$

Where C= Dominance Index, Where,

ni = number of individuals in the 'each' species,

N = total number of individuals,

S = total number of species,

Index values range from 0 - 1 by the following categories:

$0 < C < 0.5$ = Low Dominance.

$0.5 < C \leq 0.75$ = Moderate Dominance.

$0.75 < C \leq 1.0$ = High Dominance.

Results and Discussion

Effect of netting on bird damage in sunflower differed significantly among the treatment. The highest percentage of head and plant damage were recorded in control treatment 36.06 % and 49.58% respectively where no netting was set compared with all other treatments. The lowest head and plant damage were recorded in the where the whole crop was covered by netting (Table 1). There were no significant differences in all the netting combinations. Consequently, Lower head and plant damage was recorded in all the netting combinations and no significant differences among them. The highest yield kg/plot and t/ha was found in the treatment where the whole crop was covered by net (2.78 kg/plot and 1.39 t/ha respectively) and lowest in control plot (0.70 kg/plot and 0.35 t/ha respectively) (Table 1)

Table 1. Effect of different netting against bird damage and yield of sunflower during 2020-21 at BARI central research farm, Gazipir.

Treatments	% of Head damage	% head damage reduction over control	% of plant damage	% plant damage reduction over control	Yield Kg/plot	Yield t/ha
T_1 = One side netting	6.21 ± 3.23 a	82.79	12.5 ± 4.78 b	74.79	1.45±0.15 b	0.73±0.07 b
T_2 = Two side netting	2.58 ± 2.58 a	92.84	7.5 ±7.5 b	84.87	1.83 ±0.3 ab	0.91±0.17 ab
T_3 = Four side netting	0.50 ± 0.5 a	98.61	2.50 ± 2.5 b	94.96	1.79±0.21ab	0.89±0.11 ab
T_4 = Whole crop cover by net	0.00 a	100.00	0.0 b	100.00	2.78±0.45 a	1.39±0.23 a
T_5 = Only top of the crop cover by net	7.25 ± 4.75	79.90	6.25 ± 3.75 b	87.39	1.8±0.17 ab	0.94±0.08 ab
T_6 = Untreated control	36.06 ± 6.7 b	-	49.58 ± 3.7 a	-	0.70±0.11 b	0.35±0.05 b

Values in a column having same letter did not differ significantly (p=0.05)

Benefit Cost and return analysis of different netting treatments for repelling birds from the sunflower field has been presented in Table 2. The highest BCR (2.49) was obtained from whole crop covered by net treated plots followed by two side (2.58) and one side netting (2.28). However, lowest BCR was obtained from four side netting treated plots (1.47).

Table 2. Cost and return analysis of sunflower as influenced by different types of netting practice during robi season of 2020-21.

	Total yield (t ha^{-1})	Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	MBCR
T_1=One side netting	0.73	43800	40000	3800	2.28
T_2= Two side netting	0.91	54600	43000	11600	2.58
T_3= Four side netting	0.89	53400	52000	1400	1.47
T_4= Whole crop covered by net	1.39	83400	55000	28400	2.49
T_5= Only top of the crop covered by net	0.94	56400	50000	6400	1.77
T_6= Untreated control	0.35	21000	30000	-9000	

- Selling price of sunflower= Tk 60/Kg

The structure of Birds populations visited sunflower field at BARI research field, Gazipur was differed. The acquired data demonstrated that the total number of wild bird species obtained was 17 species belonging to 15 families and 7 orders during the study periods. Passeroformes was the most dominant order (53%) represented 8 families and 9 species (Table 3) followed by order Collumbiformes (2 families 2 species) and order Coraciiformes (2 families 2 species). While the lowest order in numbers were Psittaciformes, Cuculiformes, Accipitriformes and Pelicaniformes, which is illustrated by one species for each. The birds species richness value was highest in the morning (17) and afternoon (9), whereas this was lowest at noon (7) in a days at sunflower field (Table 4). Passeriformes order was the dominant species in our study, this result was also supported by another studies (Hussain and Adity, 20124; Yashmita-Ulman and Singh, 2021; Mahatu et al., 2021; Kumar and Sahu, 2019 and Issa, 2019). A study of avifauna survey maximum birds species were found in agricultural field (51.82%) followed by aquatic system (29.20%) and association with human habitation (18.98%) (Kumar and Sahu, 2020; Hussain and Adity, 2014). The number of different birds visited during flowering and fruiting stage of sunflower was recorded. Bird species richness were higher in the morning (17) and afternoon (9) compared to noon (7), This is probably due to weather condition. The sunshine and temperature were higher at noon compared to morning and afternoon. Our observation revealed that more bird species visited the sunflower in the morning and afternoon compared to noon.

Bird species diversity

The number of species and abundance of each species that live in a specific location is termed as species diversity. A diversity index is a numerical measure of how many different species are in a community (species richness) and how individuals are distributed within those species (species abundant) (You et al, 2009; Issa, 2019). Therefore, Diversity Index is considered as a calculation of variety, which is a useful tool to understand the profile of biodiversity across study area (Bibi & Ali, 2013). The species richness, diversity, evenness and dominance index and shown in Table 5.

In sunflower field in the Morning showed the highest values of diversity index, the total number of birds species were (2067) individuals, Margalef species richness index (d = 1.96), Shannon-Weiner diversity index (H′ = 2.14), and Simpson's Diversity index (= 0.86), while at noon displayed the lowest value of index, the total number were (667) individuals, species richness index (d = 0.92), Shannon-Weiner diversity index (H′ = 1.53), and Simpson's Diversity (D = 0.77). In contrast, evenness index (J′) were higher in afternoon (J′ = 0.82) than in morning and noon (J′ = 0.77).

These results were in link with Issa (2019). They mentioned that the avian diversity is an indication of habitat heterogeneity and the number of species and individuals in an area implies the importance of the area. Each habitat has a specific set of micro environments that is suitable for a species. Bibi and Ali (2013) cleared that the values of Shannon-Weiner Diversity Index usually fall between 1.5 and 3.5, only rarely it surpasses 4.5. The variation in bird diversity, richness and abundance across different habitats might be associated with vegetation composition that make chance in food preference, roosting and nesting sites, predation pressure and disturbance (Hossain & Aditya, 2016, Kiros et al., 2018). Crop composition and farming intensity also influence the species richness and abundance of birds in the agricultural fields (Cunningham *et al*., 2013; Malik *et al*., 2015).

Conclusion

From the study is revealed that lower number of head and plant damage bird were recorded in different netting than control and higher yield was recorded in netting treated plot. Maximum number of bird visited in the morning and afternoon than noon. The present study is the first scientific documentation of avifaunal diversity of sunflower field, BARI, Gazipur. The findings of the present study can be used as a baseline data for further research on conservation and management of existing bird species in the agricultural landscapes.

Table 3. Wild birds species documented from sunflower field at BARI research farm during rabi 2020-21.

English name	Species	Family	Order
Common Myna	*Acridotheres tristis*	Sturnidae	Passeriformes
Peid Myna	*Gracupica contra*	Sturnidae	Passeriformes
House sparrow	*Passer domesticus*	Passeridae	Passeriformes
Black drongo	*Dicrurus macrocercus*	Dicruridae	Passeriformes
Red-vented bulbul	*Pycnonotus cafer*	Pycnonotidae	Passeriformes
Oriental magpie-robin	*Copsychus saularis*	Muscicapidae	Passeriformes
Spotted munia	*Lonchura punctulata*	Estrildidae	Passeriformes
Common tailorbird	*Orthotomus sutorius*	Cisticolidae	Passeriformes
Jungle crow	*Corvus macrorhynchos*	Corvidae	Passeriformes
Rose-ringed parakeet	*Psittacula krameri*	Psittaculidae	Psittaciformes
Common Kingfisher	*Alcedo atthis*	Alcedinidae	Coraciiformes
Indian roller	*Coracias benghalensis*	Coraciidae	Coraciiformes
Pied Cuckoo	*Clamator jacobinus*	Cuculidae	Cuculiformes
Black Kite	*Milvus migrans*	Accipitridae	Accipitriformes
Pond Heron	*Ardeola grayii*	Ardeidae	Pelecaniformes
Spotted Dove	*Streptopelia chinensis*	Columbidae	Columbiformes
Rock Pigeon	*Columba livia*	Columbidae	Columbiformes

Table 4. Wild birds species documented from sunflower field at three parts of the days from BARI research farm during rabi 2020-21.

Morning (6 am – 11 am)	Noon (11 am – 2 pm	Afternoon (2 pm – 6 pm)
Common Myna	Common Myna	Common Myna
Peid Myna	House sparrow	House sparrow
House sparrow	Black drongo	Black drongo
Black drongo	Red-vented bulbul	Red-vented bulbul
Red-vented bulbul	Spotted munia	Spotted Dove
Oriental magpie-robin	Spotted Dove	Rose-ringed parakeet
Spotted munia	Black kite	Jungle crow
Common tailorbird		Oriental magpie-robin
Jungle crow		Rock Pigeon
Rose-ringed parakeet		
Common Kingfisher		
Indian roller		
Pied Cuckoo		
Black Kite		
Pond Heron		
Spotted Dove		
Birds species = 16 (2067)	Birds species = 7 (667)	Birds species = 9 (1394)

Table 5. Diversity of Bird species recorded Sunflower field during rabi 2020-21 at BARI research field, Gazipur.

Diversity Index	Time of the days			
	Morning	Noon	Afternoon	Over all
Margalef Species richness index (*d*)	1.96	0.92	1.11	1.92
Shannon-Wiener Diversity Index (H)	2.14	1.53	1.85	1.93
Simpson's Diversity Index (D)	0.86	0.77	0.82	0.84
Evenness Index (E)	0.77	0.77	0.82	0.68
Simpson Dominance Index (C)	0.17	0.24	0.19	0.16

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CONTROLLING OF BIRD PESTS IN SUNFLOWER CROP USING DIFFERENT REPELLENT TOOLS AT COASTAL AREAS OF BANGLADESH

K.N. Islam and M.S. Alam

Abstract

The experiment for controlling of bird pests in sunflower production was conducted under farmer's field condition in Patuakhali sadar, Patuakhali and Amtoli, Borguna during robi season of 2020-21 to find out the appropriate repellent options. Five management techniques (MT) namely: MT_1= Hanging red ribbon, MT_2= Making scarecrow, MT_3= Plastic bottle windmill, MT_4= Bird repellent mechanical device and MT_5= Control were evaluated. Among the different repellent tools the maximum seed yield of sunflower was obtained from (1.91 t ha^{-1}) Plastic bottle windmill as repellent tool which was followed by (1.90 t ha^{-1}) Bird repellent mechanical device, (1.82 t ha^{-1}) Hanging red ribbon and (1.80 t ha^{-1}) Making scarecrow while the minimum was in (1.50 t ha^{-1}) control. Similarly different repellent tools showed increase in yield of sunflower over control Over the using different repellent tools, the maximum BCR was obtained from (1.50) Plastic bottle windmill used plot followed by (1.46) Hanging red ribbon, (1.40) Bird repellent mechanical device, (1.40) Making scarecrow while the minimum (1.23) was in control.

Introduction

Sunflower (*Helianthus annuus* L.) is a globally important oilseed and a high-value crop. It is very susceptible to birds. So susceptible, in fact, that bird damage can lead to the entire crop being destroyed and abandoned. Bird damage to sunflower is recognized as an international economic problem for sunflower producers. Bird attacks on sunflower crops occur from the sowing stage. Sometimes they occur later - in almost cases - affecting the flower head. Attacks can be very frequent and cause substantial damage to the sunflower crop. However, in order to limit the damage caused by these birds, measures have to be taken to protect the sunflower crop from its inception. Different repellents options may reduce the attacking of bird pests which may help in crop production. Therefore, the present experiment was undertaken to find out the appropriate repellent options for sunflower production and to enhance production of the farmers at coastal areas of Bangladesh.

Materials and Methods

The experiment was conducted under farmer's field condition at Patuakhali sadar, Patuakhali and Amtoli, Borguna during robi season of 2020-21. Five management techniques (MT) namely: MT_1= Hanging red ribbon, MT_2= Making scarecrow, MT_3= Plastic bottle windmill, MT_4= Bird repellent mechanical device and MT_5= Control were evaluated. BARI Surjomukhi-2 was used as test crop. The unit plot size was 33 decimal for each site. Seeds were sown on 17-25 January at Patuakhali sadar and Amtoli which 50 cm x 25 cm spacing was maintained. The trial plot was fertilized with 180-150-120-120-10 kg ha^{-1} in the form of Urea, TSP, MoP, Gypsum, Boric acid, respectively in the field. Half of 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 DAS and 45 DAS in the growing season. All intercultural operations were done in proper time for better growth of the crop. Yield data were recorded properly.

The management techniques are detailed in the table:

Management techniques (MT)	Making required materials	Cost of preparing each device (Tk.)	Per hectare of land		Installation process
			number of required device	Total cost (Tk.)	
Hanging red ribbon	Red ribbon, thin plastic rope etc.	In the case of Hanging red ribbon, approximate Tk. 200 was spent on each 33 decimal of land.		1500	After maintaining the thin plastic rope at a distance of 5 m, a 1.5 feet long red ribbon was cut and tied at 2 feet intervals to the thin plastic rope.
Making scarecrow	Unused handle shirt, thick stiff stick, earthen pot etc.	25	150	3750	Each device was maintained at a distance of 10m x 10m which would require approximate 150 devices per hectare of land.
Plastic bottle windmill	Plastic bottle, red sticky tape, thin stiff stick etc.	20	150	3000	Each device was maintained at a distance of 10m x 10m which would require approximate 150 devices per hectare of land.
Bird repellent mechanical device (**Remarks:** The cost of making each device was estimated at Tk. 3,000. However, if the device is suitable for usable of 3 (three) seasons, the cost of making the device can be economically analyzed at Tk. 1000 per season)	Calling bell, battery, timer etc.	1200 (If the cost of making the device for each season is Tk. 1000 and electricity cost is Tk. 200)	7	8400	Each device was installed at 1 bigha which would require 7-8 devices per hectare of land.

Results and Discussion

The results presented in Table 1 reveal that the yield of sunflower varied by using different repellent tools. The maximum seed yield (1.91 t ha^{-1}) was received from the plot where Plastic bottle windmill was used as repellent tool for controlling of bird pests which was followed by Bird repellent mechanical device (1.90 t ha^{-1}) as repellent tool and the minimum (1.50 t ha^{-1}) was in control. Different repellent tools showed increase in yield of sunflower over control (Table 1). The maximum percent yield increase over control (27.33%) was recorded in Plastic bottle windmill used plot followed by Bird repellent mechanical device (26.67%), Hanging red ribbon (21.33%) and Making scarecrow (20.00%).

Table 1. Performance of yield of sunflower as influenced by using different repellent tools during robi season of 2020-21

Management techniques	BARI Surjomukhi-2				
	Plant height (cm)	Head diameter (cm)	1000 seed weight (g)	Seed yield (t ha^{-1})	% yield increase over control
MT_1	138.83	18.68	60.97	1.82	21.33
MT_2	135.33	18.07	60.11	1.80	20.00
MT_3	142.23	19.53	61.11	1.91	27.33
MT_4	143.53	19.51	62.04	1.90	26.67
MT_5	134.53	16.21	58.66	1.50	-

MT_1 = Hanging Red Ribbon
MT_2 = Making Scarecrow
MT_3 = Plastic Bottle Windmill
MT_4 = Bird Repellent Mechanical Device
MT_5 = Control

The gross margin and benefit cost ratio (BCR) varied depending on the cost of using different repellent tools in the experiment. The maximum gross margin (Tk. 38395 ha^{-1}) was recorded from Plastic bottle windmill used plot followed by Hanging red ribbon, Bird repellent mechanical device and Making scarecrow. Similarly the maximum benefit cost ratio (1.50) was calculated from Plastic bottle windmill used plot followed by Hanging red ribbon, Bird repellent mechanical device, Making scarecrow while the minimum (1.23) was in control (Table 2).

Table 2. Cost and return analysis of sunflower as influenced by different repellent tools during robi season of 2020-21.

Management techniques	BARI Surjomukhi-2				
	Total yield (t ha-1)	Gross return (Tk. ha^{-1})	TVC (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
MT_1	1.82	109200	74705	34495	1.46
MT_2	1.80	108000	76955	31045	1.40
MT_3	1.91	114600	76205	38395	1.50
MT_4	1.90	114000	81605	32395	1.40
MT_5	1.50	90000	73205	16795	1.23

Selling Price Sunflower= Tk 60/ kg
MT_1 = Hanging Red Ribbon
MT_2 = Making Scarecrow
MT_3 = Plastic Bottle Windmill
MT_4 = Bird Repellent Mechanical Device
MT_5 = Control

Conclusion

Considering effectiveness and profitability, it could be concluded that the using of Plastic bottle windmill is the most approach for the controlling of bird pests in sunflower production followed by Hanging red ribbon, Bird repellent mechanical device and Making scarecrow.

Farmers' opinion

- Farmers are very interested in producing sunflower crop if proper measures are taken to control the bird pests.
- Among different repellent tools for controlling bird pests, the Plastic bottle windmill is an effective approach to saving, preparing and using.
- This device is wind dependent but even if there is no air, the birds don't come to the crop field in panic as there is red sticky tape with the Plastic bottle windmill.
- They hope to make this technique more effective and efficient in repelling birds.

LOCAL PEOPLE PERCEPTION AND KNOWLEDGE ABOUT OWLS AND THEIR CONSERVATION IMPLICATIONS IN THREE DISTRICTS OF BANGLADESH

M.S. Alam and A.T.M. Hasanuzzaman

Abstract

A survey work has been done on owl conservation in Rajshahi, Jashore and Gazipur through questionnaire survey to understand the local people perception, knowledge about owls and their conservation. Most of farmers (77.22 %) replied that they had seen only one species whereas 23.33% farmers reported on two species, 3.33% farmers reported on three species. Half of the farmers (50%) mentioned available owl species as Vutum pecha whereas 43.33% farmers mentioned it as Hutum pecha and only 32.22% farmers mentioned it as Laxmi pecha i.e. Burn owl. Most of the farmers (71.11%) respond that they liked owl as bird but 28.89% farmers did not like owl. Majority of the farmers (87.77%) thought that owl had no harmful effect on human and the environment. Most of the farmers (81.11%) thought that owl had no scary effect on human being as well as the environment. Only 18.89% farmer mentioned that it is a dangerous thing. About 85% farmers replied that owl has a beneficial effect on the nature. Only 14.44% farmers thought it has not affected on nature. Majority of the farmers (85.55%) treated owl as a rat feeder whereas 11.11% farmers considered it as environmental protector.

Introduction

Rats are one of the most important pests in crop fields in tropical Asian countries. The female rat becomes sexually mature when it is three or four months old. In plantations and fields, a female rat can reproduce once every two months, giving birth to between four and eight offspring per litter. At this rate, the rat population has the potential to increase 500 times each year. Due to the high reproductive rate of rats, an "explosion" of rat populations is a common occurrence in plantations, if there is not adequate control. The barn owl (*Tyto alba*) has been found to be a very effective biological agent for controlling rats. Its use not only increases farmers' income by reducing rice losses and saving the cost of chemical rat killer, but it also saves crop fields from chemical pollution. An additional benefit is that farmers are less exposed to harmful chemicals.

Globally, local ecological knowledge and its role in wildlife conservation are increasingly receiving much attention (Huntington, 2011; Berkes *et al*., 2000; Mmassy and Roskaft, 2013). Local ecological knowledge is valuable in areas where human communities live inside and around protected areas (Trakolis, 2001; Gandiwa *et al*., 2012). This knowledge is derived from the long-standing relationships between local people and their immediate environment resulting in local people having good understanding about natural resources conservation through resource use, education and conservation awareness programmes (Jalilova and Vacik, 2012; Gandiwa *et al*., 2014). Information about local people's knowledge and perceptions about conservation is important in wildlife conservation and evaluating the success of conservation projects (Soto *et al*., 2001; Sundaresan *et al*., 2012).

The symbolic beliefs often shape the way in which animals are socially perceived and could condition human attitudes toward them. On the one hand, according to the socio- environmental context, they could raise positive protection attitudes or, conversely, they could generate aggressive attitudes which affect biological conservation goals (Campbell and Lancaster , 2010; Silva-Rodríguez *et al*., ,2006; Marques, 2005). For example, in some rural communities, local people believe that certain nocturnal birds bring news (bad and good) when their song is heard in the village. As a result, people traditionally protect these birds, killing them being forbidden (Aillapan and Rozzi, 2004; Silva-Rodríguez *et al*., 2006)

Owl is an important biological control agent for rat management. In Bangladesh owl's species are gradually decreasing day by days due to lack of breeding source and places. Owl creates their nest usually large tree hole. Large trees are gradually destroyed day by day as a result their breeding sources are also decreasing. Local people perceptions and attitude are also important about owl for natural conservation. This type of information is scanty in our country. The study was conducted to know the local people knowledge, perception and attitude about owl and their way of conservation.

Materials and Methods

The survey was conducted during July -December, 2018 in the village of Gazipur, Rajshahi and Jashore districts. The study used an interview-administered questionnaire. The questionnaire included both open-ended and fixed response questions. The questionnaire was designed to evaluate the knowledge and perceptions of local people about Owl. Education and demographic information, including gender and age, were obtained from each respondent. Interviews were conducted in residents' homes, gardens, places of business, or in village streets. Interviewers recorded all responses directly onto standardized survey forms. All interviews were conducted by a research assistant who had successfully completed at least twelve years of Higher secondary education recruited from the local community, through oral interviews carried out during the day in the local language The total response time was approximately 15 - 25 min. The research assistant administering the survey made initial contact in each village with the local village leaders to seek permission. Data were grouped and summed by response category. The responses were recorded on a data sheet and later transcribed into English and entered into a Microsoft Excel 2010 database. Where multiple responses were possible on an open-response question, data are presented as the percentage (%) of respondents giving each response, and may sum to over 100%.

Result and Discussion

This survey work was conducted is three District viz. Rajshahi, Gazipur and Jashore to know the general concept of farmers on owl. Firstly the project scientist asked farmer about the main crop they were cultivated in their field. Majority (84.44%) of farmers reported that rice was their main crop whereas 15.55% farmer reported on wheat and only 11.11% farmers opined that they cultivated vegetables and other crops as their main crop (Table 1).

Almost all farmers were medium to poor farmers. There were some landless farmers cultivated vegetables and other crops as main crop in their homestead areas. They were asked about intensity of rat damage in their crop field. About 51% farmers reported that their crop field was moderately damaged by rat whereas 34.44% farmers reported in highly damaged and only 14.44% famers reported that the intensity at rat damage in their crop field was very high (Table 2).

Scientist of Vertebrate Pest division tried to get some idea about farmer's practices for controlling rodents in their crop field. Most of the farmers (83.33%) were used poison baiting whereas 24.44% farmers were attempted to control rat by setting trap in their crop field. A few of farmers (3.33%) did not use either trap or poison (Table 3). They used only some indigenous techniques for controlling rodents in their crop fields. Farmers were asked either they had seen owl or not? Almost all farmers (97.77%) were familiar with owl whereas only 2.22% farmers had not seen owl in their life (Table 4).

Scientists of Vertebrate Pest division asked them about the number of owl species had they seen in their locality. Most of farmers (77.22 %) replied that they had seen only one species whereas 23.33% farmers reported on two species, 3.33% farmers reported on three species and only 1.11% farmers had seen more than three species is their locality (Table 5). Farmers were asked about the name of owl species. They did not know the species name. They can have mentioned only the local name of available owl species. Half of the farmers (50%) mentioned available owl species as Vutum pecha, Brown Fish Owl whereas 43.33% farmers mentioned it as Hutum pecha, Rock Eagle Owl and only 32.22% farmers mentioned it as Laxmi Pecha i.e. Burn owl (Table 6).

Once upon a time owl was a dangerous thing thus it was considered as evil omen. But now the time has been changed. Most of the farmers (71.11%) responded that they liked owl as bird but 28.89% farmers did not like owl (Table 7). Majority of the farmers (87.77%) thought that owl had no harmful effect on human and the environment, only 14.44% thought owl is not good for us. About 15% farmers reported that it has evil effect on human being (Table 8).

Farmers were asked about the scary effect of owl. Most of the farmers (81.11%) thought that owl had no scary effect on human being as well as the environment. Only 18.89% farmer mentioned that it is a dangerous thing (Table 9). Scientist of Vertebrate Pest division asked them either they were known about the food habit of owl or not. Majority of them (93.33%) were known about the food habit of owl. Out of them, cent per cent opined that rat is the main food of owl whereas 22.22% farmers thought insect is main food and only 7.77% farmers told shrew is the main food of owl (Table 10).

Farmers were asked about the beneficial effect of owl. About 85% farmers replied that owl has a beneficial effect on the nature. Only 14.44% farmers thought it has not affected on nature. Majority of the farmers (85.55%) treated owl as a rat feeder whereas 11.11% farmers considered it as environmental protector (Table 11).

Project scientists asked farmers is owl necessary to conserve? About 61% farmers opined not necessary to conserve whereas 38.89% farmers thought owl should be conserved. Farmers opinion on owl conservation options were recorded. Majority of farmers (76.66%) mentioned that public awareness can be an important tool for owl conservation whereas 15.55% farmers opined on creating un-disturbing habitat and only 7.77% farmers reported on tree plantation (Table 12).

Conclusion

Our observations demonstrate that the ethno-biological approach in schools favors respect toward cultural and symbolic differences, which results in better comprehension about the natural world as well as conservation of local bio-cultural heritage. So, we consider that this information is fundamental for the construction of intercultural plans of education and conservation of wild predatory birds in these three districts.

Table 1. Farmers response on main crop that they cultivated in the study area in 2018-19.

District	Farmers response on			
	Rice	Wheat	Vegetables	Other
Rajshahi (n=30)	23 (76.67%)	10 (33.33%)	7 (23.33%)	
Gazipur (n=30)	30 (100%)	0 (0.00%)	0 (0.00%)	
Jashore (n=30)	23 (76.67%)	4 (13.33%)	3 (10.00%)	
Average (n=30)	25.33 (84.44%)	4.67 (15.55%)	3.33 (11.11%)	

Table 2. Farmers response on damage intensity on rice & wheat by rat in the study area

District	Farmers response on		
	Very high	High	Medium
Rajshahi (n=30)	3 (10,00%)	12 (40.00%)	15 (50.00%)
Gazipur (n=30)	0 (0.00%)	0 (0.00%)	30 (100%)
Jashore (n=30)	10 (33.33%)	19 (63.33%)	1 (3.33%)
Average (n=30)	4.33 (14.44%)	10.33 (34,44%)	15.33 (51.11%)

Table 3. Farmers response on rat management techniques that they generally use for controlling rodents in their crop field.

District	Farmers response on		
	Setting traps	Poisons baiting	Others
Rajshahi (n=30)	16 (53.33%)	24 (80.00%)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	6 (20.00%)	21 (70.00%)	3 (10.00%)
Average (n=30)	7.33 (24.44%)	25 (83.33%)	1 (3.33%)

Table 4. Farmers response on the status of Owl as familiar bird in the study areas.

District	Farmers response on	
	Seen	Unseen
Rajshahi (n=30)	28 (93.33%)	2 (6.67%)
Gazipur (n=30)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	30 (100.00%)	0 (0.00%)
Average (n=90)	29.33 (97.77%)	0.66 (2.22%)

Table 5. Farmers response on number of owl species had they known in the study areas.

District	Farmers response on			
	One	Two	Three	Four
Rajshahi (n=30)	15 (50.00%)	15 (90.00%)	0 (0.00%)	0 (0.00%)
Gazipur (n=30)	30 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Jashore (n=30)	20 (66.67%)	6 (20.00%)	3 (10.00%)	1 (3.33%)
Average (n=90)	21.66 (72.22%)	7 (36.66%)	1 (3.33%)	0.33 1.11%)

Table 6. Farmers response on the name of owl species had they seen in the study areas.

District	Farmers response on species			
	Laxmi	Hutum	Vutum	Others
Rajshahi (n=30)	16 (53.33%)	23 (76.67%)	6 (20.00%)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	0 (0.00%)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	13 (43.33)	16 (53.33%)	9 (30.00%)	0 (0.00%)
Average (n=90)	9.66 (32.22%)	13 (43.33%)	15 (50%)	0 (0%)

Table 7. Farmers response on their choice of Owl as a bird in the study areas.

District	Farmers response on	
	Yes	No
Rajshahi (n=30)	27 (90.00)	3 (10.00%)
Gazipur (n=30)	28 (93.33%)	2 (6.67%)
Jashore (n=30)	9 (30.00)	21 (70%)
Average (n=90)	21.33 (71.11%)	8.66 (28.89%)

Table 8. Farmers response on harmful effect of owl in the study areas.

District	Farmers response on species			
	Yes	No	Evilomen	Others
Rajshahi (n=30)	3 (10.00%)	27 (90.00%)	3 (10.00%)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	30 (100.00%)	0 (0.00%)	0 (0.00%)
Jashore (n=30)	10 (33.33%)	22 (73.33%)	11 (36.67%)	21 (70.00%)
Average (n=90)	4.33 14.44%)	26.33 (87.77%)	4.66 (15.56%)	7 (23.33%)

Table 9. Farmers response on scary effect of owl in the study areas.

District	Farmers response on	
	Dangerous	No
Rajshahi (n=30)	6 (20.00)	24 (80.00%)
Gazipur (n=30)	0 (0.00%)	30 (100.00%)
Jashore (n=30)	11 (36.67%)	19 (63.33%)
Average (n=90)	5.66 (18.89%)	24.33 (81.11%)

Table 10. Farmers response on owl's food habit in the study areas.

District	Farmers response on food habit					
	known	Unknown	Food			
			Rat	Shrew	Insect	Others
Rajshahi (n=30)	30 (100%)	0 (0.00%)	30 (100%)	1 (3.33%)	9 (30.00%)	0 (0.00%)
Gazipur (n=30)	30 (100%)	0 (0.00%)	30 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Jashore (n=30)	24 (80%)	6 (20%)	30 (100%)	6 (20%)	11 (36.67%)	0 (0.00%)
Average (n=90)	28 (93.33%)	2. (6.66%)	30 (100%)	2.33 (7.77%)	6.66 (22.22%)	0 (0%)

Table 11. Farmers response on usefulness of owl in the study areas.

District	Farmers response on				
	Usefulness		Helpful as		
	Yes	No	Ervironmental Protector	Rat feeder	Others
Rajshahi (n=30)	28 (93.33)	2 (6.67%)	6 (20.00%)	24 (80.00%)	0 (0.00%)
Gazipur (n=30)	30 (100%)	0 (0.00%)	0 (0.00%)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	19 (63.33%)	11 (36.67)	4 (13.33%)	23 (76.67)	3 (10.00%)
Average (n=90)	25.66 (85.55%)	4.33 (14.44%)	3.33 (11.11%)	25.66 (85.55%)	1 (3.33%)

Table 12. Farmers response on owl Canservation in the study areas.

District	Farmers response on					
	Need to conserve	Owl conservation options				
	Yes	No	Tree plantation	Not disturbing	Public awrenes	Others
Rajshahi (n=30)	30 (100%)	0	7 (23.33)	8 (26.67)	15 (50.00)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	30	0 (0.00%)	0 (0.00%)	30 (100%)	0 (0.00%)
Jashore (n=21)	5 (16.67)	25 (83.33%)	0 (0.00%)	6 (20.00%)	24 (80.00%)	0 (0.00%)
Average (n=90)	11.66 (38.89%)	18.33 (61.11%)	2.33 (7.77%)	4.66 (15.55%)	23 (76.66%)	0 (0%)

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RELATIVE ABUNDANCE AND DOCUMENTATION OF AVAILABLE OWL SPECIES IN BANGLADESH

M.S. Alam an A.T.M. Hasanuzzaman

Abstract

The study was conducted in three districts (Gazipur, Rajshahi and Barishal) of owl species that are usually found in those areas and documentation and it was carried out during June, 2018 to July, 2020 to know the species of owls are available, their distribution and locality. The study was carried out once in a month and Owls were counted by line transect, point counting and look and see methods and other owl species documentation were recorded by the help of some Facebook group such as Birds Bangladesh, Birds and Wildlife of Bangladesh etc. During the study of the project period 14 species of owl have been recorded and documented. Among them Barn owl, Spotted owlet, Brown Hawk owl, Brown fish owl, Collard scops owl etc were the most abundant species in different zone. All other owl species also presented in different but their density was comparatively lower than others owl species.

Key words: Owl species, relative abundance, documentation

Introduction

Owls are a group of mainly nocturnal (active at night) birds classified as belonging to the order Strigiformes, a group which is most closely related to nightjars (Caprimulgiformes). The order is divided into two families: Tytonidae or Barn Owls and related species, and Strigidae or Typical Owls. A large, round head and huge, forward-facing eyes are features that make an Owl instantly recognizable. They also have a sharp, downward-facing beak (or bill), and soft, cryptically colored plumage. Males and Females are generally similar in appearance, although the female is often up to 25% larger. (Deane Lewis, 2012)

Owls are Raptors, or Birds of Prey, which means they hunt other living things for their food, using their special adaptations and unique abilities that set them apart from any other creature. Exceptional vision, and acute hearing play a major part in an Owl's hunting technique. Couple these with powerful talons and beak, plus the ability to fly silently, and you have a formidable predator, using stealth to hunt down prey. After Eating, Owls regurgitate pellets, which contain the indigestible bones, fur and feathers of their victims. These pellets can be collected by researchers to study Owls' eating habits. (Deane Lewis,2012). Owls are found on all continents except Antarctica, and are absent from some oceanic islands and in a great variety of habitats, from thick forests to open prairies.

Biodiversity is not evenly distributed throughout the world . It may be influence by geography (Karr, 1976). Elevation gradient distributions across the globe are a powerful test system for understanding biodiversity (McCain, 2009). From the last decades, relation between species community composition and elevation at global level is an important theme in ecology. Urbanization and human modification of the natural landscape has profound effects on existing ecological processes occurring at a variety of scales (Crooks, Suarez, & Bolger, 2004; McDonnell, 1997). Species richness and the presence of rare species are two of the most frequently used criteria for the selection of conservation areas (RodriguezFerraro and Blake, 2008). In addition, community composition and relative abundance of target species are important in selecting areas for conservation (Wijesundara. and Wijesundar. 2014).

Owls are not particularly efficient nest builders. Usually, they appropriate an abandoned woodpecker hole or natural tree cavity, or an abandoned crow or hawk nest. Owls are vocal during the nesting season, and may exchange courtship and territorial calls that both enhance the pair bond necessary to raise the young owls, and discourage other intruding owls. *(Rachel B. Tompkins, 1914).* Owls play an important role in the maintenance of a natural balance since they are at the apex of trophic levels in terrestrial and

aquatic ecosystems (Sergio et al., 2008). Understanding the diversity and structure of bird communities is essential to delineate the importance of regional or local landscapes for avian conservation. Determinations of bird population in different habitats are central to understanding the community structure and niche relationships, as well as for intelligent management of populations (Sethy et al., 2015). Moreover, seasonal monitoring is equally important to trace the dynamic movement of owls in such habitats. According to Banglapedia, Bangladesh has 15 species of owls (family Tytonidae: 1 species; family Strigidae: 14 species), of which 3 are endangered, one is vulnerable; seven could not be evaluated due to paucity of data. There is no information how many species of owls are available in our country. Therefore, the present study was undertaken to know the species of owls are available, their distribution and locality.

Materials and Methods

The present study is a list of owl species that are usually found in those areas Gazipur, Rajshahi and Barishal and documentation and it was carried out during June, 2018 to July, 2020, once in a month. Owls were counted by line transect, point counting and look and see methods by using cameras and were identified with the help of taxonomic book. Other owl species documentations were recorded by the help of some Facebook group such as Birds Bangladesh, Birds and Wildlife of Bangladesh etc. Line transect is a tape or string laid along the ground in a straight line between two poles as a guide to a sampling method used to measure the distribution of organisms. The essential feature of line transects is that one walks along a straight path and records the individuals seen and their perpendicular distance from the transect line. The simplest method of counting birds is called a "point count", in which a trained observer records all the birds seen and heard from a point count station for a set period of time. A series of point counts completed over a fixed route can then be compared to the results of the same point counts in other seasons or years. Observations were made by standing and sitting from a hiding place and recorded along with their abundance. Surveys were conducted in the morning hours (6.30 a.m. to 9.30 a.m.) and evening hours (3.30 p.m. to 7.30 p.m.) by a single observer. Samplings were made in seasonal basis for the period of three years (2018 to 2020) using same transect and time. Bird surveys were not performed during heavy rains, fog and during strong winds, since these conditions reduce bird activity and detectability (Sutherland, 2004). No specimens were collected but most of species was taken photographed for reference.

The data collected during the whole study period were analyzed in IBM SPSS 26 statistical software. Analysis of variance (ANOVA) was used to test the hypotheses, and Tukey's HSD post hoc analysis was carried to identify specific variables that differ significantly. To calculate species diversity and richness by using the following formulae.

Shannon-Wiener Index (H') $H' = -\sum\left[\left(\frac{ni}{N}\right)\right)\text{x ln}\left(\frac{ni}{N}\right)\Big]$

Where *ni* = number of individuals or amount (e.g. biomass) of each species (the *ith* species) and *N* = total number of individuals (or amount) for the site, and ln = the natural log of the number.

Simpson's Index, $\boldsymbol{\lambda = \frac{\sum ni(ni-1)}{N(N-1)}}$

Where n_i = number of individuals or amount of each species (i.e., the number of individuals of the *ith* species) and *N* = total number of individuals for the site.

Simpson's Diversity Index, D = 1- $\boldsymbol{\lambda}$

The value of D ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity

Results and Discussion

According to Banglapedia 15 species of owl have been recorded in Bangladesh of them one species was Tytonidae and fourteen species were Strigidade family. The total number of bird species, mean number of species/transects, and their density recorded in various zones are shown in Fig.1 and Fig. 2. Two species of owls were detected in three locations (Fig. 1). The most abundant species of owls were Spotted owlets (mean 2.6 birds/point count and total specie 13.33\location) followed by barn owl in Gazipur whereas barn owl species was recorded higher in Rajshahi (mean 5 1.6/point count and total species) compared to spotted owlet (Fig 1 and Fig. 2). In Barishal more or less equal number of owl species (barn owl and spotted owlet were) recorded.

Distribution of two owl species in three region, Gazipur region had recorded the highest number of Spotted owlet followed by Rajshahi and Barishal region (Fig. 3 and 4). In case of Barn owl distribution Rajshahi had the highest number compared with other two regions and followed by Barishal and Gazipur had the lowest number of barn owl species (Fig. 3 and 4). Among different zones, Spotted owlet was the most abundant in Gazipur and Barn owl for Rajshahi zone.

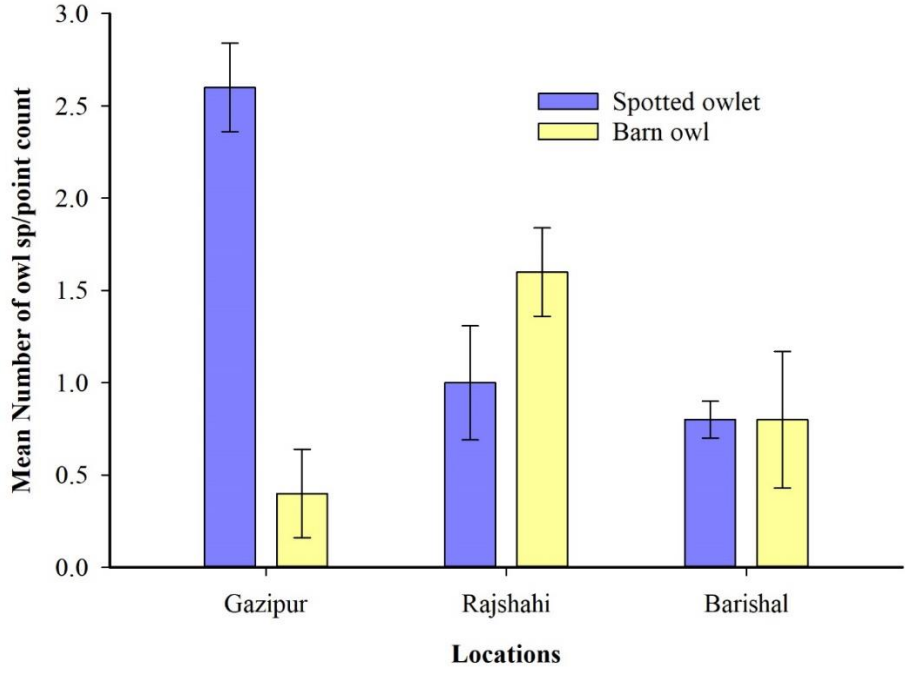

Fig 1. Mean number of owl species/count in three districts of the study areas

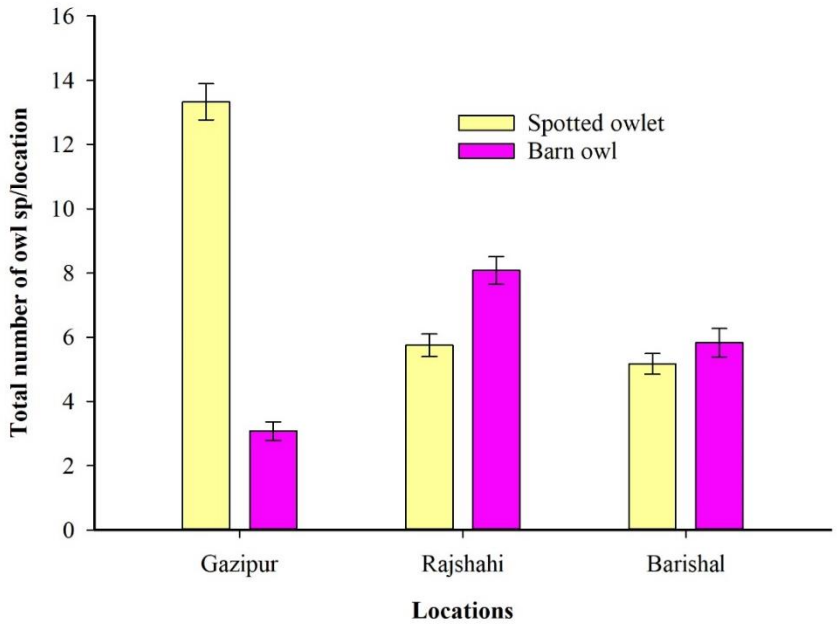

Fig 2. Total number of owl species recorded in three districts of the study areas

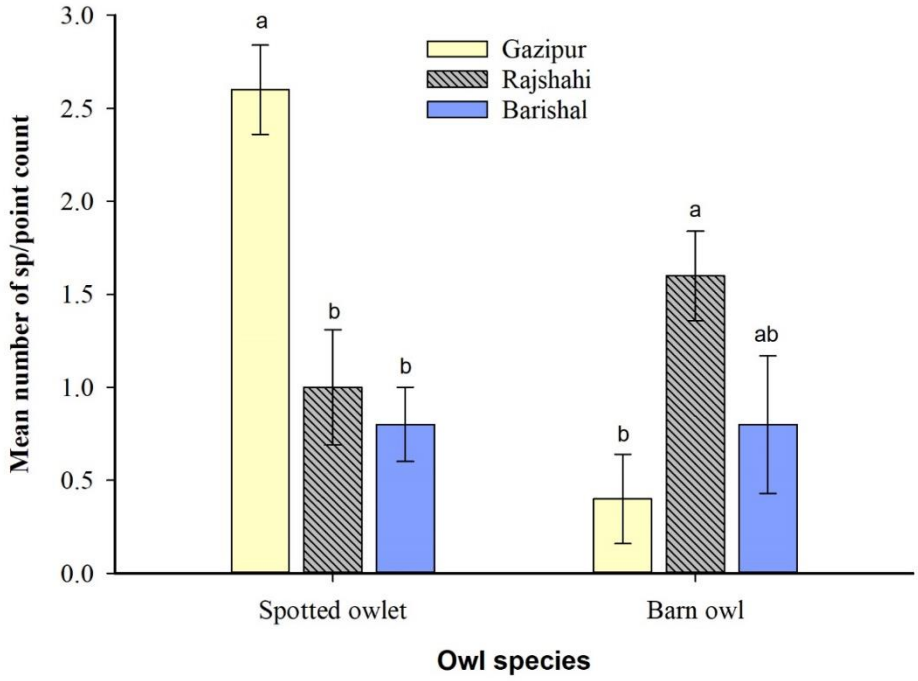

Fig. 3. Abundance of owl species (Mean number/point count) in three districts of the study areas.

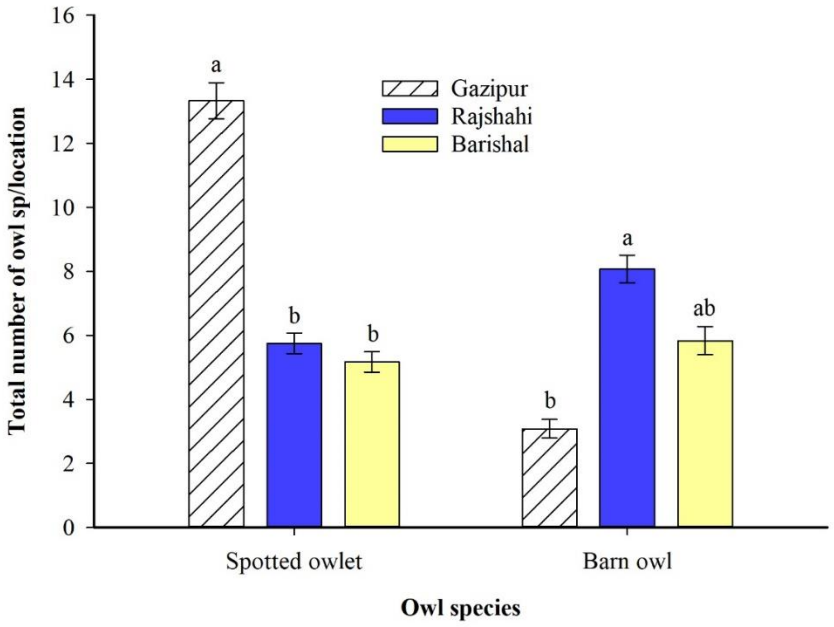

Fig. 3. Abundant of owl species (total species/location) in three location of the study area

Bird species diversity

The species diversity index fluctuated from 0.69 (site- Barishal) to 0.5 (site- BARI Head quarter, Gazipur) (Table 1). The highest diversity was shown in coconut orchard, Barishal Followed by Rajshahi (mango orchard) and the lowest diversity had recorded in Gazipur. Apart from the diversity, species evenness has shown variation in the sites with values of 0.53 (site-coconut orchard, Barishal), 0.523 (site-Mango orchard, Rajshahi), 0.0.38 (site-Gazipur). The variation in species diversity and species evenness at various sites may be due to the influx of visitors, vehicles and local people in and near the campus and the availability of food to the birds.

Shannon's diversity index indicated that Barishal and Rajshahi habitat had higher species diversity (H = 0.69 and 0.687) than Gazipur habitat (H = 0.548) (Table 1). The overall birds' diversity for Barishal, Rajshahi and Gazipur was (H =0.682). On the other hand, the Simpson's diversity index for owl species were 0.533, 0.523 and 0.38 respectively. However, the overall Simpson's diversity index for the three habitats was 0.798. This indicates greater variation in species diversity between the results obtained by using Shannon's and Simpson's diversity indices. This is because Simpson's diversity index takes into consideration relative abundance which is not the case for Shannon's diversity index. The higher diversity in the habitat may be due to high numbers of individuals in some of bird species and diverse vegetation types as microhabitats which favored varieties of bird species. The anthropogenic activities such as parking lots, housing developments and agricultural fields may have changed the diversity in the area which is well reflected by the species composition before human intervention (Sax and Steven, 2003).

Table 1. Species richness and diversity index of owl species in three locations/ study area.

Locations	Shannon-Wiener Diversity Index	Simpson's Diversity Index
Gazipur	0.548	0.38
Rajshahi	0.687	0.523
Barishal	0.69	0.533
Overall	0.682	0.498

During the study of the project period 14 species of owl have been recorded and documented (Anon., 2007, 2013, 2016). The owl species recorded and documented during the study period have been shown in Table 2.

Conclusion

Barn owl, Spotted owlet, Brown Hawk owl, Brown fish owl, Collard scops owl etc were the most abundant species in different zone. All other owl species also presented in different area but density was comparatively lower than others owl species.

Table 2. Different species of owl documented and recorded in different areas of Bangladesh

Sl.No.	Bengali name	English Name	Scientific name	Recorded place in Bangladesh
01	লক্ষী পেঁচা	Barn owl	*Tyto alba*	Rajshahi, Mirpur, Dhaka, Bola, Dhaka, Gazipur, Barishal, Dinajpur,
02	ভুতুম পেঁচা, খয়রা মেছো পেঁচা	Brown fish owl	*Bubo zeylonensis*	Dhaka, Bogra, Nilphamari, Meherpur,Faridpur, Shariatpur, sundarban, Khulna, Thakurgaon, Lakshmipur, Hobigonj
03	খয়রা শিকরে পেঁচা	Brown hawk owl	*Ninox scutulata*	Comilla, Narayangonj, Munsigonj, Dhaka, Chattagram, Gazipur, Moulvibazar, Rajshahi, Magura
04	মেটে মেছোপ্যাঁচা	Buffy Fish Owl	*Ketupa ketupu*	Sundarban, Khulna
05	নিমপোখ, কণ্ঠী নিম পেঁচা	Collared Scops Owl	*Otus lettia*	Mymensingh, Brahmanbaria, Satkhira, Hobogonj, Pirojpur, savar, mirpur, Dhaka, Rajshahi, Narayanganj, Jashore, Jhenaidah
06	ভরতীয় নিম পেঁচা	Indian Scops Owl	*Otus bakkamoena*	Thakurgaon, Rajshahi, Natore, Pabna
07	ছোট নিম পেঁচা	Oriental Scops Owl	*Otus sunia*	Rajshahi, Sylhet
08	এশীয় পেঁচা	Asian barred owlet	*Glaucidium cuculoides*	Rangamati, Hobigonj,
09	দাগিঘাড় কুটি প্যাঁচা	Collared Owlet	Glaucidium brodiei	Bandarban
10	খুড়ুলে পেঁচা	Spotted Owlet	*Athene brama*	Gazipur, Barishal, Rajshahi, Dhaka, Rangpur, Chandpur, Thakurgaon, Chattagram, Dinajpur
11	ছোটকান প্যাঁচা	Short Eared Owl	*Asio flammeus*	Rajshahi
12	মেটে হুতোম প্যাঁচা	Dusky Eagle-owl	*Bubo coromandus*	Sundarban
13	খয়রা গেছো প্যাঁচা	Brown Wood Owl	Strix leptogrammica	Diginala, Khagrachari, Lawachara, Moulvibazar
14	চিতি-পেট হুতুম পেঁচা	Spot-bellied eagle-owl -	*Bubo nipalensis*	Khagrachari, Chattagram, Bandarban

Sources: Anon., 2007, 2013, 2016

Pictorial view of different owl species

Barn owl

Brown fish owl

Brown hawk owl

Asian Barred owl

Spotted owlet

Buffy fish owl

Dusky eagle owl

Spotted beiled eagle owl

Short eared owl

Brown wood owl

Collared owlet

Collard scops owl

Indian scops owl

Oriental scops owl

Sources: Anon., 2007, 2013, 2016

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DIET OF BARN OWL, *Tyto alba* AND SPOTTED OWLET, *Athena brama* REGURGITATED PELLETS AT LOCATIONS OF GAZIPUR AND RAJSHAHI

M.S. Alam and A.T.M. Hasanuzzaman

Abstract

The diet of the Barn Owl Tyto alba and the Spotted Owlet *Athene brama* were studied in the habitat of Gazipur and Rajshahi district, Bangladesh, during January 2019 to July 2020. Regurgitated pellets of these two owl species were analyzed to understand their dietary composition. Regurgitated pellets collected from two locations in Bangladesh determined barn owl and spotted owlet average weight, length, breadth and thickness to be 5.82g, 47.95 mm, 30.43 mm and 20.29 mm, and 2.33g,26.14 mm, 15.66 mm and 11.94 mm respectively. The diet of barn owl mainly comprised small mammals such as rat, (47.85%), Shrew (27.27%) and insect coleoptera (4.88%), crab (1.73%). Spotted owlet pellets contained small mammals only mice (32.29%), followed by insect (38.72%) of them coleoptera (23.92%), Orthoptera (9.29), Hemiptera (3.28%), Odonata (2.23%), snail (2.14%) and crab (6.75%) and unidentified (15.74%). The remains of insect and crab in the pellets comprised of wing, legs, heads, shell etc.

Introduction

The barn owl (*Tyto alba*) and the spotted owlet (*Athene brama*) reside the agroecosystems of different habitat of Bangladesh, where most of the cultivations are concentrated. The barn owl is a cosmopolitan species residing both hemispheres and is well adapted to the subtropical and the temperate areas of the world. In Bangladesh, the barn owl is distributed in where large tree hollows and suitable man-made buildings offer nesting and roosting shelters. Various species found in Bangladesh among them the spotted owlet, *Athena brama* is the most common small-size owl. Both species are sympatric in Bangladesh Agricultural Research Institute campus, Gazipur and On-farm Research Station, Shampur, Rajshahi.

The diet of the barn owl in Pakistan consists exclusively of rodents and the house shrew (*Suncus murinus*; Ali and Ripley, 1969). The barn owl population of arid southern Australia mainly feeds on rodents (Morten and Martin, 1979). In Europe, three groups of small mammals, i.e., voles (Microtidae), shrews (Soricidae), rats and mice (Muridae) are predominant with regional variations (Pikula et al., 1984; Brunet-Lecompte and Delibes, 1984; Smal, 1987; Taylor, 1994). Mahmood-ul-Hassan et al. (2007b) reported that in six districts of central Punjab 75% of the diet of the barn owl is due to *Suncus murinus* while murid rodents contribution is 28% and that of birds is 4.2%. The diet of barn owl studied in India mainly comprised small mammals such as *Suncus murinus* (61.53%) and Mus booduga (23.07%) and bird ()7.69%) (Patki et al, 2014). The diet of the Barn Owl mainly comprised small mammals such as *Suncus murinus* (51.9%) and *Rattus rattus* (28.6%), while the diet of the Spotted Owlet comprised mostly arthropods (84.9%); Coleoptera (40.9%) and Orthoptera (32.4%). in Tamil Nadu, India (Ali and Santhanakrishnan, 2012).

Spotted has adapted to varied environments such as parks, groves, agricultural fields, abandoned buildings in garden and villages, towns and crowded cities, and any open area with trees substantial enough to provide adequate roosts (Sridhara 1981; Ali & Ripley 1987). It roosts in small groups in hollows of trees or branches or in cavities of rocks or buildings. It is nocturnal and generally crepuscular, but is sometimes seen in the day. It feeds on diverse prey such as rodents, small birds, reptiles, amphibians and invertebrates such as insects and annelids (Pande et al. 2004, 2007).

Spotted owlet feeds mainly on insects and small mammals. The diet of the owlet population of central Punjab is mainly due to insects while small mammals are of secondary importance (Beg et al., 1990; Shah and Beg, 2001; Shah et al., 2004). Mahmood-ul-Hassan et al. (2007a) reported that in spite of the

numerical dominance of insects, small mammals account for 98% of the biomass the owlet consumes. In Jodhpur (India), the owlet consumes more rodents, especially *Mus* spp., prior to the breeding season (Jain and Advani, 1984). The spotted owlet has also been reported to prey on bats, toads, small snakes, scorpions and mollusks (Jadhav and Parasharya, 2003; Pande et al., 2007).

Owls generally swallow their prey whole or in large pieces, and the indigestible parts (hair, bones, exoskeleton, etc.) are regurgitated in the form of a pellet. The pH of an owl's stomach is less acidic than that of many other predatory birds, and hence most of the bones of ingested prey are left undigested (Smith & Richmond 1972). The skulls and lower jaws of even the most delicate small mammals and birds are found intact in pellets and can easily be identified (Taylor 1994). Owls are known for their important role in biocontrol of pests (Pande & Dahanukar 2011).

Pellet analysis of owls can provide information on the existence of prey species within the owl's range, its capability to take such prey and relative abundance of prey species in the owl's diet. Such study is very important not only for its significance in conservation but also for their predatory potential, as they are the main predators of insects and on-insect pests of forestry and agricultural importance. No information is available about their diet composition from Bangladesh. The present study is the first of its kind from Bangladesh recording information on the dietary composition of Barn owl and Spotted Owlet around their nesting and roosting sites.

Martials and Methods

The study was conducted at BARI Head quarter central farm, Gazipur and Shampur, Rajshahi During January 2019 to October 2020. The geographical location of Gazipur is between and the Shampur, Rajshahi is between Latitude: 24.37175 N 24°22'18.28952'' to Longitude: 88.66124 E 88°39'40.45795''.The regurgitated pellets of barn owl and spotted owlet were collected from two site.

Pellet analysis

Pellets were collected from BARI research field, Gazipur and Rajshahi. Total 40 pellets of barn owl, *Tyto alba* and 25 pellets of spotted owlet, *Athene brama* were collected form Gazipur and 20 pellets of barn owl and 15 pellets of spotted owlet were collected from the roosting site of Rajshahi district. Regurgitated pellets found at all the sites were collected in polythene bags and brought to the laboratory. In the laboratory, pellets were kept at 60^0C in a hot air oven for 24hr to kill the associated insects and any other infectious agent. These pellets were then used for analysis. All the pellets were first weighed on electronic balance and then their morphometric measurements, i.e., length (mm), breadth (mm) and thickness (mm) were recorded. To record the diet composition of the Spotted Owlet and Barn owl, each pellet was first soaked in 8% sodium hydroxide solution for about two hours as described by Neelanarayanan *et al*. (1998) and Mittal (1997). This solution assisted in easy separation of the osseous remains (skulls and other bones) and chitinous contents (undigested insect remains) from other contents like hair, debris etc. The contents were then sieved to separate all the prey remains from the dust and soil particles. To completely separate the prey remains from these unwanted components, a number of washings were given. Then the prey remains were put on filter paper and dried in an oven for 24hr at 60^0C. After complete drying, the skulls, bones, feathers, beaks and insect remains were separated out for identification of prey items (Shehab, 2005; Malhotra and Singla, 2018).

The length and breadth of the pellets were measured by using a Vernier scale and the pellets were weighed using an electronic balance. At the time of analysis, each pellet was put in warm water for softening. The pellet material was disentangled carefully with tweezers. Using a magnifying glass or a binocular microscope the prey items (viz. hairs, feathers, skulls, beaks, and claws) were identified. Fragments of exoskeletons of insects were also separated. The biomass was calculated by multiplying the number of prey items found in pellets by the mean body mass and expressed as a percentage of total biomass consumed (Nadeem et al, 2012). Descriptive statistics (mean and SE) were used to illustrate



Barn owl regurgitated pellets



Different bone and scull of rat from barn owl analyzed pellet


Different appendages of insects and crab of spotted owlet analyzed pellet

Different appendages of insects, crab and different seeds of spotted owlet analyzed pellet

Different bone of mouse, rice husk and snail from spotted owlet analyzed pellet

different diet and size of pellets. To assess and compare the diversity in the diet of two owl species by using Margalef species richness (d), Shannon's-Weiner Diversity index (H), Peilou's evenness (E) indices and Simson dominance index (C) (Magurran, 1988; Ferdous et al, 2015; Ulfah et al, 2019).

Margalef species richness (d)

The total number of prey species in the diet of owl

$$d = \frac{(S-1)}{\text{Log } (N)}$$

Where,
S = Total species,
N = Total individuals
Higher the index greater the richness

Diversity Index

Diversity index (H') states the circumstances of the organism's population mathematically to analyze the number of individuals in each growth step or genus in a habitat community. The most commonly used diversity index is the Shannon-Weiner index (Odum, 1971)

$$H = -\sum(Pi \times \ln Pi)$$

Where H = Shannon-Weiner index, Pi = $\frac{ni}{N}$
ni = Number of individuals of a species, N =Total individuals of all species
The diversity index criteria are as follows:

$H \leq 1$	= Low diversity
$1 < H \leq 3$	= Moderate diversity
$H \geq 3$	= high diversity

Evenness Index
The evenness index (E) describes how evenly represent the number of prey species in the diet of owl. The more evenly distributed individuals among species, the more balanced the ecosystem will be. The formula used is (Odum, 1971):

$$J = \frac{\mathrm{H}}{\mathrm{Hmax}}$$

Where E = Evenness index, H = Diversity index, H_{max} = ln S, S = Number of species found
The evenness index value ranges from 0-1. Furthermore, the evenness index based on Kreb, 1989 is categorized as follows:

$0 < E \leq 0.5$	= Depressed community
$0.5 < E \leq 0.75$	= Unstable community
$0.75 < E \leq 1$	= Stable community

The smaller the evenness index, the population uniformity smaller as well. It shows the distribution of the number of individuals of each species is not similar so there is a tendency for one species to dominate. The greater the uniformity value describes the number of biota in each species the same or not much different.

Simpson dominance Index
An uniformity index and small diversity indicates a high dominance of a species against other species. The dominance index formula as follows (Odum, 1971):

$$C = \sum_{i=1}^{s} \left(\frac{\mathrm{ni}}{\mathrm{N}}\right)^2$$

Where C= Dominance Index, Where,
ni = number of individuals in the 'each' species,
N = total number of individuals,
S = total number of species,
Index values range from 0 - 1 by the following categories:
$0 < C < 0{,}5$ = Low Dominance.
$0{,}5 < C \leq 0{,}75$ = Moderate Dominance.
$0{,}75 < C \leq 1{,}0$ = High Dominance.

Result and Discussion

Pellets morphometric characters

A total of 60 pellets of Barn owl were collected from Gazipr and 25 pellets collected from Rajshahi. The pellets were found to black when collected fresh or dark grey in colour when dry. The old pellets were pale in colour and loosely bound. The size of pellets varied from small to large depending upon the number and size of prey consumed. The average weight of fresh barn owl pellets were 7.64 ± 0.64g and dry 5.73 ± 0.51g with a range of 2 to 17g in Gazipur and the pellets weight have no significant difference between the weight of Gazipur and Rajshahi collected pellets (Table 1). The morphometric measurement of all the pellets collected revealed average length of 47.41±2.32 mm, 48.5 ±2.51 mm

(range 25.0 – 88.0 mm), breath 28.10± 1.83 mm, 32.75 ± 1.62 mm (range 10.0 – 65.0 mm) and thickness 18.28 ± 1.32 mm, 22.30 ±1.54 (range 8.0 - 43.0 mm at both Gazipur and Rajshahi district respectively. The weight the barn owls' pellets of our study area were larger in size. The weight of barn owl pellets recorded the present study are similar to those in other works (Alvarez-Castaneda et al., 2004, Nadeem et al., 2012).

A total 40 pellets (25 from Gazipur and 15 from Rajshahi) of spotted owlet were collected fron two locations. The pellets were dark black to brown in colour. The average length of pellets of spotted owlet were 27.0 ± 1.93 mm, 25.27± 2.11 mm (range 13.0 – 40.0 mm), breath 15.04 ± 1.35 mm, 16.27± 1.47 mm and thickness were 11.6± 0.97 mm, 12.27 ± 1.51 mm at Gazipur and rajshahi location respectively. The average weight of regurgitated pellets were found 4.27± 0.60 g and 3.04 ± 0.34 g (range 1.0 – 5.99 g) at Gazipur and Rajshahi locations respectively (Table 1). The pellets length, breath, thickness and weight of spotted owlet had no significant differences between two locations. The weight, length and breadth of spotted owlet pellets reported in the present study are similar to those reported to other works (Malhorta and Singla, 2018; Ali and Santhanakrishnan 2012; Nadeem et al, 2012).

Table 1. Size and shape and weight of Pellets of Barn owls and Spotted owlet collected from Gazipur and Rajshahi district in Bangladesh

Owl species	Locations	Length (mm)	Breath (mm)	Thichness (mm)	Weight (g)	
					Wet	Dry
Barn owl	Gazipur	47.41±2.32	28.10± 1.83	18.28± 1.32	7.64 ± 0.64	5.73 ± 0.51
	Rajshahi	48.5 ±2.51	32.75 ± 1.62	22.30±1.54	8.20 ± 0.57	5.90 ± 0.45
Spotted owlet	Gazipur	27.0 ± 1.93	15.04 ± 1.35	11.6± 0.97	4.27± 0.60	2.63 ± 0.31
	Rajshahi	25.27± 2.11	16.27± 1.47	12.27 ± 1.51	3.04 ± 0.34	2.03 ± 0.29

Diet of barn owl pellets

The regurgitated pellet consisted of hair, small pieces of vertebrate bones whole insect or pieces of insect integuments, insect appendages etc. However, some of this material was so crushed that it was very difficult to identify the taxa to which they belonged. Vertebrate bones found in the Owl pellet, formed the basis of identification of small mammals.

All the barn owl pellets collected from two locations were found to contain bones and insect remains. Remains of total 314 prey items were found in 65 pellets. These were of 56 rat, 26 shrew, 3 mice), one frog (unidentified), 15 snail, 11 crabs, 89 coleopteran insects, 31 orthopteran insects, 15 Homopteran insects, 10 different seeds and 39 unidentified materials (Fig. 1).

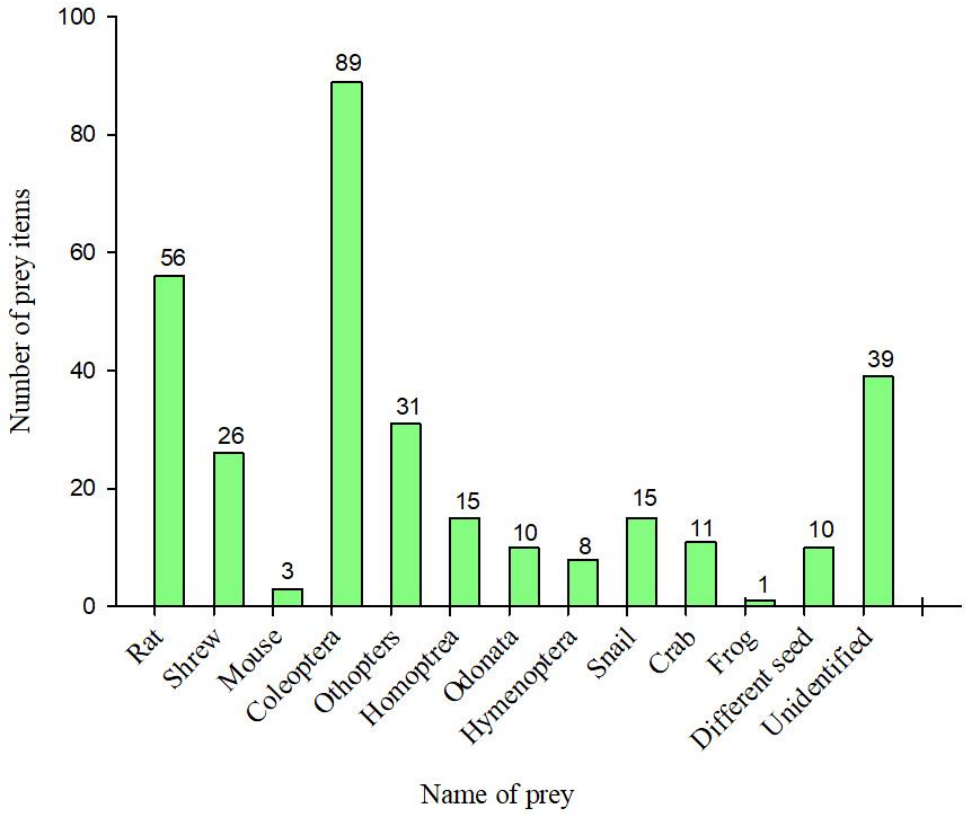

Figure 1. Total number of prey items found in pellets of Barn owl at the locations.

Analysis of 39 pellets of barn owl in Gazipur, numerically the diet contained vertrebrate 48.84% and 30.41% insect 20.75% other invertebrate species (Table 2). Among the small mammals, rat was 42.51%, followed by Shrew, *Suncus* sp (4.14%) and *Mu*s sp (2.19%). Among the insect the coleoptera order were contributed (14.72%) Orthoptera (10.38%) and Homoptera (2.56%). In case of Biomass, vertebrate contributed 66.39%, and insect and other invertebrate contributed 33.61% of the die. In Gazipur. Other's invertebrate diet contain snail, frog, crab and also contain different seeds. However 25 pellets in Rajshahi numerically 65.89% diet of barn owl contain small mammals and insect only 4.26%, followed by crab (2.74%) and different seed (18.5%) was also presented in diet. Small mammals contributed 32.65% rat and 33.24% *Suncus* sp. Whereas as % biomass small mammals contributed 89.32% of the total diet of barn owl in Rajshahi site. Different seed contained rice husk, date seed, brinjal, pumpkin, different spices etc. The diversity and species richness index revealed that both value were higher in Gazipur than Rajshahi indicated that more species and more diverse foods were consumed by barn owl in Gazipur than Rajshahi. However evenness and dominance index showed that the barn owl is not more or less dependent on one prey species (Fig. 2).

Table 2. Comparative Picture of Prey Frequencies (% Number) and biomass (%) consumed by barn owl at Gazipur and Rajshahi district in Bangladesh.

Prey Items	Gazipur		Rajshahi	
	% Number	% Biomass	% Number	% Biomass
Rat	42.51	54.45	32.65	41.16
Shrew, Suncus sp	4.14	6.32	33.24	48.16
Mus species	2.19	5.94	-	-
Coleoptera	14.72	8.74	4.26	1.02
Othopters	10.38	2.69	-	-
Homoptrea	2.56	0.65	-	-
Odonata	2.49	0.44	-	-
Hymenoptera	0.26	0.09	-	-
Millipeds	0.27	0.14	-	-
Snail	0.93	1.45	-	-
Crab	0.10	0.86	2.74	2.60
Frog	0.21	0.53	-	-
Different seed	7.26	7.23	18.50	3.20
Unidentified	4.73	4.69	8.59	3.84

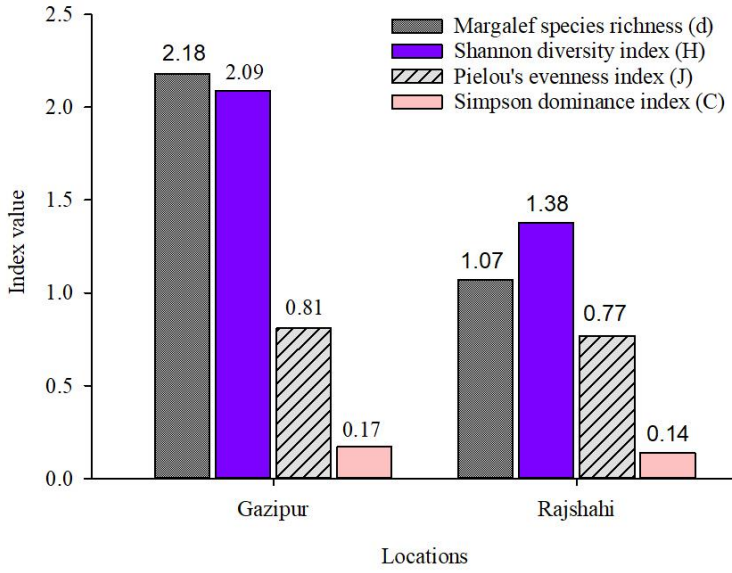

Figure 2. Prey diversity in the diet of barn owl at two locations of Gazipur and Rajshahi.

Diet of Spotted owlet pellets

All the Spotted owlet pellets collected from two locations were found to contain bones and insect remains. Remains of total 341 prey items were found in 40 pellets. These were of 35 rodents (only mice mice), eight snail, 14 crabs, 108 coleopteran insects, 47 orthopteran insects, 31 Hemipteran insects, 25 Odonata, 21 Hymenoptran insect, seven different seeds and 45 unidentified materials (Fig. 3).

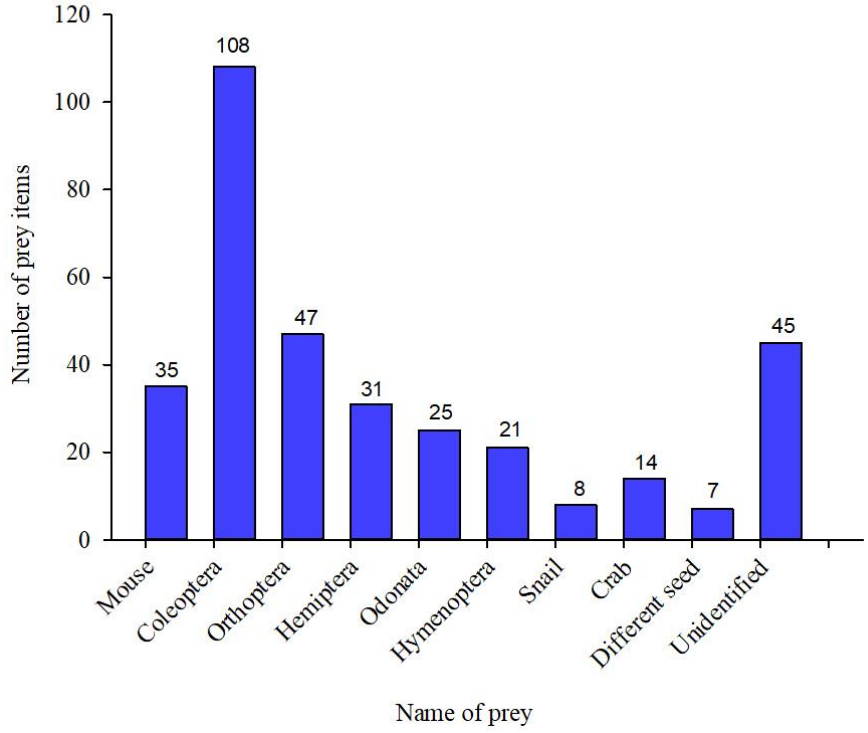

Figure 3. Total number of prey items found in pellets of Spotted owlet at the locations.

The diet of spotted owlet contains *Mus s*p, insect, snail, crab and different seeds. The remnants of insects in the pellets of the owl comprised wings, legs, antennae and head. On the basis of these remnants, insects belonging to the orders Orthoptera (Grasshoppers), Hemiptera (Bugs), Coleoptera (Beetles) were recorded from the pellets. Analysis of 25 pellets of spotted owlet in Gazipur showed that insects (55.56%) were numerically predominant followed by small mammals only mus sp (7%), snail (2.29%), Crab (2.24%) and different seed (17.37%) (Table 3). However, most of the biomass consumed was due to insect (41.62%) followed by small mammals (15.52%), followed by snail (2.67%), Crab (4.66%) and different seed (16.26%). Fifteen pellets analyzed in Rajshahi During the collection period, the owlet seemed to feed more dependent on small mammals (Table 3), both by numbers and biomass consumption (32.13%; 49.06%), only *Mus sp* was consumed. Insects dominated through numbers (53.48%), but their contribution through biomass was only 38.96%. Crab was also consumed during this period, while frogs were not eaten and contributed only 3.42% by number and 8.84% through biomass. The diversity and species richness index revealed that both values were similar to Gazipur and Rajshahi indicated that more species and more diverse foods were consumed by spotted owlet in both Gazipur and Rajshahi. However evenness and dominance index showed that the spotted owlet is not dependent on one prey species (Fig. 4).

Table 3. Comparative Picture of Prey Frequencies (% Number) and biomass (%) consumed by spotted owlet at Gazipur and Rajshahi district in Bangladesh.

Prey Items	Gazipur		Rajshahi	
	% Number	% Biomass	% Number	% Biomass
Mouse	7.0	15.52	32.13	49.06
Coleoptera	27.19	22.35	29.22	25.49
Othopters	14.08	11.08	10.60	7.50
Homoptrea	4.16	2.90	7.09	3.65
Odonatan	6.54	3.50	3.04	0.96
Hymenoptera	3.59	1.97	3.53	1.36
Snail	2.29	2.67	1.53	1.60
Crab	2.24	4.66	3.42	8.84
Different seed	17.37	16.26	-	-
Un-identified	20.53	23.31	10.47	8.16

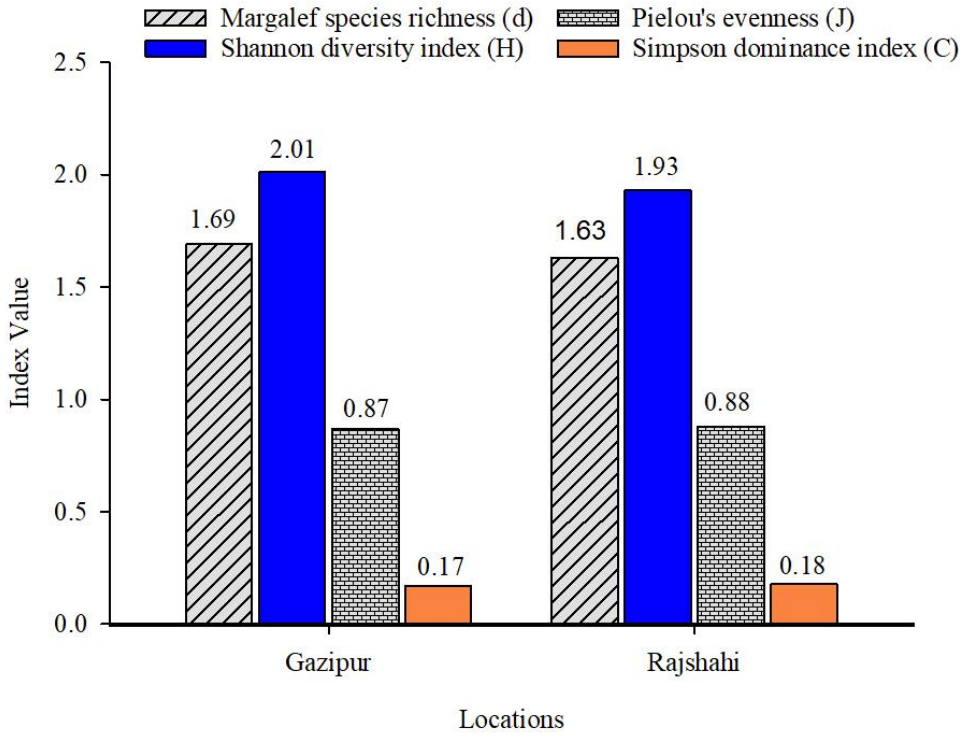

Figure 4. Prey diversity in the diet of barn owl at two locations of Gazipur and Rajshahi.

Discussion

As pellet analysis serves as nondestructive means of diet determination for both prey and predator (Talmale & Pradhan, 2009), the present study is aimed to accurately identify the prey species data for the studied owlet species. For the first time, key identifying characters of the dung beetles along with the illustrations were provided which may further be used by naturalists and conservationists for identification of these taxa in the pellets of spotted owlet (Paunikar et al, 2015). The study on the pellets of owl is ecologically and in conservation point of view very significant as it reveals the faunal diversity of insects, amphibian, reptiles and small mammals occurring in the area and this data can further be utilized in conservation planning and management of barn owl and spotted owlet species in Bangladesh.

The size and weight of barn owl pellets were larger in our study this was also described by other study (Hassan, 1998; Ahmad, 2000; Alvarez-Castaneda et al., 2004, Nadeem et al., 2012) The pellets size varied considerably throughout the year due diet and size of prey consumed. Supported by Stegemen (1957) and Hardy (1977) stated that the size of the pellets greatly varied, which depended on the composition of the diet and the size as well as nutritive value of taken prey. The barn owls of our study preyed on rat, shrew regularly, produced larger pellets perhaps because of the presence of bone, scull, crab in them. In our study higher number of shrew and lower species diversity were found in Rajshahi compared to Gazipur because Rajshahi agriculture farm were rice and wheat ecosystem and surrounded nearby human residential area, whereas Gazipur was diverse ecosystems and more species diversity were recorded in diet. Nadeem et al., (2012) studied the pellets of barn owl and spotted owlet at Punjab, Pakistan and observed that the barn owl mainly consumed *Suncus murinus* (60.2%), birds (24.1%) and rodents (12.7%), while the spotted owlet depended on *Mus* species (36.8%), *Suncus murinus* (20.1%), birds (14.1%), reptiles (8.9%) and insects (6.7%) for its food. In the present study 42 – 89% contributed small mammals (rat, 42.51%, shrew, *Suncus* sp 48.16%) and insects contributed 4.26 – 30.41%.

In the present study among rodents, mouse, *Mus* sp found to be the major contributor of spotted owlets diet. Among invertebrate, the diet mainly consisted of insect followed by snail, crab. Insect consumed by spotted owlet were mainly of orders coleoptera, followed by orthoptera, hemiptera, odonatan, hymenoptera and some unidentified order. Different authors have reported the diet of the spotted owlet covering of insect, earthworms, mice, lizards, frogs, and birds (Sandhu 1978; Majumdar 1984; Ali & Ripley 1987). In our present study, however, the remains of earthworms, lizards, frogs, and birds were not observed in the pellets of spotted owlet. Zade et al. (2011) examined 52 pellets of Spotted Owlet in Maharashtra, India and determined the percent relative frequency of occurrence of various food remains. The study revealed that insects belonging to the orders Orthoptera (Grasshoppers), Hemiptera (Bugs), Coleoptera (Beetles) and Dermaptera (Earwig) occupied 78.84% of the diet followed by small mammals (38.46%). The remnants of insects in the pellets comprised of wings, legs, antennae and head. Ali & Santhanakrishnan (2012) observed the diet of the Spotted Owlet comprising mostly of arthropods (84.9%), i.e., Coleoptera (40.9%) and Orthoptera (32.4%) insects followed by vertebrates (12.1%). Malhorta and Singla (2018) found insects alone constituted 53.8% and small mammals constituted 45% of the diet of Spotted Owlet. In the present study insect alone contributed 51.13% and small mammals contributed 32.13% of spotted owlet diet.

Paunikar et al. (2015) examined the food habits of the Spotted Owlet in Tropical Forest Research Institute campus, Jabalpur, India by analyzing their regurgitated pellets and observed the remnants of three dung beetle species, *Onitis philemon, Onitis virens* and *Onitis brahma* and five species of small mammals, *M. booduga, Vandeleuria oleracea, M. meltada, Suncus etruscus* and *Suncus murinus*. In the present study, however, the diet of Spotted Owlet was found constituted only of *Mus sp* among small mammals, particularly the rodents.

Conclusion

The presence of remnants rat, shrew, mice among different rodent species found in the diet of Barn owl and Spotted Owlet in the present study indicates their potential in regulating rodent populations in crop fields as one of the components in integrated rodent pest management. Studies may, however, be taken to attract them to the crop fields by installing artificial nest boxes, X-shaped perches or poles.

Acknowledgement

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ASSESSMENT OF RAT DAMAGE SURROUNDING THE WATCH TOWER AREAS AND NEST BOX OCCUPATION BY OWL

M.S. Alam and A.T.M. Hasanuzzaman

Abstract

A study was carried out to assessed the rat damage around the watching tower and the effectiveness of nest box for owl occupation at Rajshahi and Gazipur district. watch towers were set at the field and nest box were installed in different tree above 12-15 feet from the ground level in both the location. Wheat, Barley, Potato, Sweet potato and Groundnut crop damaged by rat were assessed at 0-25, 26-50 and 51-75 meters apart around the watch tower areas. Nest box occupancy was also recorded for nesting and roosting by owl. Percent rat damage in different growth stage of wheat and barley differed significantly in active burrow count methods and cut uncut methods around the owl watching tower areas. Significantly the lowest number of active burrow (0.6) was recorded in 0-25-meter distance around the watching tower followed by 25-50m distance and the highest number of active burrows was observed in 50-75 m distance from watching tower both in Rajshahi and Gazipur. Rat damaged and number of active burrows were higher as increase the distance from the watch tower areas. In Rajshahi 55 % nest boxes were occupied by owl whereas 50 % nest boxes were occupied by ow. In Gazipur maximum nest box were occupied by spotted owlet (*Athena brama*) and in Rajshahi most of the nest box occupied by barn owl (*Tyto alba*).

Key words: Owl, watch tower, rat damage, nest box, occupation

Introduction

Rodents considerably damage agricultural production around the globe. Asia, Singleton (2003) estimated losses of 5-10% in annual rice production. Rats are the serious pest of wheat crop throughout southern Asia causing damage from 3.5 to 12% (Bindra and Sagar, 1968; Sood and Guraya, 1976; Ahmad, 1986). According to Ahmed et al. (1986) rat cause 5.7% losses to deep water rice. Burrowing rat hoards a large quantity of food in its burrows (Parrack, 1969; Roy, 1974). Rodents reproduce at an alarming rate. One female mouse or rat can produce up to 120 offspring in a single year. The over-population of rodents can equal devastation to anyone working in the agricultural business. Trapping and the use of poisons are typical remedies for a rodent infestation. But the rodents catch on to the use of traps and poisons are damaging to our eco-systems. Moreover, poison treatments are frequently tardy both because rodent population outbreaks are unpredictable and poisons have short-run impacts due to the rapid immigration of rodents from adjacent untreated areas; furthermore, poisons are often considered by farmers to be too costly (Skonhoft et al., 2006; Davis et al., 2004; Stenseth et al., 2003). Brown et al. (1997) estimated that in order to cover the costs of rodenticide application, 8-13% of the yield damage to cereal crops needs to be prevented. Risks of mortality by self-poisoning (Eddleston, 2000) and detrimental impacts on non-target animals (Cox and Smith, 1990) are additional drawbacks of rodenticides. Crop quality, eco-systems and local wildlife are all adversely affected by the use poisons. Using poisons to management rodent control causes a ripple effect within the eco-system. The poisons can leech into the soil and subsequently get washed in to the watershed through rain water and crop irrigation. For additional wildlife, rodent poisoning can equal death. If a predator ingests a poisoned rodent, they can become extremely ill and die. The cycle continues if that predator is eaten by another animal and so on. Installing barn owl boxes is an effective addition to integrated pest management. They cause no damage to the environment or agricultural crops and pose no threat to additional wildlife.

Recently pest management strategies have emphasized on the ecologically sound method for rat control. Ecologically-sound rodent management provides the necessary platform for designing management strategies, which are environmentally safe (Singleton et al. 1999). For these reasons, the use of owls e.g., barn owl, spotted owlet etc. is proposed as a potential biological control method. Barn owls are superior hunters, preying on small nocturnal mammals including mice, rats, voles, and

gophers. Install a nest box to encourage barn owls to your property for natural rodent control! Barn owls need open fields or grassy slopes in which to hunt for prey. A single pair of barn owls can consume over 2000 rodents a year. Installing barn owl nesting boxes and watching tower throughout the crop field is a sure way to diminish the number of rodents destructing your crops. And because barn owls are not as territorial as other raptors, numerous boxes and watching tower can be installed throughout crop field to effectively control growing rodent population. Installing owl nest boxes and watching tower to control rodent population is an extremely cost-effective remedy. The cost to purchase and/or install an owl nest box is a one-time investment. Owl boxes from air superiority require little to no maintenance. The population of different owl species are decreasing day by day due loss or destruction of vegetation and large tree which is suitable for owl nesting and increased breeding success. The occupation of nest boxes varied with exposure and orientation. A higher percentage of occupation and more Barn Owl nestlings per breeding attempt were found in nest boxes located in the shade than in the sun, and in those facing east/north rather than other directions. The temperature in the nest boxes varied, being lowest in those located in the shade and in those facing east. Nest boxes located in crop fields fledged more young per breeding attempt than those located in date plantations (Charter et al., 2010) Increasing owl population and conservation installation of nest box is very important. In our crop field there are very little scope for searching and capturing rodent prey from crop field for owl. Therefore, watching tower installation is also important for seating, searching and capturing prey. Very little or no study have been done in these regards. The aim of the study was to assessed the rat damage around the watching tower and the effectiveness of nest box for owl occupation.

Materials and Methods

The study was conducted at two places of Bangladesh one Gazipur and another Rajshahi district. In Gazipur Bangladesh Agricultural Research Institute experimental field and residential areas ($23^0$98', $90^0$40') were used for the study and In Rajshahi Regional Wheat Research Centre, Shampur (24.37 N, 88.66E) and Fruit Research Centre, Binodpur, Rajshahi ($24^0$36' N, $88^0$65'E) areas were used for theses study. Twenty owl watching tower and fifteen nest box were installed in both the location. Watching tower are 10-12 feet ong pole prepared by bamboo with cross (X) shaped top for seating owl on it and perching and searching rat in crop field (Fig 1). Nest box (87 cm x 89.5 cm x 90.5 cm) is a triangular shaped box staying and breeding for owl safely (Fig 2). Nest box were installed in different tree and building above 15 feet apart from the ground level. One nest box was set for every four hectare of crop field. When Nest box was used by owl species for nesting, roosting and breeding was term as owl occupation. Nest box was set in north and east side to avoid excess sunlight and wind.

Fig.1. Owl watch tower

Fig. 2. Owl nest box

Wheat, Barley, Potato, Sweet potato and Groundnut crop damaged by rat were assessed around the watch tower areas. Rat damage assessment around the owl watching tower was done by two ways. One Number of active burrows count methods and another crop damage assessment method. Active burrow count and crop damage was done three 0-25, 26-50 and 51-75 meters apart around the owl watching tower. Data were recorded in three crop stage i.e., booting, grain filling and mature stages of the crop.

Rat damage estimation by cut and uncut method

Wheat and barley damage was estimated by this method. The experiment was laid out following RCB design with 10 replications. Ten plots were randomly selected. In each plot ten samples were taken. The data from these ten samples were used for calculation the damage in each plot as a percentage. Very

large or very small plots were not selected for sampling data. Ten samples along one of the diagonals were selected in each plot. The distance between samples (between 3 to 5 steps) depends on the length of the diagonal. A sample closer than 3 meters (3 large steps) from any edge of the plot was not chosen. Each sample consists of 50 cm square frame in which all tillers, cut and uncut tillers were counted. These figures were put on a record sheet. The sampling frame in placed without looking, so that taking data would be real. After taking data from one plot next plots were selected randomly and repeated up to ten samples.

Percent wheat and barley damage was calculated with following formula:

$$\text{Percent rat damage} = \frac{\text{Number of cut tillers}}{\text{Total number of tillers}} \times 100$$

Data were taken every 15 days' interval up to harvesting of the crop.

Rodent damage of Groundnut in the form of per cent pods damaged was recorded at 0-25 m, 26-50 m and 50-75 m distance from the watch tower areas. At each watch tower distance area 2 x 2 m quadrats were placed. Five plants were uprooted from each quadrat randomly to count the total number of pods and the pods damaged by rodents (those with signs of rodent gnawing) per plant. Average number of pods damaged per plant and average density of plants/4m2were determined for each field. Percent pods damaged were calculated using the formula given below:

$$\text{Percent pod damaged} = \frac{\text{Damaged pod}}{\text{Total pods}} \text{ X } 100$$

Potato and sweet potato damage by rat in the form of percent tuber damaged was also recorded at 0-25 m, 26-50 m and 50-75 m distance from the watch tower areas. Sampling of potato and sweet potato damaged was recorded as same as the groundnut. Percent tuber damaged of potato or sweet potato were calculated using the following formula

$$\text{Percent tuber damaged} = \frac{\text{Damaged tuber}}{\text{Total tuber}} \text{ X } 100$$

Collected data were analyzed by one-way analysis of variance by SPSS software and means were by least significant differences (LSD) Graphical data were presented by Sigma plot.

Results and Discussion

Rat damage Assessment

Percent rat damage in different growth stage of wheat differed significantly in active burrow count methods and cut uncut methods around the owl watching tower areas (Figure 3& 4). Significantly the lowest number of active burrow (0.6) was recorded in 0-25-meter distance around the watching tower followed by 25-50m (1.5) distance and the highest number of active burrows was observed in 50-75 m (7.5) distance from watching tower in Rajshahi. In case of cut and uncut methods follow the same trend as active burrow count methods. (Table 1). Wheat and barley damaged by rat in the form of active burrows and grain damaged at Gazipur also follow the same trend as Rajshahi. Rat damaged and number of active burrows were higher as increase the distance from the watch tower areas (Fig. 5-8)

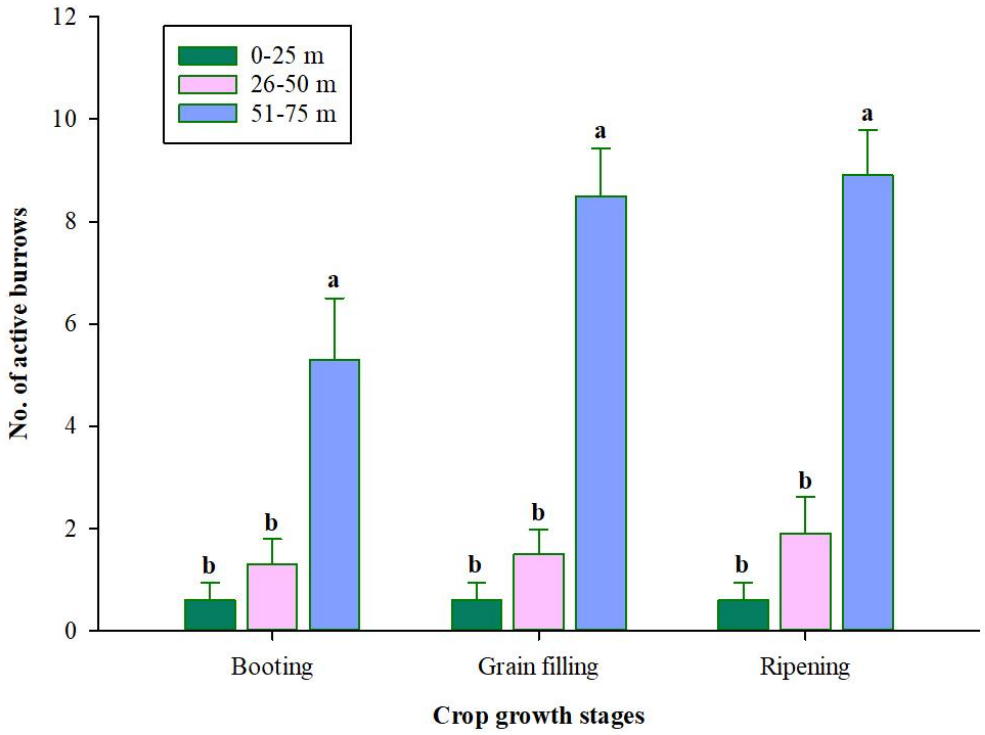

Fig. 3 Extent of rat damage in different growth stage of wheat around the watching tower area at Rajshahi by active burrow count method.

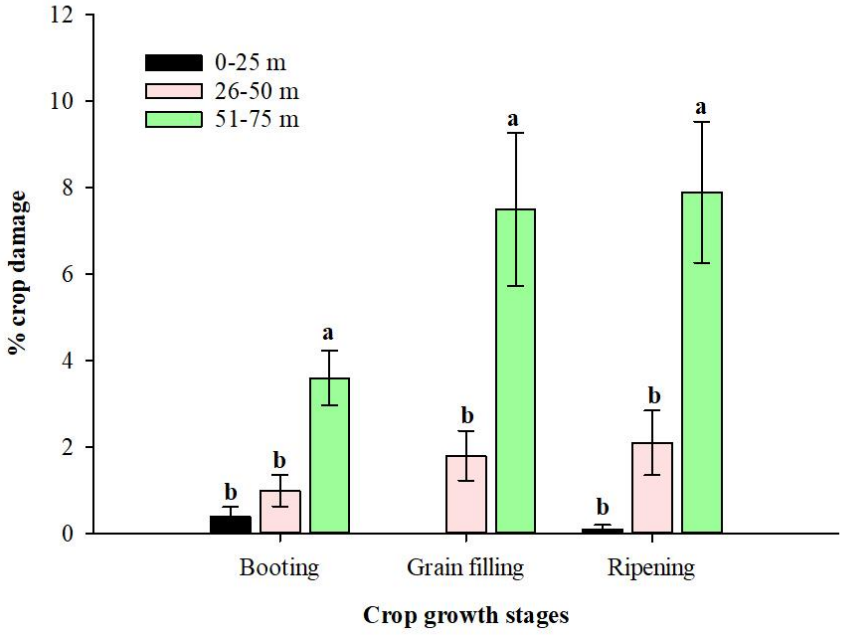

Fig. 4. Extent of crop damage in different growth stage of wheat around the watching tower area at Rajshahi by cut and uncut count method.

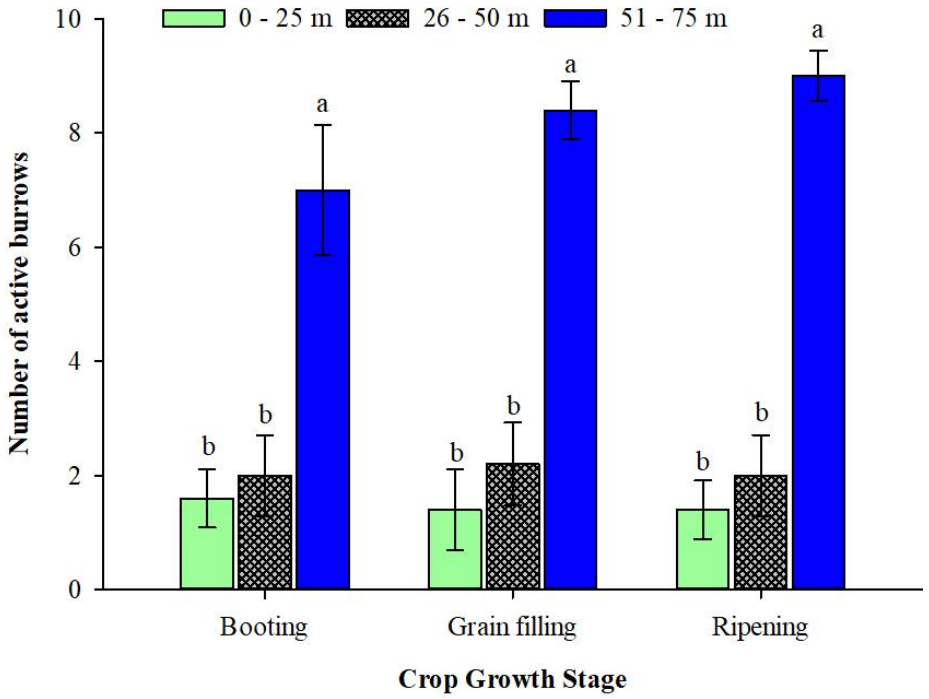

Fig. 5. Extent of rat damage in different growth stage of wheat around the watching tower area at Gazipur by active burrow count method.

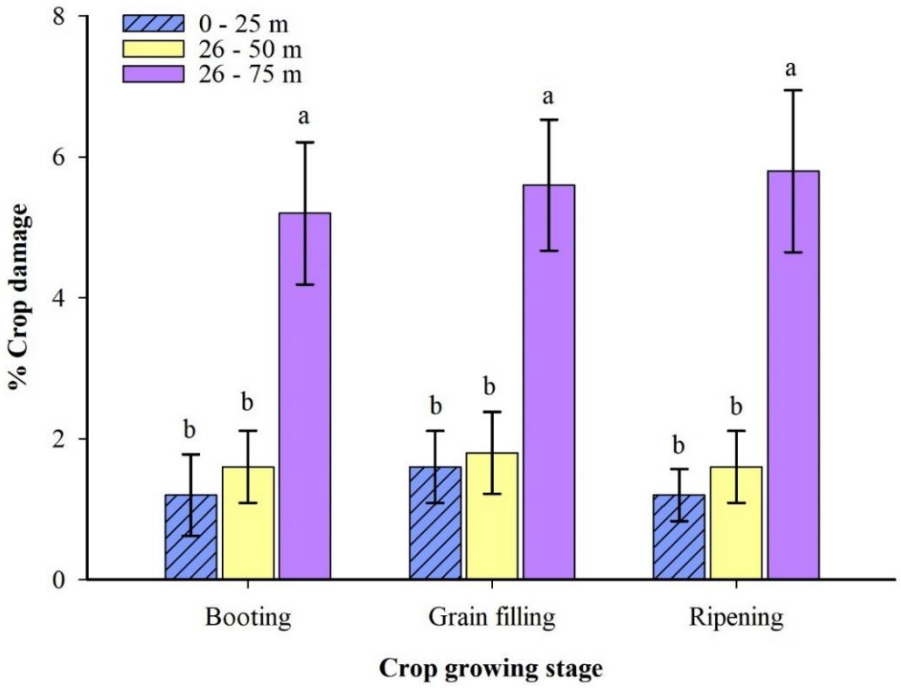

Fig. 6. Extent of crop damage in different growth stage of wheat around the watching tower area at Gazipur by cut and uncut count method.

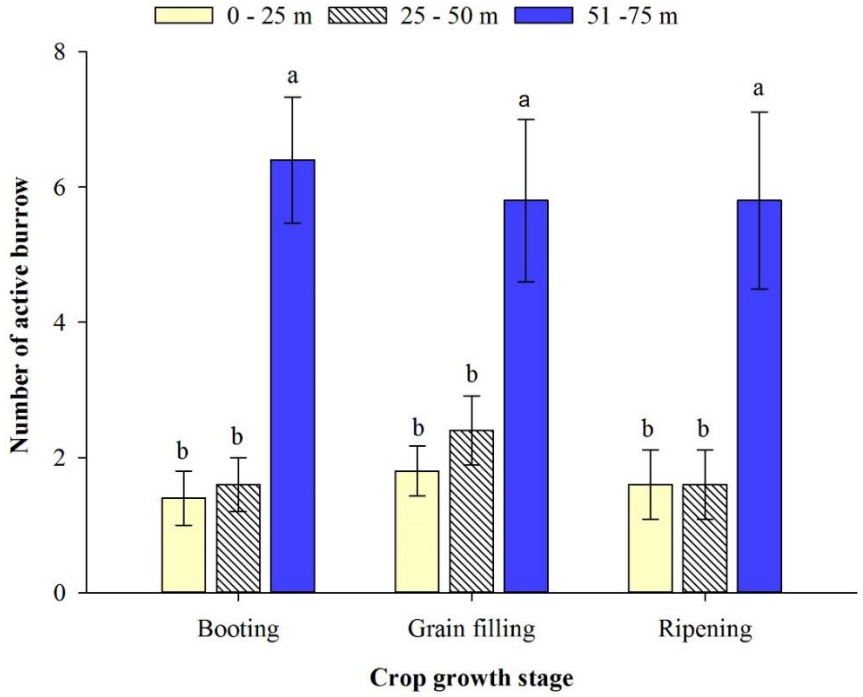

Fig. 7. Extent of rat damage in different growth stage of Barley around the watching tower area at Gazipur by active burrow count method.

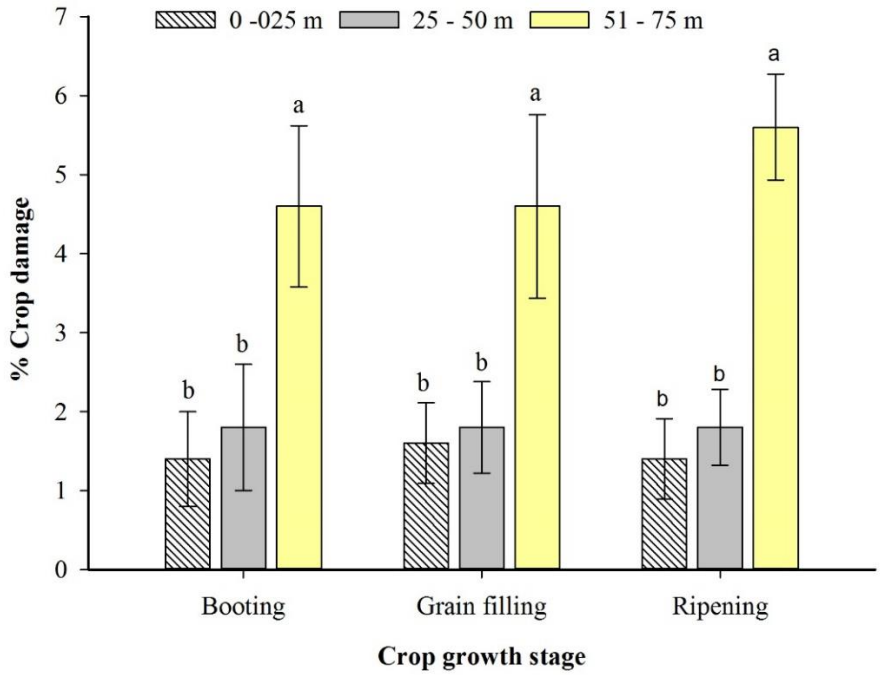

Fig. 8. Extent of crop damage in different growth stage of Barley around the watching tower area at Gazipur by cut and uncut count method.

Potato, Sweet potato and Groundnut damaged by rat and number of active burrows were differed significantly among different distance (0-25 m and 25-50 m and 51-75 m) from the watch tower. The number of active burrows were ranges from 1-1.8, 1.2-1.6 and percent damaged ranges from 0.6-1.0, 0.6-1.8 at 0-25 m and 25-50 m distance from the watch tower in potato and sweet potato respectively

compared to 51-75 m distance from the watch tower at Gazipur (Table 1). Number of active burrows and nut damaged in ground nut was also followed the same trend as potato and sweet potato at different distance from the watch tower (Table). Because owl can be easily search and detected the prey within 50 m that why the rat damaged and active rat burrows were lower within the 50 m. Malhotra and Singla (2018) studied the live active burrows count at four different radius such as 0-100 m, 101-500 m, 501-1000 m and 1001-2000 m distance around roosting and nesting sites at Punjab, India and found that numerically lower active burrow within 100 m radius and being highest at 1001-2000 m radius but no significant among four distances. In another study (Johnson and St George, 2020) a rigorous estimate of the number of rodents that barn owls remove from the landscape to nest box by using remote nest box cameras at wine grape orchard in California, USA. Results indicate that each barn owl chick received 170.2 ± 8.92 rodents before dispersing from the nest box. Combined with the average number of chicks fledged (3.62 ± 1.40), this finding indicates adults deliver on average 616 rodents per nest box, They also estimated a barn owl family could remove 3,466 rodents in a full year (estimates ranged from 1,821 to 7,563). An analysis linking videography to owl telemetry data suggested that 43% of rodents killed were taken from vineyard habitat, which nearly matches the availability of vineyard habitat around the monitored nest boxes (46%). Their results suggest barn owl nest boxes could contribute meaningfully to integrated pest management.

Table 1. Extent of rat damage of potato, Sweet potato and Groundnut around the watching tower area at Gazipur.

Crop	Watch tower distance (Meter)	Extend of rat Damage	
		Number of Active burrow (Mean ± SE)	% Tuber/pod damage (Mean ± SE)
Potato	0 -25	1.0 ± 0.32	0.60 ± 0.24
	26 -50	0.80 ± 0.37	1.00 ± 0.45
	51 -75	3.4 ± 0.68	3.0 ± 0.45
Sweet potato	0 -25	1.20 ± 0.37	0.60 ± 0.24
	26 -50	1.60 ± 0.40	1.80 ± 0.58
	51-75	3.40 ± 0.51	3.20 ± 0.58
Ground nut	0 -25	1.60 ± 0.51	1.00 ± 0.31
	26 -50	1.60 ± 0.51	1.80 ± 0.49
	51-75	5.20 ± 1.2	4.40 ± 0.24

Nest box occupied by owl

Nest box occupy mean the number owl enter into the nest box started for living. In Rajshahi 55 % nest boxes were occupied by owl whereas 50 % nest boxes were occupied by owl (Fig. 9). In Gazipur maximum nest box were occupied by spotted owlet (*Athena brama*) and in Rajshahi most of the nest box occupied by barn owl (*Tyto alba*).

Examination of pellets from our and other study revealed that 70-80% of the Barn Owls diet is composed of rodents from agricultural fields and plantations (Tores *et al.* 2005, Charter *et al.* 2007). Browning et al (2016) measured the effect of a population of barn owls on a rodent population in a 40-ha vineyard near Sacramento, California, USA. In First year 11 of 20 (55%) boxes were occupied by breeding pairs, fledging 40 young. In second year, 18 of 24 (75%) owl boxes were occupied, fledging 66 young; and in third year, three of 24 (12.5%) boxes were occupied, fledging nine young. Nocturnal observations revealed the owls hunted the study area heavily. Monthly pocket gopher surveys using the mound-count method indicated that gophers (rat species) declined on the vineyard with barn owl boxes relative to a control vineyard without barn owl boxes. Pellet analysis showed diet was composed mainly of Botta's pocket gophers (70.4%) and California voles (26.2%). Using these figures, and adding conservative estimates of adult consumption over the 165-day breeding season, and adult and fledgling consumption prior to dispersal, the total number of preys taken over the three breeding seasons was 30,020 rodents indicating 30,020 rodents were reduced over three years of 40-hectare vineyard. The presence of Barn Owls is thus welcomed by farmers in Israel. Since the establishment of the pest control

project, many farmers use Barn Owls as an alternative method of rodent control and thereby drastically reduce the use of rodenticides. The high occupancy of nest boxes by Barn Owls detailed in this study demonstrates, as also found in other studies throughout the world, that not only were natural nest sites lacking in the area, but also that nest boxes offer Barn Owls alternative nest sites, that can increase owl numbers in agricultural fields both for conservation and biological pest control aspects. Nest box orientation and habitation also affect the occupation of owl. Motti et al (2010) studied the effect of exposure, orientation, and habitat on nest box occupation and breeding success of Barn Owls in a semi-arid environment. The occupation of nest boxes varied with exposure and orientation. A higher percentage of occupation and more Barn Owl nestlings per breeding attempt were found in nest boxes located in the shade than in the sun, and in those facing east/north rather than other directions. The temperature in the nest boxes varied, being lowest in those located in the shade and in those facing east. Nest boxes located in crop fields fledged younger per breeding attempt than those located in date plantations.

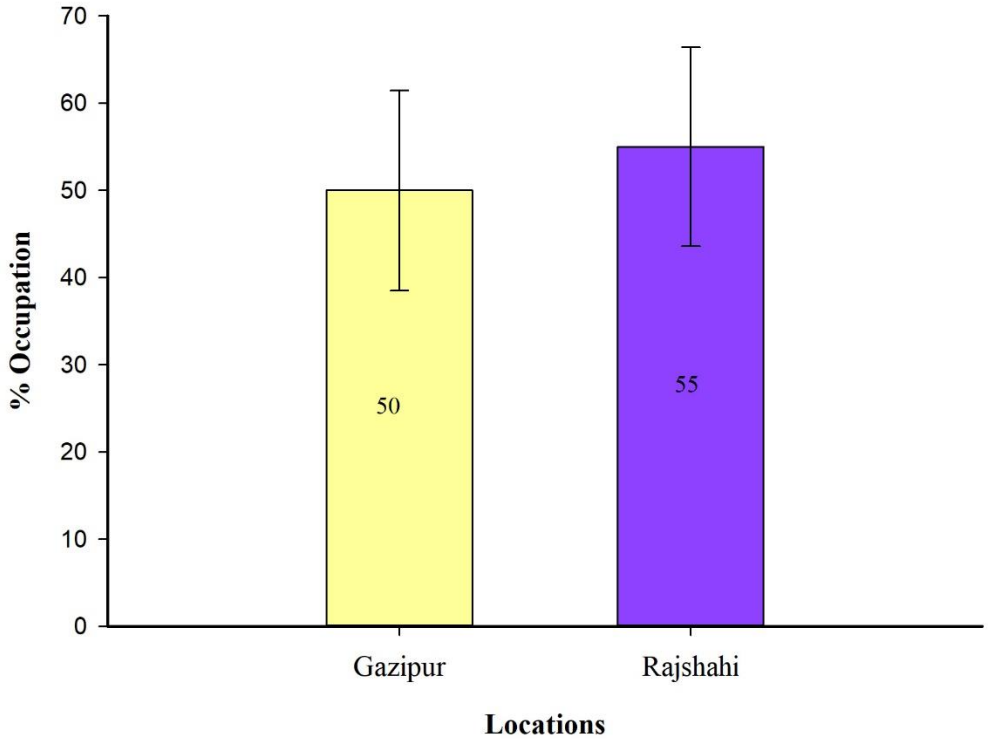

Fig. 9. Nest box occupation by owls as a function of exposure at two locations of Gazipur and Rajshahi.

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EFFICACY OF COMMANDO, ZILL PHOSPHIDE AND ZERO PHOSPHIDE FOR CONTROLLING RATS

M. S. Alam and A.T.M. Hasanuzzaman

Abstract

The experiment was conducted at ARS, Rajbari, Dinajpur to study the effectiveness of 'Zero phosphide, Commando and Zill phosphide all were acute poison (Zinc phosphide) supplied from company. In field trial test all the rodenticide showed more than 80% rodent control success was recorded. The average poison bait consumption was 0.81, 1.17 and 1.83 g/rat/day in Zero phosphide, Commando and Zill phosphide treated bait respectively.

Introduction

Rat is the major vertebrate pest in Bangladesh. It causes serious damage to our crops in the field and in storage. According to Ahmed *et al*. (1986) rat cause 5.7 % losses to deepwater rice, and Sultana & Jaeger (1992) described wheat and rice losses as 2.3 and 1.9 % of the expected yields in two areas of Bangladesh between 1986 and 1988 respectively. Rats are major problem in the poultry sector too. They share the poultry food from the food tray, damage the eggs, chicken and also destroy the food in the storages. They damage the floor of the farm by extensive burrowing and also attack the young birds (Roy *et al*., 1987) and disseminate different kinds of diseases.

In Bangladesh, farmers commonly use zinc phosphide, aluminum phosphide and lanirat to control rodents. Trapping and flooding the burrows are also common practice among the farmers. Zinc phosphide bait is effective poison but creates bait shyness and also creates environmental pollution. Bait shyness problem was solved by the introduction of anticoagulant poison. In anticoagulant, rat does not associate poisoning symptoms with the bait material. As a result complete control of rodent population is possible with anticoagulant poison. Recently, Second generation single dose anticoagulant rodenticides like bromadiolone and brodifacoum are found very effective against many rodent species (Brooks, *et al*., 1974; Mathur and Prakash, 1981, Chopra *et al*., 1983; Buckle *et al*, 1984, Prashad *et al*, 1985).

Recently pesticide companies have submitted three sample namely 'Zero phosphide, Commando and Zill phosphide are acute poison basically Zinc phosphide (80% a.i), for evaluating their rodenticidal properties. The present study was aimed at evaluating the efficacy of 'Zero phosphide, Commando and Zill phosphide' against field rat.

Material and methods

The experiment was conducted in the laboratory of Vertebrate Pest Division, BARI, Gazipur and ARS, Rajbari, Dinajpur during 2020-21. Two type of test was conducted for this study, choice feeding and field test. Choice feeding test was done previous year. This year only field test was done. Bandicoot rats, *Bandicota bengalensis* (Gray), were collected from Vertebrate Pest Division laboratory rat enclosure and the rats were reared in the rat enclosure for breeding purposes. Rats were kept in 40 X 25 X 18 cm rearing cage in the laboratory.

Choice test

Zero phosphide, Commando and Zill phosphide bait contain 2% Zinc phosphide (80% a.i) as an active ingredient. The choice feeding tests were conducted in the laboratory using 20 (10 male and 10 female) acclimatized adult rats in each sample. Six hours starved rats were exposed individually to poison bait

in a food cup for 24 hours. Two food cups were provided to each animal, one cup containing 10g of poison bait and the other containing 20g of plain wheat grains for each sample. Rodenticide was supplied for three consecutive days and the plain wheat grain was provided up to end of the experiment (up to 15 days). Spilled bait material or wheat grains were collected in a paper placed beneath the cages and weighted in both the tests. Water was supplied at ad libitum. Consumption of bait material or food and mortalities of the test rats were recorded every day.

Field test

Field test of all the three rodenticides were conducted in wheat field at ARS, Rajbari, Dinajpur. At booting stage of wheat, 60 active rat burrow systems were selected. The activity of burrow was confirmed by setting tracking tile. About 20 g of poison bait was applied near the burrow opening or runway as well as the premises of active burrow system. The poison bait was applied in the evening and application was continued for consecutive three days. After application, rodent activity was observed up to seven days. Then post treatment tile index data was taken. Efficacy of the treatment was judged on the basis of rodent activity.

Result and Discussion

Choice test: Out of ten males and ten female rats all the males and female rats were died within 24 hours in both Zero phosphide and Zill phosphide treated baits, whereas nine male and nine females were died in case of Commando treated bait. The average bait consumption per rat per day was very low i.e. 0.50g only. The average mortality was 100% for the both male and female rats in case of 'Zero phosphide and Zill phosphide' brand zinc phosphide and 90% mortality was observed in Commando treated bait. (Table 1). The average consumption of plain bait was male 9.67±0.39g female 10.43±1.1g, poison bait was male 0.79±0.12g female 0.83±0.12g and plain bait male 8.4±1.3g female 5.85±1.4g, poison bait was male 2.3±0.4g female 1.34±0.35g in both Zero phosphide and Zill phosphide respectively whereas in case of commando consumption was plain bait male 17.7±2.2g female 11.79±1.9g, poison bait male 1.35±0.46g female 0.99±0.19g respectively (Table 1).

Field test: Zero phosphide and Zill phosphide showed a considerable reduction in rodent number in wheat field, Rajbari, Dinajpur. The average reduction of rodent number in both Zero phosphide and Zill phosphide were observed 81.66% whereas the average reduction of rodent number in Commando was observed 80% in field test (Table 2). This finding is comparable to another result where Rahman and Brooks (1982) recorded 84 % reduction of rodent activities by applying zinc phosphide bait outside the burrow system inside house in Bangladesh. In another experiment, 80% mortality with Zinc phosphide bait was recorded for controlling *Nesokia indica* (Anonymous, 1994). Higher mortality (83.33%) with zinc phosphide bait was also reported by Haque (1993) for controlling *Nesokia indica* in the northern districts of Bangladesh. Hasanuzzaman et al., (2003) studied that 81.99 % reduction of rodent activities was recorded by applying lanirat bait (Bromadiolone 0.005%) outside the burrow system in poultry farm of Gazipur district in Bangladesh.

The results of the present field study indicated that the efficacy of all these supplied zinc phosphide products Zero phosphide, Commando and Zill phosphide satisfactory and all these three rodenticides can be recommended for controlling field rats in Bangladesh.

Table 1. Effect of "Choice" test on Zero Phosphide, Commando and Zill Phosphide on bandicoot rat, *Bandicota bengalensis* (Gray) in VPD Laboratory, BARI, Gazipur diuring 2019-20.

Rodenticide	Rat tested	Rat Body weight (g)	Average consumption/ rat/day (g)		Dead rat (no.)	Rat mortality (%)	Average mortality (%)
			Poison bait	Plain bait			
Zero Phosphide	10 Males	275 ±8.06	0.79±0.12	9.67±0.39	10	100	100
	10 Females	218±7.42	0.83±0.12	10.43±1.1	10	100	
Commando	10 Males	200± 9.07	1.35±0.46	17.07±2.2	9	90	90
	10 Females	222±10.72	0.99±0.19	11.79±1.9	9	90	
Zill Phosphide	10 Males	243±9.1	2.31±0.40	8.40±1.3	10	100	100
	10 Females	180±5.35	1.34±0.35	5.85±1.4	10	100	

Table 2. Field efficacy of rodenticide for controlling rodent using active burrow count method at Rajbari, Dinajpur during 2020-21

Treatments	No. of pre-treatment active burrow	No. of post-treatment active burrow	% Population reduction
Zero Phosphide	60	11	81.66
Zill Phosphide	60	11	81.66
Commando	60	12	80.00

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Appendix I: List of Scientists and Scientific Staffs of Vertebrate Pest Division BARI, Gazipur

Sl. No.	Name and Designation	Remarks
Scientists		
01.	Dr. Md. Shah Alam, Principal Scientific Officer	Divisional Head.
02.	Dr. A.T.M. Hasanuzzaman, Senior Scientific Officer	
03.	Md. Arifur Rahman Senior Scientific Officer	Attached to DNCC
Scientific staffs		
01.	Ferdhowshi Begum Scientific Assistance	
	Md. Shariful Islam Suman Lab. Technician	
02.	Md. Mahtab Miah Lab. Attendant	LPR

APPENDIX II: কর্মসম্পাদন সূচক, লক্ষ্যমাত্রা এবং অর্জন- ২০২০-২০২১ (সেকশন ৩)

ক্রমিক নং	সূচক	একক	২০২০-২১	২০২০-২১
			লক্ষ্যমাত্রা	(অর্জন)
১.	প্রশিক্ষিত কৃষক	সংখ্যা	৬০	৬২
২.	স্থাপিত প্রদর্শনী	সংখ্যা	২	২
৩.	আয়োজিত সেমিনার/ওয়ার্কশপ	সংখ্যা	১	১
৪.	বার্ষিক গবেষণা রিপোর্ট	সংখ্যা	১	১
৫.	মাঠ দিবস/র‍্যালী	সংখ্যা	১	২
৬.	লিফলেট, বুকলেট, নিউজলেটার, জার্নাল, বুলেটিন, প্রকাশনা ইত্যাদি	সংখ্যা	১	১
৭.	বিতরণকৃত ইদুর দমনের জন্য গবেষণাগারে তৈরি বিষটোপ	সংখ্যা	২০০	২৬০
৮.	বিজ্ঞানীদের গ্রুপ ডিসকাশন/ মাসিক সভা	সংখ্যা	৬	৮
৯.