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Storage pests of maize and their status in Bangladesh

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ABSTRACT

Maize (zea mays) is the most important cereal crop after rice in Bangladesh. During storage, maize grains are severely destroyed by insect pests. Most of the farmers of Bangladesh do not know how to preserve corn seed properly due to insufficient knowledge of storage pest of maize. An experiment was conducted to assess the major pests associated with stored maize, the damage and losses they cause in Bangladesh during July to December 2017. Sixty (60) farmer's farms from fifteen major maize growing districts of Bangladesh were assessed. Sixteen Arthropods, Fifteen Coleopterans, Five Lepidopterans and one Acarina were documented from the collected samples. Maize weevil (Sitophilus zeamais) followed by maize grain moth (Sitotroga cereallela), rice weevil (Sitophilus oryzae), flour beetle (Tribolium confusum) and Areca nut weevil (A. fasciculatus) were the major pests of stored maize in the study area. Among them, Maize weevil (S. zeamais) is the dominant, destructive and most important pest of maize in Bangladesh. This pest was found in abundance in all areas assessed damaging maize grain. Quantitative average grain damage of 75.85% and losses of 51 to 85% are common in the store within five to six months after storage. An integrated weevil management method should be implemented to prevent the high quantitative and qualitative grain losses incurred to contribute towards family food security in Bangladesh.

Key words: *Storage pests, Pest status, Maize weevil (Sitophilus zeamais), Grain damage and Grain loss.*

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I. Introduction

Maize (*Zea mays*) has emerged as the most important cereal crop for its food and feed values after rice in Bangladesh (Alam *et al.* 2018). It belongs to the family of grasses (*Poaceae*). It is known as corn, in Bengali is called as *Bhutta*. The country's annual maize output has reached to a new height of 2.85 M.M tons in 2016-17, and 90% of home grown maize is feeding a burgeoning poultry and fish feed industry (Alam *et al.* 2018). The production and productivity of maize has increased since the development of high yielding hybrid varieties by the Bangladesh Agricultural research Institution (BARI), Gazipur,

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Bangladesh. Large areas of Bangladesh are covered by maize crop and the area under production is still increasing if not because of seed constraint. Yet, these hybrid varieties are reported to be highly susceptible to insect pest attacks both in the field and storage (Girma *et al.* 2008). Hence, farmers are not as such the beneficiaries of this increased production and productivity potential of new varieties. Traditionally, maize grain is stored by Bangladeshi farmers, both in and outdoors for consumption and sell in the later months of the year depending on the quantity produced per household. Maize seed like also mustard seed (Alam *et al.* 2015) has to be stored from harvesting to next planting season (usually about 7-9 months) and safe storing of maize seed (like as onion) has become an important issue in Bangladesh (Mollah *et al.* 2016).

The stored maize is attacked and damaged by several pests that lead to quality deterioration forcing farmers to sell at reduced prices and below the production cost. Insects are most often considered as the principal cause of maize grain losses (Alam *et al.* 2014; Abraham, 1995; Ali *et al.* 2007). The most important insect pests that cause damage to maize in the field and storage are lepidopterous stalk borers and coleopterous weevils, respectively (Alam *et al.* 2018; Emana and Tsedeke, 1999). More than 37 species of arthropod pests are associated with maize grain in storage (Abraham, 1995). During storage period, insect-pests and diseases have been playing a significant role in reducing production and productivity coupled with germination potential (Mollah *et al.* 2016). Among insect-pests, maize weevil, *Sitophyllus zeamais* and maize grain moth, *Sitotroga cerealla* are the most serious insects in stored maize of Bangladesh because, most of maize grown farmer are remain their grain in open floor of his room without proper maintain of storage's rules. About 60% of maize grain is lost during this period (Alam *et al.* 2014). The main reason behind this is farmers' lack of adequate knowledge regarding the status of insect pest in stored condition. The global picture of losses of grain and pulse crops after harvest is estimated to be 10% mostly due to insect pests and this is very serious in developing countries (Boxall *et al.* 2002). The FAO (1985) estimated that storage pests and lack of proper storage methods cause losses of about 200 million tons of grains each year. The annual grain losses in Bangladesh range between 20-30% (Alam *et al.* 2018). Information on storage pests of maize that cause damage and weight losses in Bangladesh is not available. This experiment was carried out to assess the major insect pests associated with stored maize, the damage and loss caused by these insect pests in this area.

II. Materials and Methods

Survey area: The survey was conducted in the fifteen major maize grown areas in Bangladesh *viz.* Rangpur, Dinajpur, Gaibandhah, Bogura, Joypurhat, Naogaon, Rajshahi, Kushtia, Jassore, Khulna, Kumilla, Chattagram, Sylhet, Mmensingh, Gazipur during July to December 2017. The study was conducted to assess the major pests associated with stored maize, the damage and losses they cause in Bangladesh. This research zone lies between latitudes 24°00'N and longitudes 90°00'E. It situated under sub-tropical climate, which is characterized by high temperature, high humidity and heavy precipitation with occasional gusty winds from April to September and scanty rainfall associated with moderately low temperature and humidity from October to March (Table 01).

Sampling: A survey was conducted to find out the status of insect pests, damage and losses in stored maize in major maize grown areas in Bangladesh. Generally, these areas were favorable for storage pest infestations owing to its environmental conditions. The study was also conducted when maize grain was in storage for three to six months and infestation and grain damage levels were most likely to be serious. Fifteen (15) survey sites were selected based on their maize production status (major maize producing areas) of Bangladesh. 60 farm stores from all selected survey were visited and 1 kg maize grain samples were collected from at least two sites of each selected area. Selection of sites, storage containers and samples were made in such a way that they are the representative of all major maize grown area of Bangladesh at random. The samples of grains were obtained from as many different parts of the various storage facilities as possible (top, sides, center and bottom). Each sample was put in a paper bag and labeled with the necessary information for further inspection in laboratory as per the methods used by Firidissa (1999). Inspection of the samples was made within two weeks of collection in the laboratory of Department of Entomology of Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh.

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Table 01. Average annual temperature and relative humidity at the survey areas during the stored period (July-December, 2017)

Survey areas	Average Temperature (^{0}C)						Average Relative Humidity (%)					
	July	August	Sep	Oct	Nov	Dec	July	August	Sep	Oct	Nov	Dec
Ranpur	31	31	31	30	28	26	78	77	73	74	61	60
Dinajpur	32	32	32	29	26	25	71	71	71	77	60	53
Gaibandha	28.7	28.6	28.3	27.1	23.0	19.4	73	72	70	73	61	58
Bogura	28.9	28.7	28.5	27.1	23.2	19.5	74	72	70	74	62	59
Joypurhat	28.9	28.9	28.6	27	22.8	19.3	73	73	71	73	60	54
Naogaon	32	32	32	29	27	25	72	73	71	74	61	54
Rajshahi	32	32	32	30	27	26	77	77	71	72	56	51
Kushtia	32	31	31	29	27	25	76	76	71	73	56	55
Jassore	31	30	31	28	28	25	75	75	71	72	56	54
Khulna	31	31	31	29	27	26	76	79	78	77	57	53
Kumilla	30	30	30	29	27	25	82	81	79	82	71	66
Chattagram	29	29	29	28	27	25	87	86	85	83	76	75
Sylhet	30	31	31	29	27	24	85	83	80	82	73	75
Mymensingh	31	31	31	29	27	25	80	77	74	77	66	63
Gazipur	30	31	31	29	28	26	79	76	75	75	63	60

Source: Weather report, 2017 of Bangladesh Meteorological Department, Dhaka.

Laboratory study: Laboratory study was done at the Department of Entomology of Bangladesh Agricultural University (BAU), Mymensingh-2202. After collection of samples, grains were sieved over a 2 mm mesh sieve (Abraham, 1995) according to each sample of survey areas. Insects were removed, counted and grouped to order & family, and were preserved dry as pinned collections or in 75% ethanol for identification. Identification was made using combination of insect identification keys, books, journals, handbook, pictures, booklet and comparisons with already identified specimens in laboratory. Again, it was identified and confirmed with the help of specialized persons of the Department of Entomology, BAU, Mymensingh. Then, rate of insect infestation were recorded from each sample of the selected areas.

Data collection

Grain weight loss: After collection of samples, 100 grains were randomly taken from each sites of each collected sample and they were separated into damaged and undamaged categories. Then these grains were separately counted and weighted. Percentage weight loss was calculated using count and weight method for each sample of all sites of survey areas (Adams, 1976).

$$\text{Weight loss (\%)} = \frac{(Wu \times Nd) - (Wd \times Nu)}{Wu \times (Nu + Nd)} \times 100$$

Where, Wu = Weight of undamaged seed, Nu = Number of undamaged seed, Wd = Weight of damaged seed, Nd = Number of damaged seed

Percentage grain damage: Insect damage was assessed by the count method. 100 grains were randomly taken from each sites of each collected sample and they were separated into damaged and undamaged categories. Then, percentages of insect damaged grains were calculated (Fekadu *et al.* 2000; Wambugu *et al.* 2009) as follows:

$$\text{Insect damaged grain (\%)} = \frac{\text{Number of insect damaged grain}}{\text{Total number of grain}} \times 100$$

III. Results and Discussion

In this study, all stores tested were infested with insect pests. List of the major pests, their status and abundance are given in Tables 02 and 03. Sixteen arthropod species were recorded on maize grain in major maize grown districts of Bangladesh. Fifteen species of Coleoptera (two species in Curculionidae, Cucujidae, Bostrichidae each, Six species in Tenebrionidae, one species in Anthribidae, Buruchidae and Silvanidae each), Five species of Lepidoptera (four species in Pyralidae and one in Gelechiidae) and one species of Acaridae in the Acarina were identified. Among the different arthropods, the dominant species in all area surveyed was maize weevil (*Sitophilus zeamais)* followed by maize grain moth (*Sitotroga cereallela),* flour beetle (*Tribolium confusum)* and Areca nut weevil, *Araecerus fasciculatus*

(Table 03). These pests were widespread, abundant and caused damage and loss to maize grain (Table 04). Abraham (1997) worked on this matter. He collected 37 species of arthropods associated with stored maize grain seeds in western part of Ethiopia, Bako area. He further reported that the most important arthropods were maize weevil, grain moth and flour beetle. However, Emana (1993) reported *S. cereallela* followed by *S. zeamais*, as the two most important pests of stored maize in Southern Ethiopia. This may be because of the similarity of the environmental conditions, which are warm and humid, in the Jimma and Bako areas and differences in the southern part where the environment is cooler. There was no new record of insect pest of maize in research areas. But some insect-pest was not recorded because they were less important, less abundance and difficult to collect them. In this study *S. zeamais* was the most common and destructive of all the insect pests recorded (Table 03). Most of the insects mentioned earlier were found attacking maize. *S. zeamais* was recorded in abundance from all the samples at all sites in whole storage time.

Grain damage and weight loss: Grain damage and weight loss caused by the different pests, which was statistically different from each pest and the results are presented in Table 04. Mean percentage grain damage and weight losses caused by the pests under traditional farmers storage practices were 75.85 and 70.23%, respectively. The maximum damage and weight loss was caused by *S. zeamais*. Grain damage ranged from 62 to 82% between three to six months of storage whereas the weight loss varied from 51 to 85%. More of the number of weevils associated with stored grains at each site was associated with more number of grain damage and weight losses. As the length of storage period increased, the damage and losses also increased. The highest grain damage and weight losses at all location may be due to the conduciveness of the environmental condition for the pests. Schmutterer (1971) reported the severity of *S. zeamais* on both maize and sorghum in storage and showed a loss estimate of up to 80% in maize stored in unprotected silos in Bako area. The storage loss was found to be 80% in Cameroon after six to eight months of storage (Nukenine *et al.* 2002). Kerstin *et al.* (2010) reported 10 to 12% loss of maize stored in traditional storage containers due to insect pests. Abebe and Bekele, 2006 also stated that same type of results. Farmers are managing insect pests of importance such as weevils by using chemicals, botanicals, sanitation and mechanical tools. Most of the species recorded in the present study are cosmopolitan pests in stored grains. Farmers in the study area were using different pest management methods such as application of insecticides, botanicals, ashes, salt, smoke, sanitation and mixing of maize seeds with other grains.

Table 02. Identity list of insect pests associated with stored maize and their status in fifteen selected survey areas in Bangladesh

Order	Family	Common name	Specific name	Status
Coleoptera	Curculionidae	Maize weevil	*Sitophilus zeamais* Motschulsky	Major
	Anthribidae	Coffee Bean weevil/ Areca Nut weevil	*Araecerus fasciculatus* (De Geer)	Major
	Curculionidae	Rice weevil	*Sitophilus oryzae* (L.)	Major
	Cucujidae	Flat grain beetle	*Cryptolestes pusillus* (Schonherr)	Intermediate
	Cucujidae	Red rust grain beetle	*C. ferrugineus* (Stephens)	Minor
	Bostrichidae	Lesser grain borer	*Rhyzopertha dominica*(Fabricius)	Intermediate
	Bostrichidae	Larger grain borer	*Prostephanus truncates* (Horn)	Minor
	Tenebrionidae	Flour beetle	*Tribolium* sp	Intermediate
	Tenebrionidae	Red rust flour beetle	*T. castaneum* (Herbst)	Intermediate
	Tenebrionidae	Maize Flour beetle	*T. confusum* Jacquelin du Val	Major
	Tenebrionidae	Yellow mealworm beetle	*Tenebrio molitor* L.	Minor
	Buruchidae	Bean weevil	*Zabrotes subfaciatus* (Boheman)	intermediate
	Silvanidae	Grain beetle	*Oryzaephilus surinamensis* (L.)	Minor
Lepidoptera	Pyralidae	Tropical warehouse moth	*Ephestia cautella* (Walker)	Intermediate
	Pyralidae	Rice moth	*Corcra cephalonica* (Stainton)	Intermediate
	Pyralidae	Maize grain meal moth	*Plodia interpunctella* (Hubner)	Major
	Gelechiidae	Maize grain moth	*Sitotroga cerealella* (Olivier)	Major
Acarina	Acaridae	Flour mite	*Acarus siro*	Minor

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Table 03. Mean number of the most important insect pests of maize recorded from maize grain samples in fifteen (15) major maize growing districts of Bangladesh (number of storages, n=60)

Insect pests		Number of stores with the pest	Mean number per 100 g of seed (Mean± SD)
Common Name	Scientific Name		
Maize weevil	*S. zeamais*	60	83.56 ± 2.32
Maize grain moth	*S. cerealella*	40	38.87 ± 1.95
Flour beetle	*T. confusum*	32	23.08 ± 2.02
Areca nut weevil	*A. fasciculatus*	21	14.39 ± 1.84

Table 04. Percentage grain damage and weight losses of stored maize grain in fifteen major maize growing districts of Bangladesh five to six months after storage (Number of storages, n=60)

Districts	No. of stores	Grain damage	Weight loss
1	4	69.97±0.60	66.43±0.08
2	5	75.89±0.10	52.30±0.60
3	3	80±1.40	69.35±0.08
4	2	75.30±2.01	51±2.50
5	6	77.56±2.17	79.51±0.15
6	4	81.8±0.40	85±0.35
7	3	82±1.78	75.24±1.27
8	5	74.98±1.27	80.60±0.09
9	6	74.01±0.35	78.90±2.01
10	3	71.58±2.14	76.85±1.40
11	4	78.96±0.08	51±2.3
12	2	69.10±1.29	52.26±0.19
13	4	74.63±2.18	84.01±1.21
14	5	72.40±1.56	81.05±2.3
15	4	79.6±1.20	70±1.4
Mean ± SE	-	75.85±1.23	70.23±1.06
Range	-	62 to 82	51 to 85

IV. Conclusion

Maize (*Zea mays*) has emerged as the most important cereal crop after rice in Bangladesh. Eighteen insect pests were associated with stored maize in the area. Maize weevil followed by maize grain moth, flour beetle and Areca nut weevil was the most important. Significant grain damage (average of 75.85%) associated with losses of up to 85% was caused by the pests within three to six months of storage. Further study that covers all growing area to evaluate the economic importance of their infestation for devising bio-intensive integrated pest management strategies was needed. Further identification using molecular techniques needed. In addition, losses caused by the major pest species in the different types of stored produce under different management practices should be determined. Novel management practices should be conducted and recommended for the area.

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