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Relative abundance of insect pests and loss assessment of rice seeds at different storage conditions

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Abstract

An investigation on abundance of storage insects of rice seeds and loss assessment were made in Aman during February to July, 2002 and Boro during May to October, 2002 in different storage structures viz. Dole, Motka, Kolshi, Steel Drum, Kerosene Tin, Polythene/Plastic Bag, Gunny Bag and Plastic Drum at three villages of Mymensingh Sadar upazila. Analysis of seed sample of 250g from each storage structure at monthly interval showed four insect species namely, *Sitotroga cerealella* Oliv., *Rhizopertha dominica* Fab., *Sitophilus oryzae* L. and *Tribolium castaneum* Hebst. Higher insect population was recorded in Boro seeds. In Aman, the mean number of *S. cerealella, R. domonica, S. oryzae, T. castaneum* was recorded as 13.8, 2.1, 0.38, 0.6, respectively and in Boro, it was 18.6, 1.6, 2.7, 1.0 in 250g of seeds, respectively. The highest insect population, seed damage and weight loss were recorded in Gunny Bag and the lowest were in metal structures (Steel Drum in Aman or Kerosene Tin in Boro) followed by Polythene/Plastic Bag. Seed damage and weight loss was increased with storage period in Aman but decreased after initial increase in Boro. Highest moisture content was also found in Gunny Bag. More than 80% germination was recorded in all structures except in Gunny Bag in both seasons after six month. The germination was decreased with increasing storage period. Therefore, the storage structures, Steel Drum, Kerosene Tin and Polythene/Plastic Bag could be used for safe storage of rice seeds.

Keywords: Storage structures, Storage period, Storage insects, Abundance, Seed quality

Introduction

Rice alone constitutes 95 percent of food grain production in Bangladesh (Julfiqure *et al.* 1998). Among various factors responsible for poor yield of rice, use of poor quality seeds is the major one. Only 10 percent of certified rice seeds are available in Bangladesh (Fakir, *et al.* 2002). So, the rest 90 percent of the total requirement come from farmers' own saved source. However, the qualities of these seeds are not in standard limit. Some parameters like germination capacity is quite low compared to the existing provision of seed standard of the country (Bashar and Nasiruddin, 1995). Farmers stored their own seeds in various traditional storage structures. Commonly used seed storage structures for various crops including rice at farmers level are Steel Drum, Kerosene or Biscuit Tin, Hessian Bag, Polythene Bag, Dole, Kolshi, Motka (Razzaque, 1980; Clement *et al.,* 1984). Characteristics of some structures are not suitable for seed storage upto the next planting season. These lead to losses of seed quality in storage. Bala (1991) reported that annual loss of paddy during storage in Bangladesh is to be 3-8 percent, whereas Khan (1991) mentioned it is about 15 percent in rice. Storage structures and its environment, storage insects, rodent pests, etc. were found responsible for causing these losses. Khare *et al.* (1974) used five types of storage structures and reported that lowest losses were 1.5 percent in metal drums and the highest were 4.3 percent in gunny bags. The situation is quite vulnerable in Bangladesh because of (i) hot and humid climate favouring rapid insect population development, deterioration of seed storage life and (ii) the lack of knowledge and facilities to prevent such losses. Insects were reported to be the number one factor causing 10 percent losses in storage (Islam, 1984). The present study was undertaken to investigate the impact of storage structures on insect infestation in rice.

Materials and Methods

The present study was conducted in three villages namely, Boyra, Chatrapur, and Sutiakhali of Mymensingh Sadar upazila and in MS Laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202 during January to October, 2002.

Identification of the rice seed storage structures

To identify the storage structures used by the farmer's for storing rice seeds, data were collected by farm survey with a pre-made questionnaire during January to February 2002. A total of 169 farmers were randomly interviewed. The prevalence of insect pests of stored rice seeds at various traditional storage structures was studied in Aman and Boro season.

Prevalence of insect pests and determination of their population

Seed samples of 250g were collected by a Trier from the top layer of farmer's storage structures (15-20 cm). Samples were kept in a polythene bag with an identification card and tied with a thread. Samples were collected from each storage structures at monthly interval for six months of each season (For Aman during February to July 2002 and for Boro during, May to October, 2002) and were brought to MS Laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh. Thirty-six farmers and eighteen farmers were selected for Aman and Boro season, respectively. Seeds of BR-11 and BR-14 rice varieties were selected for Aman and Boro season, respectively. For easy identification and counting, samples were kept in deep freeze (2-4ºC) for few minutes and then total number of insects of each insect species was counted for each sample. Different prevailing insects were identified based on their respective identifying characters.

Assessment of seed quality

The quality of rice seeds was assessed by determining percent seed damage, weight loss, moisture content and germination percentage.

Seed damage: The seed damage caused by insects sample was determined at monthly intervals and expressed as percent seed damage with the following formula:

$$\text{Percent seed damage} = \frac{Nd}{Nu+Nd} \times 100$$

where, Nd = Number of damaged seeds and Nu = Number of undamaged seeds
Nu+Nd = 1000

Weight loss: Thousand seeds were randomly selected from each sample and the percent of weight loss was calculated with the following formula (Lal, 1988):

$$\text{Percent weight loss} = \frac{UNu - DNd}{U\,(Nd + Nu)} \times 100$$

where, U = The weight of undamaged seeds, D = The weight of damaged seeds, Nu = Number of undamaged seeds and Nd = Number of damaged seeds

Seed moisture content: Moisture content of samples was measured every time after collection by electric moisture meter (Grain Moisture meter, Riceter J, by Kett Electric Laboratory, Japan).

Germination percent: The viability of seeds was determined by petridish method using filter paper as medium. For these, 400 seeds were selected and placed in petridish and wet by applying water. These were kept in the laboratory having the temperature 25±2ºC. Germination was recorded after 10 days of seed setting. The percentage of all the seeds was calculated for each seed sample and then the average was obtained for all replications (ISTA, 1985).

Statistical Analysis

Completely Randomized Design (CRD) was used to analysis the data. The recorded data on various parameters were statistically analyzed after necessary transformation using MSTAT statistical package programme. Analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) was done as following by Gomez and Gomez (1984).

Experimental Results

Rice seed storage structures: Survey data on storage structures revealed that the farmers practice both bulk and bag storage of rice seeds in eight types of structures. They could be grouped into following five categories:

A. Bamboo woven storage structures: Dole/Dool
B. Earthen jar: Motka / Jala / Rashoo and Kolshi
C. Metal storage structures: Kerosene Tin and Steel Drum
D. Plastic storage structures: Plastic Drum
E. Bag storage: Gunny Bag and Polythene/Plastic Bag

It was recorded that 36.52, 17.96, 14.97, 10.18, 7.19, 4.79, 5.99, and 2.4% of farmers used Motka, Kolshi, Dole, Gunny Bag, Steel Drum, Kerosene Tin, Polythene/Plastic Bag and Plastic Drum, respectively.

Insect species composition and their prevalence

Four insect species were identified in rice seeds stored at farmers' houses in both Aman and Boro season. These were: Angoumois grain moth, *Sitotroga cerealella* Oliv. (Gelechiidae : Lepidoptera), Rice weevil, *Sitophilus oryzae* L. (Curculionidae : Coleoptera), Red flour beetle, *Tribolium castaneum* Hebst. (Tenebrionidae:Coleoptera) and Lesser grain borer, *Rhizopertha dominica* Feb. (Bostrichidae : Coleoptera). The population of the prevailed insects in different storage structures and storage periods of Aman and Boro seasons is presented in Table 1 & 2.

Prevalence in Aman season: The prevalence of the recorded insects during Aman season was found significantly influenced both by storage structures and storage periods at farmers' house (Table 1 & 2). Highest insect population (31.48) was found in Gunny Bag and lowest was in Steel Drum (11.60), which was statistically identical with Dole and Polythene/Plastic Bag after six month of storage. Insect population was found to be increased with storage period with storage period up to June, then showed a decreasing trend (Table 2). After six months of sampling, 22.7, 4.2, 1.3 and 3.28 mean number of *S. cerealella, S. oryzae, R. dominica, T. castaneum* was recorded in Gunny Bag, respectively, which was highest among all others structure (Table 1). The mean number of *S. cerealella, S. oryzae, R. dominica, T. castaneum* was recorded as 13.8, 2.1, 0.38, 0.6, respectively (Table 2).

Table 1. Mean number of recorded insects of Aman and Boro rice / 250 g of seeds in different storage structures

	Storage season	Insect species	Storage structures						
			Dole	Gunny Bag	Steel Drum	Kerosene Tin	Motka	Plastic/ Polythene Bag	Total mean
Mean number of different insects	Aman	SC	9.20c	22.70a	10.10c	12.60bc	15.60b	12.30bc	13.80
		SO	2.20b	4.20a	1.20b	2.00b	1.16b	1.40b	2.10
		RD	0.10b	1.30a	0.30b	0.00b	0.30b	0.53b	0.38
		TC	0.46b	3.28a	0.0b	0.00b	0.00b	0.00b	0.60
		Total mean	**11.96c**	**31.48a**	**11.60c**	**14.60b**	**17.06b**	**14.23bc**	16.88
	Boro	SC	22.90a	26.40a	14.10b	21.40a	12.80b	14.10b	18.60
		SO	1.60	1.67	1.40	1.18	2.17	1.22	1.60
		RD	7.20a	2.30b	1.30c	2.50b	1.00c	2.20c	2.70
		TC	0.00c	2.50a	0.00c	0.00c	2.10a	1.50b	1.00
		Total mean	**31.70ab**	**32.87a**	**16.80c**	**25.08b**	**18.07c**	**19.02c**	23.90

Data were analyzed after square root transformation Mean values having same letter do not differ significantly at 1% level of significance

SC = *S. cerealella*, RD = *R. dominica*
SO = *S. oryzae*, TC = *T. castaneum*

Table 2. Mean number of recorded insects of aman and boro rice / 250 g of seeds in different storage periods

	Storage Season	Storage period	Prevailing Insects				Total mean
			SC	SO	RD	TC	
Mean number of different insects	Aman	Feb	3.30e	0.40c	0.10b	0.50	4.30e
		Mar	6.40d	1.40b	0.20ab	0.50	8.50e
		Apl	11.30c	2.30ab	0.40ab	0.90	14.90c
		May	16.0b	2.20a	0.60ab	1.10	19.90b
		Jun	25.20a	2.70a	0.40ab	1.50	29.80a
		Jul	24.2a	3.50a	0.70a	0.40	28.80a
		Total mean	**13.80**	**2.10**	**0.38**	**0.60**	**16.88**
	Boro	May	17.7	1.5	**3.4ab**	1.1	23.75abc
		Jun	22.4	1.9	**3.1ab**	1.0	28.40a
		Jul	20.7	2.1	**3.3ab**	1.2	26.68ab
		Aug	17.3	1.4	**2.6abc**	1.1	22.42bc
		Sept	16.7	1.5	**2.20c**	0.9	21.25c
		Oct	16.9	1.7	**1.70c**	0.7	21.01c
		Total mean	**18.6**	**1.6**	**2.7**	**1.0**	**23.90**

Data were analyzed after square root transformation, Mean values having same letter do not differ significantly at 1% level of significance

SC = *S. cerealella*, RD = *R. dominica*
SO = *S. oryzae*, TC = *T. castaneum*

Prevalence in Boro season: Both storage structures and periods significantly influenced the insect population development during Boro season (Table 1 & 2). Highest and lowest insect abundance was found in Gunny Bag (32.87) and Steel Drum (16.80), respectively (Table 1). The insect population was identical during the first three months (May-July), and then showed a gradual decrease (Table 2). After six months of sampling, highest mean number of *S. cerealella, S. oryzae, R. dominica, T. castaneum* was recorded as 26.4, 1.67, 2.3 and 2.5 in 250g of seeds in Gunny Bag (Table 1). The mean number of *S. cerealella, S. oryzae, R. domonica, T. castaneum* was recorded as 18.6, 1.6, 2.7, 1.0 in 250g of seeds, respectively (Table 2).

Relative abundance: The relative abundance of the recorded insects in Aman season follows the order: *S. cerealella* > *S. oryzae* > *R. dominica* >*T. castaneum* and in Boro, the relative prevalence was in the order: *S. cerealella* > *R. dominica* > *S. oryzae* > *T. castaneum*. (Table 1). Higher insects were prevailed in Boro season and *S. cerealella* was the most dominant insect.

Effect of storage structures and insect infestation on seed quality

Seed damage and weight loss: Seed damage and weight loss done by the recorded insects was significant both in Aman and Boro season in different structures.

In aman rice seeds: Storage structures and periods had a significant effect on seed damage and weight loss as presented in Figs. 1 & 2. The highest seed damage and weight loss was found in Gunny Bag (Fig.1) and lowest seed damage and weight loss was recorded in metal storage structures (Steel Drum, Kerosene Tin) (Fig. 2). Both seed damage and weight loss was gradually increased with the advancement of storage period. Highest seed damage (4.3%) and weight loss (2.6%) was recorded in the month of July (Fig. 2).

In Boro rice seeds: Storage structures had a significant effect on seed damage and weight loss but Storage period did not. Highest seed damage and weight loss was found in Dole and Gunny Bag (Fig.3) and Lowest was in Kerosene Tin and Motka (Fig. 3). Both were gradually decreased after an intial increase (Fig. 4).

Moisture content: Table 3 & 4 represents changes of moisture content in Aman and Boro seeds in storage structures and period, respectively. Highest moisture was recorded in Gunny Bag in both season and lowest was in Steel Drum in Aman seeds, and in Polythene Bag in Boro seeds (Table 4). Moisture content was minimum (13.63) at February and maximum (14.39) at July in Aman season (Table 4). In Boro seeds, highest (14.33) moisture was recorded at initially and then showed a decreasing trend up to the fourth month, then an increasing trend again (Table 4).

Germination percentage: Germination of rice seeds were significantly influenced both by storage structures and periods (Table 3 & 4). In Aman season, highest germination was recorded in Steel Drum (83.1) and lowest was found in Gunny Bag (70.9). In Boro, highest germination was recorded in Motka (82.7) followed by Polythene/Plastic Bag (82.27) and lowest (71.4) germination was recorded in Gunny Bag, as in Aman season. Germination of rice seeds deteriorates sharply with the increase of storage duration in both seasons (Table 3 & 4). Initially, seeds showed more than 90% germination but after six month, it was reduced to almost 61% in both cases.

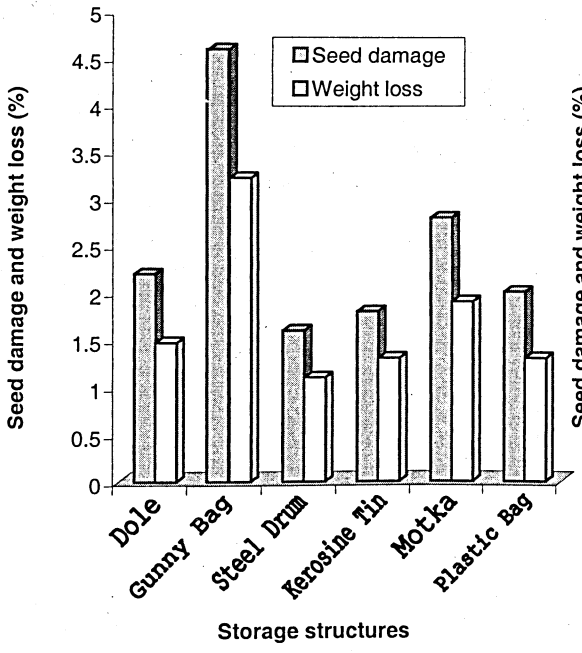

Fig. 1. Percent seed damage and weight loss in various storage structures of Aman rice seeds

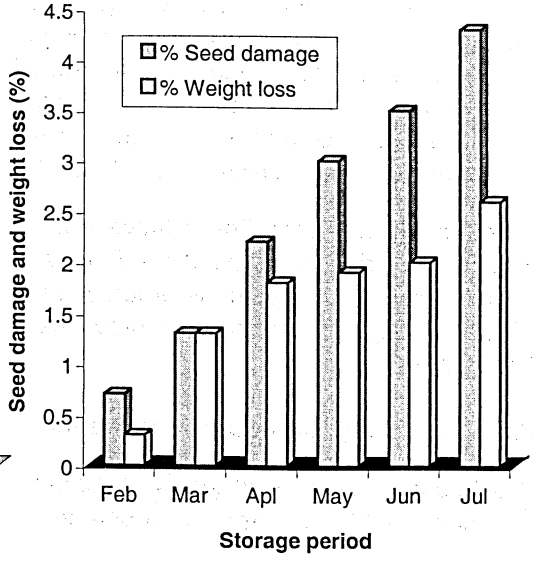

Fig. 2. Percent seed damage and weight loss in various storage periods of Aman rice seeds

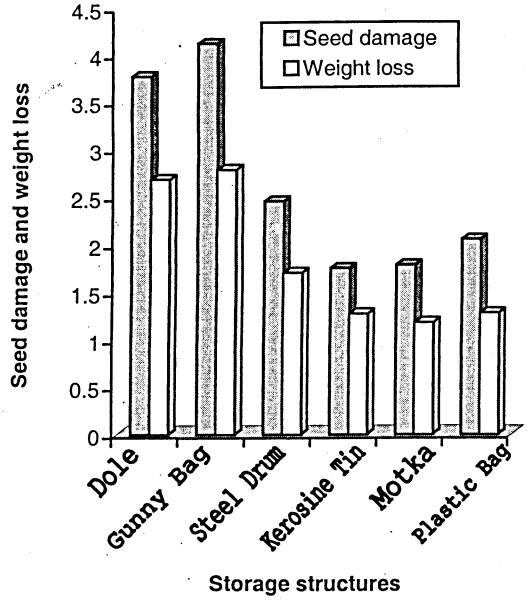

Fig. 3. Percent seed damage and weight loss in various storage structures of Boro rice seeds

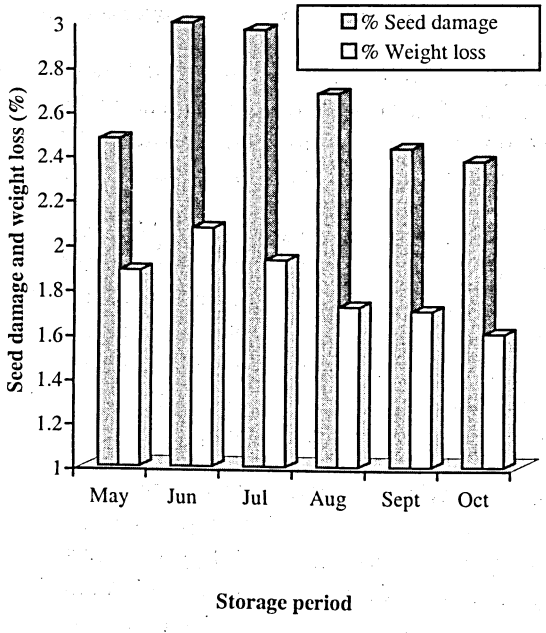

Fig. 4. Percent seed damage and weight loss at different storage periods of Boro rice seeds

Table 3. Change of moisture content (MC) and germination of rice seeds in different storage structures during Aman and Boro season

Storage structures	Aman rice seeds		Boro rice seeds	
	MC (%)	Germination (%)	MC (%)	Germination (%)
Dole	13.70c	73.10b	13.29c	80.06a
Gunny Bag	15.10a	70.90b	14.77a	71.40b
Steel Drum	13.20d	83.1a	13.75b	81.03a
Kerosene Tin	13.70c	81.4a	13.30c	82.17a
Motka	13.50cd	80.8a	14.03b	82.70a
Polythene Bag	14.40b	81.0a	13.06c	82.27a
Mean	**13.94**	**78.40**	**13.60**	**79.91**

Values having same letter do not differ significantly at 1% level

Table 4. Change of moisture content (MC) and germination of rice seeds in different storage periods during Aman and Boro season

Storage Periods*	Aman rice seeds		Boro rice seeds	
	MC (%)	Germination (%)	MC (%)	Germination (%)
1 Month	13.63c	90.4a	14.33a	93.11a
2 Month	13.73bc	87.0b	13.87b	89.30b
3 Month	13.78bc	83.5c	13.44c	85.83c
4 Month	13.97bc	77.6d	13.32c	78.20d
5 Month	14.15ab	71.1e	13.47c	71.39e
6 Month	14.39a	60.8f	13.47c	61.80f
Mean	**13.94**	**78.40**	**13.65**	**79.94**

* = For Aman = February to July 2002 and for Boro = May to October 2002
Values having same letter do not differ significantly at 1% level

Discussion

It was found that in Mymensingh Sadar upazila farmers used eight types of storage structures viz. Dole, Motka, Kolshi, Gunny Bag, Polythene/Plastic Bag, Kerosene Tin, Steel Drum and Plastic Drum for rice seed storage. This finding coincides with Razzaque (1980), Clements *et al.* (1984). They made survey on on-farm wheat storage in Bangladesh and reported the same above-mentioned structures.

The fact is that in Bangladeshi farmers use the same type of structures for seed and grain storage of different crops like rice, wheat, pulses. Similar reports made by Krain (1985) and Hashem (1984). Survey findings visualize that for rice seed storage, Motka, Kolshi, Dole, Gunny Bag structures are the most common ones. Saha *et al.* (1996) that 56% farmers store rice in Dole/Dool, 22% in Gola, 14% in Earthen Pot and only 8% in Drum. This report was on rice grain storage. Here, Gola as a structure was not found because it is usually used to store food grains and the present study was on rice seed storage. Observation on abundance of different insects in those structures revealed four insect species namely, *S. cerealella, S. oryzae, R. dominica* and *T. castaneum.* Various authors supported such result: Srivastava *et al.* (1973), Sukprakarn (1985), Aviles and Guibert (1986), Karim (1987), Thakur and Sharma

(1996), White and Jayas (1996), Yao *et al.* (1998). Among them, Sukprakarn (1985) reported that 70 insect species infest stored grains or seeds, but the *S. cerealella*, *R. dominica*, *Sitophilus* sp. were the dominant ones. Abundance of the recorded insects was made during Aman and Boro seeds and found higher insects in Boro seeds. The insect population was highest in Gunny Bag both in season. This was perhaps due to high moisture of seeds as it was found in seeds of Gunny Bag, hygroscopic nature of rice seeds and easy to absorb atmospheric moisture through the pores of Gunny Bag. Shahjahan (1975) also reported higher infestation in grains having higher moisture. The moisture protection of rice seeds stored in metal storage structures was found best. Ching *et al.* (1960) and Khare *et al.* (1974) reported similar observations.

On average, 2.50 % and 2.65 % seed damage was found after six months storage at Aman and Boro season, respectively. This result was in the range as earlier reported by Mookherjee *et al.* (1998). The result of weight loss was also coincides with the findings of Thakur and Sharma (1996). Mandal *et al.* (1984) and Irshad and Talpur (1993) also made similar observations. Germination of rice seeds gradually decreased with the advancement of storage period. This trend also reported by Kaur *et al* (1990). After six month, all structures except Gunny Bag showed more than 80% germination. Seeds in Gunny Bag have produced lowest germination. This might be due to the insect infestation, as they feed seed kernel and reduce viability. Khare *et al.* (1974), Mian and Fakir (1989), Ahmed (1990), and Eswarappa *et al.* (1991) also reported similar results. Seeds stored in metal storage structures like Steel Drum, Kerosene Tin produced higher germination. as supported by Khare *et al.* (1974) and Haque (1982). Thus, metal structures seem to better than other structures as mentioned by Rabbani (1976) and Rao (1978). Therefore, Gunny Bag should be avoided for rice seed storage purpose and metal structures like Steel Drum, Kerosene Tin and also Polythene/ Plastic Bag can be considered for safe storage of rice seeds.

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