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Effect of Storage Duration and Storage Devices on Seed Quality of Boro Rice Variety BRRI dhan47

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Abstract

An experiment was conducted to evaluate the effect of storage device and storage duration on seed germination and seedling growth parameters of Boro rice variety BRRI dhan47. The experiment was laid out in a completely randomized design (CRD) with two factors and three replications. The storage devices used in this study were gunny bag, earthen container, tin container and plastic container. The storage durations were 2 months, 4 months and 6 months. Germination test was done in the laboratory following rolled paper method. Data were collected on moisture percentage, insect population, germination percentage, and root and shoot length, root dry mass and shoot dry mass. Seed germination and seedling parameters showed wide variations due to different storage devices and storage duration. Germination parameters were negatively affected by increasing storage duration. The number of insect population were increased; while the germination percentage, root length, shoot length, root dry mass and shoot dry mass decreased in the seeds stored into different storage devices and with increasing storage duration. All the seedling parameters were found zero for the seeds stored in all the four containers after 6 months of storage with few exceptions in gunny bag. Seeds stored in porous containers gave better performance than the seeds stored in airtight containers.

Keywords: Boro rice; BIRRI dhan47; Storage duration; Storage device; Seed

Introduction

Rice is one of the most important and extensively cultivated cereal crops in Bangladesh since the primitive period of time [1]. In Bangladesh, approximately 80% of the total cultivated land covering about 11.20 million hectares produces 43.50 million tons of rice annually [2]. Considerable amount of works have been done on storage of rice seeds in relation to varied storage conditions in different parts of the world [3,4].

Seed is one of the vital inputs for crop production. It has been shown experimentally that only by using good quality seed rice yield could be increased by 15% to 20%. In Bangladesh more than 80% of the rice seeds are produced and preserved by farmers [5]. Seed storage is an important aspect of any sound seed program, because badly stored seeds are not much helpful to yield healthy and vigorous plant. In most cases farmer's stored seeds are badly infested with stored grain pests and moulds with very poor germination [6]. A good quality seed may also be seriously deteriorated if stored under sub optimal condition. From this information the average annual wastage of seed could be estimated as 0.353 million mt. equivalent to Taka 5295 million i.e. US$ 91.3 million [7].

Storage duration is another factor, which affects seed quality. Seed moisture content goes up gradually during storage reducing seed quality depending on reduction in germination percentage. But at 15.5% moisture level invasion of rough rice by storage fungi and germination percentage reduction were proportional to increasing moisture content and the increasing length of storage [8]. Rough rice was infected at moisture content of 13.4% to 13.8% within 413 days of storage causing reduction in germination percentage [9]. So, proper storage of seed is necessary in our country for getting quality seed. Under this circumstances the present study has been formulated with the following objectives-

- To determine the effect of different storage devices on seed quality of Boro rice during storage time.
- To find out the effect of storage period on seed quality of Boro rice.
- To generate information about the suitable storage devices under Bangladesh condition for storage of rice.

Materials and Methods

The experiment was carried out at the Agronomy Laboratory of Agrotechnology Discipline, 2nd Academic Building, Khulna University, and Khulna. The experiment was conducted from June to December, 2011. The experiment was laid out in a completely randomized design (CRD) with three replications. Total numbers of treatment combination were 36 (3 storage duration × 4 Devices × 3 Replications). Boro rice variety was used for the experiment, which was BRRI dhan47 (High Yielding Variety). The storage devices were kept in the growth chamber (25°C ± 2°C) for observation.

Experimental treatment

There were two factors

Factor A-Storage device **Factor B**-Storage duration

S_1=Gunny bag D_1=2 months

S_2=Plastic container D_2=4 months

S_3=Tin container D_3=6 months

S_4=Earthen container

Characteristics of BRRI dhan47: It is salinity tolerant Boro season rice. It can tolerate 12 dS/m to 14 dS/m salinity in seedling stage. The

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average yield is 4 ton/ha to 7 ton/ha. Plant height is about 100 cm. The total life cycle is completed within 140-150 days. It contains 28.3% amylase. Disease and pest attack is less than other varieties.

Collection of seeds: Seeds were collected from a farmer of Batiaghata Upazila, Khulna District. Seeds were procured on 5th June, 2011 from farmer's house just at the point of storage or selling to the seed traders. Seeds, thus procured, were brought to the Agronomy Laboratory of Agrotechnology Discipline, Khulna University.

Drying of seeds: Prior to storage, seeds were air-dried on a clean polythene sheet spreading over the concrete floor for 3-4 days to attain a moisture content of 12%. During drying, seeds were turned up and down several times and mixed thoroughly in order to obtain a single uniform composite lot.

Selection of the storage containers: Four types of storage containers were used for the experiment:

1. Gunny bag: The grades available in market which is commonly used by farmers for the storage of seeds.

2. Plastic container: Plastic containers with air-tight lid were used for the storage of the seeds.

3. Tin container: Tin containers with air-tight metal lid were used.

4. Earthen container: Earthen containers with earthen lid were used. The mouth of the container was covered with polythene sheet.

Storage of seeds

The seeds of BRRI dhan47 were collected, dried and then the seeds were stored at 12% moisture content in the four selected containers on June 10, 2011. The seeds were stored for next six months where three replications were maintained for each treatment. Seed quality tests were performed every two months interval.

Test of seed quality and data collection

- **Moisture test:** The moisture content of a seed sample was recorded before storage and after storage with two months interval. Oven dry method was used to determine the moisture content of seeds and the results were expressed in percentage (%).

- **Thousand (1000) seed weight:** A composite seed sample was taken from the variety. Then 1000 seeds from the seed sample were counted and their weight (23.52%) was recorded in gram (g) with the help of an electronic balance.

- **Count of Insect population and insect damaged seeds:** Insect population refers to the number of insects, which remain in the seeds. Population of insects was counted in number with naked eyes by physical seed sorting. Both dead and live insects were counted.

- **Germination test:** The germination test was conducted using the rolled paper method. Two pieces of germination paper were taken and soaked with water. Then twenty seeds of BRRI dhan47 were placed in between two wet papers and given rolled shape. Each treatment was replicated three times. The roll papers were observed every two days interval and the numbers of germinated seeds were recorded. Within eight days after seed setting maximum number of seeds were germinated. A seed was considered to be germinated as produced normal seedling. Data on seed germination was recorded before and after storage.

The germination percentage was calculated using the following formula

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated after 192 hours}}{\text{Total number of seeds placed for germination}} \times 100$$

Measurement of root and shoot length

Root and shoot length of the seedlings were measured after 8 days of seed setting. After counting the number of seedlings for germination test, the normal seedlings were carefully taken in such a way that the root and shoot parts remain uninjured. By separating the root and shoot portion of the seedling carefully, the length of shoot and root were measured by a centimeter scale.

Measurement of root and shoot dry mass

After measuring root and shoot length, the root and shoot samples were wrapped separately with brown paper and were dried in an electric oven maintaining 70°C for 72 hours and weigh the dry mass. These were measured by four digit electronic balance and expressed in gram (g).

Statistical analysis

All the data were analyzed for variance (ANOVA) by using computer operated statistical package MSTAT-C. The differences between the treatment means were determined by using Duncan's Multiple Range (DMRT).

Results and Discussion

Results on various parameters of the experiments are presented in different tables and figures and necessary discussion are given below in systematic manner.

Seed Moisture Content

Seed moisture content of BRRI dhan47 was 12.0% before storage (Table 1). During storage seed moisture content of stored rice seeds varied from 4.9% to 21.6% depending on storage containers and length of storage. The mean moisture content was 14.35%, 17.88% and 11.93% after 2, 4 and 6 months of storage irrespective of storage device. The maximum moisture content (21.6%) was recorded in the seeds stored in tin container after 6 months of storage, while minimum moisture content (4.9%) was recorded in the seeds stored in gunny bag after 6 months of storage (Table 1). Rahman et al. [10] reported that moisture content and germination of farmers stored rice seeds varied from 11.7% to 16.5% and 71% to 78%, respectively with respect to containers and additives used.

Insect population

Four species of insects recorded they were- rice moth (*Corcyra cephalonica*), rice weevil (*Sitophillus oryzae*), red flour beetle (*Tribolium castaneum*) and lesser grain borer (*Rhyzopertha dominica*).

At the time of storing BRRI dhan47 seeds had no insect population. The number of insects increased with the increase of storage time, irrespective of storage containers. Insect population during storage varied from 4 g to 38/10 g seed. The minimum number of insects (4) was found in the seeds stored in gunny bag after 2 months and in tin container after 6 months of storage, while maximum number of insects (38) was recorded in the seeds stored in tin container for 2 months (Table 2). It may be revealed that the number of insect population increased with increase in storage time irrespective of storage containers used.

Almost similar observation was given by Mia et al. [11]. They observed that the number of insect population, insect damaged and dead seeds were found to increase with the increase in storage duration. Fakir et al. [12] also stated that the number of insect damaged seeds and insect population during storage period ranged from 5-79 and 4.60

Seed moisture before storage (%)	Storage device	Seed moisture after storage (%)		
		2 months	4 months	6 months
12.0	Gunny bag	13.6	15.3	4.9
	Plastic container	13.6	17.8	14.0
	Tin container	15.3	19.0	21.6
	Earthen container	14.9	19.4	7.2
	Mean	14.35	17.88	11.93

Table 1: Seed moisture content of BRRI dhan 47 due to storage duration and storage devices.

Germination (%)	Seedlings growth parameters			
	RL (cm)	SL (cm)	RDM (g)	SDM (g)
98.33	11.61	8.76	0.89	0.23
RL=Root Length, SL=Shoot Length, RDM=Root Dry Mass, SDM=Shoot Dry Mass				

Table 2: Insect population identified in BRRI dhan47 during different storage duration and storage device.

Before storage insect population			Storage device	After storage insect population								
Dead	Live	Total		2 months			4 months			6 months		
				Dead	Live	Total	Dead	Live	Total	Dead	Live	Total
0	0	0	Gunny bag	0	4	4	5	3	8	0	9	9
			Plastic container	0	10	10	0	37	37	0	16	16
			Tin container	0	38	38	0	18	18	0	4	4
			Earthen container	5	2	7	2	6	8	0	15	15

Table 3: Seed germination and seedling growth parameters of BRRI dhan47 before storage.

Storage duration	Seedling growth parameters				
	Seed germination (%)	RL (cm)	SL (cm)	RDM (g)	SDM (g)
2 months	76.57^{a} (77.87%)	8.96^{a} (77.17%)	7.91^{a} (90.29%)	0.06^{a} (6.74%)	0.14^{a} (48.28%)
4 months	28.72^{b} (29.21%)	3.85^{b} (33.16%)	2.88^{b} (32.88%)	0.01^{b} (1.12%)	0.06^{b} (20.69%)
6 months	8.75^{c} (8.90%)	1.39^{c} (11.97%)	0.24^{c} (2.74%)	0.005^{c} (0.56%)	0.008^{c} (2.76%)
LS	0.01	0.01	0.01	0.01	0.01
CV (%)	5.83	3.76	3.04	19.20	13.58
Figures in a column with similar letter (s) do not differ significantly, CV=Coefficient of variation, LS=Level of Significance, RL=Root Length, SL=Shoot Length, RDM=Root Dry Mass, SDM=Shoot Dry Mass					

Table 4: Effect of storage duration on seed germination and seedling growth parameters in BRRI dhan47.

to 70.00 per 100 g seed, respectively that varied with respect to storage containers, storage period and additives used.

Seed germination and seedlings growth parameters in BRRI dhan47 before storage

At the time of storage, the average germination percentage was 98.33% in BRRI dhan47 seeds. The average root length was 11.61 cm and the average shoot length was 8.76 cm (Table 3). The average root dry mass 0.89 g and the average shoot dry mass 0.23 g were found before storage (Table 3).

Effect of storage duration on seed germination and seedlings growth parameters in BRRI dhan47

Seed germination varied significantly due to storage duration. Germination percentage decreased with increase in storage duration compared to its initial germination before storage. The highest germination percentage 76.57% was found after 2 months of storage and lowest germination percentage 8.75% was found after 6 months of storage (Table 4). Christensen and Lopez [13] stated that at 15.5% moisture level invasion of rough rice by storage fungi and germination percentage reduction were proportional to increasing moisture content and the increasing length of storage.

Germination percentage obtained after 2, 4 and 6 months of storage were 77.87%, 29.21% and 8.90% respectively to its initial value before storage. Root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) decreased with increase in storage duration.

Figures in the parenthesis indicate percentage of corresponding values between before storage percentage and respective months' percentage.

The highest root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) was found 8.96 cm, 7.91 cm, 0.06 g and 0.14 g respectively after 2 months of storage. While the lowest root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) was found 1.39 cm, 0.24 cm, 0.005 g and 0.008 g respectively after 6 months of storage (Table 4).

The root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) were 77.17%, 90.29%, 6.74% and 48.28% respectively at 2 months of storage which decreased to 11.97%, 2.74%, 0.56% and 2.76% respectively to its initial values at 6 months of storage (Table 4).

Seed germination and seedling growth parameters were decrease with increase in storage duration which might be the cause of attaining dormancy of seed due to increase in storage duration.

Storage device	Seedling growth parameters				
	Seed germination (%)	RL (cm)	SL (cm)	RDM (g)	SDM (g)
Gunny bag	51.50^{a}	6.29^{a}	4.03^{a}	0.08^{a}	0.11^{a}
Plastic container	38.56^{b}	4.70^{b}	3.94^{a}	0.02^{b}	0.07^{b}
Tin container	27.33^{c}	3.21^{c}	2.88^{b}	0.02^{b}	0.07^{b}
Earthen container	34.67^{b}	4.75^{b}	3.86^{a}	0.02^{b}	0.10^{a}
LS	0.01	0.01	0.01	0.01	0.01
CV (%)	5.83	3.76	3.04	19.20	13.58

Figures in a column with similar letter (s) do not differ significantly, CV=Co-efficient of variation, LS=Level of Significance, RL=Root Length, SL=Shoot Length, RDM=Root Dry Mass, SDM=Shoot Dry Mass

Table 5: Effect of storage device on seed germination and seedling growth parameters in BRRI dhan47.

Interaction		Seedling growth parameters				
Storage duration	Storage device	Seed germination (%)	RL (cm)	SL (cm)	RDM (g)	SDM (g)
2 months	Gunny bag	75.00^{b}	9.05^{b}	7.74^{b}	0.07^{cd}	0.14^{ab}
	Plastic container	90.30^{a}	10.57^{a}	9.43^{a}	0.06^{cd}	0.18^{a}
	Tin container	77.00^{b}	8.70^{b}	8.00^{b}	0.05^{de}	0.16^{ab}
	Earthen container	64.00^{c}	7.54^{c}	6.47^{c}	0.04^{def}	0.15^{ab}
4 months	Gunny bag	44.50^{d}	5.44^{ef}	4.07^{fg}	0.02^{efg}	0.13^{ab}
	Plastic container	25.37^{gh}	3.51^{h}	2.67^{h}	0.01^{fg}	0.08^{c}
	Tin container	5.00^{j}	0.94^{j}	0.65^{j}	0.005^{fg}	0.04^{de}
	Earthen container	40.00^{e}	5.53d^{e}	4.15^{f}	0.02efg	0.06^{f}
6 months	Gunny bag	35.00^{f}	4.38g	4.09f	0.02^{efg}	0.0^{6cd}
	Plastic container	0.00^{k}	0.00^{k}	0.00^{k}	0.00^{g}	0.00^{f}
	Tin container	0.00^{k}	0.00^{k}	0.00^{k}	0.00^{g}	0.00^{f}
	Earthen container	0.00^{k}	0.00^{k}	0.00^{k}	0.00^{g}	0.00^{f}
LS		0.01	0.01	0.01	0.01	0.01
CV (%)		5.83	3.76	3.04	19.20	13.58

Figures in a column with similar letter (s) do not differ significantly, CV=Co-efficient of variation, LS=Level of Significance, RL=Root Length, SL=Shoot Length, RDM=Root Dry Mass, SDM=Shoot Dry Mass

Table 6: Interaction effect of storage duration and storage devices on seed germination and seedling parameters in BRRI dhan47.

Effect of storage device on seed germination and seedling growth parameters in BRRI dhan47

Germination percentage varied significantly and ranged between 51.50% and 27.33% for different storage devices. The highest value (51.50%) was found in the seeds stored in gunny bag and the lowest value (27.33%) was found in the seeds stored tin container (Table 5).

Root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) varied significantly. The highest root length, shoot length, root dry mass and shoot dry mass (6.29 cm, 4.03 cm, 0.08 g and 0.11 g respectively) were recorded in the seeds stored in gunny bag (Table 5).

The lowest root length (3.21 cm) and shoot length (2.88 cm) were recorded in the seeds stored in tin container; while the lowest root dry mass (0.02 g) was found in the seeds stored in plastic, tin and earthen containers and the shoot dry mass (0.07 g) in plastic and tin containers (Table 5).

According to Ching et al. [8], impermeable containers keeps seed moisture content lower but in permeable storage containers seed moisture content goes up gradually during storage reducing seed quality depending on reduction in germination percentage.

Interaction effect of storage duration and storage devices on seed germination and seedling growth parameters in BRRI dhan47

Seed germination, root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) varied significantly in BRRI dhan47 seeds due to interaction of storage duration and storage devices.

Seed germination percentage varied from 90.30% to 5.0% where the highest value was 90.30% in the seeds stored in plastic container for 2 months of storage and the lowest value (5.0%) was found in the seeds stored in tin containers for 4 months of storage (Table 6).

Root length, shoot length were the highest (10.57 cm and 9.43 cm respectively), in the seeds stored in plastic container for 2 months; while they were the lowest (0.94 cm and 0.65 cm respectively) in the seeds stored in tin container for 4 months. The root dry mass was the highest (0.07 g) in the seeds stored in gunny bag for 2 months; while the highest shoot dry mass (0.18 g) was obtained in the seeds stored in plastic container for 2 months. The lowest roots dry mass (0.005 g) and the lowest shoot dry mass (0.04 g) were obtained in the seeds stored in tin container for 4 months (Table 6).

All the seedling parameters were found zero (0.0) for the seeds stored in all the four containers after 6 months of storage with few exceptions in gunny bag which might be due to the attaining of seeds in dormant condition (Table 6).

Changes of germination and seedling growth parameters with storage duration in BRRI dhan47

Germination percentage, root length, shoot length, root dry mass and shoot dry mass were found to reduce with increase in storage duration.

Reduction of germination (%) with storage duration in BRRI dhan47

After 2 months of storage, the germination percentage was reduced in BRRI dhan47 seeds and the reduction was 22.13%.

After 4 months of storage, the germination percentage reduction increased to 70.79%. After 6 months of storage, the germination percentage reduction also increased and the reduction was 91.1% (Figure 1).

Reduction of root length with storage duration in BRRI dhan47

After 2 months of storage, the root length reduced and the reduction was 22.83%. After 4 months of storage, the root length reduction percentage increased and the reduction was 66.84%. After 6 months of storage, the root length reduction percentage also increased and it was 88.03% (Figure 2).

Reduction of shoot length with storage duration in BRRI dhan47

After 2 months of storage, the shoot length reduced 9.71% to its initial value. After 4 months and 6 months of storage, the shoot length reduction percentage increased and the reduction was 67.12% and 97.26% respectively (Figure 3).

Reduction of root dry mass with storage duration in BRRI dhan47

Root dry mass of BRRI dhan47 reduced with increase in storage duration. The reduction percentage were 93.26%, 98.88% and 99.44% for 2 months, 4 months and 6 months of storage respectively (Figure 4).

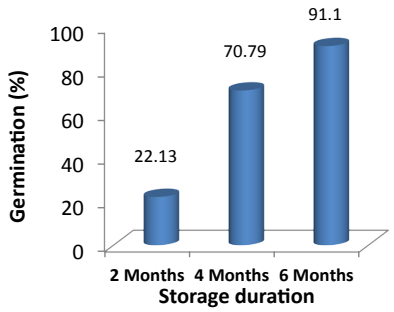

Figure 1: Reduction of germination (%) with storage duration.

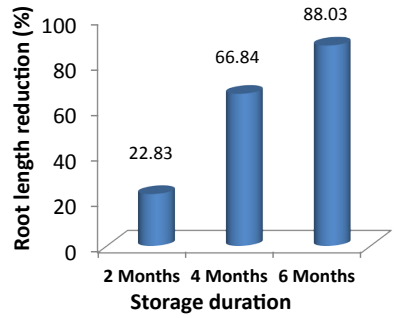

Figure 2: Reduction of root length with storage duration.

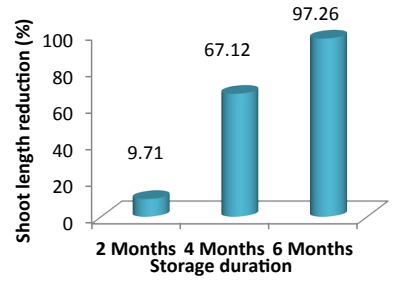

Figure 3: Reduction of shoot length with storage duration.

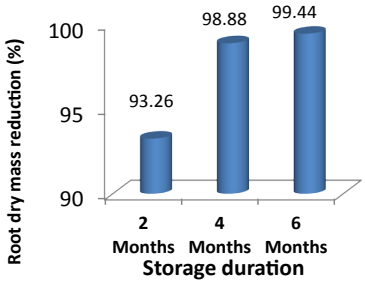

Figure 4: Reduction of root dry mass with storage duration.

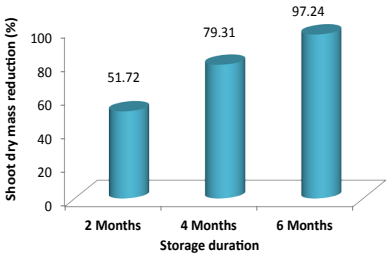

Figure 5: Reduction of shoot dry mass with storage duration.

Reduction of shoot dry mass with storage duration in BRRI dhan47

After 2 months of storage, the shoot dry mass reduced to 51.72% to its initial value. After 4 months of storage, the shoot dry mass reduction percentage increased and the reduction was 79.31%. After 6 months of storage, the shoot dry mass reduction percentage also increased and the reduction was 97.24% (Figure 5).

Summary and Conclusion

Variations were observed in seed moisture content, insect population, and germination percentage and seedling parameters due to storage devices and storage duration. At the time of storage, the moisture content and the germination percentage of BRRI dhan47 were 12.6% and 98.33%, respectively. The insect population at the time of storage was 0. Germination percentage decreased with increase in storage duration compared to its initial values before storage. The highest germination in BRRI dhan47 was 76.57% at 2 months of storage. The lowest germination (8.75%) was found at 6 months of storage. Reduction on germination percentage may be due to dormancy of seed and it was 0.0% after 6 months of storage. Root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) decreased due to storage of seeds. The higher values were in 2 months of storage; while the lower values were in 6 months of storage.

The highest germination (51.50%) was found in gunny bag and the lowest germination (27.33%) was found in tin container. Root length (RL), shoot length (SL), root dry mass (RDM) and shoot dry mass (SDM) were varied due to storage device. Higher values for all the parameters were observed in seeds stored in gunny bag. In case of interaction, seed germination percentage varied from 90.30% to 5.0% where the highest value was found in the seeds stored in plastic container for 2 months and the lowest value was found in tin container for 4 months. All the seedling parameters were found zero for the seeds stored in all the four containers after 6 months of storage with few exceptions in gunny bag.

Based on the results of the present investigation, it may be concluded that-

• Seed germination and seedling growth parameters reduced with increasing storage duration due to dormancy of seed. BRRI dhan47 showed the tendency to become dormant after storage.

• After six months of storage seed germination percentage and seedling growth parameters were almost zero.

• Seeds stored in porous containers give better performance than the seeds stored in air tight containers.

• Further research is necessary as temperature affect the porous containers and airtight containers differently.

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