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Performance of Alternate Storage Devices on Seed Quality of Boro Rice

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Abstract: The experiment was carried out to evaluate the efficiency of storage devices on seed quality of Boro rice seed. Different storage devices used in this study was T_1= Organic Cocoon, T_2= Rexin Cocoon, T_3= Polythene bag, T_4= Poly + Gunny bag and T_5= Gunny bag. Germination percentage of Boro seeds stored in organic cocoon was significantly the highest (91%) compared to that of rexin cocoon (87%), Polythene bag (80%), polythene in Gunny bag (79.667) and Gunny bag (68%). Seeds stored in organic cocoon performed better in maintaining higher germination due to lower moisture content (12.10%) below the critical level (14%), reduced oxygen level (4.9%) and higher proportion of dead insects (97%) caused by reduced oxygen.

Key words: Rice seed · Storage device · Germination · Relative humidity

INTRODUCTION

In Bangladesh, majority of food grains come from rice (*Oryza sativa* L.). About 80% of cropped area of this country is used for rice production, with annual production of 25.18 million tons from 10.29 million ha of land [1]. The average yield of rice in Bangladesh is 2.45 t ha^{-1} [2]. This average yield is almost less than 50% of the world average rice grain yield. Although, the agro-ecological conditions of Bangladesh are favorable for rice cultivation through the year, the yield per hectare is very low compared to other major rice growing countries of the world [3]. In order to meet the demand of rice, the yield per unit area should be increased, as the horizontal expansion of rice area is not possible due to heavy population pressure. In agro-based rural Bangladesh, small and marginal farmers cover about 75% of the total rice cultivation. With the present production technologies available, it is possible to maximize the yield of rice. Amongst many constraints, quality seeds, post harvest drying and storage facilities are considered as the major uptake barriers of improved rice production technologies available at Research Institutes in Bangladesh.

In many areas of Bangladesh the farmers do not have proper information and appropriate technology for production and storage of rice. Farmers traditionally store their seeds in motka, dole, jute sacks, polythene bags etc. These devices are primitive and non scientific. The seeds stored in these devices are low quality, show less germination and have less vigor. With a view to strengthening community storage facilities, RDRS being one of the leading NGO in Northern Bangladesh has started establishing pucca seed stores through its People's Institution (Federation) at union level. With this view, RDRS has installed an insecticide free organic cocoon from Allied Agro-Industries Ltd., Bangladesh who imported it from Grain pro. International, USA. The cocoon is made of PVC materials in Plastic strain and can control humidity, temperature, oxygen and pests. Several other low cost option are also available namely rexin made cocoon (an alternative device developed by RDRS), traditional polythene bag, polythene in gunny bag and gunny bag. Nevertheless, the comparative advantage of alternate devices over the traditional one in terms of pests and germination was meagre. In this regard, a critical assessment of these alternate organic storage devices needs to be undertaken on the seed quality of rice.

The present study was therefore undertaken to compare the performance of alternate storage devices in maintaining seed quality of boro rice and to find out the suitable alternate storage device (s) under Bangladesh condition.

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MATERIALS AND METHODS

The experiment was conducted at the Mohendranagar Union Federation of Lalmonirhat Sadar Upazila under Lalmonirhat district during the period from July 2001 to December 2001. The material used in the study was rice seeds which was collected from the farmers of Lalmonirhat Sadar Upazila who participated in and have been trained from PETRRA project for quality seed production of rice. Complete Randomized Design (CRD) was followed with three replications having the treatments storage devices (T_1 - Organic Cocoon, T_2 - Rexin Cocoon, T_3- Polythene bag, T_4- Poly + Gunny bag, T_5-, Gunny bag) and variety (Boro seed- BRRI dhan28)

Description of Treatments

Organic Cocoon (USA): The cocoon is made of Polyvinyl chloride (PVC) materials in plastic strain. These are hermetic (airtight) because they use a special, advanced grade, flexible PVC material and zipper system. The PVC thickness is 0.8 mm. It's capacity ranges from 1 to 150 tons. Grain pro Inc., USA, has developed this technology and become the distributor worldwide. This cocoon effectively prevents rain water, ground water and vapour penetration. It can control humidity, temperature, oxygen and pests. Insects available in the grains are quickly killed as the cocoon naturally creates a low oxygen and high CO_2 atmosphere. Filled cocoon's smooth, slippery surface has been proven to be resistant to rodent attack even when set directly in fields.

Rexin Cocoon: The Rexin cocoon is developed by RDRS. This cocoon is made of improved rexin lined inside with polythene. These cocoons are airtight because it has zipper system.

Polythene Bag: These bags are made of improved polythene. The bag is thick than normal grades of polythene bag. This thick Poly bag is developed by RDRS. It contains 5 kg rice seeds.

Poly + Gunny Bag: Normal grades Poly bag and Gunny bag which are commonly used by farmers for storage of seeds. First, seeds are stored in gunny bag and then the gunny bag with seeds is kept in polythene bag.

Gunny Bag: Normal grades available in market which is commonly used by farmers for storage of seeds.

Before storing, seeds were sun dried to the moisture content between 12-13% and then stored in different types of devices.

Description of Data Collection

Moisture Test: Seed moisture refers to the amount of moisture in seeds. Seed moisture content was measured by moisture meter. Seed moisture was recorded two times one before storage and other after storage (before seed sowing).

Germination Test: Germination was done in petridishes at the laboratory of Agronomy Department. Sand was used as germination media which was collected, washed and dried. Then the petridishes were filled with sand leaving 2cm from the top. Adequate moisture level was maintained in the germination media.

Germination test for each storage container was carried out taking 400 seeds at every sampling time in four replications. Germination test was also carried out at different moisture content immediately before putting the seed in containers. At the first count, only normal seedlings were carefully examined on each replicate of 100 seeds and removed, counted and recorded. All other seeds and seedlings were left until the 7^{th} days of the test when the final count was made. At the final count, all categories of seedlings were recorded. Normal seedlings were totaled at each replicate. Abnormal seedlings and dead seeds were not counted. The replicate results were averaged to give the mean percentage of normal germination.

Oxygen Level: Oxygen level refers to the amount of oxygen in the storage device where seeds are stored. It was measured by oxygen meter. Oxygen level was recorded two times, one before storage and other after storage (before seed sowing).

Insect Population: Insect population refers to the number of insects which remain in stored seeds. It was counted by watching with necked eye. Both dead and live insects were counted

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique and the means were compared by Duncan's Multiple Range Test [4].

RESULT AND DISCUSSION

Effect on Seed Quality

Seed Moisture Content: During 1st sampling (pre storing), the moisture content of rice seeds were not significantly affected by different storage devices (Table 1). Before storing seeds were dried to recommended moisture level (12%) and then stored in all the devices on the same day which eventually contributed to insignificant variation in moisture content. But during 2nd sampling (after storage), different storage devices showed a significant variation in moisture content of seeds. The data revealed that the moisture content of seed stored in USA organic cocoon was significantly the lowest (12.10%) and seed stored in gunny bag was significantly the highest (15.53%) compared. to that of other devices. No significant difference in moisture content of seed was observed when stored in poythene and polythene in gunny bag (14.5% and 14.8% respectively). Rexin cocoon, however, maintained a lower level of moisture content of seed (13%) than the above polythen devices. This results indicate that the USA organic cocoon and rexin cocoon maintained moisture content of seeds below the critical level (14%) which is a critical factor in seed storage for good germination and vigor. Increase in moisture content of seed stored in gunny bags correlates with the findings of Warham [5] who explained that gunny bag offered no resistance to moisture penetration.

Oxygen Level: Oxygen level inside the storage device did not significantly vary among the storage devices under study before storing seeds (Table 1). This result was primarily due to the fact that all the devices were exposed to air before storage and the data from all devices were taken on the same date. But after storage, the oxygen level was significantly affected by storage devices. The data revealed the oxygen level in organic cocoon was significantly the lowest (4.9%) while the highest level was found in the Gunny bag (21%). Polythene bag and polythene in gunny bag, showed insignificant variation in oxygen level (19% and 18.5% respectively) while rexin cocoon had 15% oxygen level. The oxygen level inside the USA organic cocoon was lower as it is hermetic (airtight). More over, it relies on the principle that when seeds are stored it is already infested with insects and the insect respiration with in the USA organic cocoon reduces the oxygen and increase co_2 concentration until the insects are dead. De Dios [6] reported that the organic cocoon reduced oxygen level to 4% when milled rice was stored.

Insect Population: There was a significant effect of storage device on the population of insects during storage of seeds (Table 1). Significantly the highest proportion of live insects were found in the seed samples stored in gunny bag (85.10%) while the lowest was observed in Organic cocoon (3%) compared to that in rexin cocoon (32.67%), polythen bag (33.33%) and polythene in gunny bag (35.0%) during the sampling date November 2001. The latter three devices did not significantly differ in proportion of live insects. The result also reveals that the cocoon killed the highest proportion of insects (97%) in seeds compared to a very minimal proportion of dead insects (14.90%) found in seeds stored in gunny bag on the same sampling date. Corresponding proportion of dead insects in rexin cocoon (66.33%), in polythene bag (66.67%) and in polythene plus gunny bag (65%) did not vary significantly among themselves.

Table 1: Effect of storage devices on moisture percentage, oxygen level, insect population and germination percentage of rice seed

	% moisture		Oxygen level (%)		Insect population (%)		Germination (%)	
Storage device	1st sampling (Pre storage)	2nd sampling (After storage)	1st sampling (Pre storage)	2nd sampling (After storage)	Dead	Live	1st sampling (Pre storage)	2nd sampling (After storage)
Organic Cocoon (T1)	12.067	12.1d	20.333	4.9 d	97 a	3 c	88	91 a
Rexin Cocoon (T2)	12.8	13 c	20.667	15 c	67.333 b	32.667 b	88	87 b
Polythene bag (T3)	12.4	14.5 b	20.5	19 b	66.667 b	33.333 b	87	80 c
Polythenein Gunny bag (T4)	12.3	14.8 ab	20.233	18.5 b	65 b	35 b	87.66	79.667c
Gunny bag (T5)	12.267	15.533 a	20.033	21 a	14.9 c	85.1 a	87.66	68 d
Level of significance	NS	0.01	NS	0.01	0.01	0.01	NS	0.01
LSD	NS	0.828	NS	1.47	2.76	2.77	NS	2.048
CV (%)	5.32	3.25	4.18	5.14	2.45	4.02	1.67	1.39

In a column, figures having similar letter (s) do not differ significantly where as figures bearing dissimilar letter (s) differ significantly

NS= Not significant

Table 2: Monthly mean of daily maximum, minimum and average temperature, average relative humidity

	Temperature°C			
Month	Maximum	Minimum	Average	Average humidity (%)
July	30	24	27.0	86
August	30	26	28.0	85
September	30	25	27.5	84
October	29	23	26.0	79
November	27	21	24	75
December	25	14	19.5	73

These results indicate that USA organic cocoon reduced the pressure of insect population of stored seeds and thereby reduce the damage of seeds. This reduction of insect might be due to reduction of oxygen level lethal to insects. Cham Kaewmanee [7] of the stored product Insect research group in Bangkok reported that no live insects or seed damage were found in the USA organic cocoon, where as in the conventional structure 30.2% of seeds were damaged and 271 adult weevils were found. More over, lower moisture content in the USA organic cocoon of this experiment also contributed to lower population of insects. This result corroborates well with the findings of Pratima and Roy [8] who reported that higher moisture content resulted in greater colonization of storage fungi. The rexin cocoon through was able to maintain lower moisture content of seeds, could not kill the insects significantly due to higher oxygen level (15%) inside the device which was favorable for respiration of insects.

Germination: Storage devices did not significantly affect the germination percentage of seeds during the 1st sampling before storage while it was found significant during 2nd sampling after storage (Table 1). The significantly highest germination (91%) was obtained from the seeds stored in organic cocoon which was followed by that in rexin cocoon (87%).

Significantly the lowest germination (68%) was obtained from the seeds when stored in gunny bag. No significant variation was observed in germination of seeds stored in polythene (80%) and in polythene plus gunny bag (79.67%). Razzaque [9] and Rahman *et al.* [10] reported that when seeds were stored in ordinary devices and conditions, they absorb moisture and subsequently germination percentage was reduced. The highest germination of seeds stored in organic cocoon was due to the lower moisture content, reduced oxygen level and absence of live insects compared to other devices. This result is in conformity with the findings of Paderes *et al.* [11] who found a significant negative correlation between % germination and moisture content. Though insects were not significantly killed by rexin cocoon because of higher oxygen level, the device was however able to maintain higher germination (87%) compared to poly and gunny bag due to maintenance of lower moisture content (13%) below critical level (14%) during storage.

Micro Temperature and Relative Humidity under Storage Condition: Weekly average Temperature and humidity recorded from the inner side of the USA organic cocoon and RDRS made rexin cocoon during storage were found significantly affected due to storage device by t test (Fig. 1 and Fig. 2). Temperature data in Fig. 1 revealed that the organic cocoon maintained significantly a lower level temperature over the rexin cocoon at all the weeks. The temperature in organic cocoon ranged from 22.85°c to 26.78°c (Table 2) which was found lower and stable over time compared to fluctuating minimum and maximum temperature range from 12.5°c to 34°c of the outside ambient temperature. Rexin cocoon temperature range during storage of seed was from 23.71°c to 28.85°c indicating a higher range than that in USA cocoon but it was able to stabilize the range compared to outside ambient temperature.

Fig 2 shows the trend of weakly average relative humidity inside the USA cocoon and Rexin cocoon. The trend revealed that the humidity in the USA cocoon was significantly lower compared to that in the rexin cocoon at all the weeks during storage period. The USA cocoon maintained a stable range of relative humidity from 73.38% to 74.44% (Table 2) which was lower compared to fluctuating range from 67.6% to 80% of the outside ambient relative humidity. The range of relative humidity inside the rexin cocoon was from 73.01 % to 80.42 % (Table 2) during the storage period indicating a higher range compared to that in the USA cocoon and a closer range compared to that in the outside ambient humidity (67.6% to 80%). These results indicated that USA cocoon maintained a narrow and lower rang of both temperature and relative humidity conducive for good vigour and protecting insect proliferation and good germination.

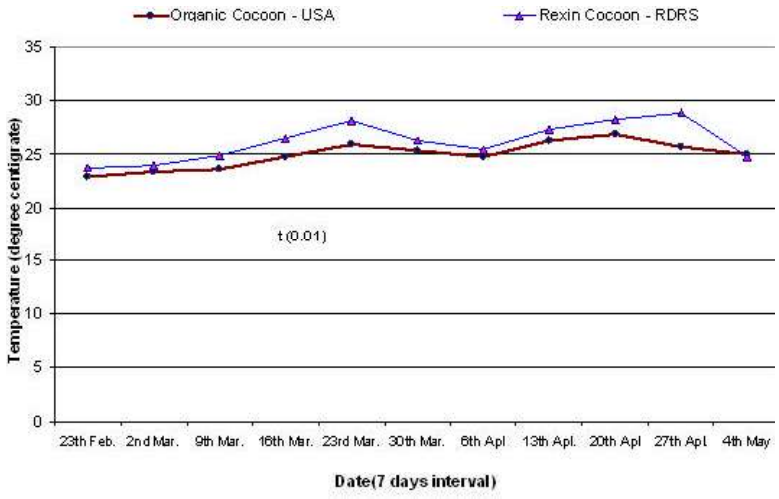

Fig. 1: Average weekly temperature in Organic Cocoon-USA and Rexin Cocoon-RDRS after 7 days interval

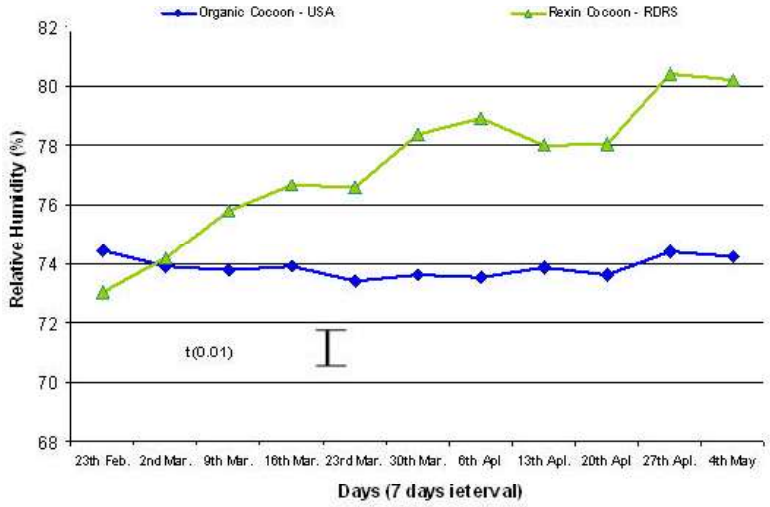

Fig. 2: Average weekly relative humidity in Organic Cocoon-USA and Rexin Cocoon-RDRS after 7 days interval

One of the most congenial conditions for prolonging the life span of seeds is the reduced storage temperature, which slow down respiration and other life process without injuring the embryo. The relative humidity of the ambient air of the seeds stored in USA cocoon remained low, which kept the seed equilibrium moisture content low and the vigour and the viability of seeds were maintained for a longer period. The reason was that, in a sealed container there is a finite amount of moisture in the air, which can move into the seeds. This causes a very insignificant increase in seed moisture content. Similar results were also obtained by Harrington [12] who stored seeds in moisture proof container so that the relative humidity of the store remained low.

CONCLUSION

The overall results indicate that the USA organic cocoon maintained germination at an excellent rate (>90%). RDRS made rexin cocoon also maintained a satisfactory level of germination (87-88%). Seed vigour, shoot and root growth were affected when seeds were stored in polythene type of bags and rexin cocoon though these devices were able to maintain a fair germination range of 82-87%. Considering relative the stable weather during July to November when boro seeds were tested, further follow-up research has to be undertaken to see the comparative advantage of these devices in terms of seed vigour, seedling growth and cost effectiveness of the devices.

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