



Research Article

Hermetic Cocoon for Large-scale Paddy Seed Storage in Bangladesh

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ABSTRACT

Quality seed gives higher germination and production and contributes to food security. Safe seed storage refers maintaining quality of seeds during storage. Bangladesh Agricultural Development Corporation (BADC) meets up the major share of paddy seed demand in Bangladesh. In the study, paddy seed storage in hermetic cocoon and traditional gunny bag was studied thoroughly for large scale paddy seed storage in BADC. The hermetic cocoon is a large pouch that can enclose bagged paddy seed in an airtight environment. Three hermetic cocoons (30-ton capacity each) were set up alongside of traditional bulk seed storage in gunny bags at BADC, Madhupur, Tangail for comparison. Seed samples were collected during the experiment. Moisture content of paddy seed stored in hermetic cocoon was much more stable than traditional gunny bag storage. Though insect infestation was absent in both gunny bag and hermetic cocoon storage intermediate activities i.e. several rounds of fumigation and insecticides application were required for keeping paddy seeds free from insect attack in case of traditional gunny bag storage. However, hermetic cocoon kept the paddy seed insect free without such kind of chemical application. Germination rate of stored paddy seed was found higher (92.94%) than that in traditional storage (91.47%). Thus, hermetic cocoon has the potentiality to replace intermediate activities of traditional storage at BADC maintaining paddy seed quality. Therefore, hermetic cocoon could be an appropriate technology for large-scale paddy seed storage in BADC of Bangladesh.

Keywords: Hermetic Cocoon, Gunny Bag, Insect, Seed Quality and Storage

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1. Introduction

Bangladesh is the third largest paddy producer in the world [1]. Paddy is the staple food crop of Bangladesh and is grown in Aus, Aman and Boro season. Quality paddy seed is a prerequisite for stable paddy production in the country. Yearly demand of paddy seed in Bangladesh is about 3.583 million metric ton. The contributions of public sector (BADC, DAE, BMDA), private sector and farmers to farmers transaction are 26.09%, 18.08% and 55.83%, respectively [2]. In Bangladesh, seed storage practices are divided into three categories, such as storage by farmers, storage by private sectors and storage by government in large commercial stores/go-downs. Among the government sectors, Bangladesh Agricultural Development Corporation (BADC) is only the large-scale paddy seed producing and storing national organization for farmers under the Ministry of Agriculture (MoA). Bangladesh Agricultural Development Corporation (BADC) fulfills about 24.4% of annual paddy seeds (49.11% in Boro, 12.62% in Aman and 13.84% in Aus) demand in the country [2]. Farmers are dependent on BADC paddy seed for quality seed and better yield. BADC produces, collects seeds through contract growers. Seed are processed and stored accordingly in it's seed go-downs. There are 58 Seed Processing Centres (SPC) in different areas of Bangladesh with the seed go-down capacity of 2,44,062 metric tons [3].

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Normally, varieties of breeder paddy seed invented or developed in the breeding stations like BRRI, BARI released by National Seed Board after proper examination and then handed over to BADC for multiplication as foundation seeds. Foundation seeds are multiplied as certified/truthfully labeled seeds at Seed Multiplication Farms (SM Farm) and Contract Growers (CG) zones of BADC. Seeds produced by SM Farms and Contract Growers are collected and processed properly in BADC Seed Processing Centers (SPC) and ultimately, they are distributed among the farmers through BADC's distribution network. Thus, BADC is an entrusted national organization with the task of production, processing, storage of quality seeds and making them available to the farmers. During storage in BADC go-downs, they conduct some intermediate operations for the storage of seeds to maintain the desired moisture content (12%), insect free environment and germination rate (80%) of the stored seeds. To do these tasks there are some involvement of additional manpower and other necessary costs [4].

Seed is the foundation and very important input of agriculture for quality crop production. Traditional methods of storage cause deterioration of seed health and quality through the activities of insects, mites, and rodents. Loss of paddy during storage in Bangladesh was estimated to be 3-8% in the year 1993 [5], 3.05-7.50% in the year 2015 [6], 6.2% in the year 2017 [7] and 3.03% in the year 2021 [8]. But, sealed or hermetic storage systems are very effective means of controlling grain/seed moisture content and insect activity for grain stored in tropical regions. Hermetic storage technology is a non-chemical storage system which provides an air tight, safe and pesticide-free method of storing [9]. By placing an airtight barrier between the grain and the outside atmosphere the moisture content of the stored grain will remain the same as when the storage was sealed. Biological activity inside the sealed container will consume the oxygen and as a result most insects will die [10,11]. In hermetically sealed storage systems (GrainPro/PICS bags and Cocoon) grains are placed inside an airtight container, which stops oxygen and water movement between the outside atmosphere and the stored grain [12]. Hermetic storage technology like airtight technology has emerged as a significant alternative to other methods of storage that protect especially seeds from different infestations. The technology is suitable for storage of a variety of seeds to preserve germination potential and vigor. Many studies found that this hermetic storage maintains germination of 85%-92% for the periods up to 9 months [4,7] while traditional storage in gunny bags reduces germination down by 5%-29% after 5 months of storage [4].

To maintain health and vigor potentiality of the paddy seed stored in traditional gunny bag during the storage period, BADC requires continuous quality monitoring. Sometimes, re-drying and re-stacking are also required to maintain moisture content 12% or less. In addition, it is also necessary to apply several rounds of fumigation and insecticides for keeping paddy seeds free from insect attack and keeping germination rate above 80%. The process is laborious, time consuming and hazardous for human health and environment. However chemical fumigants employed improperly, leave harmful residues in the grain and are a potential health hazard for the person doing fumigation [13]. Gradually, major pests of stored cereals develop resistance against commonly used chemical fumigants [14-16]. As the hermetic cocoon storage provides constant moisture content and insect control without chemical application and required less monitoring, hence the study was taken to assess the suitability of hermetic cocoon for large-scale paddy seed storage in BADC.

2. Materials and Methods

In the study, performance of hermetic cocoon was determined and compared with traditional gunny bag storage for bulk paddy seed. Experiment was carried out at Bangladesh Agricultural Development Corporation (BADC) seed processing centre, Madhupur, Tangail. Properly dried BRRI Dhan49, one of the popular varieties in Aman season, was stored in the hermetic cocoon for determining the performance in terms of moisture content, insect infestation and germination along with the traditional gunny bag storage practice of BADC. Polyethylene (PE) type three hermetic cocoons (30-ton capacity each) along with same capacity traditional gunny bags (50kg each bag) stack of paddy seed. The experiment was conducted during January to April 2021 following the experimental layout (Figure 1). Here, it is essential to mention that, hermetic cocoon cannot be opened in between the storage period for sample collection. That's way performance parameters (Moisture content, Insect infestation and Germination) were measured at the 1st day (storage day) and 105th day (opening day) in case of hermetic cocoon. Whereas, parameters were checked at each 15 days interval starting from the 1st day of storage in case of traditional gunny bag storage.

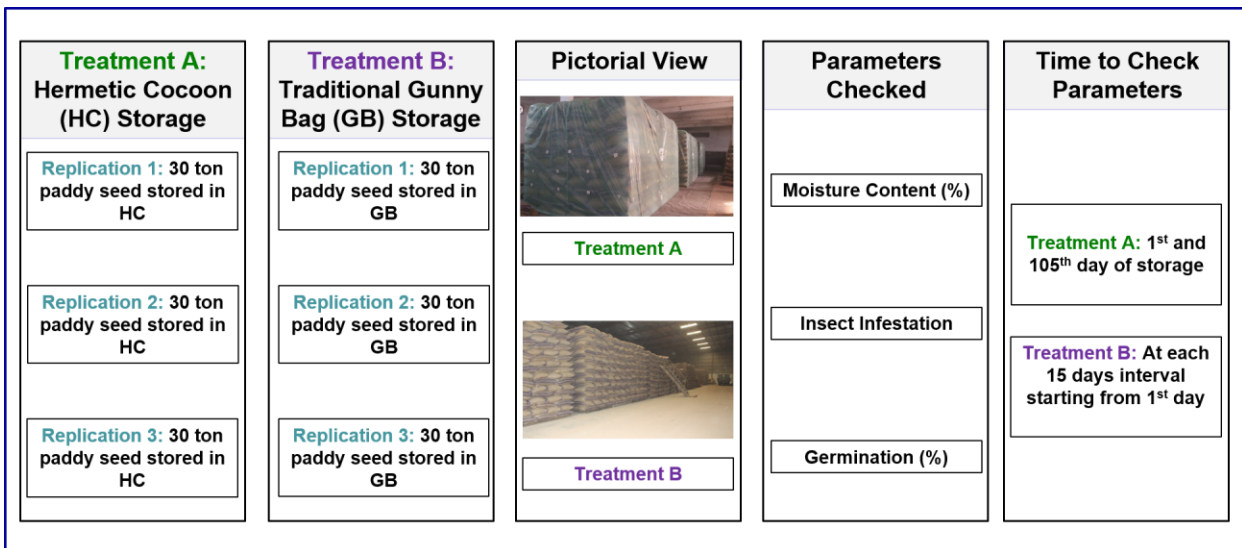


Figure 1. Experimental Layout of the study

2.1 Location of the study

The study was conducted in Seed Processing and Storage Centre (SPSC) at BADC, Madhupur, Tangail, Bangladesh. The GPS (24.612447535794438, 90.03118891273145) location of the study site is shown in Figure 2.

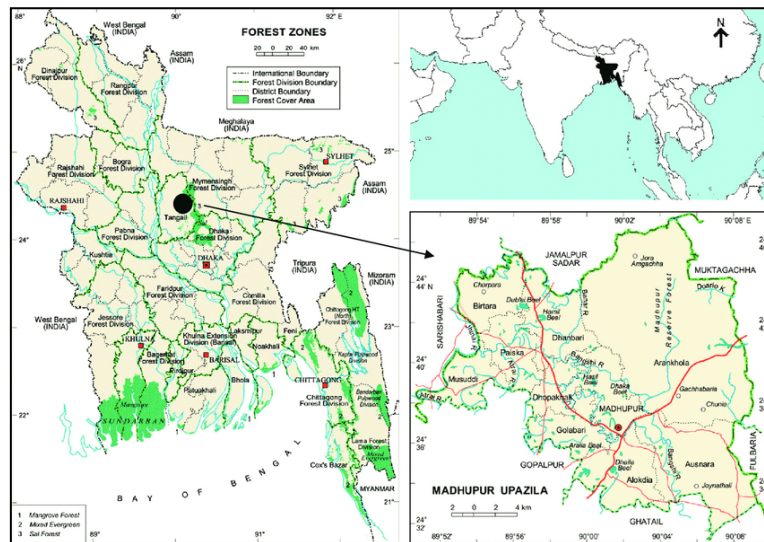


Figure 2. Location of the study site

2.2 Storage environment

Temperature ($^{\circ}\text{C}$) and relative humidity (%) of the storage go-down were measured at 1-hr interval during storage period using Lutron HT-3007SD Humidity/Temperature meter as shown in Figure 3 (operating condition: Less than 90% R.H. and 0 to 50°C).



Figure 3. Humidity/Temperature meter used in the study

2.3 Moisture content

Quality of paddy seed depends on moisture content of the stored paddy. In the study, moisture content of stored paddy was determined using INDOSAW moisture meter available at the BADC seed processing and storage centre (Figure 4a). Moisture content was expressed as percentage on dry weight basis. Seed moisture of paddy stored in hermetic cocoon was determined at the storage day and at the opening day (105 days after storage). But, moisture content of paddy stored in traditional methods was also measured periodically at 15 days interval (Figure 4b).

2.4 Insect infestation

Paddy samples (250 g) were collected from hermetic cocoon at the storage day and at the opening day (105 days after storage). Here in case of hermetic cocoon storage, paddy seed remained in a sealed environment and hence no sample was collected during the storage period. Collected paddy seed samples were kept in polythene bag with an identification card and tied with a thread. For easy identification and counting, samples were kept in freeze (2-4°C) for few minutes to make insect immobile. Then total number of insects was counted for each sample. In the same way, insect infestation of paddy seed stored in traditional storage method was determined at 15 days interval during the whole storage period.



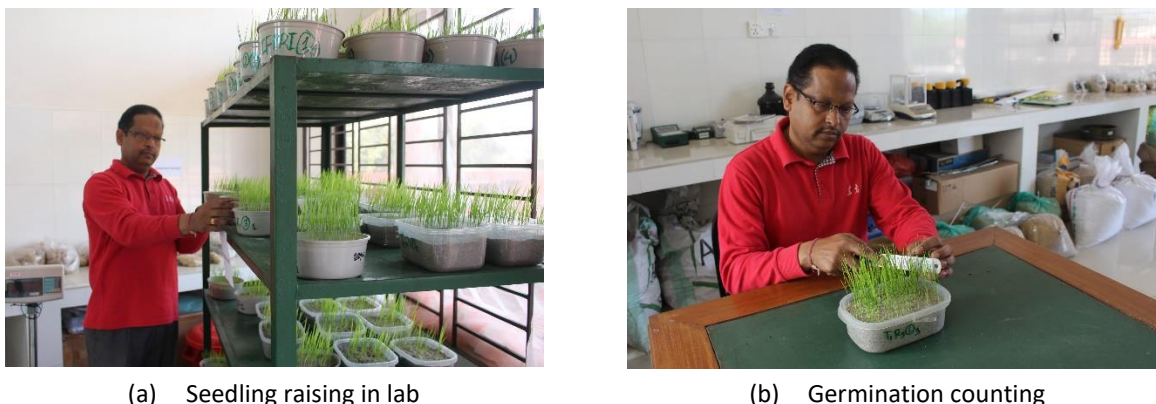
(a) INDOSAW moisture meter

(b) Measurement of moisture content of stored paddy

Figure 4. Measure of moisture content of stored paddy seed using INDOSAW moisture meter

2.5 Germination test

According to the International Seed Testing Association rules [17], germination (%) of stored paddy seed was determined in sand media as shown in Figure 5a. Seed germination percentage was calculated from the sample collected at the storage day and opening day (Figure 5b). Whereas, germination percentages of paddy seed stored in traditional gunny bag was determined from paddy seed samples collected periodically at 15 days interval.



(a) Seedling raising in lab

(b) Germination counting

Figure 5. Determination of paddy seed germination

3. Results and Discussion

3.1 Storage environment

Temperature ($^{\circ}\text{C}$) and relative humidity (%) in the indoor of the storage go-down were measured during storage period. The trends of temperature and relative humidity (%) based on average values of the particular storage day are shown in Figure 6. The range of temperature and relative humidity during the storage period were observed 22.4-33.6 $^{\circ}\text{C}$ and 52-72%, respectively. Temperature and humidity affect the quality of the seeds during the storage period. The use of low temperature and air humidity can keep the viability and vigor of seeds as investigated by Rahmawati and Aqil [18].

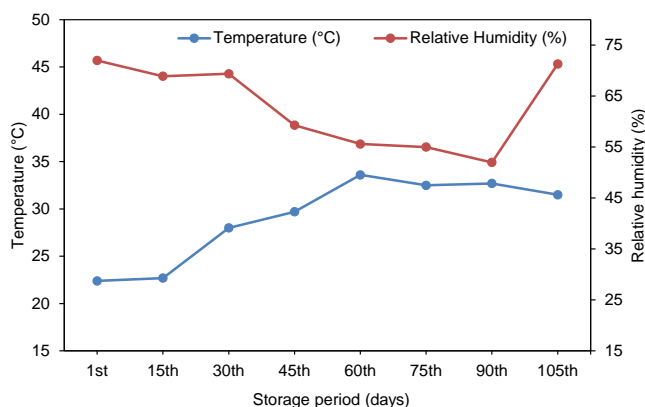


Figure 6. Temperature and relative humidity during storage period

3.2 Seed moisture content

The moisture content of paddy seeds stored in traditional and hermetic cocoon storage systems were same (12.57%) at the day of storage. The moisture content of paddy seed stored in traditional gunny bag storage was measured 12.82%, 12.28%, 12.82%, 11.96%, 11.91%, 11.97% and 12.01% at each 15 days interval from the storage day as shown in Figure 7. Here, in case of traditional storage moisture content fluctuates a lot which is unfavourable for maintaining paddy seed quality during storage period. In case of hermetic cocoon moisture content of stored paddy seed was found 12.23% at the opening day (after 105 days of storage). So, moisture content of paddy seed stored in hermetic cocoon deflected less (0.34%) than traditional storage (0.56%) after 105 days of storage.

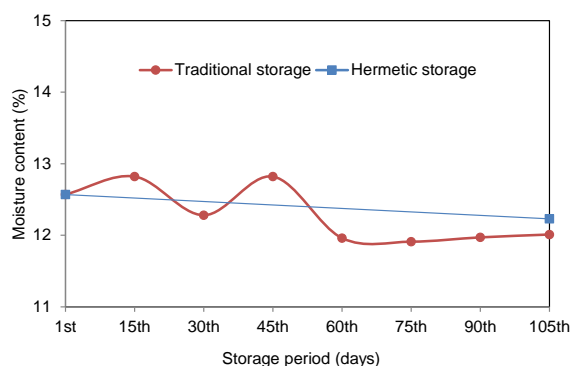


Figure 7. Moisture content variation of paddy seed stored in traditional gunny bag storage and hermetic cocoon

3.3 Insect Infestation

Insect infestations were counted through physical inspection for the entire storage period in the traditional storage and hermetic cocoon storage. No insect was found in both practices. But in case of traditional storage, BADC applied insecticides and conducted fumigation twice during the storage period to keep the paddy seed free from insect. However, in case of hermetic cocoon storage, no insecticides and fumigation were applied due to the intrinsic property of multi-layer hermetic cocoon, O₂ percentage reduced from 20.53% to 6.69% inside it (Figure 8) and produced lethal effect for the insect [11,19,20]. Thus, hermetic cocoon kept the paddy seed free from insects without any chemical application and maintenance.

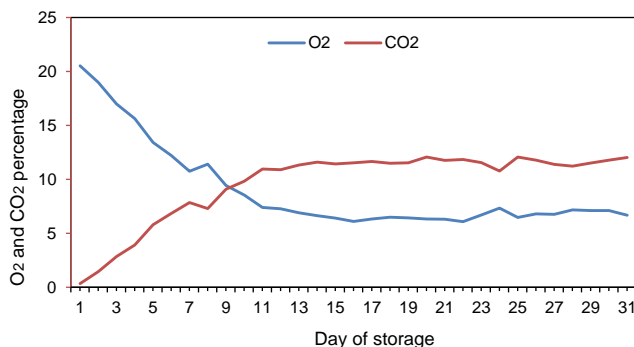


Figure 8. Trend of O₂ and CO₂ concentration in hermetic cocoon during the first 31 day of storage

3.4 Germination rate of stored paddy seed

Germination percentage of stored paddy in both the storage technologies has been presented in Figure 9. Sample of paddy seed was collected on the first day of storage and 89.83% germination rate was found. After 105 days of storage, highest germination (%) was recorded in hermetic cocoon (92.94%) whereas, germination percentage of paddy seed stored in traditional storage was found 91.47% after 105 days of storage. At the day of storage, due to dormancy effect germination percentage of paddy seed was low. Seed dormancy is the temporary failure of a viable seed to germinate after dispersal or harvest under a particular set of environmental conditions that normally allow germination after the dormant state has been terminated naturally or artificially [21]. Seed dormancy usually lasts for a few weeks, depending on species [22]. However, after the dormancy period, germination percentage of paddy seed increased for both cases though little fluctuation in germination rate was observed in paddy seed stored in traditional gunny bag. The germination test indicates the superiority of hermetic cocoon over traditional storage in case of maintaining germination rate of stored paddy seed as it required no chemical application.

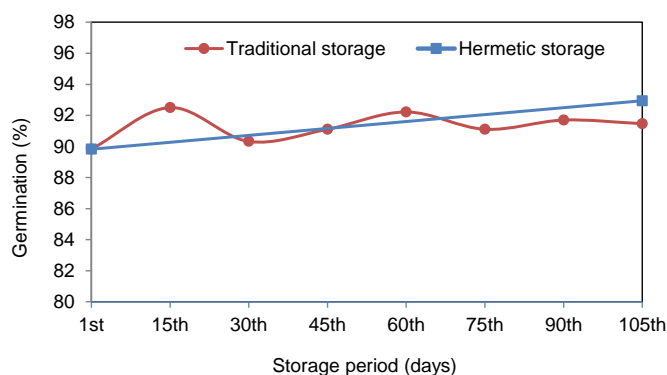


Figure 9. Germination percentage of paddy seed stored in traditional gunny bag storage and hermetic cocoon.

4. Conclusions

Storage of paddy seed is one of the major concerning issues for the large-scale paddy seed processing and storage center of Bangladesh Agricultural Development Corporation (BADC). BADC faces difficulty to maintain the stability of seed moisture content throughout the storage period following traditional practice. The hermetic cocoon was found to be effective in storing large scale paddy seed in terms of seed moisture content maintenance, insect control and germination preservation. The environment friendly hermetic cocoon can be recommended for storing large scale paddy seed processing and storage centers of Bangladesh like BADC.

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