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Effect of storage condition on seed quality and health in jute O-9897

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ABSTRACT

The experiments were conducted in the laboratory of Plant Pathology Department, Bangladesh Jute Research Institute. The experiments were conducted during the period 15 January 2010 to 5 March 2012. Nine different types of containers viz. tin pot, plastic pot, poly bag, gunny bag, gunny bag lined with polythene, earthen pot, cloth bag, brown paper and IRRI poly bag, two level of moisture contents viz. farmers' condition (13%) and recommended moisture condition (9.5%) by Bangladesh Gazette (2010) and seed treatment with Provax-200 and control (untreated) were used for the present study. Seeds were stored for 12 months and examined after 4. 8 and 12 months of storage. Among the nine containers, tin pot was found better in respect of moisture content, germination, mean germination time, vigour index and 1000- seed weight. Health condition of seeds was also superior compared to other containers. The poorest performance was observed in earthen pot regarding moisture content, germination, mean germination time, vigour index, 1000- seed weight and seed borne infection. The findings of the present study also reveal that recommended moisture content was better than farmers' condition. Provax-200 treated seed also resulted better performance than non treated seed. So, Quality of jute seeds can be maintained by storage in tin pot with provax-200 treated and recommendation moisture content (9.5%).

Keyword: Effect, storage container, seed quality and health

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Introduction

Jute (*Corchorus capsularis* L. and *Corchorus olitorius* L.) is one of the main cash crops of Bangladesh. It accounts for 6% of the foreign currency earnings from exports (Islam 2009). Millions of people earn their livelihood from agricultural and industrial activities based on jute and allied fibres crops. Moreover, beyond the farmland and factory, jute and jute goods keep alive the transport sector, the service sector like banks and insurance and the agro-industrial job market. The jute crop also greatly improves the soil fertility status by incorporating organic matter to the soil through decomposition of shaded leaves and plant residues and helps in breaking plough-pans through its long taproots. Also, jute and jute goods have been recognized as being friendly to the environment. Jute is mostly grown in the Indo-Bangladesh region and in some countries of Southeast Asia. Among the jute growing countries of the world, Bangladesh ranks second in respect of production (Islam 2007). Two species of jute (*Corchorus capsularis* and *Corchorus olitorius*) are cultivated in Bangladesh. The land and climatic conditions of Bangladesh are congenial for the production of high quality jute. In Bangladesh, about 0.709 million hectares of land was under jute cultivation and the total yield was 8.40 million bales (BBS 2011; IJSG website 2012-13). As per Khandakar, 1987, Bangladesh annually needs about 4000 metric tons of jute seeds of which only 12-15% is produced and supplied by the Bangladesh Agricultural Development Corporation (BADC). The rest of the seeds, about 85% or more of the requirement, are produced and managed by farmers' (Hossain *et al*. 1994a). BADC produces 300 tons of seed (Olitorius seed =125 tons and Capsularis seeds = 175 tons) and distributes them to the farmers. BADC produces jute seeds through contact growers. Infected jute seed fail to germinate or the young seedlings emerging from the infected seed die. Infection of jute seed causes germination failure, post emergence damping off and seedling blight (Fakir 1989). Jute seedlings or growing plants produced in the field from the infected seeds and escaping early infection may often be infected at the later stages of their growth by the primary seed borne inocula grown and multiplied on the infected dead seeds and seedlings. Later on, these inocula may be transmitted to the healthy growing plants of the same or neighboring plants or even neighboring fields resulting to disease outbreak, often in epidemic form. Seed borne pathogens causing diseases on the growing jute plants in the field quite often attack the capsules or pods and subsequently infect the seed, resulting to production of infected or unhealthy seeds. Therefore, proper disease control measure should be taken for the production of quality jute seeds. Seed viability in store may be maintained by midstorage hardening treatments in many plant species. Midstorage seed hardening is very effective for medium and low vigor seeds. The principle behind the midstorage hardening is to allow the stored seeds to take up moisture of 20 to 30% (wet basis) for certain preventive, corrective, or restorative actions followed by thorough drying back for restorage (Basu 1994). The mode of action of the midstorage hardening includes (i) removal of inhibitors and toxic metabolic byproducts of stored seed during hydration, (ii) germination advancement, (iii) reduced moisture uptake by treated seeds, (iv) antimicrobial effect, (v) enzymatic repair of biochemical lesions and (vi) counteraction of lipid peroxidation reactions. The farmers of the country often have to depend on market seeds having poor quality. Hence, the production of quality healthy jute seed as well as its quality storage is highly essential to ensure the higher yield of quality fibre in order to meet the challenging need for natural fibre in Bangladesh. Considering the above facts, the present study was carried out with the objective was to develop an eco-friendly model of safe storing methods for quality jute seeds.

Materials and Methods

Experimental sites and period

The experiments were conducted in the laboratory of Plant Pathology Department, Bangladesh Jute Research Institute (BJRI), Manik Mia Avenue, Dhaka. The experiments were conducted during the period 15 January 2010 to 5 March 2012.

Varieties used

Seed of O-9897 was used. 110 kg O-9897 seeds collected from one farmer in Monirampur, Jessore.

Containers used

For this experiment nine different types of storage containers were used, viz. T_1= Tin pot, T_2= Plastic pot, T_3= Poly bag having 25 µm thickness, T_4= Gunny bag, T_5= Gunny bag lined with polythene, T_6= Earthen pot, T_7 = Cloth bag,

T_8= Brown paper and T_9= IRRI Poly bag (Super Grain bag II Z) having 78 µm thickness.

Moisture content of seeds

Seeds having two level of moisture were used, viz.

i) Recommended moisture content (9.5%) as per reference of Khandakar and Bradbeer 1983; Bangladesh Gazette 2010.
ii) Farmers' condition

Seed treatment

The seeds were treated with Provax-200 WP (0.4% of seed weight).

Methodology of seed treatment

Seed samples were obtained from the seed lots of each variety. Seed samples were mixed thoroughly and were divided equally into two parts. Half of seeds of both samples were mixed thoroughly with Provax-200 WP (0.4% of seed weight) and then kept into nine different containers and rest of unmixed seeds of samples treated as control kept in other nine different containers. All the containers had three replications and were labeled properly and preserved in room temperature till the samples were used for further study. Before storing, quality and health status of collected seed samples were tested. The quality and health test of stored seeds were done for three (3) times viz. i) After 4 months of storing, ii) After 8 months of storing and iii) After 12 months of storing.

Determination of seed quality and seed health of stored seeds in the laboratory

All the tests for determining seed quality and health status were conducted following the International Rules for Seed Testing (ISTA 1999) except the seed vigour index. Seed vigour index was determined following the rules of Jain and Saha 1971.

Determination of seed moisture content

Jute seed moisture was determined by constant temperature oven dry method (Khandakar 1983; ISTA 1999). The amounts of working samples depended on the diameter of the container which was used for determination of the moisture of the seed samples. The diameter of the container was less than 8 cm and the amount of seed samples were 4-5g. The working sample was evenly distributed over the surface of the container. The weight of the container and its lid were recorded before and after filling the container with the seed samples. The container was placed rapidly on the tops of its lid, and placed in an oven maintaining the temperature of 103± 2^0 C and dried for 17±1 hrs. At the end of the prescribed period, the containers were covered with lids and placed in the desiccators to make it cool for 30-40 minutes. After cooling, weight of the container with its lid and contents were recorded. The relative humidity of the ambient air in the laboratory at the time of moisture determination was less than 70%. The moisture content of the seed samples were calculated by means of the following formula (ISTA 1999) and expressed as percentage.

$MC (\%) = (M_2 - M_3) \times 100 / (M_2 - M_1)$

MC = Moisture Content

M_1 = Weight in grams of container and its cover/ lid

M_2 =Weight in grams of the container, its cover and its contents before drying

M_3 = Weight in grams of the container, cover and contents after drying.

Seed germination

Two hundred seeds were taken randomly from the well mixed seed sample (ISTA 1999). The working samples were divided into eight replications and thus one replication contained 25 seeds. The seeds were germinated on top of three layers of Whatmann No. 1 filter paper. The filter papers were soaked in water and placed at the bottom of 9 cm diameter plastic petridish and thereafter 25 seeds were placed on the top of filter paper (ISTA 1999). Evaporation of water was minimized by tightly fitting the lids of the petridishes. The petridishes were placed inside the incubator maintaining the temperature at 30^0C for five days. Seeds producing both plumule and radical after incubation were counted as germinating seeds. The results expressed as percentage.

Seed vigour index

Seed vigour index was assessed through speed of germination of seeds. Speed of germination was derived from the germinated seedlings at an interval of 24 hours for five days according to Copeland 1976 using the following formula.

$$\text{Vigour Index} = \frac{\text{Number of germinating seedlings (First count)}}{\text{Number of day to first count}} + \text{Number of germinating seedlings (Second count)} +$$

……

Number of day to second count

Number of germinating seedlings (last count) +

Number of day to last count

Determination of 1000- seed weight

For weight determination the thousand seeds of jute was randomly counted for each pure seed sample and measured in an electronic balance (Model- PC- 180).

Detection of seed borne fungi of jute seeds (Seed Health Test)

Seed health analysis was conducted by blotter method following the International Rules for Seed Health Testing (ISTA 1999). In this method 9 cm diameter plastic petridish and locally packed Whatman No.1 filter paper was used. Two hundred seeds from each sample were taken randomly and placed on the moist filter paper in eight replicate petridish. The petridishes with seeds were incubated at $22+2^0$C, 12/12 hours alternating cycles of near ultraviolet (NUV) light and darkness in the incubation chamber of Plant Pathology Department of BJRI for seven days. The presence of seed borne fungal pathogens was identified by observing their growth characteristics on the incubated seeds in blotter under stereomicroscope at 25X magnification. If there were any difficulty for identification of pathogen(s), temporary slides were prepared and the fungi were identified accordingly. The seed borne fungi were identified by following the keys of Sutton 1980; Ellis 1993; Melone and Muskett 1964; Mathur and Kongsdal 2003; Raper and Funnel 1965. Results were expressed as percentage of seeds infected by the pathogens.

Statistical analysis

Data were analysed statistically and treatments effects were compared by Duncan's Multiple Range Test (DMRT). Relation between seed borne fungal pathogens and germination was observed with regression equations (Gomez and Gomez 1984).

Results

Initial quality and health status of O-9897 seed samples

The moisture content, germination, mean germination time (MGT), vigour index, 1000-seed weight and % seed borne fungal pathogen were shown in (Table 1).

Moisture content of seeds

Farmers' seed

Moisture content of farmers' seeds varied from 10.00 to 16.57% in O-9897 variety depending on the different seed storage containers, time and seed treatments. Moisture content continuously increased depending on the storage duration (Table 2). After 12 months of storage moisture content of seed was higher than after 4 and 8 months of storage. Initial stage moisture content was 16.00%. After 12 months of storage, highest moisture content 16.57% was recorded storing seeds in brown paper under control condition and 15.73% storing seeds in earthen pot when seed were treated with provax-200 (Table 2). Storing seeds in tin pot increased lowest moisture content 11.40% and 10.13% under control and provax-200 treated seed, respectively.

Seeds having recommended moisture content (9.5%) by Bangladesh Gazette

As per Bangladesh Gazette recommended moisture content varied from 9.18 to 15.07% (Table 3). At initial stage, recommended moisture content was 9.50%. Seed moisture content continuously increased in plastic pot. After 12 months of storage, highest moisture contents 14.87% and 15.07% were recorded in plastic pot storing seeds in both the treatments (Table 3).

Germination

Farmers' seed

Germination of non treated and treated seeds belonging to O-9897 obtained from different storage containers used for storing seeds varied significantly from 1.00 to 85.00% (Table 4). Before storage, germination percentage was 89% in O-9897 variety. In storage condition, germinarion percentage continually was decreasing depending on the storage containers and storage duration. After 12 months of storage lowest germination was 1.00% was observed with storing seeds in gunny bag and earthen pot. Highest germination 77.00% and 65.00% storing seeds in IRRI poly bag with both the treatments (Table 4).

Seeds having recommended moisture content (9.5%) by Bangladesh Gazette

As per recommended moisture content, germination varied from 1.00 to 88.00% in O-9897. (Table 5). Initial stage, recommended germination was 93.00% in O-9897. After 12 months highest germination was 82.00% in tin pot storing seeds under control condition and 81.33% storing seeds in tin and plastic pot with

Provax-200 treated seeds. Lowest germination 1.00% and 5.00% in earthen pot storing seeds under non treated (control) and treated seeds, respectively (Table 5).

Mean germination time (MGT)

Farmers' seed

In farmers' seed, mean germination time (MGT) varied from 25.10 to 76.80 hours in O-9897 (Table 6). MGT continuously increased depending on the storage duration. The highest MGT was 64.32 hrs in storing seeds in plastic pot and brown paper under non treated seed and 76.80 hrs in earthen pot storing seeds under Provax-200 treated seed. lowest MGT was 30.00 hrs and 28.56 hrs in IRRI poly bag and tin pot storing seeds under control and treated condition, respectively (Table 6). Above mentioned that, initial stage MGT was 25.02 hrs in both conditions.

Seeds having recommended moisture content (9.5%) by Bangladesh Gazette

Initial stage, MGT of recommended moisture content (9.5%) was 26.12 hrs in O-9897 (Table 7). After 12 month of storage the highest MGT was 79.92 hrs and 57.60 hrs in earthen pot storing seeds under non treated and treated condition, respectively (Table 7).

Seed vigour index

Farmers' seed

Vigour index of farmers' seeds varied significantly depending on the storage containers and time. Vigour index varied from 0.08 to 79.32 in O-9897 (Table 8). Vigour index continuously decreased in storage duration. Initial stage vigour index was 83.33. After 12 months of storage the lowest vigour index was 0.61% in storing seeds in earthen pot and cloth bag under control condition and 0.08 in earthen pot storing seeds under Provax-200 treated. Highest 62.92 and 62.67 in IRRI poly bag storing seeds in case of non treated and treated seeds condition, respectively (Table 8).

Seeds having recommended moisture content (9.5%) by Bangladesh Gazette

As per Bangladesh Gazette recommended moisture condition vigour index varied from 0.17 to 81.83% in O-9897 (Table 9). Initial stage, vigour index was 85.17 in O-9897 variety. After 12 months the highest vigour index was 73.08 in storing seeds in cloth bag in case of control condition and 78.00in tin pot storing seeds under Provax-200 treated condition (Table 9). **1000-seed weight**

Farmers' seed

1000-seed weight varied from 1.00 to 1.59 gm in O-9897. Initial stage, 1000-seed weight of farmers' seed was 1.5gm in O-9897. After 12 months of storage duration the highest 1000-seed weight was 1.35 gm and 1.41 gm in storing seeds in tin pot and plastic pot under non treated and treated conditions, respectively (Table 10).

Seeds having recommended moisture content (9.5%) by Bangladesh Gazette

Initial stage, 1000- seed weight of recommended moisture content was 2.20 gm in O-9897. After 12 months of storage, highest 1000- seed weight was 1.51 gm and 1.55 gm in storing seeds in poly bag under both conditions. Lowest 1000-seed weight was 1.10 gm and 1.15 gm in storing seeds in earthen pot under non treated (control) and Provax-200 treated conditions, respectively (Table 11).

Seed health

Occurrence of pathogenic fungi in O-9897

Farmers' seed

In total, 12 fungal pathogens were found to be associated with the collected seed samples from farmers' seed at different stages of storage condition. The fungi detected were *Macrophomina phaseolina* (Tassi. Goid), *Botryodiplodia theobromae* Pat., *Aspergillus flavus*, *A. candidus*, *Penicillium* spp., *Fusarium moniliforme*, *F. semitectum* Berk. and Rave., *Chaetomium* spp., *Curvuluria lunata* (Wakker), *Cladosporium cladosporioides*, *Myothecium* sp., *Alternaria tenuies* and *Rhizoctonia solani* (Tables 12-13). *Colletotrichum corchori* was not found in olitorius varieties for their structural formation (Ahmed, 1966). In case of control condition, the incidence of *Fusarium* spp. was (46.00%), (45.62%), (39.19%) and (34.04%) recorded in initial stage, after 4, 8 12 months of storage, respectively. The occurrence of *Aspergillus* spp. in seed samples collected after 4, 8, and 12 months of storage ranged from 14.89 to 29.80% (Table 12). In treated condition, *Chaetomium* spp. caused highest percent of seed infection (36.05%) after 12 months of storage followed by *Aspergillus* spp. (30.79%), *Fusarium* spp. (16.32%) and *Penicillium* spp. (11.06%) (Table 13).

Seeds having recommended moisture content (9.5%) by Bangladesh Gazette

There were 12 pathogenic fungi identified and

after 12 months of storage condition the most predominant fungi in order of prevalence were *Fusarium* spp. (37.41%), *Aspergillus* spp. (35.00%), *Chaetomium* spp. (14.00%) and *Penicillium* spp. (8.21%) under control condition. In case of Provax-200 treated seed, after 12 months in order of prevalence were *Fusarium* spp. (31.64%), *Aspergillus* spp. (26.68%), *Chaetomium* spp. (19.86%) and *Penicillium* spp. (10.86%) (Tables 14-15). Initial stage in order of prevalence was *Fusarium* spp. (40.00%), *Chaetomium* spp. (12.00%), *Penicillium* spp. (8.00%) and *Aspergillus* spp. (4.00%).

Seed germination and seed borne pathogens recorded in O-9897 variety

Farmers' seed

Seed germination and seed borne fungal pathogens recorded in non treated seeds of farmers' condition belonging to different storage containers and time are presented in Table 16. Germination percentage was found always decreasing and fungal pathogens increasing depending upon storage duration. Initial germination was recorded 89.00%. After 12 months, the highest germination was 77.00% in storing seeds in IRRI poly bag similar to storing seeds in gunny bag lined with polythene 68.00% and cloth bag 65.00%. The highest total seed borne fungal pathogens 119.00 was recorded in earthen pot storing seeds followed by gunny bag 108.67, poly bag 103.33, brown paper 90.00, plastic pot 75.67, cloth bag 67.00, IRRI poly bag 48.33 and tin pot 41.33 storing seeds. Individual seed borne pathogens were also highest in storing seeds in earthen pot and lowest in tin pot. In treated seeds, highest germination was 65.00% in IRRI poly bag storing seeds followed by gunny bag 51.00%, plastic pot 35.00%, tin pot 34.00%, brown paper 25.00%, poly bag 20.00% and gunny bag lined with polythene, gunny bag and cloth bag 1.00% storing seeds. (Table 17). The highest total seed borne fungal pathogens 56.00 was recorded in earthen pot which was statistically similar to other containers except IRRI poly bag storing seeds 25.54. Individual seed borne pathogens were also highest in earthen pot storing seeds and lowest in IRRI poly bag storing seeds. Germination, individual seed borne pathogens and total fungal pathogens differed significantly with respect to different containers and storage periods.**Seeds having recommended moisture content (9.5%) by Bangladesh Gazette**

Seed germination and seed borne fungal pathogens recorded in non treated recommended moisture content seeds belonging to different containers and storage period are presented in Table 18. After 12 months, the highest germination 82.00% was recorded in tin pot followed by poly bag 80.00%, plastic pot 77.00%, cloth bag 75.00%, IRRI poly bag 72.33%, gunny bag lined with polythene 72.00%, gunny bag 57.00%, brown paper 40.00% and earthen pot 1.00% storing seeds. The highest total seed borne fungal pathogens 44.33 was recorded in gunny bag storing seeds which was statistically similar to other containers. Gunny bag storing seeds also had highest individual seed borne fungal pathogens and the lowest individual seed borne pathogens were recorded in tin pot storing seeds. Beside in treated seed condition, highest germination 81.33% was recorded in tin pot and plastic pot storing seeds which were similar to all other containers except gunny bag and earthen pot storing seeds (Table 19). Lowest germination 5.00% was recorded in earthen pot storing seeds. Highest total fungal pathogens 37.00 were recorded in earthen pot storing seeds and lowest was 22.34 in tin pot storing seeds. Individual seed borne fungal pathogens were also highest in earthen pot storing seeds and lowest in tin pot storing seeds. Germination, individual seed borne pathogens and total fungal pathogens differed significantly with respect to different containers and storage periods.

Disscussion

Nine different types of containers viz. tin pot, plastic pot, poly bag, gunny bag, gunny bag lined with polythene, earthen pot, cloth bag, brown paper and IRRI poly bag, two level of moisture contents viz. farmers' condition (13%) and recommended moisture condition (9.5%) by Bangladesh Gazette, 2010 and seed treatment with Provax-200 and control (untreated) were used for the present study. Seeds were stored for 12 months and examined after 4. 8 and 12 months of storage. Among the nine containers, tin pot was found better in respect of moisture content, germination, mean germination time, vigour index and 1000- seed weight. Health condition of seeds was also superior compared to other containers. The poorest performance was observed in earthen pot regarding moisture content, germination, mean germination time,

vigour index, 1000- seed weight and seed borne infection. The other containers in order of prevalence were IRRI poly bag, poly bag, plastic pot, gunny bag lined with polythene, cloth bag, gunny bag and brown paper. In storage condition, germination and vigour index were decreased and moisture was increased. If seed moisture content increased viability and germination sharply declined. The findings of the present study are in accordance with the finding of Ali 1963. Bhattacharyya and Dutta 1972; Sobhan and Khatun 1986 similarly reported that a big fluctuation in moisture content was observed in storage and also reported that the lowest viability loss (1.5%) in metal drum and the highest (4.3%) in gunny sack. Khatun and Sobhan, 1986 also reported that jute seeds with moisture content of 4-7% showed 85% viability up to 12 months at room temperature. They also reported that kenaf and mesta seeds stored with moisture content of 14.3-24.5% resulted sharp decline in viability and vigour with the increase of storage period as a result germination decrease. Negative relationship had been observed between percent total fungal pathogens and percent germination in different types of containers, moistures content and management of seeds in two jute varieties that indicated the seed germination lowered with the increase of seed borne infections. Haque 2014; Akanda and Fakir 1985; Fakir *et al.* 1988 similarly reported that the fungi associated with the jute seeds reduced the germination of seeds. Highest percent seed borne fungal infection was recorded in earthen pot and lowest fungal infection was recorded in IRRI poly bag which was statistically similar to tin pot in all conditions. Altogether 13 pathogenic fungi (*Macrophomina phaseolina*, *Botryodiplodia theobromae*, *Colletotrichum corchori*, *Aspergillus flavus*, *A. candidus*, *Penicillium* spp., *Fusarium moniliforme*, *F. semitectum*, *Chaetomium* spp., *Curvuluria lunata*, *Cladosporium cladosporioides*, *Myothecium* sp., *Alternaria tenuies* and *Rhizoctonia solani*) were detected in nine different types of containers, two different types of moisture and seed management practices of two jute varieties seeds. Hossain *et al.* 1994b reported that earthen pot, gunny sack and polyethylene bag were not conducive to seed health at storage. Similar observations were also made by Shaw 1921; Agarwal and Singh 1974; Fakir 1977; Fakir *et al.* 1993 & 1988; Akanda and Fakir 1985; Ashraf khan M. A., 1992; Khan and Fakir 1993. *Macrophomina phaseolina*, *Botryodiplodia theobromae* and *Colletotrichum corchori* the causal organisms of stem rot, black band and anthracnose of jute, respectively were considered as established seed borne pathogens of the crop and of major importance (Fakir 2001). These pathogens transmitted through jute seeds (Ahmed 1966). Among all the pathogenic fungi, *Fusarium* spp.; *Aspergillus* spp. and *Penicillium* sp. were the most predominant pathogenic fungi followed by *Macrophomina phaseolina*, *Botryodiplodia theobromae* and *Colletotrichum corchori* as observed in the present study. The findings of the present study also reveal that recommended moisture content (9.5% moisture content in seed) was better than moisture content at farmers' condition. Provax-200 treated seed also resulted better performance than non treated (control condition) seed. So, preservation and storage ecology regarded as an important consideration in agricultural practices (Haque 2014; Barton 1961; Heydecker 1973). Poor storage conditions resulted quality deterioration, greatly affecting seed vigour and loss of viability (Heydecker 1969).

Conclusion

Therefore, the following conclusion may be drawn for storage jute seeds from the findings of this study:

- In storage period, germination, viability, moisture, oil and protein content of seeds and health status depend upon storage containers, duration and environmental condition.

So, the following recommendation may be drawn for storage and production of quality healthy jute seeds from the findings of this study:

- ✓ Quality of jute seeds can be maintained by storage in tin pot with provax-200 treated and recommendation moisture content (9.5%)

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References

Agarwal, V.K. and Singh, O.V. 1974. Seed borne fungi of jute and their control. Indian Phytopathol, 27(4): 651-652.

Ahmed, Q.A. 1966. Problems in jute plant pathology. Jute and Jute fabrics Pakistan, July, 184-186.

Akanda, M. A. M. and Fakir, G.A. 1985. Effect of seed dressing chemicals for the conterol of major seed borne pathogens of jute. Bangladesh J.Pl. Pathol., 1(11): 13-19.

Ali, M. K. 1963. Effect of storage containers on the moisture content, viability and other qualities of jute seed. Pakistan J. Sci. Res., 15 (3). 85-93.

Ashraf Khan, M. A. 1992. Occurrence of seed borne fungal pathogens during seed development and maturation in jute. M.Sc. (Ag.) Thesis in Plant Pathology. Bangladesh Agricultural University, Mymensingh .

Bangladesh Gazette (Additional). December 20, 2010. 12.

Barton, L. V. 1961. Seed Preservation and Longevity. Leonard Hill, London.

Basu, R.N. 1994. An appraisal of research on wet and dry physiological seed treatments and their applicability with special reference to tropical and sub-tropical countries. Seed Sci. & Technol., 22: 107-126.

BBS, 2011. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Planning Ministry, Dhaka.

Bhattacharyya, J. P. and Dutta, A. K.1972. Storage of jute seeds. Jute Bull., 33 (7 and 8): 129-130.

Copeland, L. O. 1976. Principles of Seed Science and Technology. Burgess Pub. Com., Minnaeapolis, Minnesofa, 164-165.

Ellis, M.B. 1993. Dematacеous hypomycetes. Cab. International Wallingford oxen 0x10 Bde UK, 95-98.

Fakir, G. A. 2001. An annotated list of seed borne diseases in Bangladesh. Seed Pathology Laboratory, Dept. Plant Path. BAU, Mymensingh, 7-8.

Fakir, G.A. 1977. Corynespora cassicola, a new seed borne pathogen of Jute in Bangladesh J. Jute Fib. Res., 2 (51-55).

Fakir, G.A. 1989. Seed health test in seed quality control and seed certification. Seed Path. Lab. Pub. No., 4:11.

Fakir, G.A. Islam, M.R. and Islam, F. 1993. Transmission of three major seed-borne fungal pathogens from seed to plant to seed in jute Corchorus capsularis L.) Abst. Progress in Plant Pathology. Proceedings of the 5th Biennial Conf. of Bangladesh Phytopath. Soc., 87.

Fakir, G.A., Islam, M.R. and Anzumanara, K. 1988. Curvularia lunata and Fusarium spp. In jute seeds. Third Biennial Conf. Abst. Bangladesh Phytopathol. Soc., 4.

Gomez, A. K. and Gomez, A. A. 1984. Statistical Procedures for Agric. Res. Second Edn. Intl . Rice Res. Inst. Manila, Philippines, 680.

Haque S.M.A., Hossain, I., Rahman M. A., Pervin N and Ali M.S. 2014. Efficacy of BAU-Biofungicide, Provax-200 on disease incidence, seed quality and yield in jute variety O-9897. The Journal of Plant Pathology. Photon, Article in Press (Impact Index 3.76)

Heydecker, W. 1969. The vigour of seeds - a review. In Proc. Intnl. Seed Test Assoc., 34: 201-209.

Heydecker, W. 1973. Seed Ecology. Butterworth, London.

Hossain, A.; Haque, S.; Sultana, K.; Islam, M. and Khandaker, A.L. 1994b. Varietal suitability for late planting technique on seed yield productivity. Late Jute Seed Production, Seed treatment and Vigor Test. Ministry of Agriculture (Seed Wing). Agricultural Support Services Project, GOB/ WORLD BANK/ ODA, 1-5.

Hossain, M. A.; Talukder, F. A. H.; Islam, M. and Morshed, G. 1994a. Studies on C. olitorius pipeline varieties . Ann. Rep. Bangladesh Jute Res. Inst., Dhaka, 132-137.

IJSG website. 2012-13. www.jute.org

Islam, M. M. 2007. About jute seed research. R.S. printing press, Kalwalapara, Mirpur-1, Dhaka-1216, 1.

Islam, M. M. 2009. Jute seed technology. College gate binding and printing, Dhaka-1207, 89-97.

ISTA, 1999. International Rules for Seed Testing Association. Seed Sci. and Technol., 4: 42-47.

Jain, N. K. and Saha, J. R. 1971. Effect of storage length on seed germination in jute (Corchorus spp.). Agronomy Journal, 63. 635-638.

Khan, A. A. and Fakir, G. A. 1993. Association of seed borne pathogens with growing capsules and their entry into developing seeds in jute. Bangladesh J. Plant Pathol., 9 (1&2): 1-3.

Khandakar, A. L. 1983. Physio-chemical examination of jute seed (C. capsularis L.) and (C. olitorius L.) for quality. Bangladesh J. Jute Fib. Res., 8:1-4.

Khandakar, A. L. 1987. Jute seed at farm level. Bangladesh Agric. Res. Coun., Dhaka. 1-77.

Khandakar, A. L. and Bradbeer, J. W. 1983. Jute Seed Quality. Agric. Econ. and Social Sci. Prog. Bangladesh Agric. Res. Coun., Dhaka, 1-92.

Khatun, Rahima & Sobhan, M. A. 1986. Moisture absorption by jute pods. Bangladesh J. of Jute and Fibre Res., 6(1&2): 83-86.

Mathur, S.B. and Kongsdal, O. 2003. Common

Laboratory Seed Health Testing Methods for detecting fungi. DGISP for developing countries, Thorvaldsanvej 57, DK-1871 Frederiksberg c, Copenhagen, Denmark.
Melone, J.P. and Muskett, A.E. 1964. Seedborne fungi, description of 77 fungus species. Proc. Int. Testing Asso., 29: 179-384.
Raper, K.B. and Funnel, D.I. 1965. The genus Aspergillus. The Williams and Wilkins Co., Baltimore, 686.
Shaw, F. J. F. 1921. Studies on the diseases of jute plant (Diplodia corchori Syd.). Dept of Agric., India, Bot. Seires, 21:37-58.
Sobhan, M. A. and Khatun, R. 1986. Effect of moisture and temperature on the viability and vigour of jute, kenaf and mesta seeds. Abst. Res. (1992). Bangladesh Jute Res. Inst., Dhaka, 221.
Sutton, B. C. 1980. The Coelomycetes. Commonwealth Mycological Institute. Kew, Surrey, England, 696.

Table 1 Initial status of seed quality and seed health of the O-9897 samples.

% moisture content	% Germination	MGT (hrs)	Vigour index	1000-seed weight (gm)	% seed borne fungal pathogen							
					M.p.	B.t.	C.c.	Asp. spp[1]	Pen. spp	Fusa. Spp.[2]	other fungi[3]	Total pathogens
16.00	89.00	25.20	83.33	1.50	0.33	0.50	0.00	0.67	0.33	3.83	2.50	8.16

MGT = Mean Germination time (hrs); M.p.=Macrophomina phaseolina, B.t.=Botryodiplodia theobromae, C.c.=Colletotrichum corchori, Pen spp. = Penicillium spp; [1]Aspergillus spp. (Aspergillus flavus & A. candidus), ; [2]Fusarium spp. (Fusarium moniliforme & F. semitectum) ; [3]Other fungi (Curvuluria lunata, Cladosporium cladosporioides, Myothecium sp., Rhizoctonia solani and Alternaria tenuies)

Table 2 Effect of moisture content of farmers' seed of O-9897 in different storage containers used for storing seeds and seed management practices.

Container	Moisture content (%)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1	16.00	11.00 d	11.37 e	11.40 d	10.00 e	10.07 f	10.13 g
T_2		11.63 cd	12.80 d	12.90 c	10.23 e	10.67 e	11.23 h
T_3		12.10 cd	12.80 d	12.87 c	12.20 bcd	12.63 c	12.70 d
T_4		14.83 a	14.87 b	15.10 b	14.27 a	13.60 b	14.67 c
T_5		12.60 bc	14.00 c	14.90 b	12.63 b	13.10 bc	15.10 b
T_6		14.67 a	16.17 a	16.33 a	14.53 a	15.70 a	15.73 a
T_7		11.50 d	12.70 d	12.83 c	12.30 bc	12.53 c	12.60 de
T_8		13.33 b	16.37 a	16.57 a	11.70 cd	11.67 d	12.30 e
T_9		11.10 d	11.27 e	11.47 d	11.67 d	11.63 d	11.70 f
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag; Data in column having common letter(s) do not differ significantly at 1% level of significance.

Table 3 Effect moisture content of Bangladesh Gazette recommended moisture content (9.5%) seeds of O-9897 stored in different storage containers under two treatments.

Container	Moisture content (%)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1		9.73 e	10.30 e	10.93 f	9.18 e	9.53 f	9.97 g
T_2		10.27 d	10.90 c	14.87 a	10.33 c	10.40 e	15.07 a
T_3		10.07 de	10.13 e	10.60 e	9.87 d	9.70 f	10.57 f
T_4		10.80 c	11.23 bc	11.30 d	11.00 ab	11.77 b	12.53 c
T_5	9.50	10.70 c	10.57 d	13.70 b	10.60 c	10.67 de	12.03 d
T_6		12.87 a	13.20 a	13.70 b	11.20 a	12.83 a	13.93 b
T_7		11.60 b	11.90 b	12.07 c	10.90 abc	11.10 cd	11.23 e
T_8		11.37 b	11.63 b	12.03 c	10.90 abc	11.37 bc	12.53 c
T_9		11.07 b	11.17 bc	11.77 cd	11.20 a	11.77 b	12.00 d
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag; Data in column having common letter(s) do not differ significantly at 1% level of significance.

Table 4 Effect of germination of farmers' seed of O-9897 in different storage containers used for storing seeds and seed management practices.

Container	Germination (%)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1	89.00	61.00 cd (7.84)	57.00 cd (7.58)	50.00 b (7.11)	73.00 a (8.57)	50.00 c (7.11)	34.00 c (5.87)
T_2		42.00 e (6.52)	38.00 e (6.20)	25.00 c (5.05)	58.00 b (7.65)	50.00 c (7.11)	35.00 c (5.96)
T_3		66.00 c (8.15)	62.00 c (7.91)	40.00 b (6.36)	54.00 b (7.38)	26.00 d (5.15)	20.00 d (4.53)
T_4		58.00 d (7.65)	2.00 f (1.58)	1.00 d (1.22)	75.00 a (8.69)	60.00 b (7.78)	51.00 b (7.18)
T_5		72.00 b (8.51)	71.00 b (8.46)	68.00 a (8.28)	32.00 c (5.70)	2.00 e (1.58)	1.00 e (1.22)
T_6		84.00 a (9.19)	6.00 f (2.55)	1.00 d (1.22)	78.00 a (8.86)	1.33 e (1.35)	1.00 e (1.22)
T_7		76.00 b (8.75)	71.00 b (8.46)	65.00 a (8.09)	50.00 b (7.11)	1.33 e (1.35)	1.00 e (1.22)
T_8		85.00 a (9.25)	51.00 d (7.18)	41.00 b (6.44)	73.00 a (8.57)	50.00 c (7.11)	25.00 d (5.05)
T_9		87.00 a (9.35)	80.00 a (8.97)	77.00 a (8.80)	72.00 a (8.51)	70.00 a (8.40)	65.00 a (8.09)
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag; Figures in parentheses indicate the tranformed values;
Data in column having common letter(s) do not differ significantly at 1% level of significance.

Table 5 Effect of germination of recommended moisture content (9.5%) seeds by Bangladesh Gazette of O-9897 stored in different storage containers and seed management practices.

Container	Germination (%)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1	93.00	88.00 a (9.41)	85.00 a (9.25)	82.00 a (9.08)	85.00 a (9.25)	82.00 a (9.08)	81.33 a (9.05)
T_2		81.00 bc (9.03)	78.00 ab (8.86)	77.00 ab (8.80)	81.57 ab (9.06)	81.46 a (9.05)	81.33 a (9.05)
T_3		84.00 ab (9.19)	82.00 a (9.08)	80.00 ab (8.97)	85.00 a (9.25)	86.00 a (9.30)	80.00 a (8.97)
T_4		85.00 ab (9.25)	82.00 a (9.08)	57.00 c (7.58)	75.00 b (8.69)	75.00 a (8.69)	56.00 b (7.52)
T_5		75.00 cd (8.69)	72.00 b (8.51)	72.00 b (8.51)	81.00 ab (9.03)	80.00 a (8.97)	75.00 a (8.69)
T_6		72.00 d (8.51)	3.00 c (1.87)	1.00 e (1.22)	79.00 ab (8.92)	8.00 b (2.92)	5.00 c (2.35)
T_7		82.00 ab (9.08)	82.00 a (9.08)	75.00 ab (8.69)	81.00 ab (9.03)	80.00 a (8.97)	75.00 a (8.69)
T_8		75.00 cd (8.69)	72.00 b (8.51)	40.00 d (6.36)	85.00 a (9.25)	82.00 a (9.08)	74.67 a (8.67)
T_9		85.00 ab (9.25)	73.00 b (8.57)	72.33 b (8.53)	78.00 b (8.86)	78.00 a (8.86)	72.00 a (8.51)
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag; Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance.

Table 6 Effect of mean germination time of farmers' seed of O-9897 in different storage containers used for storing seeds and seed management practices.

Container	Mean germination time (hrs)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1		28.08 c	29.76 c	31.44 b	25.10 c	28.08 c	28.56 c
T_2		54.72 a	49.68 a	64.32 a	40.56 abc	36.00 bc	38.64 bc
T_3		30.72 bc	32.16 c	32.88 b	31.92 bc	45.12 bc	46.56 bc
T_4		29.76 bc	33.12 c	41.76 ab	48.00 ab	53.28 b	60.72 ab
T_5	25.02	29.28 bc	46.56 ab	50.16 a	32.40 bc	36.96 bc	39.84 bc
T_6		40.08 b	42.96 ab	60.00 a	55.92 a	72.00 a	76.80 a
T_7		29.76 bc	34.80 bc	41.52 ab	31.44 bc	35.28 bc	38.16 bc
T_8		31.20 bc	35.52 bc	64.32 a	52.80 a	54.72 b	59.52 ab
T_9		29.04 bc	29.28 c	30.00 b	28.32 bc	35.04 bc	42.48 bc
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag

Data in column having common letter(s) do not differ significantly at 1% level of significance.

NS = Not significant

Table 7 Effect of mean germination time of recommended moisture content (9.5%) by Bangladesh Gazette of O-9897 stored in different storage containers and seed management practices.

Container	Mean germination time (hrs)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1		26.64 b	28.32 d	30.24 b	26.40 b	26.40 b	26.64 d
T_2		27.36 b	28.56 d	35.04 b	29.52 a	29.28 b	30.48 cd
T_3		27.84 b	30.00 cd	38.88 b	27.60 b	27.60 b	28.80 cd
T_4		31.68 b	33.60 a	35.04 b	26.64 b	30.96 b	48.96 b
T_5	26.12	28.56 b	30.96 bc	32.40 b	27.36 b	28.56 b	28.80 cd
T_6		30.00 b	31.92 bc	79.92 a	29.28 a	39.12 a	57.60 a
T_7		36.24 ab	38.40 a	39.36 ab	26.16 b	27.84 b	32.64 c
T_8		55.44 a	60.48 a	61.92 ab	26.64 b	27.84 b	32.64 c
T_9		31.92 b	33.12 b	35.04 b	27.36 b	28.56 b	30.00 cd
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag

Data in column having common letter(s) do not differ significantly at 1% level of significance.

Table 8 Effect of vigour index of farmers' seed of O-9897 in different storage containers used for storing seeds and seed management practices.

Container	Vigour index						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1	83.33	68.66 d (7.01)	63.42 b (7.99)	61.92 b (7.90)	54.67 e (7.43)	50.75 b (7.16)	48.50 b (7.00)
T_2		45.33 h (6.62)	27.67 f (5.31)	24.42 g (4.99)	58.33 d (7.67)	42.92 c (6.59)	39.17 c (6.30)
T_3		54.67 e (7.43)	54.50 c (7.42)	49.00 d (7.04)	52.00 g (7.25)	19.00 f (4.42)	12.50 f (3.61)
T_4		53.00 f (7.31)	39.83 d (6.35)	38.08 e (6.21)	53.92 f (7.38)	33.92 d (5.87)	29.92 d (5.52)
T_5		68.92 d (8.33)	62.50 b (7.94)	59.25 c (7.73)	37.75 h (6.18)	1.14 g 1.28)	1.00 g (1.22)
T_6		72.00 b (8.51)	2.50 g (1.73)	0.61 h (1.05)	74.25 b (8.65)	0.33 g (0.91)	0.08 g (0.76)
T_7		69.67 cd (8.38)	0.83 h (1.15)	0.61 h (1.05)	59.42 c (7.74)	1.00 g (1.22)	1.00 g (1.22)
T_8		75.00 a (8.69)	36.17 e (6.06)	33.67 f (5.85)	58.17 d (7.66)	31.08 e (5.62)	24.83 e (5.03)
T_9		70.42 c (8.42)	70.00 a (8.40)	62.92 a (7.96)	79.32 a (8.93)	72.17 a (8.52)	62.67 a (7.95)
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag;Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance.

Table 9 Effect of vigour index of recommended moisture content (9.5%) seeds by Bangladesh Gazette of O-9897 stored in different storage containers and seed management practices.

Container	Vigour index						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1	85.17	81.83 a (9.07)	74.83 a (1.19)	72.03 a (8.52)	80.50 a (9.00)	79.50 a (8.94)	78.00 a (8.86)
T_2		76.33 d (8.77)	66.92 d (8.21)	64.42 d (8.06)	71.00 f (8.46)	69.25 e (8.35)	68.00 f (8.28)
T_3		75.42 e (8.71)	62.83 e (7.96)	60.33 f (7.80)	79.50 b (8.94)	72.33 d (8.53)	68.50 f (8.31)
T_4		81.00 b (9.03)	74.67 a (8.67)	68.42 b (8.30)	71.67 f (8.50)	68.42 e (8.30)	63.67 g (8.01)
T_5		68.00 f (8.28)	66.50 d (8.19)	66.00 c (8.15)	79.50 b (8.94)	73.25 d (8.59)	72.00 d (8.51)
T_6		65.00 g (8.09)	0.92 f (8.19)	0.17 g (0.82)	73.25 e (8.59)	5.55 f (2.46)	3.50 h (2.00)
T_7		76.58 d (8.78)	72.33 b (8.53)	73.08 a (8.58)	78.25 c (8.87)	74.83 c (8.68)	73.33 c (8.59)
T_8		76.42 d (8.77)	70.00 c (8.68)	62.00 e (7.91)	80.50 a (9.00)	77.67 b (8.84)	69.67 e (8.38)
T_9		79.18 c (8.93)	75.33 a (8.40)	63.92 d (8.03)	77.17 d (8.81)	77.00 b (8.80)	76.50 b (8.77)
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7 = Cloth bag; T_8= Brown paper and T_9= IRRI poly bag Figures in parentheses indicate the transformed valuesData in column having common letter(s) do not differ significantly at 1% level of significance.

Table 10 Effect of 1000- seed weight of farmers' seed of O-9897 in different storage containers used for storing seeds and seed management practices.

Container	1000- seed weight (gm)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1		1.44	1.43 a	1.35 a	1.47 a	1.47 a	1.40 a
T_2		1.44	1.18 ab	1.18 bc	1.55 a	1.50 a	1.41 a
T_3		1.38	1.30 ab	1.25 b	1.50 a	1.50 a	1.32 a
T_4		1.34	1.28 ab	1.03 c	1.30 b	1.05 c	1.00 d
T_5	1.50	1.20	1.10 b	1.00 c	1.47 a	1.45 a	1.35 a
T_6		1.37	1.35 ab	1.05 c	1.47 a	1.40 b	1.25 bcd
T_7		1.20	1.08 b	1.02 c	1.44 a	1.37 b	1.20 ab
T_8		1.20	1.05 b	1.00 c	1.59 a	1.45 a	1.22 cd
T_9		1.25	1.10 b	1.00 c	1.37 a	1.37 b	1.37 a
Level of significance		NS	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7= Cloth bag; T_8= Brown paper and T_9= IRRI poly bag

Data in column having common letter(s) do not differ significantly at 1% level of significance.

NS = Not significant

Table 11 Effect of 1000- seed weight of recommended moisture content (9.5%) seeds by Bangladesh Gazette of O-9897 stored in different storage containers and seed management practices.

Container	1000- seed weight (gm)						
	Without treatment (Control)				Treated with Provax-200		
	Storing period (in months)						
	0	4	8	12	4	8	12
T_1		1.90 abc	1.63 a	1.48 a	1.98 ab	1.58 ab	1.45 b
T_2		2.20 a	1.48 ab	1.35 b	2.15 a	1.61 ab	1.50 a
T_3		1.70 abc	1.51 a	1.51 a	1.70 b	1.44 b	1.55 a
T_4		1.70 abc	1.50 a	1.10 c	1.60 b	1.52 ab	1.15 c
T_5	2.20	2.00 ab	1.60 a	1.30 b	1.90 ab	1.48 b	1.45 b
T_6		1.70 abc	1.52 a	1.15 c	2.15 a	1.84 a	1.25 c
T_7		1.60 bc	1.41 ab	1.15 c	1.60 b	1.48 b	1.40 ab
T_8		1.65 bc	1.50 a	1.15 c	1.97 ab	1.83 a	1.52 a
T_9		1.40 c	1.27 b	1.15 c	1.85 ab	1.48 b	1.55 a
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7= Cloth bag; T_8= Brown paper and T_9= IRRI poly bag

In a column, means followed by common letter(s) are statistically identical

Table 12 Frequency of occurrence of pathogenic fungi identified in farmers' seed of O-9897 in storage condition and seed management (without treatment) practices.

Fungi	% Infected seed sample[a]				% Pathogenic fungi				% Total infection			
	Storing period (in months)				Storing period (in months)				Storing period (in months)			
	0	4	8	12	0	4	8	12	0	4	8	12
Macrophomina phaseolina	0.00 b	11.11 e	44.44 d	55.56 d	0.15 d	0.17 e	1.67 d	1.33 e	2.00 d	0.16 e	1.76 d	1.21 cd
	(0.71)	(3.41)	(6.70)	(7.49)	(0.82)	(0.82)	(1.47)	(1.35)	(1.58)	(0.81)	(1.50)	(1.31)
Botryodiplodia theobromae	0.00 b	11.11 e	77.78 c	11.11 e	0.50 cd	0.17 e	2.50 d	0.17 f	6.00 cd	0.17 e	2.65 d	0.15 d
	(0.71)	(3.41)	(8.85)	(3.41)	(1.00)	(0.82)	(1.73)	(0.82)	(2.55)	(0.81)	(1.77)	(0.81)
Aspergillus spp.[1]	100 a	88.89 b	100.00 a	88.89 b	0.66 c	15.50 c	17.67 b	32.83 b	8.00 c	14.89 c	18.63 b	29.80 a
	(10.02)	(9.45)	(10.02)	(9.45)	(1.08)	(4.00)	(4.26)	(5.77)	(2.92)	(3.92)	(4.37)	(5.50)
Penicillium spp.	100 a	100.00 a	100.00 a	88.89 b	0.17 d	34.00 b	19.50 b	16.33 c	2.00 d	32.67 b	20.56 b	14.83 b
	(10.02)	(10.02)	(10.02)	(9.45)	(0.82)	(5.87)	(4.47)	(4.10)	(1.58)	(5.76)	(4.59)	(3.92)
Chaetomium spp.	100 a	55.56 d	88.89 b	100.00 a	0.50 cd	3.18 d	6.84 c	17.83 c	6.00 cd	3.04 d	7.22 c	16.19 b
	(10.02)	(7.49)	(9.45)	(10.02)	(1.00)	(1.92)	(2.71)	(4.28)	(2.55)	(1.88)	(2.78)	(4.09)
Fusarium spp.[2]	100 a	100.00 a	100.00 a	100.00 a	3.84 a	47.50 a	37.17 a	37.50 a	46.00 a	45.62 a	39.19 a	34.04 a
	(10.02)	(10.02)	(10.02)	(10.02)	(2.08)	(6.93)	(6.14)	(6.16)	(6.82)	(6.79)	(6.30)	(5.88)
Other[3]	100 a	66.67 c	77.78 c	77.78 c	2.50 b	3.61 d	9.50 c	4.17 d	30.00 b	3.47 d	10.02 c	3.78 c
	(10.02)	(8.20)	(8.85)	(8.85)	(1.73)	(2.03)	(3.16)	(2.16)	(5.52)	(1.99)	(3.24)	(2.07)
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

[a] Total number of seed samples were 9 (initial stage 1); [1] *Aspergillus* spp. (*Aspergillus flavus & A. candidus*); [2] *Fusarium* spp. (*Fusarium moniliforme & F. semitectum*), [3] Other fungi (*Curvuluria lunata, Cladosporium cladosporioides, Myothecium* sp., *Rhizoctonia solani* and *Alternaria tenuies*) Data represent the means of 200 seeds/sample Figures in parentheses indicate the transformed values Data in column having common letter(s) do not differ significantly at 1% level of significance

Table 13 Frequency of occurrence of pathogenic fungi identified in farmers' seed of O-9897 in storage condition and seed management (Treated by Provax-200) practices.

Fungi	% Infected seed sample[a]				% Pathogenic fungi				% Total infection			
	Storing period (in months)				Storing period (in months)				Storing period (in months)			
	0	4	8	12	0	4	8	12	0	4	8	12
Macrophomina phaseolina	0.00 b	11.11 e	44.44 e	33.33 c	0.18 d	0.17 d	1.00 c	0.67 d	2.00 d	0.23 e	1.86 d	1.05 c
	(0.71)	(3.41)	(6.70)	(5.82)	(0.82)	(0.82)	(1.22)	(1.08)	(1.58)	(0.85)	(1.54)	(1.24)
Botryodiplodia theobromae	0.00 b	11.11 e	55.56 d	22.22 d	0.51 cd	0.17 d	1.32 c	0.22 d	6.02 cd	0.23 e	2.48 d	0.34 c
	(0.71)	(3.41)	(7.49)	(4.77)	(1.00)	(0.82)	(1.35)	(0.85)	(2.55)	(0.85)	(1.73)	(0.92)
Aspergillus spp.[1]	100 a	100.00 a	88.89 b	88.89 b	0.67 c	9.83 b	6.67 b	19.50 a	8.00 c	13.73 c	12.37 c	30.79 a
	(10.02)	(10.02)	(9.45)	(9.45)	(1.08)	(3.21)	(2.68)	(4.47)	(2.92)	(3.77)	(3.59)	(5.59)
Penicillium spp.	100 a	88.89 b	88.89 b	88.89 b	0.16 d	14.01b	11.34 ab	7.01 b	2.00 d	19.53 b	21.05 b	11.06 b
	(10.02)	(9.45)	(9.45)	(9.45)	(0.82)	(3.81)	(3.44)	(2.74)	(1.58)	(4.48)	(4.64)	(3.40)
Chaetomium spp.	100 a	33.33 d	88.89 b	100.00 a	0.50 cd	4.00 c	8.00 b	22.85 a	6.00 cd	5.59 d	14.86 bc	36.05 a
	(10.02)	(5.82)	(9.45)	(10.02)	(1.00)	(2.12)	(2.92)	(4.83)	(2.55)	(2.47)	(3.92)	(6.05)
Fusarium spp.[2]	100 a	100.00 a	100.00a	100.00 a	3.84 a	39.83 a	18.00 a	10.33 b	46.00 a	55.58 a	33.44 a	16.32 b
	(10.02)	(10.02)	(10.02)	(10.02)	(2.08)	(6.35)	(4.30)	(3.29)	(6.82)	(7.49)	(5.63)	(4.10)
Other[3]	100 a	66.67 c	77.78 c	88.89 b	2.50 b	3.67 c	7.50 b	2.79 c	30.00 b	5.12 d	13.93 c	4.39 c
	(10.02)	(8.20)	(8.85)	(9.45)	(1.73)	(2.04)	(2.83)	(1.81)	(5.52)	(2.37)	(3.80)	(1.21)
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

[a] Total number of seed samples were 9 (initial stage 1); [1]*Aspergillus* spp. (*Aspergillus flavus & A. candidus*); [2]*Fusarium* spp. (*Fusarium moniliforme & F. semitectum*);[3]Other fungi (*Curvuluria lunata, Cladosporium cladosporioides, Myothecium* sp., *Rhizoctonia solani* and *Alternaria tenuies*); Data represent the means of 200 seeds/sample; Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance

Table 14 Frequency of occurrence of pathogenic fungi identified in recommended moisture content (9.5%) of seeds by Bangladesh Gazette of O-9897 in storage condition and seed management (without treatment) practices.

Fungi	% Infected seed sample[a]				% Pathogenic fungi				% Total infection			
	Storing period (in months)				Storing period (in months)				Storing period (in months)			
	0	4	8	12	0	4	8	12	0	4	8	12
Macrophomina phaseolina	0.00 b	33.33 d	66.67 c	33.33 d	0.33 a	0.50 d	2.51 c	0.50 e	8.00 c	0.64 d	2.85 e	0.72 f
	(0.71)	(5.82)	(8.20)	(5.82)	(0.91)	(1.00)	(1.73)	(1.00)	(2.92)	(1.07)	(1.83)	(1.10)
Botryodiplodia theobromae	0.00 b	11.11 e	55.56 d	22.22 e	0.34 a	0.17 d	1.83 c	0.28 e	8.00 c	0.21 d	2.09 e	0.41 g
	(0.71)	(3.41)	(7.49)	(4.77)	(0.91)	(0.82)	(1.53)	(0.88)	(2.92)	(0.84)	(1.61)	(0.95)
Aspergillus spp.[1]	100 a	100.00 a	100.00 a	88.89 b	0.17 a	11.83 b	20.17 ab	24.17 a	4.00 d	15.25 b	23.02 b	35.00 b
	(10.02)	(10.02)	(10.02)	(9.45)	(0.82)	(3.51)	(4.55)	(4.97)	(2.12)	(3.97)	(4.85)	(5.96)
Penicillium spp.	100 a	100.00 a	100.00 a	77.78 c	0.33 a	14.00 b	14.17 b	5.68 c	8.01 c	18.04 b	16.16 c	8.21 d
	(10.02)	(10.02)	(10.02)	(8.85)	(0.91)	(3.81)	(3.83)	(2.48)	(2.92)	(4.31)	(4.08)	(2.95)
Chaetomium spp.	100 a	44.44 c	88.89 b	100.00 a	0.50 a	1.00 d	9.83 bc	9.67 b	12.00 c	1.29 d	11.22 d	14.00 c
	(10.02)	(6.70)	(9.45)	(10.02)	(1.00)	(1.22)	(3.21)	(3.19)	(3.54)	(1.34)	(3.42)	(3.81)
Fusarium spp.[2]	100 a	100.00 a	100.00 a	100.00 a	1.67 a	45.33 a	30.83 a	25.84 a	40.00 a	58.41 a	35.17 a	37.41 a
	(10.02)	(10.02)	(10.02)	(10.02)	(1.47)	(6.77)	(5.60)	(5.13)	(6.36)	(7.68)	(5.97)	(6.16)
Other[3]	100 a	66.67 b	88.89 b	88.89 b	0.83 a	4.78 c	8.33 bc	2.94 d	20.00 b	6.16 c	9.51 d	4.26 e
	(10.02)	(8.20)	(9.45)	(9.45)	(1.15)	(2.30)	(2.97)	(1.85)	(4.53)	(2.58)	(3.16)	(2.18)
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

[a] Total number of seed samples were 9 (initial stage 1); [1]*Aspergillus* spp. (*Aspergillus flavus & A. candidus*); [2] *Fusarium* spp. (*Fusarium moniliforme & F. semitectum*), [3]Other fungi (*Curvuluria lunata, Cladosporium cladosporioides, Myothecium* sp., *Rhizoctonia solani* and *Alternaria tenuies*); Data represent the means of 200 seeds/sample; Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance

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Table 15 Frequency of occurrence of pathogenic fungi identified in recommended moisture content (9.5%) of seeds by Bangladesh Gazette of O-9897 in storage condition and seed management (Treated by Provax-200) practices.

Fungi	% Infected seed sample[a]				% Pathogenic fungi				% Total infection			
	Storing period (in months)				Storing period (in months)				Storing period (in months)			
	0	4	8	12	0	4	8	12	0	4	8	12
Macrophomina phaseolina	0.00 b	22.22 e	55.56 d	11.11 d	0.33 a	0.33 e	1.83 d	0.17 d	8.00 c	0.50 e	2.44 d	0.31 d
	(0.71)	(4.77)	(7.49)	(3.41)	(0.91)	(0.91)	(1.53)	(0.82)	(2.92)	(1.00)	(1.71)	(0.90)
Botryodiplodia theobromae	0.00 b	22.22 e	44.44 e	22.22 c	0.33 a	0.22 e	0.67 d	0.33 d	8.00 c	0.33 e	0.89 d	0.62 d
	(0.71)	(4.77)	(6.70)	(4.77)	(0.91)	(0.85)	(1.08)	(0.91)	(2.92)	(0.91)	(1.18)	(1.06)
Aspergillus spp.[1]	100 a	88.89 b	100.00 a	100.00 a	0.17 a	4.50 c	10.69 bc	14.35 ab	4.00 d	6.75 c	14.19 c	26.68 ab
	(10.02)	(9.45)	(10.02)	(10.02)	(0.82)	(2.24)	(3.34)	(3.85)	(2.12)	(2.69)	(3.83)	(5.21)
Penicillium spp.	100 a	100.00 a	100.00 a	100.00 a	0.33 a	10.50 b	17.01 b	5.84 c	8.00 c	15.75 b	22.62 b	10.86 c
	(10.02)	(10.02)	(10.02)	(10.02)	(0.91)	(3.32)	(4.18)	(2.52)	(2.92)	(4.03)	(4.81)	(3.37)
Chaetomium spp.	100 a	33.33 d	88.89 b	100.00 a	0.50 a	1.17 d	8.67 c	10.67 b	12.00 c	1.75 d	11.53 c	19.86 b
	(10.02)	(5.82)	(9.45)	(10.02)	(1.00)	(1.29)	(3.03)	(3.34)	(3.54)	(1.50)	(3.47)	(4.51)
Fusarium spp.[2]	100 a	100.00 a	100.00 a	100.00 a	1.67 a	45.00 a	25.16 a	17.00 a	40.00 a	67.50 a	33.48 a	31.64 a
	(10.02)	(10.02)	(10.02)	(10.02)	(1.47)	(6.75)	(6.07)	(4.18)	(6.36)	(8.25)	(5.83)	(5.67)
Other[3]	100 a	44.44 c	77.78 c	33.33 b	0.83 a	4.94 c	11.17 bc	5.39 c	20.00 b	7.42 c	14.86 c	10.03 c
	(10.02)	(6.70)	(8.85)	(5.82)	(1.15)	(2.33)	(3.42)	(2.43)	(4.53)	(2.81)	(3.92)	(3.24)
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

[a] Total number of seed samples were 9 (initial stage 1; [1]*Aspergillus* spp. (*Aspergillus flavus & A. candidus*); [2] *Fusarium* spp. (*Fusarium moniliforme & F. semitectum*), [3]Other fungi (*Curvuluria lunata, Cladosporium cladosporioides,* Mycelium, *Myothecium* sp., *Rhizoctonia solani* and *Alternaria tenuies*); Data represent the means of 200 seeds/sample; Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance

Table 16 Seed germination and seed borne fungi recorded in farmers' seed of O-9897 in different storage containers used for storing seeds and seed management (without treatment) practices.

Container	% Germination *Macrophomina phaseolina*				% seed borne fungal pathogens *Botryodiplodia theobromae*			*Aspergillus* spp.[1]					
	Storing period (in months)				Storing period (in months)			Storing period (in months)			Storing period (in months)		
	0	4	8	12	4	8	12	4	8	12	4	8	12
T_1	89	61.00cd (7.84)	57.00 cd (7.58)	50.00 b (7.11)	0.67 (1.08)	2.67 (1.78)	4.67 (2.27)	0.33 b (0.91)	2.33 (1.68)	5.34 (2.41)	5.67 ab (2.48)	7.33 b (2.80)	8.67 de (3.03)
T_2		42.00 e (6.52)	38.00 e (6.20)	25.00 c (5.05)	1.33 (1.35)	3.33 (1.96)	6.67 (2.68)	1.67 ab (1.47)	3.67 (2.04)	7.33 (2.80)	8.00 ab (2.92)	8.33 ab (2.97)	10.67 cde (3.34)
T_3		66.00 c (8.15)	62.00 c (7.91)	40.00 b (6.36)	1.00 (1.22)	3.00 (1.87)	5.33 (2.40)	0.67 ab (1.08)	4.33 (2.20)	5.67 (2.48)	6.00 ab (2.55)	17.00 a (4.18)	33.33 ab (5.82)
T_4		58.00 d (7.65)	2.00 f (1.58)	1.00 d (1.22)	1.33 (1.35)	4.67 (2.27)	6.33 (2.61)	1.67 ab (1.47)	5.34 (2.41)	7.67 (2.86)	12.67 a (3.63)	14.67 ab (3.89)	32.67 ab (5.76)
T_5		72.00 b (8.51)	71.00 b (8.46)	68.00 a (8.28)	1.33 (1.35)	4.33 (2.20)	4.33 (2.20)	1.33 ab (1.35)	3.67 (2.04)	5.67 (2.48)	8.33 ab (2.97)	9.67 ab (3.19)	32.33 ab (5.73)
T_6		84.00 a (9.19)	6.00 f (2.55)	1.00 d (1.22)	1.67 (1.47)	5.67 (2.48)	8.33 (2.97)	2.00 a (1.58)	6.33 (2.61)	6.33 (2.61)	12.67 a (3.63)	13.67 ab (3.76)	52.00 a (7.25)
T_7		76.00 b (8.75)	71.00 b (8.46)	65.00 a (8.09)	0.67 (1.08)	4.00 (2.12)	4.00 (2.12)	1.67 ab (1.47)	3.67 (2.04)	3.67 (2.04)	6.33 ab (2.61)	9.00 ab (3.08)	17.67bcd (4.25)
T_8		85.00 a (9.25)	51.00 d (7.18)	41.00 b (6.44)	1.00 (1.22)	5.33 (2.40)	5.67 (2.48)	1.33 ab (1.35)	6.35 (2.62)	6.33 (2.61)	13.00 a (3.67)	6.67 b (2.68)	22.00 bc (4.74)
T_9		87.00 a (9.35)	80.00 a (8.97)	77.00 a (8.80)	2.33 (1.68)	2.33 (1.68)	6.67 (2.68)	1.33 ab (1.35)	1.33 (1.35)	7.67 (2.86)	4.33 b (2.20)	6.67 b (2.68)	5.33 e (2.42)
Level of significance		0.01	0.01	0.01	NS	NS	0.01	0.01	NS	NS	0.01	0.01	0.01

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Container	% seed borne fungal pathogens											
	Penicillium spp.			*Fusarium* spp. [2]			Other fungi [3]			Total pathogens		
	Storing period (in months)			Storing period (in months)			Storing period (in months)			Storing period (in months)		
	4	8	12	4	8	12	4	8	12	4	8	12
T_1	6.00 c	7.33 b	6.33 b	11.67 b	14.67 bcd	13.67 cd	1.00 c	3.33 c	2.67 c	25.33 c	37.66 cd	41.33 c
	(2.55)	(2.79)	(2.61)	(3.49)	(3.89)	(3.76)	(1.22)	(1.96)	(1.78)	(5.08)	(6.18)	(6.47)
T_2	7.32 bc	10.33 ab	11.00 ab	13.67 ab	13.67 cd	25.00 ab	5.00 ab	4.00 bc	15.00 a	37.00 bc	43.33bcd	75.67 abc
	(2.79)	(3.29)	(3.39)	(3.76)	(3.76)	(5.05)	(2.35)	(2.12)	(3.94)	(6.12)	(6.62)	(8.73)
T_3	7.67 bc	24.00 a	24.00 a	18.33 ab	25.00 ab	29.00 ab	3.33 bc	9.00 ab	6.00 b	37.00 bc	82.33 a	103.33 ab
	(2.86)	(4.95)	(4.95)	(4.34)	(5.05)	(5.43)	(1.96)	(3.08)	(2.55)	(6.12)	(9.10)	(10.19)
T_4	15.67 ab	16.67 ab	19.00 ab	28.33 a	29.67 a	39.33 a	1.00 c	7.00 abc	3.67 b	60.67 a	78.00 a	108.67 ab
	(4.02)	(4.14)	(4.42)	(5.37)	(5.49)	(6.31)	(1.22)	(2.74)	(2.04)	(7.82)	(8.86)	(10.45)
T_5	9.00 bc	9.67 ab	10.66 ab	15.67 ab	16.33 bcd	28.33 ab	1.67 bc	7.33 abc	6.33 b	37.33 bc	51.00 bc	87.67 ab
	(3.08)	(3.19)	(3.33)	(4.02)	(4.10)	(5.37)	(1.47)	(2.80)	(2.61)	(6.14)	(7.18)	(9.39)
T_6	10.33 abc	15.67 ab	16.67 ab	20.33 ab	21.00 abc	29.00 ab	4.00abc	14.00 a	6.67 b	51.00 abc	76.33 a	119.00 a
	(3.29)	(4.02)	(4.14)	(4.56)	(4.64)	(5.43)	(2.12)	(3.81)	(2.68)	(7.18)	(8.77)	(10.93)
T_7	8.00 bc	8.67 ab	10.33 ab	19.67 ab	22.33 abc	23.67 bc	3.33 bc	8.33 abc	7.66 ab	39.67 bc	56.00 b	67.00 bc
	(2.92)	(3.03)	(3.29)	(4.49)	(4.78)	(4.92)	(1.96)	(2.97)	(2.86)	(6.34)	(7.52)	(8.22)
T_8	19.33 a	9.67 ab	12.33 ab	15.67 ab	17.67abcd	36.67 ab	3.00 bc	5.01 bc	7.00 b	53.33 ab	50.67 bc	90.00 ab
	(4.45)	(3.19)	(3.58)	(4.02)	(4.26)	(6.10)	(1.87)	(2.35)	(2.74)	(7.34)	(7.15)	(9.51)
T_9	7.00 bc	7.67 b	9.00 ab	11.00 b	10.67 d	10.33 d	9.34 a	2.01 c	9.33 ab	35.33 c	30.67 d	48.33 c
	(2.74)	(2.86)	(3.08)	(3.39)	(3.34)	(3.29)	(3.14)	(1.58)	(3.13)	(5.99)	(5.58)	(6.99)
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7= Cloth bag; T_8= Brown paper and T_9= IRRI poly bag [1] *Aspergillus* spp. (*Aspergillus flavus & A. candidus),* [2] *Fusarium* spp. (*Fusarium moniliforme* & *F. semitectum*) Other fungi (*Curvuluria lunata, Cladosporium cladosporioides, Myothecium* sp., *Rhizoctonia solani* and *Alternaria* tenuies) Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance; NS = Not Significant

Table 17 Seed germination and seed borne fungi recorded in farmers' seed of O-9897 in different storage containers used for storing seeds and seed management (Treated by Provax-200) practices.

Container	% Germination *Macrophomina phaseolina*				% seed borne fungal pathogens								
					Botryodiplodia theobromae			*Aspergillus* spp.[1]					
	Storing period (in months)				Storing period (in months)			Storing period (in months)			Storing period (in months)		
	0	4	8	12	4	8	12	4	8	12	4	8	12
T_1	89.00	73.00 a (8.57)	50.00c (7.11)	34.00c (5.87)	0.33 b (0.91)	1.67 (1.47)	2.67 (1.78)	0.67 ab (1.08)	2.00ab (1.58)	3.33 (1.96)	3.67 ab (2.04)	3.00 b (1.87)	4.67 bc (2.27)
T_2		58.00 b (7.65)	50.00c (7.11)	35.00c (5.96)	1.00 ab (1.22)	1.67 (1.47)	4.33 (2.20)	1.33 a (1.35)	2.33ab (1.68)	3.67 (2.04)	3.33 ab (1.96)	4.33 ab (2.20)	4.67 bc (2.27)
T_3		54.00 b (7.38)	26.00d (5.15)	20.00d (4.53)	1.00 ab (1.22)	1.33 (1.35)	3.33 (1.96)	0.67 ab (1.08)	2.67ab (1.78)	4.67 (2.27)	4.33 ab (2.20)	7.33 ab (2.80)	10.67 abc (3.33)
T_4		75.00 a (8.69)	60.00b (7.78)	51.00b (7.18)	1.00 ab (1.22)	3.67 (2.04)	2.33 (1.68)	1.00 ab (1.22)	3.33ab (1.96)	4.33 (2.20)	7.67 a (2.86)	8.00 a (2.92)	14.67 ab (3.89)
T_5		32.00 c (5.70)	2.00 e (1.58)	1.00 e (1.22)	0.67 ab (1.08)	4.00 (2.12)	4.33 (2.20)	0.33 b (0.91)	3.33ab (1.96)	5.67 (2.48)	2.33 b (1.68)	6.00 ab (2.55)	15.33 a (3.98)
T_6		78.00 a (8.86)	1.33 e (1.35)	1.00 e (1.22)	0.67 ab (1.08)	3.33 (1.96)	5.00 (2.35)	1.33 a (1.35)	4.67 a (2.27)	3.33 (1.96)	7.33 a (2.80)	8.67 a (3.03)	23.67 a (4.92)
T_7		50.00 b (7.11)	1.33 e (1.35)	1.00 e (1.22)	0.67 ab (1.08)	2.67 (1.78)	1.33 (1.35)	1.67 a (1.47)	2.33ab (1.68)	2.67 (1.78)	4.67 ab (2.27)	8.33 a (2.97)	13.33 abc (3.72)
T_8		73.00 a (8.57)	50.00c (7.11)	25.00d (5.05)	1.00 ab (1.22)	3.67 (2.04)	3.67 (2.04)	0.67 ab (1.08)	4.33ab (2.20)	3.33 (1.96)	5.33 ab (2.42)	6.33 ab (2.61)	12.33 abc (3.58)
T_9		72.00 a (8.51)	70.00a (8.40)	65.00a (8.09)	1.67 a (1.47)	1.33 (1.35)	2.67 (1.78)	1.00 ab (1.22)	0.67 b (1.08)	3.67 (2.04)	5.67 ab (2.48)	6.00 ab (2.55)	4.33 c (2.20)
Level of significance		0.01	0.01	0.01	0.01	NS	NS	0.01	0.01	NS	0.01	0.01	0.01

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Container	% seed borne fungal pathogens									Total pathogens		
	Penicillium spp.			*Fusarium* spp. [2]			Other fungi [3]					
	Storing period (in months)			Storing period (in months)			Storing period (in months)			Storing period (in months)		
	4	8	12	4	8	12	4	8	12	4	8	12
T_1	5.00	5.67	6.00 ab	7.00 b	6.67 b	7.00	5.67 b	3.66 ab	4.00 ab	22.34	22.66	27.67 ab
	(2.35)	(2.48)	(2.55)	(2.74)	(2.68)	(2.74)	(2.48)	(2.04)	(2.12)	(4.78)	(4.81)	(5.31)
T_2	4.00	6.33	6.33 ab	8.00 b	9.00 ab	9.33	16.34 a	4.33 ab	5.33 ab	34.00	28.00	33.66 ab
	(2.12)	(2.61)	(2.61)	(2.92)	(3.08)	(3.14)	(4.10)	(2.20)	(2.40)	(5.87)	(5.34)	(5.84)
T_3	4.33	7.67	8.00 ab	9.67 ab	8.00 ab	8.67	3.33 bc	5.67 a	9.33 a	23.33	32.67	44.66 ab
	(2.20)	(2.86)	(2.92)	(3.19)	(2.92)	(3.03)	(1.96)	(2.48)	(3.14)	(4.88)	(5.76)	(6.72)
T_4	6.67	6.33	8.67 ab	16.00 a	13.67 ab	14.33	2.67 bc	1.67 bc	5.33 ab	35.00	36.67	49.67 ab
	(2.68)	(2.61)	(3.03)	(4.06)	(3.76)	(3.85)	(1.78)	(1.47)	(2.42)	(5.96)	(6.10)	(7.08)
T_5	5.67	5.33	6.00 ab	10.33 ab	8.33 ab	8.33	4.33 bc	1.00 c	5.67 ab	23.66	28.00	45.34 ab
	(2.48)	(2.42)	(2.55)	(3.29)	(2.97)	(2.97)	(2.20)	(1.22)	(2.48)	(4.92)	(5.34)	(6.77)
T_6	7.00	6.67	7.00	8.33 b	9.33 ab	10.00	1.33 c	6.00 a	7.00 ab	26.00	38.67	56.00 a
	(2.74)	(2.68)	(2.74)	(2.97)	(3.14)	(3.24)	(1.35)	(2.55)	(2.74)	(5.15)	(6.26)	(7.52)
T_7	5.33	5.33	3.33	13.33	14.33 a	14.33	1.00 c	4.33 ab	4.66 ab	26.67	37.33	39.66 ab
	(2.42)	(2.42)	(1.96)	(3.72)	(3.85)	(3.85)	(1.22)	(2.20)	(2.27)	(5.21)	(6.15)	(6.34)
T_8	6.67	5.00	9.67	10.67	11.33 ab	10.00	2.00 bc	7.33 a	8.34 a	26.33	38.00	47.34 ab
	(2.68)	(2.35)	(3.19)	(3.34)	(3.44)	(3.24)	(1.58)	(2.80)	(2.97)	(5.18)	(6.20)	(6.92)
T_9	3.00	4.67	4.67	8.67	7.33 ab	7.67	1.66 bc	1.67 bc	2.53 b	21.66	21.67	25.54 b
	(1.87)	(2.27)	(2.27)	(3.03)	(2.80)	(2.86)	(1.47)	(1.47)	(1.74)	(4.71)	(4.71)	(5.10)
Level of significance	NS	NS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NS	NS	0.01

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7= Cloth bag; T_8= Brown paper and T_9= IRRI poly bag [1] *Aspergillus* spp. (*Aspergillus flavus & A. candidus),* [2] *Fusarium* spp. (*Fusarium moniliforme* & *F. semitectum*) [3] Other fungi (*Curvuluria lunata, Cladosporium cladosporioides, Myothecium* sp., *Rhizoctonia solani* and *Alternaria tenuies*) Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance NS = Not Significant

Table 18 Seed germination and seed borne fungi recorded in recommended moisture content (9.5%) of seeds by Bangladesh Gazette of O-9897 in different storage containers used for storing seeds and seed management (without treatment) practices.

Container	% Germination				% seed borne fungal pathogens								
	Macrophomina phaseolina				*Botryodiplodia theobromae*			*Aspergillus* spp.[1]					
	Storing period (in months)				Storing period (in months)			Storing period (in months)			Storing period (in months)		
	0	4	8	12	4	8	12	4	8	12	4	8	12
T_1	93	88.00 a (9.41)	85.00 a (9.25)	82.00a (9.08)	0.33 b (0.91)	1.33 (1.35)	1.67 (1.47)	0.33 b (0.91)	1.67 (1.47)	2.33 (1.68)	2.67 (1.78)	3.00 (1.87)	4.33 (2.20)
T_2		81.00 bc (9.03)	78.00 ab (8.86)	77.00ab (8.80)	0.67 ab (1.08)	1.00 (1.22)	2.67 (1.78)	1.00ab (1.22)	2.00 (1.58)	3.33 (1.96)	3.00 (1.87)	4.67 (2.27)	4.67 (2.27)
T_3		84.00 ab (9.19)	82.00 a (9.08)	80.00ab (8.97)	1.00 ab (1.22)	1.33 (1.35)	3.00 (1.87)	0.67ab (1.08)	1.67 (1.47)	3.67 (2.04)	3.67 (2.04)	5.67 (2.48)	7.33 (2.80)
T_4		85.00 ab (9.25)	82.00 a (9.08)	57.00c (7.58)	0.67 ab (1.08)	2.33 (1.68)	3.00 (1.87)	1.00 ab (1.22)	2.67 (1.78)	4.33 (2.20)	5.67 (2.48)	7.33 (2.80)	11.67 (3.49)
T_5		75.00 cd (8.69)	72.00 b (8.51)	72.00b (8.51)	0.67 ab (1.08)	3.00 (1.87)	3.67 (2.04)	0.33 b (0.91)	3.33 (1.96)	4.00 (2.12)	4.33 (2.20)	6.33 (2.61)	11.67 (3.49)
T_6		72.00 d (8.51)	3.00 c (1.87)	1.00 e (1.22)	1.00 ab (1.22)	2.67 (1.78)	3.67 (2.04)	1.00ab (1.22)	3.33 (1.96)	3.33 (1.96)	5.67 (2.48)	7.33 (2.80)	14.37 (3.86)
T_7		82.00 ab (9.08)	82.00 a (9.08)	75.00ab (8.69)	0.67 ab (1.08)	1.67 (1.47)	2.33 (1.68)	1.33 a (1.35)	2.00 (1.58)	2.67 (1.78)	4.00 (2.12)	4.67 (2.27)	10.00 (3.24)
T_8		75.00 cd (8.69)	72.00 b (8.51)	40.00d (6.36)	1.33 a (1.35)	2.33 (1.68)	3.67 (2.04)	1.33 a (1.35)	3.67 (2.04)	3.33 (1.96)	4.33 (2.20)	5.67 (2.48)	12.00 (3.54)
T_9		85.00 ab (9.25)	73.00 b (8.57)	72.33b (8.53)	1.00 ab (1.22)	1.00 (1.22)	2.67 (1.78)	1.00ab (1.22)	1.00 (1.22)	3.67 (2.04)	3.33 (1.96)	5.00 (2.35)	5.67 (2.48)
Level of significance		0.01	0.01	0.01	0.01	NS	NS	0.01	NS	NS	NS	NS	NS

Cont'd

Container	% seed borne fungal pathogens									Total pathogens		
	Penicillium spp.			*Fusarium* spp. [2]			Other fungi [3]					
	Storing period (in months)			Storing period (in months)			Storing period (in months)			Storing period (in months)		
	4	8	12	4	8	12	4	8	12	4	8	12
T_1	3.33 ab (1.96)	4.67 ab (2.27)	5.67 ab (2.48)	5.67 (2.48)	8.00 (2.91)	8.00 (2.92)	9.01 a (3.08)	3.00 bcd (1.87)	2.33 bc (1.68)	21.34 (4.67)	21.67 (4.71)	24.33 (4.98)
T_2	3.00 ab (1.87)	5.33 ab (2.41)	6.00 ab (2.55)	6.67 (2.68)	8.33 (2.97)	8.67 (3.03)	3.33 bc (1.96)	4.33 bc (2.20)	1.67 c (1.47)	17.67 (4.26)	25.66 (5.11)	27.01 (5.24)
T_3	3.67 ab (2.04)	6.67 a (2.68)	7.33 a (2.80)	6.33 (2.61)	7.67 (2.86)	8.00 (2.92)	1.66 c (1.47)	5.67 ab (2.48)	1.33 c (1.35)	17.00 (4.18)	28.68 (5.40)	30.66 (5.58)
T_4	5.00 ab (2.35)	5.67 ab (2.48)	7.33 a (2.80)	10.00 (3.24)	12.67 (3.63)	13.00 (3.67)	2.00 bc (1.58)	3.33 bcd (1.96)	5.00 ab (2.35)	24.33 (4.98)	34.00 (5.87)	44.33 (6.70)
T_5	4.00 ab (2.12)	4.33 ab (2.20)	5.67 (2.48)	8.33 (2.97)	8.00 (2.91)	8.00 (2.92)	5.33 abc (2.41)	1.67 cd (1.47)	1.33 c (1.35)	22.99 (4.85)	26.66 (5.21)	34.34 (5.90)
T_6	6.67 a (2.68)	6.67 a (2.68)	7.00 a (2.74)	7.67 (2.86)	8.33 (2.97)	9.67 (3.19)	1.67 c (1.47)	5.00 b (2.35)	1.67 c (1.47)	23.68 (4.92)	33.33 (5.82)	39.71 (6.34)
T_7	1.33 b (1.35)	2.00 b (1.58)	2.33 b (1.68)	11.67 (3.49)	12.67 (3.63)	13.00 (3.67)	2.67 bc (1.78)	9.33 a (3.14)	3.33 abc (1.96)	21.67 (4.71)	32.33 (5.73)	33.66 (5.84)
T_8	3.67 ab (2.04)	4.33 ab (2.20)	6.67 ab (2.68)	7.00 (2.74)	8.33 (2.97)	9.67 (3.19)	5.67 ab (2.48)	1.33 d (1.35)	5.67 a (2.48)	23.33 (4.88)	25.66 (5.12)	41.01 (6.44)
T_9	2.00 ab (1.58)	3.67 ab (2.04)	4.33 ab (2.20)	5.67 (2.48)	6.33 (2.61)	7.00 (2.74)	5.00 abc (2.35)	4.33 bc (2.20)	1.00 c (1.22)	18.00 (4.30)	21.33 (4.67)	24.34 (4.98)
Level of significance	0.01	0.01	0.01	NS	NS	NS	0.01	0.01	0.01	NS	NS	NS

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7= Cloth bag; T_8= Brown paper and T_9= IRRI poly bag; [1] *Aspergillus* spp. (*Aspergillus flavus & A. candidus);* [2] *Fusarium* spp. (*Fusarium moniliforme* & *F. semitectum*); [3] Other fungi (*Curvuluria lunata, Cladosporium cladosporioides, Myothecium* sp., *Rhizoctonia solani* and *Alternaria tenuies*); Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance; NS = Not Significant

Table 19 Seed germination and seed borne fungi recorded in recommended moisture content (9.5%) of seeds by Bangladesh Gazette of O-9897 in different storage containers used for storing seeds and seed management (Treated by Provax-200) practices.

Container		% Germination *Macrophomina phaseolina*			% seed borne fungal pathogens								
					Botryodiplodia theobromae			*Aspergillus* spp.[1]					
		Storing period (in months)			Storing period (in months)			Storing period (in months)			Storing period (in months)		
		4	8	12	4	8	12	4	8	12	4	8	12
T_1	93	85.00a	82.00 a	81.33 a	0.30	1.33	1.33	0.33	1.33	2.00	1.67	2.67	3.67 d
		(9.25)	(9.08)	(9.05)	(0.90)	(1.35)	(1.35)	(0.91)	(1.35)	(1.58)	(1.47)	(1.78)	(2.04)
T_2		81.57ab	81.46 a	81.33 a	0.33	1.00	1.67	0.67	1.67	2.67	2.33	3.33	4.33bcd
		(9.06)	(9.05)	(9.05)	(0.91)	(1.22)	(1.47)	(1.08)	(1.47)	(1.78)	(1.68)	(1.96)	(2.20)
T_3		85.00a	86.00 a	80.00 a	1.00	1.33	2.30	0.33	1.67	3.00	1.67	5.33	6.67abcd
		(9.25)	(9.30)	(8.97)	(1.22)	(1.35)	(1.67)	(0.91)	(1.47)	(1.87)	(1.47)	(2.42)	(2.68)
T_4		75.00b	75.00 a	56.00 b	1.01	1.67	3.02	1.00	2.00	3.67	4.67	6.33	9.67 ab
		(8.69)	(8.69)	(7.52)	(1.23)	(1.47)	(1.89)	(1.22)	(1.58)	(2.04)	(2.27)	(2.61)	(3.19)
T_5		81.00ab	80.00 a	75.00 a	0.67	2.33	2.33	0.67	2.67	3.33	3.00	4.33	8.33abcd
		(9.03)	(8.97)	(8.69)	(1.08)	(1.68)	(1.68)	(1.08)	(1.78)	(1.96)	(1.87)	(2.20)	(2.97)
T_6		79.00ab	8.00 b	5.00 c	0.68	2.00	3.67	0.67	3.00	3.33	1.67	3.33	8.33abcd
		(8.92)	(2.92)	(2.35)	(1.09)	(1.58)	(2.04)	(1.08)	(1.87)	(1.96)	(1.47)	(1.96)	(2.97)
T_7		81.00ab	80.00 a	75.00 a	0.67	1.33	2.00	0.67	1.67	2.67	2.33	3.67	9.00abc
		(9.03)	(8.97)	(8.69)	(1.08)	(1.35)	(1.58)	(1.08)	(1.47)	(1.78)	(1.68)	(2.04)	(3.07)
T_8		85.00a	82.00 a	74.67 a	1.00	2.00	2.67	1.00	3.33	4.00	4.67	4.33	10.33 a
		(9.25)	(9.08)	(8.67)	(1.22)	(1.58)	(1.78)	(1.22)	(1.96)	(2.12)	(2.27)	(2.20)	(3.29)
T_9		78.00b	78.00 a	72.00 a	0.33	1.00	2.00	1.00	1.00	2.33	1.00	3.00	4.33bcd
		(8.86)	(8.86)	(8.51)	(0.91)	(1.22)	(1.58)	(1.22)	(1.22)	(1.68)	(1.22)	(1.87)	(2.20)
Level of significance		0.01	0.01	0.01	NS	NS	0.01	NS	NS	NS	NS	NS	0.01

Cont'd

Container	% seed borne fungal pathogens									Total pathogens		
	Penicillium spp.			*Fusarium* spp. [2]			Other fungi [3]					
	Storing period (in months)			Storing period (in months)			Storing period (in months)			Storing period (in months)		
	4	8	12	4	8	12	4	8	12	4	8	12
T_1	2.00	3.33	4.67 ab	4.33	6.67	7.67	2.01	3.67 bc	3.00 ab	10.67	19.00	22.34
	(1.58)	(1.96)	(2.27)	(2.20)	(2.68)	(2.86)	(1.58)	(2.04)	(1.87)	(3.34)	(4.42)	(4.78)
T_2	2.33	4.00	5.00 ab	5.67	7.33	8.00	2.33	5.00 abc	1.33 b	13.67	22.33	23.00
	(1.68)	(2.12)	(2.35)	(2.48)	(2.80)	(2.92)	(1.68)	(2.35)	(1.35)	(3.76)	(4.78)	(4.85)
T_3	3.67	5.67	6.33 a	6.00	7.00	7.33	3.34	7.00 ab	3.00 ab	16.00	28.00	28.66
	(2.04)	(2.48)	(2.61)	(2.55)	(2.74)	(2.79)	(1.96)	(2.74)	(1.87)	(4.06)	(5.34)	(5.40)
T_4	3.67	5.00	6.33 a	8.67	10.33	11.67	1.67	5.00 abc	1.33 b	20.68	30.33	35.67
	(2.04)	(2.35)	(2.61)	(3.03)	(3.29)	(3.49)	(1.47)	(2.35)	(1.35)	(4.60)	(5.55)	(6.01)
T_5	2.67	3.67	4.00 ab	8.00	8.33	9.67	1.99	2.33 c	2.01 b	17.00	23.67	29.67
	(1.78)	(2.04)	(2.12)	(2.92)	(2.97)	(3.19)	(1.58)	(1.68)	(1.58)	(4.18)	(4.92)	(5.49)
T_6	5.00	6.00	6.33 a	7.33	8.00	9.00	3.66	6.00 abc	6.33 a	19.00	28.33	37.00
	(2.35)	(2.55)	(2.61)	(2.80)	(2.92)	(3.08)	(2.04)	(2.55)	(2.61)	(4.42)	(5.37)	(6.12)
T_7	1.00	1.67	2.00 b	10.00	11.33	12.33	4.66	9.33 a	3.66 ab	19.33	29.00	31.66
	(1.22)	(1.47)	(1.58)	(3.24)	(3.44)	(3.58)	(2.27)	(3.14)	(2.04)	(4.45)	(5.43)	(5.67)
T_8	2.67	3.33	4.33 ab	6.67	7.67	8.33	1.00	4.34 abc	7.00 a	17.01	25.00	36.66
	(1.78)	(1.96)	(2.20)	(2.68)	(2.86)	(2.97)	(1.22)	(2.20)	(2.74)	(4.18)	(5.05)	(6.10)
T_9	1.33	3.00	4.00 ab	4.00	5.67	6.33	3.34	4.00 bc	5.00 ab	11.00	17.67	23.99
	(1.35)	(1.87)	(2.12)	(2.12)	(2.48)	(2.61)	(1.96)	(2.12)	(2.35)	(3.34)	(4.26)	(4.95)
Level of significance	NS	NS	0.01	NS	NS	NS	NS	0.01	0.01	NS	NS	NS

T_1= Tin pot; T_2= Plastic pot; T_3= Poly bag; T_4= Gunny bag; T_5= Gunny bag lined with polythene; T_6= Earthen pot; T_7= Cloth bag; T_8= Brown paper and T_9= IRRI poly bag; [1] *Aspergillus* spp. (*Aspergillus flavus & A. candidus);* [2] *Fusarium* spp. (*Fusarium moniliforme* & *F. semitectum*) ; [3] Other fungi (*Curvuluria lunata, Cladosporium cladosporioides,* Mycelium, *Myothecium* sp., *Rhizoctonia solani* and *Alternaria tenuies*); Figures in parentheses indicate the transformed values; Data in column having common letter(s) do not differ significantly at 1% level of significance ; NS = Not Significant