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EFFECT OF STORAGE CONTAINERS AND LENGTHS OF STORAGE ON THE GERMINATION, MOISTURE CONTENT AND PEST INFESTATION OF WHEAT SEED

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ABSTRACT. A laboratory experiment was conducted at the Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dianjpur-5200, Bangladesh to evaluate the storage containers and duration of seed storage on the germinability and health of wheat seeds. The experiment was carried out in two factors, *viz.* three storage containers naming i) sealed tin container, ii) plastic container, iii) gunny bag, and four storage periods of i) 15 days, ii) 30 days, iii) 45 days, and iv) 60 days. Completely randomized design (CRD) was used in this experiment with eight replications. The results revealed that the germination percentages (GP) of the seeds stored in the gunny bag decreased quickly from 66.1 to 32.8% due to contained with high moisture content in seed. But, slowly decreasing trends of GP from 80.4% to 69.2% was observed in the sealed tin container seeds with lesser moisture content than that of gunny bag and plastic container. The reduction of GP was so higher of 50.38% in the seeds contained in gunny bag than that of only 13.93% in the seeds contained sealed tin container. Wheat seeds stored in sealed tin container, plastic container and gunny bag significantly increased moisture content in ambient condition for 60 DAS. The moisture content of the seeds stored in gunny bag was found to rise remarkably more than other containers. This escalation of seed moisture content was closely related to the surrounding environmental conditions, like temperature and relative humidity where seeds were stored. The rate seed deterioration in gunny bag and plastic container paralleled the level of invasion by storage insect was found. During storage period, insect infected the seeds, and the insect bitten seeds were also found higher in gunny bag and plastic container, but lower in sealed container. Wheat seeds should be stored in air tight sealed container and

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drying should be done after some days of storage (45-60 DAS).

Keywords: wheat; containers; duration; germination; moisture content; biotic factors

INTRODUCTION

Wheat (*Triticum aestivum* L.), belonging to the family Gramineae, is world's most widely cultivated food crop and the second important cereal crop next to rice in Bangladesh. Wheat grain are used to make flour, breads, biscuits, cakes, cookies, pasta, noodles and also for beer, other alcoholic beverages or biofuel (Knott et al., 2009). It provides 21% of the food calories for more than 4.5 billion peoples in 94 countries of the world (Braun *et al.*, 2010). Today, wheat is grown on more than 200 million hectares of the cultivated land in the world, and is the most important agricultural commodity in international trade (FAO, 2010). In Bangladesh, about 13,55,000 tons wheat are produced from 4,89,000 ha of land, which is very low as compared the total requirement of 4.5 million tons (BBS, 2017). To meet up our internal demand we are losing huge amount of currency during the importation of wheat. Therefore, an enormous increase in food production is crucial importance to supply sufficient food for a rapid growing population. The national average yield of wheat is 2.77 t ha^{-1} in Bangladesh (BBS, 2017), which is unfortunately far below from other wheat growing countries of the world, like China, India, USA, Russia. Unavailability of good quality seed and uses of low quality seed is the major constraints of lower yield of wheat.

Now-a-day, food security is a major challenge in the worlds, especially in Bangladesh, and could only be accomplished by increasing the crop productivity. In order to increase wheat productivity, good quality must be used. Huda (2001) reported that only good seed alone increased 5-50% more production as compare to the seed of a poor seed stock. Healthy crop with high yield potential can be obtained only from healthy seed. In order to maintain crop quality, seed quality should be maintained. Wheat is grown during the Rabi season (November to March) and seeds from harvested crops are stored for at least 6-7 months before sowing in the next season. During the storage period, seeds tend to lose their viability due to the effect of biotic and abiotic factors, viz. pathogens, insects, temperature, relative humidity, initial viability, stage of maturity at harvest, seed moisture content, storage gas and the initial moisture content of seed entering (Harrington, 1972). The loss of seed viability becomes faster if the seeds are not dried properly and not stored suitable containers, and not controlled the environmental conditions (Bass, 1973; Delouche *et al.*, 1973). One of the most important factors in seed storage is the quality of seed when it enters storage and particularly the initial moisture content of seeds. According to Justice and Bass (1978), the risk of insect,

fungal and bacterial attack increases when in storage condition the moisture content of seed goes above the critical level (8-9%). Good storage condition can be achieved by storing the seeds in a climatic region where relative humidity exists to a favorable level or by storing the seed in the moisture proof containers (Delouche, 1968; Bass, 1973).

This phenomena indicates that storage containers are the deciding factor for retaining the seed quality while in the storage. In keeping the higher germination, the suitability of air tight metal container over gunny bag was observed by Haque (1982) in rice seed, Islam (2008) in durum wheat seed, Hasan et al. (2017a) in lentil seed, Islam *et al.* (2017) in mungbean seed, Islam *et al.* (2018) in black gram seed.

The reduction in moisture content extends the life of seeds as reported by Barton (1954). Infestation in stores becomes serious when temperatures are varied from 85 to 105^{o}F, and the humidity ranges between 65 to 85% and the moisture content of stored grains remain above 12% (Griffith *et al.*, 1959).

Adequate provisions and facilities for storage are, therefore, important components of seed production program in all climatic regions.

Considering the above facts, the present research work was undertaken to identify the best container for storage of wheat seed and to determine the best storage length for wheat seed.

MATERIALS AND METHODS

Location

The investigation was conducted at the Laboratory-1, Department of Agronomy, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during summer season (April to June, 2008).

Plant material

The material used in the study was wheat seeds of BARI Gom-24 (Prodip) variety, developed by Bangladesh Agricultural Research Institute (BARI) in 2005. The variety has a high tillering ability, bolder grain (TSW 48-55 g), leaf blight and rust diseases tolerant high yielding (4.3-5.1 t ha^{-1}) variety. The wheat seed was collected from the Institute of Research and Training (IRT), HSTU, Dinajpur, Bangladesh.

Experimental treatments

The experiment was carried out in two factors, *viz.* three storage containers naming i) sealed tin container, ii) plastic container, iii) gunny bag, and four storage periods of i) 15 days, ii) 30 days, iii) 45 days, and iv) 60 days.

Experimental design

The experiment was laid out in Completely Randomized Design (CRD) with sixteen replications.

Storage condition

Seeds were stored in room condition in different containers.

The prevailing meteorological information during the study regarding temperature and relative humidity inside the room and outside the room was recorded in 10.00 am and 12.30 pm, 16.00 pm a day and presented in *Fig. 1.*

Testing of seeds

During the storage period, the seed samples were taken every 15 days from each container for determination of moisture content (wet basis), germination percentage, germination rate, and presence of insect and diseases.

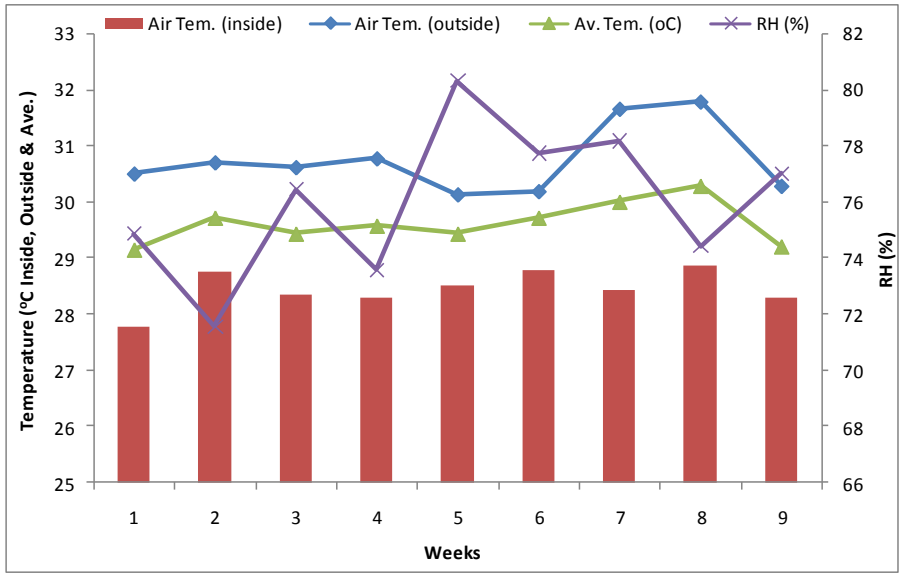

Figure 1 - Weekly temperature (°C inside, outside and average) and relative humidity (%) during experimentation

Seed sampling from containers

Sampling was carried out at 15 day intervals up to 60 days, *i.e.* four times. At each sampling, data were taken randomly from each of the storage container.

Germination test

Germination test was done in Petri dishes at the Agronomy Laboratory-1, HSTU, Dinajpur. Blotter paper was used as germination media, which was collected and dipping with some moisture. Required moisture level was maintained in the germination media. Germination test for three storage containers was carried out taking 400 seeds at every sampling time from initial stage, *i.e.* before storing of seeds to 60 days after storage (DAS) at every 15 days intervals.

During germination test normal seedlings, abnormal seedlings, fresh seeds, hard seeds and dead seeds were carefully identified from each replicate of 25 seeds and then counted and recorded at the date of final count (10th day of setting for germination). A seed was considered to be germinated as seed coat ruptured, plumule and radicle came up to 5 mm in length. The normal seedling was identified by following the Interna-tional Seed Testing Association (ISTA) Seedling Evaluation Guide (ISTA, 2008). The germination percentage was calculated using the following formula (ISTA, 1985):

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Number of seeds tested}} \text{ X } 100$$

The replicate results were averaged to give the mean percentage of normal germination.

Moisture content test

Moisture content was determined by using high constant temperature oven method following International Rules for Seed Testing (Ansari *et al.*, 1996) at the Agronomy Laboratory of HSTU. Seed samples of 3 g from each the each container were taken and weighed. After weighing, seeds were poured in a small container with cover and kept in an oven maintained at a temperature of 130-133oC for a period of 2 hrs.

$$MC\ (\%) = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

M_1 = Wt. of container + cover

M_2 = Wt. of container + cover + wheat seed before drying

M3 = Wt. of container + cover + wheat seed after drying

Similar procedure was performed for every 15 day from beginning of storage.

Looking for organisms in the seed

Fungi

Fungi grown from the seed was also recorded at the time of seedling evaluation. The fungi were detected by observing their growth character on the seed in blotter under Compound microscope at the laboratory of Plant Pathology Department, HSTU. Identification was confirmed after preparing slides and examining under compound microscope by using key.

Insects

In every week, presence and number of insects were also observed in the stored wheat seed. Numbers of insects were counted from 1 kg of seeds. The insects were identified with the help of Entomology Department, HSTU.

Statistical analysis

The recorded and calculated data were analyzed statistically using a MSTAT-C program in accordance with the principles of Completely Randomized Design (Gomez and Gomez, 1984). Duncan's Multiple Range test (DMRT) was performed to compare variations among treatments.

RESULTS AND DISCUSSION

Germination percentages of wheat seeds

The germination percentage (GP) of wheat seeds was found decreased from the initial GP with the advancement of storage times *(Fig. 2)*. The decrease of the GP was closely related with the high moisture contents of the seeds. The seeds stored in gunny bag lost their germination capacity rapidly due to high moisture content, than the seeds contained tin sealed container with lower moisture content during storage period. Agrawal (2003) reported that the deterioration of seed quality through reduced germination percentages increased with increasing moisture content of the seed.

The rapid reduction of GP of seeds in this study might be due to absorption of moisture from the air over the elevated storage periods, which perhaps encouraged the insects

and diseases infestation. Kaur *et al.* (1990) observed the pathogenic inoculum in the soybean seed due to increased moisture content for long time storage, which ultimately reduced seed germination. The initial GP was recorded 81% before storage of seeds in different types of containers with lower moisture content (12%). After passing of storage periods from 0 to 60 DAS, the values of GP reduced and the maximum values of GP of 80.4, 78.3 and 70.1% were recorded at 15 DAS, while the minimum values of 69.2, 59.3 and 32.8% were at 60 DAS in tin pot, plastic container and gunny bag, respectively. The rate of reduction, due to storage periods from 15 to 60 DAS, were 13.27, 23.29 and 50.38% in tin pot, plastic containers and gunny bag, respectively. The germination capacity of seeds contained in gunny bag severely lost (50.38%), as compared to tin pot and plastic container at all levels of studied storage periods. The results in our experiment are in agreement with the findings of Umarani and Selvaraj (1996) in soybean, Islam (2008) in durum wheat, Hasan *et al.* (2017a) in lentil, Islam *et al.* (2017) in mungbean, Islam *et al.* (2018) in blackgram, who reported that the GP gradually decreased with increasing storage periods due to absorption moisture from the surrounding environment, which outstandingly depend on the nature of the storage containers. It has been well established in earlier that seeds absorbed moisture from the surrounding environment due to its hygroscopic nature, which ultimately reduced germination capacity of seeds (James, 1967; Harrington, 1972; Delouche *et al.*, 1973; Agrawal, 2003). Copeland (1967) reported that longer storage periods of seeds significantly declined the seedling vigor.

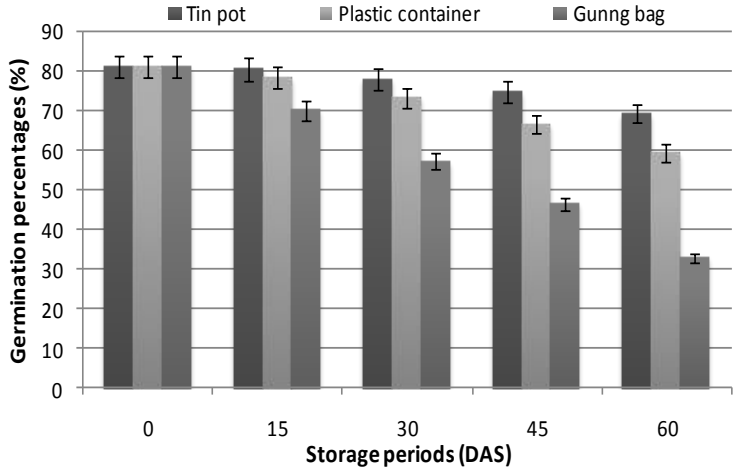

Figure 2 - Germination percentage of wheat seed as influenced by storage containers during storage periods up to 60 DAS

Moisture content of seed

Moisture content (MC) of wheat seeds was determined at different storage periods and it was observed that the MC increased progressively with the expansion of storage periods in the three storage containers (*Fig. 3*). The initial MC of seeds before storage was only 12.0%, but after 15 DAS, the MC increased the values in the sealed container, plastic container and gunny bag were 12.4, 13.1 and 14.6%, respectively. The MC remained fairly constant in the seeds contained in tin container during storage. The seeds of gunny bag came to the contact with air, consequently increased their MC from the initial level. The MC of the seeds of gunny bag was found to increase from 12.0% to 22.8% within 60 DAS of storage, whereas the MC of seeds stored in sealed container and plastic container were increased from 12.0% to 14.6% and 12.0% to 16.7% throughout same storage periods, respectively. The moisture of wheat seed increased from 11.20% to 17.25% in bag storage was reported by Sawant *et al.* (2012).

As sealed container and plastic container was open for counting moisture percentage, then the seeds of these containers could come to the contact with ambient room air resulting significant change of their moisture content.

Our results support those of Harrington (1960, 1963) and Ansari *et al.* (1996), who reported that moisture absorption by the seeds increased with the increasing storage periods. Seed is highly hygroscopic living material and it absorbs moisture from air when the relative humidity is higher than the moisture content in the seed. For this reason, seeds absorbed moisture from the ambient air and go ahead to equilibrium with relative humidity, consequently the MC increased.

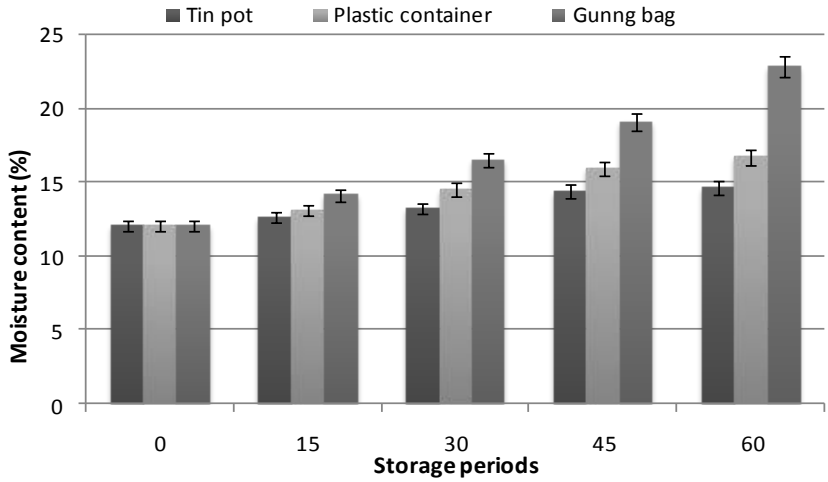

Figure 3 - Effect of storage containers on the moisture content of wheat seed during storage periods up to 60 DAS

These findings are in corroborated with the results of Kaur *et al.* (1990) and Hasan *et al.* (2017b), who stated that seeds absorbed moisture from atmosphere over time and increased the infestation of insects and diseases resulting decreased GP, as well as shoot and root length. Seed deterioration is natural phenomena and life span of seeds decrease with the passing of time. The longevity of seeds in storage is mainly determined by seed moisture content (Harrington, 1972; Roberts, 1973; Ellis and Roberts, 1980). Similar results were also reported by Islam (2008), who found that the durum wheat seeds, stored in the gunny bags, absorb moisture from the surrounding environment and increased the moisture content considerably within 60 days after storage, as compared to tin container and polythene bag. It is generally accepted that climatic condition leads to physical changes in stored seeds through the movement of moisture, which leads to seed deterioration.

Biotic factors

Fungi

The presence of Black point of wheat is a seed borne disease cause by *Bipolaris sorokiniana* fungi was found, but it does not hamper the germination of wheat seeds.

Insects

During storage period, every week presence and number of insects was observed in the containers used in this experiment. With the increase of moisture content of seed, the number of insects was found to increase. After one week of storing, the adult lesser grain borer was found only with the seeds of gunny bag and plastic container. In sealed container, this adult was found after 30 days of storing because moisture content was lower than that of gunny bag and plastic container *(Fig. 4)*.

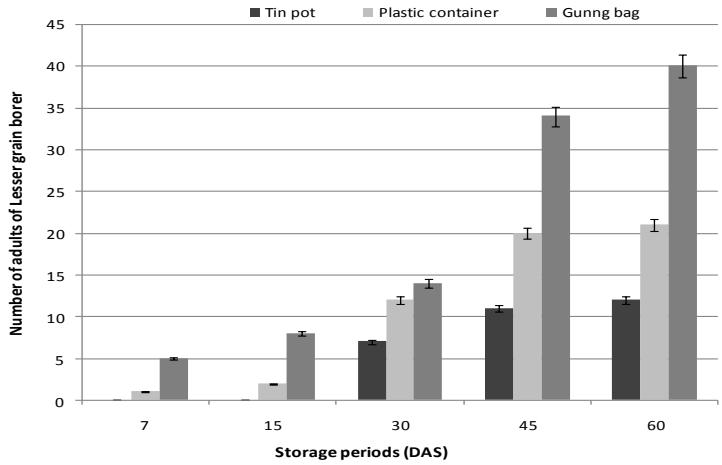

Figure 4 - Effect of storage periods on the number adults of lesser grain borer per kg of wheat seed in different containers

The population of this insect was found increasing in all containers, but number of adult of this lesser grain borer was higher in gunny bag (40) with high moisture content of seed, followed by plastic container and sealed container (21 and 12, respectively). The adult of insect is 1.0 to 1.5 mm long, blackish color. The most important physical factor in grain storage is moisture content because it affects the growth of mould, with which stored grains is infected (Sawant *et al.,* 2012). Insect infestation is the most important factor that affected the germination of wheat seed (Sawant *et al.*, 2012). The life-span of seed is mainly determined by seed moisture content and the seed longevity in storage decreased progressively with increasing moisture content in seeds, which invites storage pests and deteriorates seed (Harrington, 1972; Roberts, 1973; Ellis and Roberts, 1980). The risk of insect, fungal and bacterial attack increases when the moisture content of seed in storage condition goes above the critical level of 8-9% (Justice and Bass, 1978).

CONCLUSION

Wheat seeds stored in sealed tin container, plastic container and gunny bag significantly decreased GP, but increased MC in ambient condition at 60 DAS. The GP decreased rapidly from 66.1 to 32.8% in the seeds of gunny bag, but it decreased slowly from 80.4 to 69.2% in the seeds of sealed tin container. The MC of the seeds stored in gunny bag was found to increase remarkably than the other containers. The increase of MC was closely related to the temperature and relative humidity in storage room. Insects infected the wheat seeds during storage periods and the intensities of infestation were closely related with the MC of the seeds. The rate of seed deterioration in gunny bag was also equivalent to the level of attack of storage insects. Insect bitten seeds were also found higher in gunny bag, but lower in sealed container. Wheat seeds should be stored in air tight container and maintained their MC at the standard level.

REFERENCES

Agrawal, R.L. (2003). Seed technology. *Oxford and IBH Pub. Co. Ltd.*, New Delhi, India, pp. 395-397.

Ansari, T.H., Suratuzzaman, M. & Islam, M.S. (1996). Status of health and germination of seed stored in different containers at farmers level in Mymensingh. *Progress Agric.,* 7(2): 109-111.

Bass, L.N. (1973). Controlled atmosphere and seed storage. *Seed Sci.Technol.*, 1: 463-472.

Barton, L.V. (1954). Storage and packaging of seeds of Douglas-fir and western hemlock. *Contr. Boyce Thompson Inst.*, 18: 25-37.

BBS (2017). Statistical yearbook of Bangladesh. Bangladesh Bur. Stat., Min. Plann., Govt. People's Repub. Bangladesh, Dhaka, p. 101.

Braun, H.J., Atlin, G. & Payne, T. (2010). Multi-location testing as a tool to identify plant response to global climate change. In: Reynolds M.P.(ed.) Climate change and crop production. Wallingford, UK: *CABI Publishers*, pp. 115-113.

Copeland, L.O. (1967). Principles of seed science and technology. *Burgess Pub. Com.*, Minneapolis, Minnesota, USA. pp. 164-165.

Delouche, J.C. (1968). Precepts for storage fungi. *Proceedings of Mississippi Seedmen's Short Course*, pp. 85-119.

Delouche, J.C., Matthes, R.K. Dougherty, G.M. & Boyd, A.H. (1973). Storage of seed in sub-tropical and tropical regions. *Seed Sci.Technol.*, 1: 671-700.

Ellis, R.H. & Roberts, E.H. (1980). Improved equations for the prediction of seed longevity. *Ann.Bot.,*45:13-30, DOI: 10.1093/ oxfordjournals.aob.a085797

FAO (2010). Food and Agriculture Organization of the United Nations (FAO). *FAO statistical database*; available: http://faostat.fao.org

Gomez, K.A. & Gomez, A.A. (1984). Statistical procedures for agricultural research, 2nd Ed. John Wiley and Sons, Inc. New York, USA.

Griffiths, D.A., Hodson, A.C. & Christensen, C.M. (1959). Grain storage fungi associated with mites. J. Econ. *Entomol*., 52: 514-518, DOI: 10.1093/jee/52.3.514

Haque, M.A. (1982). Studies on viability and vigor of BR8 and BR9 rice seeds. Workshop on modern rice cultivation in Bangladesh held at BRRI, Gazipur, Bangladesh.

Harrington, J.F. (1960). Drying, storing and packing seed to maintain germination and vigor. Seed drying and storage. Seed Tech. Lab. State College, Mississippi, USA,13: 120-124.

Harrington, J.F. (1963). Thumb rules of drying seeds. *Crops Soils*, 13: 16-17.

Harrington, J.F. (1972). Seed storage and longevity. Seed Biology. In: Kozloski, T.T. (ed.). *Academic Press*, New York, USA, pp. 145-245.

Hasan, K., EL Sabagh, A., Barutçula, C. & Islam, M.S. (2017a). Seed quality of lentil (*Lens culinaris* L.) as affected by different containers and storage periods. *Sci.J. Crop Sci.*, (6(1): 146-152.

Hasan, K., Sikdar, S.I., EL Sabagh, A. & Islam, M.S. (2017b). Effect of moisture levels and storage periods on the seed quality of lentil (*Lens culinaris* L.). *Agr.Adv.*, 6(1): 383-390.

Huda, M.N. (2001). Why quality seed? Reality & vision *Bangladesh context. Bangladesh German Seed Development Project* (B-GSDP), 158-191.

Islam, M.S. (2008). Effect of abiotic and biotic factors on the quality of durum wheat (*Triticum turgidum* L. var. *durum*) seed. A PGT Thesis on Seed Technology, Institute of Research and Training (IRT), Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh. p. 23.

Islam, M.S., Hasan, K., Shaddam, O. & EL Sabagh, A. (2017). Effect of storage periods and containers on the germinablity of mungbean seeds. *Agril.Adv*., 6(7): 418-424, DOI: 10.14196/aa.v6i7.2468

Islam, M.S., Hasan, M.K., Hossain, A.K.M.M., Hakim, M.A., Islam, M.S. & EL Sabagh A. (2018). Germination percentages of black gram (*Vigna mungo* L.) seed is influenced by different storage containers and storage periods. *Cercet. Agron. Moldova*, Vol. LI, 2: 35-42, DOI: 10.2478/cerce-2018-0014

ISTA (International Seed Testing Association) (1985). International rules for seed testing. *Seed Sci. Technol.*, 13(2): 309-343.

ISTA (2008). International rules for seed testing, Ed. 2008, International Seed Testing Association, Bassersdorf, CH-Switzerland.

James, E. (1967). Preservation of seed stocks. *Adv. Agron*., 19, 87-106, DOI: 10.1016/S0065-2113 (08 60733-6

Justice, O.L. & Bass, L.N. (1978). Principle and practices of seed storage. *Agricultural Handbook*, No. 506, Washington, D.C.

Kaur, J., Randhawa, H.S., Sharma, H.L., 1990. Influence of moisture and container on viability of paddy seed during storage under ambient conditions of Punjab. *Ann. Biol.*, Ludhiana, India, 6(2): 129-134.

Knott, C.A., Van Sanford, D.A. & Souza, E.J. (2009). Genetic variation and the effectiveness of early-generation selection for soft winter wheat quality and gluten strength. *Crop Sci.,*49: 113-119, DOI:10.2135/cropsci2008. 05.0290

Roberts, E.H. (1973). Predicting the storage life of seeds. *Seed Sci.Technol.*,1: 499-514.

Sawant, A.A., Patil, S.C. Kalse, S.B. & Thakor, N.J. (2012). Effect of temperature, relative humidity and moisture content on germination percentage of wheat stored in different storage structures. *Agric.Eng.Int.: CIGR Journal*, 14(2): 1-14.

Umarani, R. & Selvaraj, J.A. (1996). Effect of *Trianthema portulacastrum* on soybean. *Allelopathy J.*, 3: 261-266.