Sci., Tech. and Dev., 31 (1): 10-18, 2012

EFFECT OF DIFFERENT PACKING MATERIALS AND STORAGE CONDITIONS ON THE VIABILITY OF WHEAT SEED (TD-1 VARIETY)

SHAKEEL H. CHATTHA[1], LIAQUAT A. JAMALI[1], KHALIL A. IBUPOTO[2] AND H.R. MANGIO[1]

[1]*Faculty of Agricultural Engineering, Sindh Agriculture University, Tandojam, Pakistan.*
[2]*Pakistan Science Foundation, Islamabad, Pakistan.*

Abstract

The present research was carried out to investigate the effect of different packing materials (metal bin, earthen bin, plastic bag, cloth bag and gunny bag) and grain moisture content at packing (10% and 16%) on viability of wheat seed for ten months of storage in the laboratory of Farm Structures, Sindh Agriculture University, Tandojam, Pakistan, during the year 2010-11. Temperature, moisture content and germination capacity were recorded throughout the storage period. When the gunny, cloth and plastic bags were used as the packing material, the moisture content and germination capacity were decreased and the seed temperature was increased with the increase of storage period despite the moisture content (10% and 16%) of wheat seed at packing. When seed was packed in metal and earthen bins the reduction in viability of seed with time of storage varied with the moisture content of seed at packing. Wheat seed stored in metal and earthen bins with initial moisture content of 10% showed satisfactory temperature, moisture content and germination capacity throughout the storage period than those packed with 16% moisture. Wheat seed stored in gunny, cloth and plastic bags were in good terms with temperature, moisture content and germination capacity in comparison with those in metal and earthen bins.

Keywords: Packing materials, Germination capacity, Moisture content.

Introduction

Pakistan is the 6th most populous country in the world with a population of 160.9 million in mid 2008 at the present growth rate of 1.8% (GOP, 2008). Wheat, the most important crop and being the staple diet, is cultivated on the 8.459 million hectares with a production of 22.5 million tons. It contributes 13.7% to the value added in agriculture and 3.0% to GDP (GOP, 2008). About 9.3 to 42% of attainable wheat production is lost as a result of attack of various pests, pathogens and weeds in spite of control measures (Dhaliwal and Arora, 2001).

Grain quality is an important parameter for marketing and processing, and can affect the commodity value. These factors can be physical, such as temperature and humidity; chemical, such as oxygen supply; and biological, such as bacteria, fungal, insects and rodents (Brooker et al., 1992). Safe storage preserves the qualitative and quantitative aspects of the grains by providing unfavorable conditions for the development of insects, rodents and microorganisms (Bailey, 1974). The storage of grains in the natural environment of tropical areas poses great problems due to the temperature conditions and relative humidity, when compared to the areas having a cold or temperate climate (Abba and Lovato, 1999). The parameters of temperature and relative humidity during storage are decisive in the process of loss of seed viability and composition (Lacerda et al., 2003).

Grain storage occupies a vital place in the economies of developed and developing countries (Ellis et al., 1992). In Pakistan, improper traditional and recent methods of grain storage have caused lots of losses in terms of physical and chemical qualities. Proper grain storage in

***Author for correspondence E-mail: k_iibupoto@yahoo.com**

developing countries plays an important role in the maintenance of their economy. Most of the researchers noted reduction in germination percentage from 5.2-10.7, if wheat seed is sown immediately after harvesting. Singh et al. (2000) observed 5-17% reduction in seed germination when grain was stored approximately for five months. They further noted that, when seed stored in concrete bins, the seed germination was higher against metal bins. However, Sinha and Sharma (2004) observed maximum changes in wheat quality when stored in jute bags compared to metal bins.

The fluctuations in temperature, dampness during storage and its longevity results in significant nutrient losses (Shah et al., 2002). Prolonged storage period with high seed moisture percentage also causes reduction in germination, seedling vigor, accelerate seed aging, increases germination time, electrical conductivity, insect infestation and finally loss in seed weight (Mersal et al., 2006).

Keeping in view these facts, this study was carried out to investigate the changes of temperature, moisture content and germination capacity during storage of wheat grain.

Materials and Methods

The present study was carried out to investigate the effect of different packing materials and conditions on the viability of wheat seed. The experiment was conducted in the laboratory of Farm Structures, Sindh Agriculture University, Tandojam, Pakistan, during 2010-11. Moisture content of seed samples was adjusted to the required level (10% and 16%) either by spraying water to seed samples or by sun drying. After obtaining the required seed moisture content, grain of wheat were packed in five selected packing materials (metal bin, earthen bin, plastic bag, cloth bag and gunny bag) and were placed on raised platforms inside a ventilated room. Each pack contained 10 kilogram of wheat. Sampling was done by inserting a sampling instrument through a hole at the center of each packing material. These samples were used to determine the seed moisture content and germination capacity. The stored grain was monitored at an interval of 15 days for a storage period of 10 months. All measurements were recorded at 1:00 pm.

The ambient temperature and relative humidity were also recorded during the storage period. Dry and wet bulb thermometers (psychrometer) were used for relative humidity determination.

In order to monitor the temperature of the grain, thermometer was inserted at the center position in each of the packing material.

The seed moisture content on wet basis (w.b) was determined according to the method of Association of Official Agricultural Chemist (1960). Fresh seed sample was placed in a dish and dish was weighed on weighing machine and was recorded. Then dish was kept in an oven at 105 °C for 24 hours and weight was recorded. The moisture percentage was calculated according to the following formula:

$$\text{Moisture content (w.b) \%age} = \frac{\text{Weight of fresh sample} - \text{weight of dry sample}}{\text{Weight of fresh sample}} \times 100$$

For measurement of germination capacity, a 100 randomly selected grain were placed on Petri dish lined with filter paper and placed into a germination chamber for 3 days maintained at a constant temperature of 25 °C. The filter paper was moistened every day with distill water to facilitate germination. The number of germinated seeds after 3 days was recorded as the germination percentage.

Packing Materials

1. Earthen bin, (T_1)
2. Metal bin, (T_2)
3. Plastic bags, (T_3)
4. Cloth bags, (T_4)
5. Gunny bags (made from jute fibers), (T_5)

Moisture %

a. ≤ 12 % (10%)
b. > 12 % (16%)

Experimental Treatments

Earthen bin at moisture a, (T_1a)
Earthen bin at moisture b, (T_1b)
Metal bin at moisture a, (T_2a)
Metal bin at moisture b, (T_2b)
Plastic bags at moisture a, (T_3a)
Plastic bags at moisture b, (T_3b)

Cloth bags at moisture a, (T_4a)
Cloth bags at moisture b, (T_4b)
Gunny bags at moisture a, (T_5a)
Gunny bags at moisture b, (T_5b)

Replication = 3

Name of design = Completely Randomized Design (CRD) Factorial Experiment

Variety = Wheat seeds of variety TD-1 was used for the study

Statistical Analysis

The statistical analysis was performed using the Statistix 8; Analytical software. The data were subjected to factorial analysis of variance (ANOVA) to determine the significance of individual factors and their interactions.

Results and Discussions

The ambient temperature and the relative humidity in the storeroom for the storage period starting from June 1, 2010 to March 15, 2011 are presented in Figure 1. The temperature and moisture content of the stored grain in the packing materials varied with time because of changing weather conditions. The ambient temperature and relative humidity decreased gradually throughout the storage period. The temperatures remained over 30 °C for more than five months in the summer and then gradually decreased. The average relative humidity remained around 49% throughout the storage period.

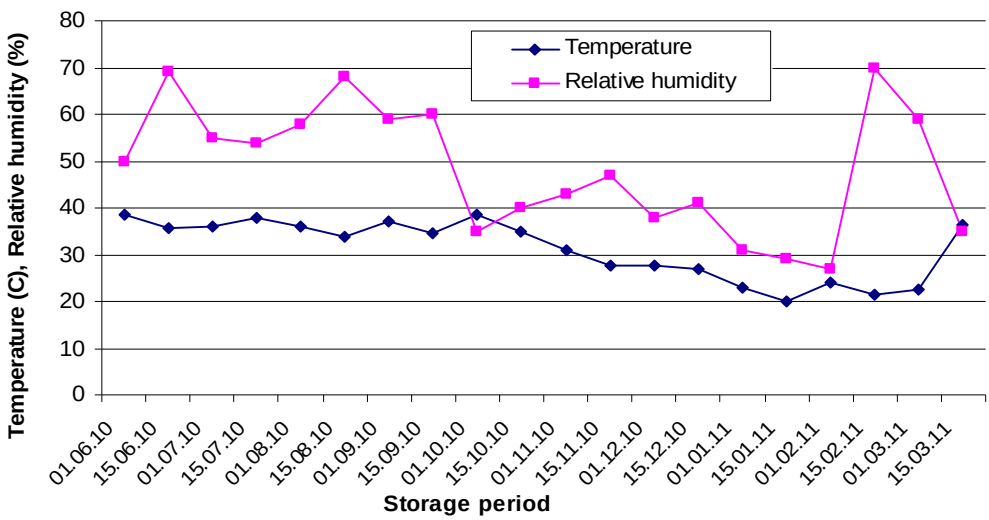

Figure 1. Ambient temperature and relative humidity in the storeroom recorded at 1pm during storage

Grain Temperature

The data collected on the temperature of wheat grain stored in different types of packing materials are presented in Figures 2 & 3 and Table 1. The results indicated that the maximum grain temperature 31.68 °C was recorded from grain stored in metal bin with 16% moisture. Whereas, the lowest grain temperature 31.16 °C was from grain packed in cloth bag with 10% moisture content. Analysis of variance indicated significant ($P < 0.05$) differences in grain temperature affected by storage period, packing materials and initial moisture contents (10 & 16%). The interaction effects of packing and moisture was non significant for grain temperature. There was also no significant difference in temperature changes between earthen and metal bins and between gunny bag and plastic or cloth bags (Table 1). The results indicated that the grain temperature in all the packing materials followed the pattern of the average ambient temperature. The grain temperatures of metal and earthen bins were little higher than that in the plastic, cloth and gunny bags. This may be due to high moisture content, higher rate of respiration of grain and no air

movement through the bins. Maximum fluctuation of temperatures was observed in plastic, cloth and gunny bags because of comparatively free air movement through these bags. However, there was a continuous persistence of high temperature both in metal and earthen bins. Our findings are similar to that of Basunia et al. (1997) who reported that the minimum fluctuation of temperature between the layers and the highest temperature was observed in metal bin. Similarly, Kaddus and Douglass (1992) reported that the temperature of the wheat grains inside the structures increased slowly during the experiment. Seed lost their viability with the increase of temperature because of almost no air movement through the metal and earthen bins.

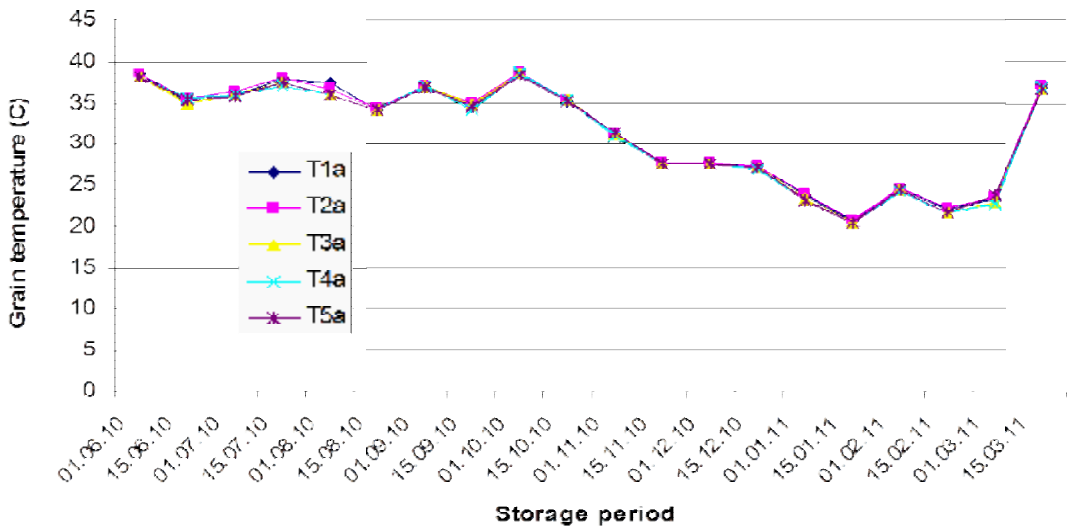

Figure 2. Mean grain temperature (°C) during storage period for grain with initial moisture content (10%).

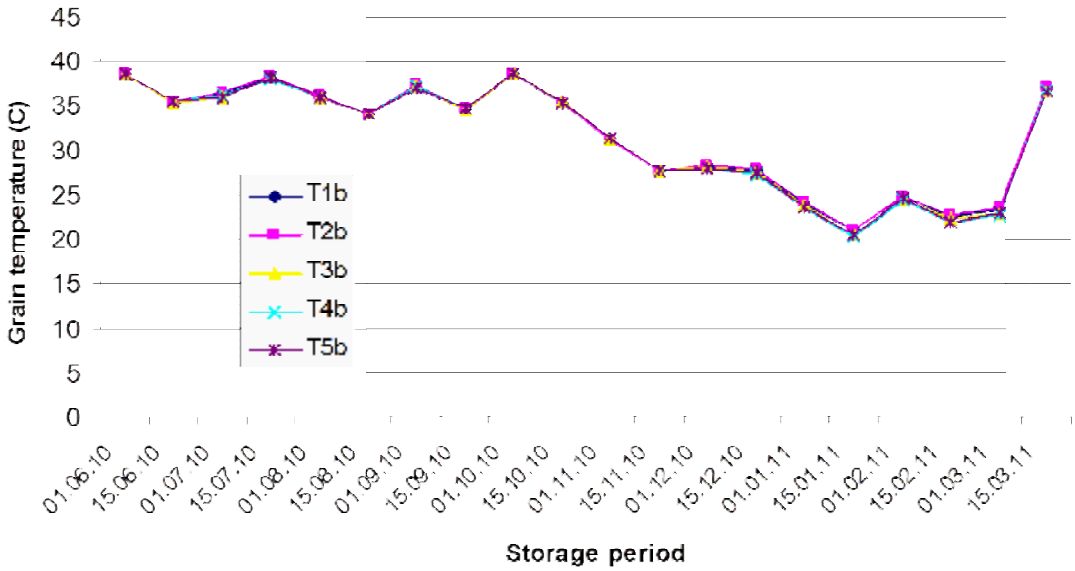

Figure 3. Mean grain temperature (°C) during storage period for grain with initial moisture content (16%)

Table-1. Effect of initial moisture and packing materials on mean grain temperature

Moisture	Packing Materials					Mean
	Earthen bin	Metal bin	Plastic bag	Cloth bag	Gunny bag	
a. (10%)	31.42	31.57	31.25	31.16	31.24	31.32b
b. (16%)	31.55	31.68	31.42	31.36	31.38	31.48a
Mean	31.48a	31.62a	31.33b	31.26b	31.31bc	

Factor	F-value	P-value	LSD at 5%
Packing	34.36	*	0.07
Moisture	44.40	*	0.04
Packing*Moisture	0.57	NS	---

* = Significant at 5% probability level, NS = Non-Significant

Moisture Content

Data obtained on moisture content during storage of wheat grain in different types of packing materials are presented in Figures 4 & 5 and Table 2. The results indicated that the maximum moisture content 13.815% was recorded from grain stored in metal bin with 16% moisture. Whereas, the lowest moisture content 9.29% was from grain packed in cloth bag with 10% moisture content. The grains had two moisture contents; 10% and 16% before storage. Moisture content gradually decreased in all five types of packing materials throughout the storage period. This is confirm with the results reported by Pessu et al. (2005) at the end of storage, there was a significant decrease in moisture contents in all the containers compared with the moisture contents before storage. Decreases were minimum in grain stored in the metal and earthen bins. Changes in moisture content in these bags were mainly due to de-sorption of moisture to the ambient air. Moisture changes in metal and earthen bins were mainly due to moisture migration within the bins. Analysis of variance indicated significant ($P < 0.05$) differences in grain moisture content affected by storage period, packing materials and initial moisture contents (10 &16%). The interaction effect of packing moisture was also found significant. There was non-significant ($P < 0.05$) difference in moisture content changes between earthen and metal bins and among the plastic, cloth and gunny bags (Table 2).

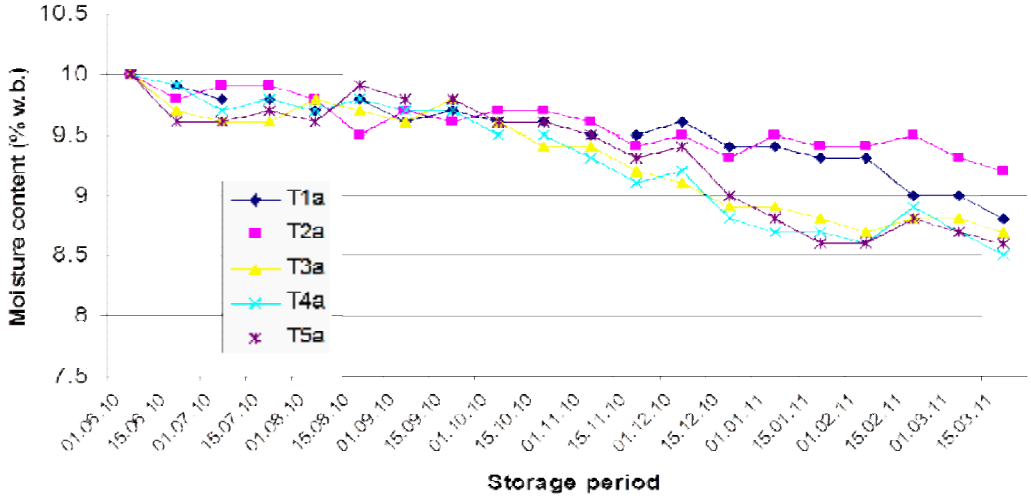

Figure 4. Grain moisture content (%) during storage period for grain with initial moisture content (10%)

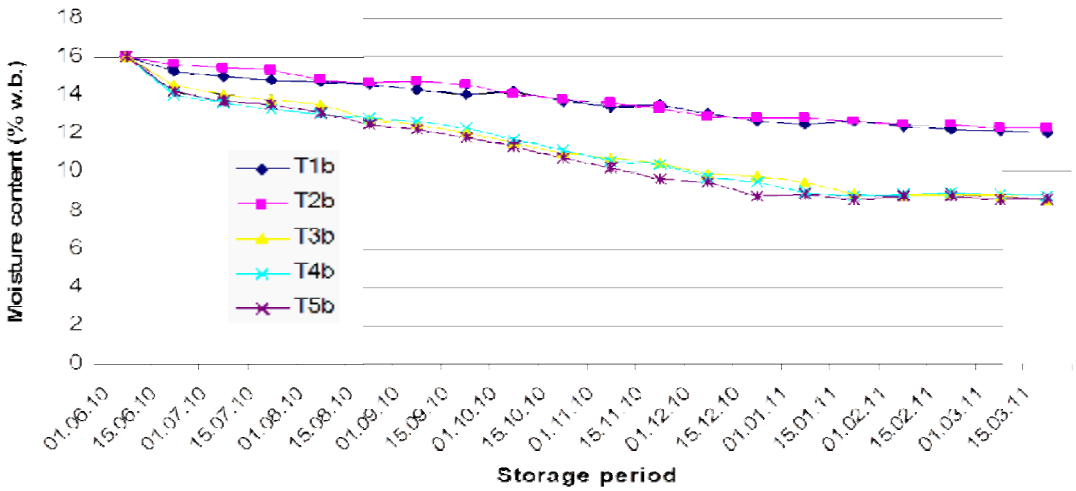

Figure 5. Grain moisture content (%) during storage period for grain with initial moisture content (16%)

Table 2. Effect of initial moisture and packing materials on grain moisture content

Moisture	Packing Materials					Mean
	Earthen bin	Metal bin	Plastic bag	Cloth bag	Gunny bag	
a. (10%)	9.51	9.58	9.30	9.29	9.32	9.40b
b. (16%)	13.64	13.81	11.26	11.16	10.94	12.16a
Mean	11.57a	11.70a	10.28b	10.22b	10.13b	

Factor	F-value	P-value	LSD at 5%
Packing	173.13	*	0.16
Moisture	2696.96	*	0.10
Packing Moisture	119.26	*	0.23

* = Significant at 5% probability level, NS = Non-Significant

Germination Capacity

Data obtained on germination capacity during storage of wheat grain in different types of packing materials are presented in Figures 6 & 7 and Table 3. The results indicated that the maximum germination capacity 85.55% was recorded from grain stored in cloth bag with 10% moisture, whereas, the lowest germination capacity 75.50% was from grain packed in metal bin with 16% moisture content. Analysis of variance indicated significant ($P < 0.05$) differences in germination capacity affected by storage period, packing materials and initial moisture contents (10 &16%). The interaction effect of packing moisture was also found significant for germination capacity. There was non-significant ($P < 0.05$) difference in germination capacity of grain between cloth and gunny bags (Table 3). The results of the present study indicate that germination capacity of wheat grains stored in different types of packing materials decreased with the progress of storage period. When the plastic, cloth and gunny bags were used as the packing materials in storage, grain with 98% viability at packing could retain not less than 80% of its viability for a period of about six months despite the moisture content (10% and 16%) of grain at packing. The main reason of falling germination capacity of the grain in these bags was due to insect infestation. The plastic, cloth and gunny bags gave higher germination capacity than the metal and earthen

bins. This may be due to quick moisture losses and available oxygen in these bags. These results are confirmed by Singh et al. (2000) who reported that 5-17% reduction in seed germination when grain was stored approximately for five months, they further noted, that when seed stored in concrete bins, the seed germination was higher against metal bins.

Germination capacity of grains packed in metal and earthen bins with 16% moisture decline below 80% by four months. However, grain packed with only 10% moisture decline below 80% by five months. Comparatively longer storability recorded for grain packed in metal and earthen bins with 10% moisture level. The main reason of falling germination capacity of the grain was due to almost no ambient air movement through metal and earthen bins. This causes the loss of viability of grain with the increase of ambient temperature.

Grains stored in plastic, cloth and gunny bags at both 10% and 16% moisture levels were superior in storability compared to those stored in metal and earthen bins in maintaining the germination level.

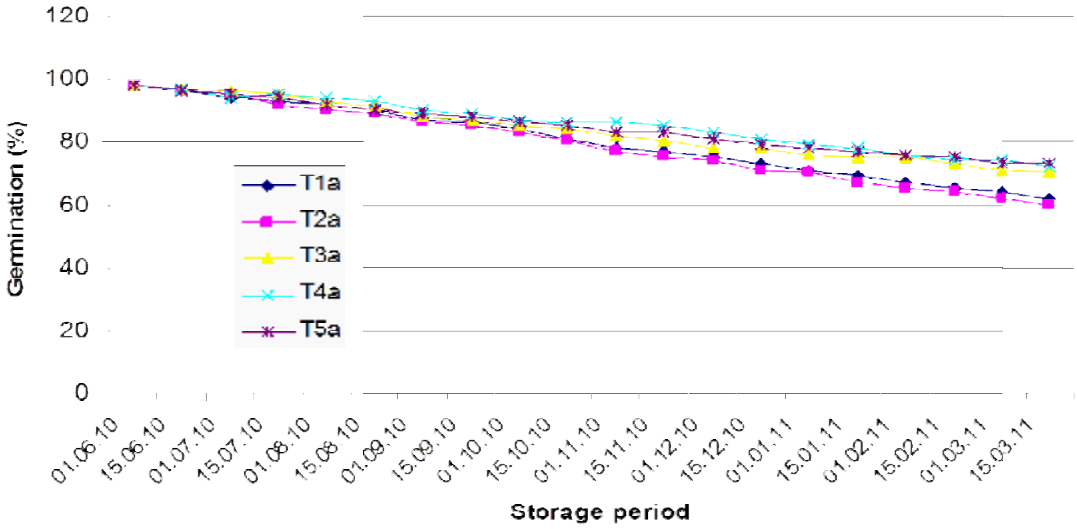

Figure 6. Germination % during storage period for grain with initial moisture content (10%)

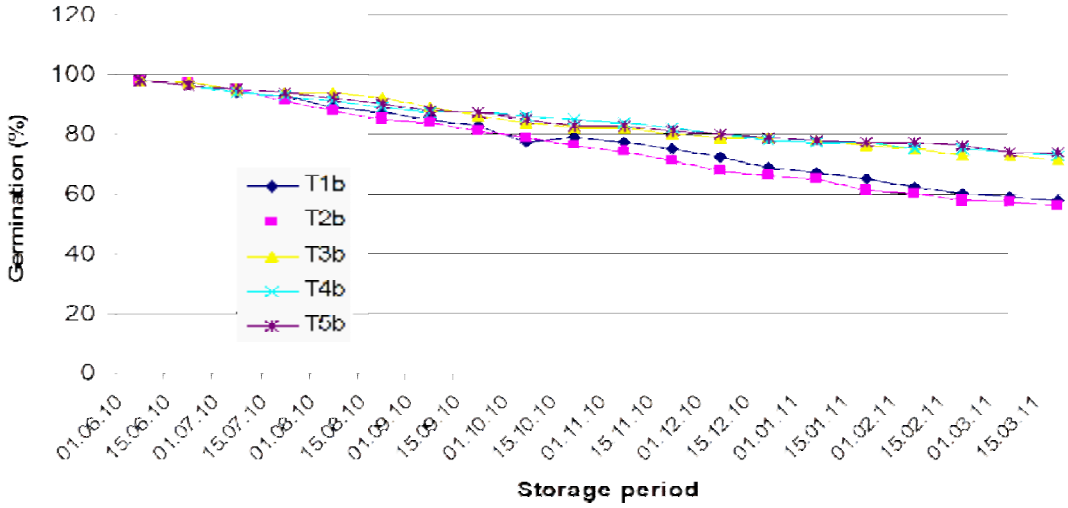

Figure 7. Germination % during storage period for grain with initial moisture content (16%)

Table 3. Effect of initial moisture and packing materials on germination capacity

Moisture	Packing Materials					Mean
	Earthen bin	Metal bin	Plastic bag	Cloth bag	Gunny bag	
a. (10%)	80.10	78.95	83.60	85.55	84.55	82.50a
b. (16%)	77.25	75.50	83.85	84.05	84.35	81.00b
Mean	78.68c	77.23d	83.73b	84.80a	84.45a	

Factor	F-value	P-value	LSD at 5%
Packing	311.64	*	0.57
Moisture	79.36	*	0.36
Packing*Moisture	17.19	*	0.80

* = Significant at 5% probability level, NS = Non-Significant

Conclusions

The grain temperatures of metal and earthen bins were little higher than that in the plastic, cloth and gunny bags. This may be due to high moisture content, higher rate of respiration of grain and no air movement through the bins.

The moisture content in all types of packing materials decreased gradually with the progress of storage period. Comparatively low moisture content was found in gunny, cloth and plastic bags due to de-sorption of moisture to the ambient air.

The germination capacity of the stored grain decreased in all types of packing materials with the progress of storage period. The grain in the metal and earthen bins lost their viability more as compared to plastic, cloth and gunny bags due to low air movement.

Overall results show that gunny bags, cloth bags and plastic bags provided better results for storing seed than earthen and metal bins.

References

Abba, E.J. and A. Lovato. 1999. Effect of seed storage temperature and relative humidity on maize seed viability and vigor. *Seed Sci. and Tech*, 27: 101-114.

Association of Official Agricultural Chemists. 9th Ed. Published by the Association of Official Agricultural Chemists, P.O. Box 540, Benjamin Franklin Station, Washington, D.C. 1960.

Bailey, J.E. 1974. Whole grain storage. In: *Christensen, C.M. (Ed.), storage of cereal grains and their products*. St. Paul. 333- 360.

Basunia, M.A., A. Takemi and H. Yoshio. 1997. A comparative study of the quality of rough rice stored in bamboo, wooden and metal bins. *J. of Agric. Mech in Asia, Africa and Latin America*, 28 (2): 41-47.

Brooker, D., F.W. Bakker-Arkema and C.W. Hall. 1992. *Drying and storage of grains and oilseeds*, Van Nostrand Reinhold, Avi Book, New York.

Dhaliwal, G.S. and R. Arora. 2001. *Integrated Pest Management: Concept and Approaches*, Kalyani Publishers, New Delhi, India, 427.

Ellis, R.H., T.D. Hong and E.H. Roberts .1992. The low-moisture-content limit to the negative logarithmic relation between seed longevity and moisture content in three subspecies of rice. *Ann. of Bot.*, 69: 53-58.

GOP. 2008. Population, Labour Force and Employment, Economic Survey of Pakistan, Government of Pakistan. p.195.

Kaddus, M.A. and M.P. Douglass. 1992. Storage Structures for Grains with Special Reference in Bangladesh. *J. of Agric. Mech. In Asia, Africa and Latin America*, 23 (3): 55-58.

Lacerda, A.D.S., E. Lazarini and W.V.V. Filho. 2003. Storage of desiccated soybean seed and the evolution of physiologic, biochemical and sanitary characteristics. *Braz. J. of Seeds*, 25: 97-105.

Mersal, I.F., A.A. El-Emam and M. Amal. 2006. Effect of storage period, seed moisture content and insecticides treatment on wheat (*Triticum aestivum* L.) seed quality. *Ann. of Agric. Sci.,* Moshtohor. 44 (1): 111-124.

Pessu, P.O., M.N. Adindu and O.C. Umeozor. 2005. Effects of long-term storage on the quality of soybean, *Glycine max* (L.) Merrill, in different containers in Southern Nigeria. *Glob. J. of Pure and Appl. Sci.,* 11 (2): 165-168.

Shah, W.H., Z.U. Rehman, T. Kausar and A. Hussain .2002. Storage of wheat with ears, *Pak. J. of Sci. and Industrial Res.,* 17: 206-209.

Singh, S.C., K. Parsad and R. Kumari. 2000. Studies on losses in wheat in relation to storage structure in the villages of Barh under Patna District of Bihar State. *Uttar Pradesh J. of Zoo.,* 20 (2): 197-198.

Sinha, M.K. and P.D. Sharma. 2004. Storage performance of wheat in different storage structures. *J. of Appl. Bio.,* 14 (2): 83-85.