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EFFECT OF DIFFERENT PACKING MATERIALS AND STORAGE CONDITIONS ON THE QUALITY OF WHEAT GRAIN

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ABSTRACT

The present research was carried out to investigate the effect of packing materials (metal bin, earthen bin, plastic bag, cloth bag and gunny bag) and grain moisture content at packing (10% and 16%) on quality of wheat grain for ten months of storage in the laboratory of Farm Structures, Sindh Agriculture University Tandojam, Pakistan. The quality characters (insect-pest infestation, 1000-grain weight, and protein and starch contents) were determined throughout the storage period and the changes in the quality of stored grain were evaluated in terms of these variables. When the gunny, cloth and plastic bags were used as the packing material, the 1000-grain weight, protein and starch contents were decreased and insect-pest infestation was increased with the increase of storage period despite the moisture content (10 and 16%) of wheat grain at packing. When grain was packed in metal and earthen bins the reduction in quality characters with time of storage varied with the moisture content of grain. Wheat grain stored in metal and earthen bins with initial moisture content of 10% showed satisfactory qualitative characters throughout the storage period than those packed with 16% moisture. Higher the moisture content of grain at packing higher was the rapidity of quality loss and shorter the time of storage of wheat grain in metal and earthen bins. Therefore, it is evident that packing grain with 10% moisture in metal and earthen bins keeps the grain in good quality. Wheat grain, stored in metal and earthen bins, was good in terms of 1000-grain weight, protein, starch and low insect-pest infestation in comparison with those in gunny, cloth and plastic bags.

Keywords: Grain moisture, storage period, packing materials, wheat grains.

INTRODUCTION

Pakistan's geographical position in the world ranks 36th and in terms of population 6th with estimated population of 184.35 million today (CIA, 2013). Wheat is most important cereal crop of the country and is considered as major food crop of Pakistan's population. The food availability can be managed by

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increasing crop productivity, especially of small and medium growers who are in majority and putting all efforts on major wheat growing areas (Mazhar *et al.,* 2007). Wheat is one of the major sources of proteins as staple diet for human beings, contributes 20% food calories of the world and contains 70% carbohydrates, 12% proteins, 2.2% crude fiber, 2% fat, about 1.8% minerals (FAO, 2002). Due to its chemical composition it is the most important human food grain and its status in the total production as a cereal crop after maize the third being rice. The storage losses caused by insect pests have been recorded about 10 to 20% (Khan *et al.*, 2010). The major reasons of these storage losses include lack of sanitary conditions, poor storage structures, inadequate and improper application of contact insecticide and fumigants and lack of trained manpower. The physical and chemical losses of grain in storage are due to infestation affecting the nutritional quality and workability of stored grain (Ahmed *et al.,* 2008).

The unstable conditions in temperature and dampness in grain storage and its longevity results in significant nutrient losses (Shah *et al.,* 2002). The prolonged storage period with high dampness are the causes of low seed viability in germination, seedling vigor, increase in germination time, high insect infestation and finally loss in seed weight (Mersal *et al.,* 2006). It has also been reported that about 9.3 to 42% of attainable wheat production is lost as a result of attack of various pests, pathogens and poor crop management (Dhaliwal and Arora, 2001). In Pakistan, due to conventional methods, grain storage has provided heavy losses in terms of physical and chemical qualities. Technological based grain storage in developing countries plays an important role in the maintenance of their economy. Most of the researchers reported that reduction in seed viability the germination percentage ranged from 5.2-10.7 if wheat seed is sown immediately after harvesting. Singh *et al.* (2000) observed the loss in germination of about 5-17% when grain was stored approximately for five months. The wheat grain must be protected at all stages of handling, from the time of harvest, through storage, transportation and processing. The post harvest loss of wheat grain has been found to be highest during storage, particularly the insects are serious threat to wheat grain (Magan *et al.,* 2003). Safe and technological based seed storage maintains the quality and quantity of seed by providing a desired environment. Pakistan is a country where growers are facing low literacy rate and poor technical knowhow in agriculture. Due to these problems mostly seed handling is poor or based on traditional methods, in addition, there is a shortage of commercial grain storage structures in the region. Keeping in view these facts, this study was carried out to determine the effect of packing materials on the quality of wheat grain.

MATERIALS AND METHODS

Wheat grain samples of TD-1 variety were obtained from Sindh Agriculture University Farms during 2010-11. The selected variety is considered as commercial and high yielding wheat variety in the region. The samples taken were free from infestation and broken grains. At the time of packing the protein and starch of the grain were 12 and 70%, respectively. The moisture content of

grain was adjusted to the required level (10% and 16%) either by spraying water to grain samples or by sun drying. As per design the grains moisture content, the required samples were packed in five selected packing materials (metal bin, earthen bin, plastic bag, gunny bag and cloth bag). The sealed packing boxes were placed on raised platform as per design inside a ventilated room, each pack contained 10 kilogram of wheat grain. The experimental units were arranged in CRD design factorial experiment with three replications. The sampling was done with sampling spears of 12 mm diameter and 45 cm length at the interval of 15 days till 10 months by inserting a seed sampler through a hole at the center of each packing materials. The samples were taken in thrice from each unit. Total 100 composite samples were taken from the experiment. The observations recorded from each sampling unit were: the ambient temperature, relative humidity (measured by dry and wet bulb thermometer Psychrometer) and 1000-grain weight. The protein and starch contents were determined through near Infrared Transmission (NIT) using Inframetic-9200 instrument). A hundred randomly selected grains were checked for insect damage (by counting the damaged grains physically), the moisture content of seed was calculated as per International Seed Testing Association (ISTA) rules (ISTA 2010) by hot air oven method. The moisture percentage was calculated accordingly.

Statistical analysis

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

RESULTS AND DISCUSSION

The mean ambient temperature and the mean relative humidity in the store room for the storage period starting from June 1, 2010 to March 15, 2011 are presented in Fig.1. The ambient temperature and relative humidity (RH %) fluctuated in the store room for full period. The ambient temperature ranged between 20 to 39 ^{0}C and relative humidity ranged between 38 to 70 percent. The data on insect-pest infestation of wheat grain in different types of packing materials are presented in Table 1 and Fig. 2 and 3. The results indicated that the maximum insect-pest infestation of 3.2% was recorded in grains stored in cloth bags with 10% moisture, while the gunny bags with 16% moisture ranked second, which was observed to be 3.0%. Compared to other packing materials, the lowest insect-pest infestation (0.85%) was recorded from grains packed in earthen bin with 10% moisture content. Analysis of variance indicated significant ($p<0.05$) differences in insect pest infestation affected by storage period and packing materials. There was non-significant difference in insect pest infestation affected by initial moisture contents (10 and 16%). The interaction effects of packing x moisture and packing date were also found to be significant ($p<0.05$). There was non-significant ($p<0.05$) difference in insect pest infestation between earthen and metal bins. Non-significant ($p<0.05$) difference of insect pest infestation was also found between gunny bag and plastic or cloth bags (Table 1).

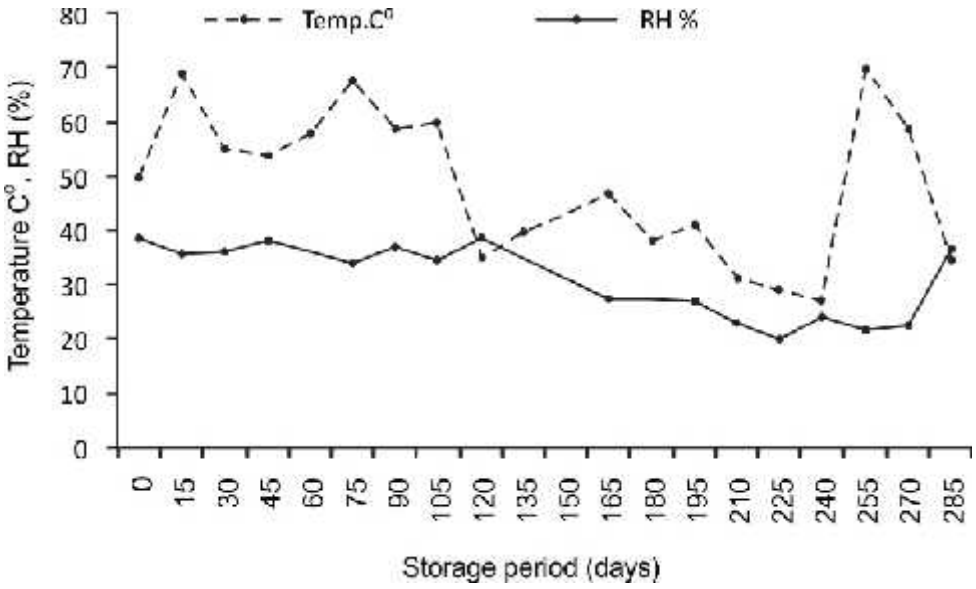

Figure 1. Ambient temperature and relative humidity in the store room recorded at 1pm during storage.

The grain infestation was observed by Angoumois grain moth in all five types of packing materials. The results of the present study indicate that insect pest infestation of wheat grain stored in different types of packing materials increased with the progress of storage period. Upto the first 4 months of storage no insect-pest infestation was observed and up to a period of 7 months no insect-pest infestation was observed in metal and earthen bins. The grain stored in metal and earthen bins showed a lesser degree of infestation than plastic, cloth and gunny bags, because of the porous nature of these bags, the insect gained easy entry and multiplied rapidly. The metal and earthen bins were found to be the best packing materials to prevent insect-pest infestation in wheat grain during storage having 10 and 16% moisture content at packing. These results are confirmed by Arain *et al.* (1995) they reported that the minimum insect infestation of 0.3% was recoded in metal bins at farm level. They further noticed that stored wheat grain at farm level is best protected in metal bins, placed in an open environment under the sun light without undertaking any insecticidal treatment. The data on 1000-grain weight of wheat packed in different types of packing materials are presented in Table 2 and Fig. 4 and 5. The results indicated that the maximum 1000-grain weight (45.51 g) was recorded from grain stored in metal bin with 16% moisture, while the earthen bin with 16% moisture ranked second, which was observed to be of 45.35g. Whereas the lowest 1000-grain weight (43.99g) was measured from grain packed in cloth bag with 10% moisture. Analysis of variance indicated significant ($p<0.05$) differences in 1000-grain weight affected by storage period, packing materials and initial moisture contents (10 and16%). The interaction effects of packing x moisture also found to

be significant. There was non-significant ($p<0.05$) difference in 1000-grain weight between cloth and gunny bags (Table 2).

The results of the present study indicated that 1000-grain weight of wheat stored in different types of packing materials with 10 and 16% moisture decreased with the progress of storage period. The weight loss during storage was significantly low in metal and earthen bins compared to plastic, cloth and gunny bags when grain moisture content was 10 and 16% at packing. The lowest 1000-grain weight was observed in the plastic, cloth and gunny bags due to high insect infestation and desorption of moisture to the ambient air. These findings are similar to Syed *et al.* (2006), who reported that the moisture content played a significant role in population growth of insect pest, percent weight loss and percent grain damage. Similarly, Sinha and Sharma (2004) observed maximum changes in wheat quality when stored in gunny bags compared to metal bins. All the packing materials except metal and earthen bins are highly porous. Thus, bins were preventing the weight loss of grain during storage period.

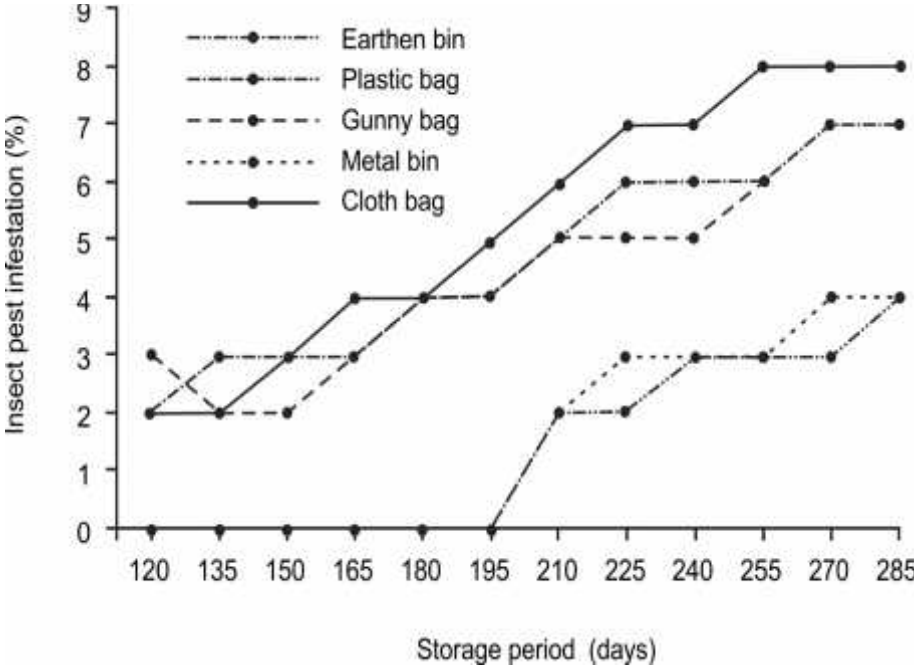

Figure 2. Insect Pest Infestation % during storage period for grain with 1% initial moisture content.

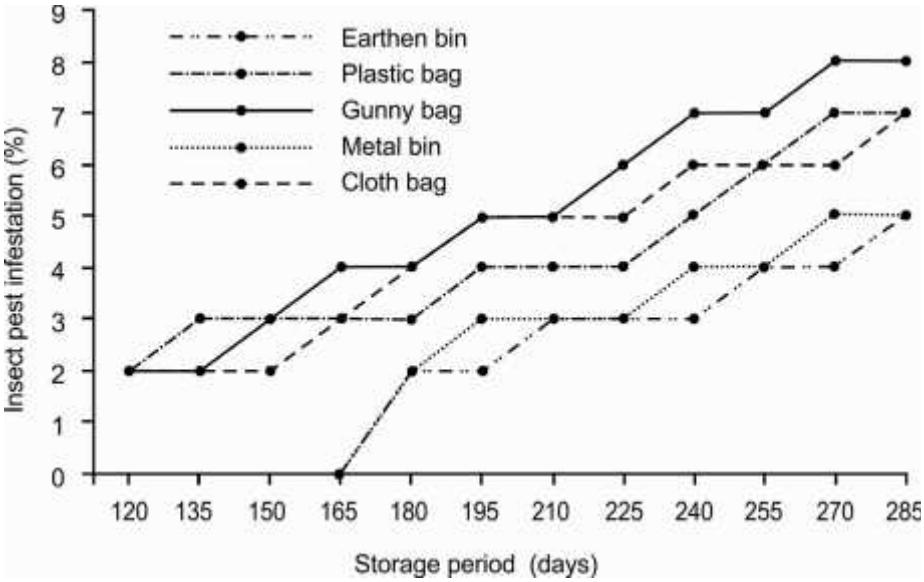

Figure 3. Insect pest infestation % during storage period for grain with 16% initial moisture content.

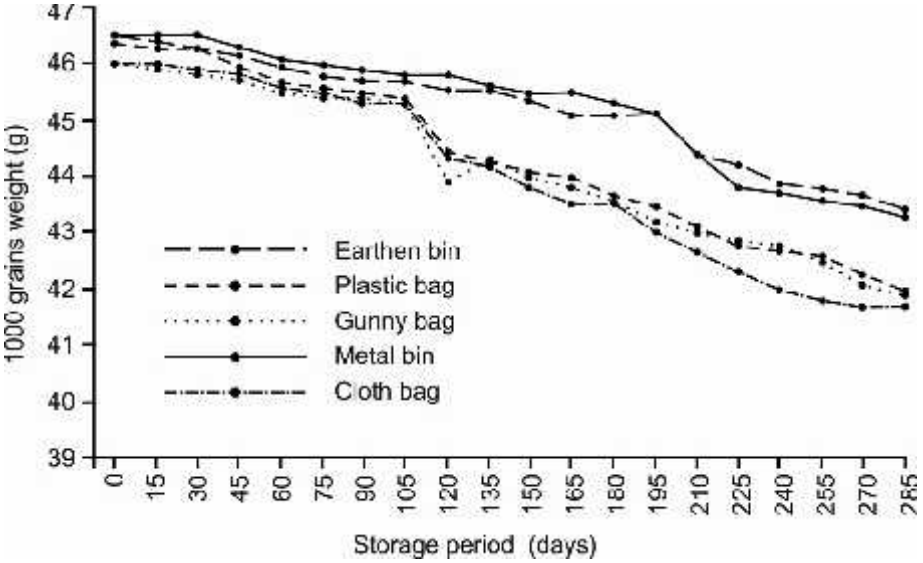

Figure 4. Effect of packing materials on 1000-grain weight (g) with 10% moisture content during storage period.

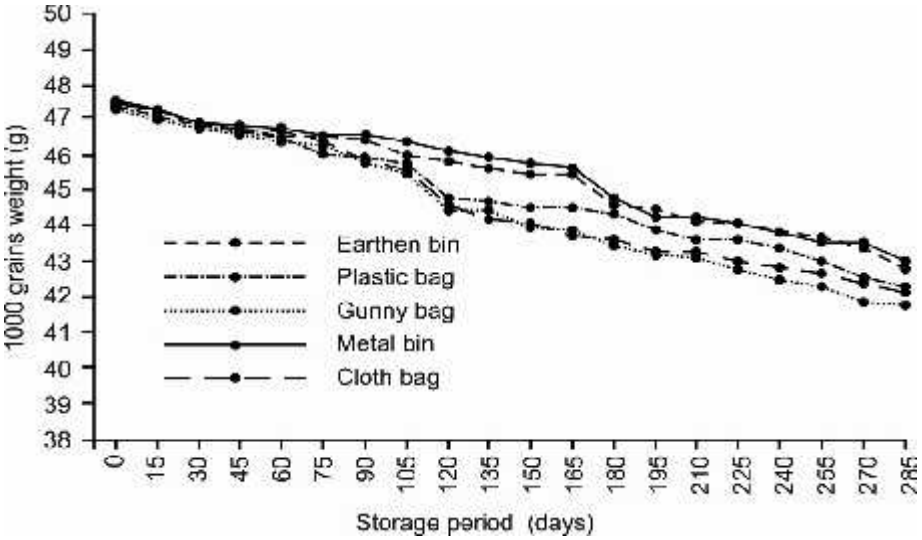

Figure 5. Effect of packing materials on 1000-grain weight (g) with 16% moisture content during storage period.

Table 1. Effect of initial moisture and packing materials on insect pest infestation (%).

Moisture %	Packing Materials					Mean
	Earthen bin	Metal bin	Plastic bag	Cloth bag	Gunny bag	
a. (10%)	0.85	0.95	2.80	3.20	2.65	2.09a
b. (16%)	1.30	1.45	2.45	2.80	3.00	2.20a
Mean	1.075c	1.20c	2.625b	3.00a	2.825ab	-

Factor	F-value	P-value	LSD
Packing	132.67	**	0.2275
Moisture	2.32	NS	-
Packing x Moisture	7.64	**	0.3217

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

Table 2. Effect of initial moisture and packing materials on 1000 grain weight (g).

Moisture %	Packing Materials					Mean
	Earthen bin	Metal bin	Plastic bag	Cloth bag	Gunny bag	
a. (10%)	45.085	45.235	44.340	43.995	44.150	44.561b
b. (16%)	45.355	45.510	44.890	44.645	44.485	44.977a
Mean	45.220b	45.373a	44.615c	44.320d	44.317d	-

Factor	F-value	P-value	LSD
Packing	315.48	**	0.0792
Moisture	273.86	**	0.0501
Packing x Moisture	9.53	**	0.1120

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

The protein contents during storage of wheat grain in different types of packing materials are presented in Table 3. The results indicated that the maximum mean value 10.35 % for protein contents of the stored wheat grain was recorded in the earthen bins, while the metal bins ranked second which was observed to be of 9.85 % whereas the lowest mean value 8.65 % for protein contents of the stored wheat grain was observed in the gunny bags. In accordance to the results of the analysis of variance, differences in protein content affected by packing materials and initial moisture contents (10 and 16%) were significant. The results are in line with Pessu *et al*. (2005) they reported that at the end of storage there was a significant decrease in protein and moisture content in all containers.

Table 3. Effect of initial moisture and packing materials on protein content (%) in wheat grain after storage period of 10 months.

Moisture %	Packing Materials					Mean
	Earthen bin	Metal bin	Plastic bag	Cloth bag	Gunny bag	
a. (10%)	10.5	10.0	9.6	9.0	8.8	9.58a
b. (16%)	10.2	9.7	9.1	8.9	8.5	9.28b
Mean	10.35a	9.85b	9.35c	8.95d	8.65e	-

Factor	F-value	P-value	LSD
Packing	93.40	**	0.2776
Moisture	22.50	**	0.1756

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

Table 4. Effect of initial moisture and packing materials on starch content (%) in wheat grain after storage period of 10 month.

Moisture %	Packing Materials					Mean
	Earthen bin	Metal bin	Plastic bag	Cloth bag	Gunny bag	
a. (10%)	67.0	66.5	64.6	63.8	64.2	65.22a
b. (16%)	66.1	65.5	64.5	64.0	63.5	64.72a
Mean	66.55a	66.00a	64.55b	63.90b	63.85b	-

Factor	F-value	P-value	LSD at 5%
Packing	22.30	**	1.0295
Moisture	4.55	NS	0.6511

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

The starch contents during storage of wheat grain in different types of packing materials are presented in Table 4. The results indicated that the maximum mean value of 66.55 % starch contents of the stored wheat grain was recorded from earthen bins, while the metal bins ranked second which was observed to be of 66.0 % whereas the lowest mean value of 63.85 % starch contents of the stored wheat grain was observed from gunny bags. Analysis of variance indicated significant ($p<0.05$) differences in starch content affected by packing materials.

There was non-significant difference in also starch content affected by initial moisture contents of 10 and 16%. There was non-significant ($p<0.05$) difference in starch content among the plastic, cloth and gunny bags (Table 4). At the end of 10 month (285 days) storage, there was a significant decrease in protein and starch contents in all the packing materials, compared with the protein and starch contents before storage. The lowest protein and starch contents were observed in the gunny, cloth and plastic bags due to high insect infestation. Thus, earthen and metal bins minimized grain deterioration by maintaining protein and starch contents to an appreciable level. These results are confirmed by Ahmedani *et al*. (2009) who observed changes in nutritional composition of the grain of different wheat varieties, when subjected to artificial infestation with insects. Similarly, Samuels and Modgil (1999) reported that with the increase in storage period, significant decreases in nutritional quality were observed due to insect infestation, they further noted that changes were maximum in wheat grain stored in gunny bag and minimum in wheat stored in metal bin.

CONCLUSION

The storage of wheat grains at different storage conditions is accompanied with quality changes. The study concluded that highest changes in quality parameters were observed in grain with 16% moisture. The grain stored in metal and earthen bins showed a lower degree of infestation than plastic, cloth and gunny bags. The lowest 1000-grain weight was observed in the plastic, cloth and gunny bags as compared to metal and earthen bins. The lowest protein and starch contents were also observed in the gunny, cloth and plastic bags, as compared to metal and earthen bins. The present study suggests that wheat grain should be stored at 10-12 % moisture in metal or earthen bins under ambient condition.

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