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Comparative study on storage behaviour of wheat in different storage bags

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Abstract

A hermetic storage bags is a safe, cost-effective storage method that controls insect infestations in addition to preserving the quality of grains, while allowing for pesticide-free, short-term and long-term qualitative and quantitative seed preservation, without refrigeration, maintaining seed vigor and pest control. Hermetic bags need to be validated for its effectiveness in hermetic storage of food grains under Bihar condition. The present study was undertaken in response to requests by farmers, traders and private seed companies to determine the effectiveness of hermetic bags for storage of wheat grain. Hence, a comparative study on storage behavior of wheat in different storage bags was made to assess the qualitative and quantitative loss and to validate the advantages of hermetic super grain bags over the conventional storage bags used in the region. Fresh and healthy wheat seeds were cleaned and graded. The experiment consisted of seven treatments using four different types of bags – Hermetic grain bags, Polythene bags, Jute bags and Plastic bags by using one chemical fumigant (Aluminium Phosphide) and dried Neem leaves. There was no any treatment in grain stored in hermetic grain bag. For neem treatment, the fresh neem leaves were taken from the tree and dried by sun drying method. The fumigant (Aluminium Phosphide) popularly known as sulphash were used. was taken and following consideration is drawn from the study, The variation in grain moisture content, water activity and germination percent of wheat was least in the hermetic grain bag while maximum in Jute bag. Germination percentage of wheat stored was maximum in super grain bag throughout the storage period than other storage modes/treatments. The variation in colour index was least in super grain bag showing the minimal effect of ambient condition to the stored wheat grain. Wheat can be stored under ambient conditions up to 3 months in hermetic storage bag with minimum qualitative and quantitative loss. There is no requirement of any chemical treatment of grains stored in hermetic super bags as the micro environment developed is sufficient enough to restrict the growth of pests, insects and micro-organism.

Keywords: Storage behaviour, wheat, different storage bags

Introduction

India is one of the highest producers of many crops like wheat and rice but due to poor storage facilities this produce can't be utilized properly due to which people lack food and many daily nutrients. Proper outcome of the grains or harvested crop is not received. This affects the countries average person's daily nutrition consumption. Due to which many people starve and have to eat poor quality of grains. Good quality of grains can only be received by good and proper post harvesting measures. Post harvesting measures mainly includes proper drying, handling, grading and proper storage facility. Nowadays, pesticides are being used extensively in the control of crop pests. Synthetic insecticides are used widely for the control of various insect pests because they can be applied whenever and wherever needed, economical and most important thing is the reliability of control method. Hence, the production and consumption of pesticides has greatly increased in recent years. The contribution of pesticides to increase agricultural production cannot be denied, but synthetic pesticides have also caused unprecedented ecological damage, also induced serious health hazard among workers during manufacture, formulation and field applications. To overcome the problems of synthetic chemical hazards, one of the best control measures is the use of plant origin products. The popularity of the plant products increasing day by day because of their biodegradability, least persistence and least toxic to non-target organisms, economic and easy availability. Today about 200 plants with insecticidal activities are known.

Among the natural products, one of the most promising natural compound is Azadirachtin, an active compound extracted from the *Azadirachta indica* A. Juss (neem) tree (*Meliaceae*) whose antiviral, antifungal, antibacterial and insecticidal properties have been known for several years. Storage losses are due to high moisture content of the stored material, the storage condition (high relative humidity), erratic climatic condition, absence of primary processing (cleaning and grading) at farm level and lack of storage facility at production catchment. The storage loss in commercial storage of food grains is around 3 to 5% when storage was done for 8 months (Krishnamurthy, 1975) [10]. Attempts to reduce these losses a method considered for the prevention of storage losses is airtight storage bags termed as 'airtight storage' or 'hermetic storage' bags. Hermetic storage systems strive to eliminate all exchange of gases between the inside and the outside of a grain storage container. If the gas exchange is low enough, living organisms such as insects within the container will deplete oxygen and produce carbon dioxide until they die or become inactive due to the low oxygen. Hermetic grain storage can be an appropriate method for many subsistence farmers. It eliminates the need for insecticides, which are costly and often inaccessible for these farmers. Misuse of insecticides by farmers is common and can cause health and environmental problems. Hermetic storage bags is a safe, cost-effective storage method that controls insect infestations in addition to preserving the quality of grains, while allowing for pesticide-free, short-term and long-term qualitative and quantitative seed preservation, without refrigeration, maintaining seed vigor and pest control. Storage at low temperature (4 °C ensures greater safety margins between insect development time and break of dormancy, although hermetic storage, even at ambient temperatures, naturally eliminates insect development altogether. To determine the effectiveness of hermetic bags for storage of wheat grain. Hence, a comparative study on storage behavior of wheat in different storage bags was made to assess the qualitative and quantitative loss and to validate the advantages of hermetic bags in wheat storage over the conventional storage bags used in the Bihar region.

Materials and Methods

The comparative study for selection of most effective grain storage method was carried out in processing lab of CAE, Pusa.

Sample preparation

Fresh and healthy wheat seeds were procured from local market at Pusa. Cleaning and grading of grain were done in specific gravity separator. 50kg cleaned and graded wheat were weighed using weighing machine (Wensar weighing scales limited, range 0.2 gm to 2000 gm with sensitivity of 0.01 gm) and stored in different storage bags.

Experimental Design

The experiment consisted of seven treatments using four different types of bags – Hermetic grain bags, Polythene bags, Jute bags and Plastic bags by using one chemical fumigant (Aluminium Phosphide) and dried Neem leaves. For neem treatment, the fresh neem leaves were taken from the tree and dried by sun drying method. The dried neem leaves 70 g in weight was mixed with the wheat at three different layers (at 20 cm from bottom and 25 between the next consecutive layers) of the bags. The surface at the top was covered with the remaining 25 gm of neem leaves and around 0.93 gm of

sulphash was placed in the centre of the bag and bag-end. The bag-end was closed by tightly twisting the free portion and then tying it by ropes or some suitable means.

Independent variables (Treatments)

1. Jute bag + Hermetic bag	-	T1
2. Jute bag + polythene + neem	-	T2
3. Jute bag + neem	-	T3
4. Plastic bag + neem	-	T4
5. Jute bag + polythene + sulphash	-	T5
6. Jute bag + sulphash	-	T6
7. Plastic bag + sulphash	-	T7

The bags were placed in a room made of concrete roofed and wall with suitable ventilation. All the treatments were kept under ambient conditions. The different treatments were arranged in two rows on a dunnage so as to protect the grains bags from the direct contact with ground. The temperature and relative humidity were recorded on a daily basis while the other dependent parameters were recorded on weekly basis.

Observations on storage study

From each bags, grain samples were obtained with a compartmentalized grain sampling spear (Seed Buro Equipment Company, Chicago, USA) at one week intervals, from 14 September 2015 to 21 December 2015. The sampling spear was 1 m long, with five slots, 15 cm long, evenly-spaced, and separated from each other by a 2.5 cm-long wooden plug. For this study, wheat samples of about 25.27 gm per slot were taken with the bottom three slots.

Moisture Content

The moisture content of sample was determined by standard hot air oven method. The samples were dried in the hot air oven at 105 °C for 24 hours. The total dry materials or the initial moisture content of sample was determined in accordance with AOAC method (Anonymous, 1990).

$$MC = \frac{W_m}{W_m + W_d} \times 100 \quad \dots (3.1)$$

1000 Grain Weight

1000 grain weight was measured with the help of Electrical balance available in the department of PFE lab. First, Randomly selected 1000 seeds from each treatment of wheat samples were taken and weighed using electronic balance of 0.01 g sensitivity.

Water Activity

Multiplication of water activity by 100 gives the equilibrium relative humidity (ERH) in percent.

$$a_w = p/p_o = \text{ERH} (\%) / 100 \quad \dots (3.2)$$

Water activity (a_w) is one of the most critical factors in determining quality and safety of the goods you consume every day.

Colour

The colour of stored wheat was measured with the help of hunter colour lab meter available in the department of PFE. In addition to Hunter L-value, a new parameter called total

colour index (E) was developed to represent the total colour index and calculated by formula.

$$E = \sqrt{L^2 + a^2 + b^2}$$

Where,

E = total color index; L = Hunter L-value (+ is lightness, - is darkness); b = hunter b-value (+ yellowness, -blueness); a = Hunter a-value (+redness, -greenness)

Germination percentage

100 grains of wheat were taken in 7 different petri-dishes. The disc was fully filled with sand and water. Water spraying was done regularly to keep the grain moist. After a time of 72 hrs germination of grain was counted carefully and germination percentage of 7 respective samples was collected.

$$\text{Germination Percentage} = \frac{\text{Number of seeds sprouted}}{\text{Total number of seeds taken}} \times 100\%$$

Insect -pest damage in stored grain

At the end of every week of storage period random samples were drawn and each sample was visually rated for damage by insect and pests. Although the storage period was short but some indication was obtained with regard to the damage under 7 different types of storage conditions.

Results & Discussion

This chapter deals with the results obtained and discussion from the comparative study of storage behavior of wheat. It deals with the presentation of the results by graphs based on experimental data. The merits and demerits of the results have been discussed to facilitate the generation of information on these aspects which would help in developing suitable storage structure.



Grain moisture content

The variation in grain moisture content with storage period of different bag storage modes under various treatments is shown in Figure 1. The initial moisture content of wheat when procured was 10.90% (w.b.). In all the treatments the moisture content of wheat showed increasing trend. This may be due increase in ambient relative humidity and dampness created by the heat of respiration of the grain. The variation in moisture content of wheat in the Jute bag with hermetic grain

bag was least which ranged between 10.90% to 11.05%. Moisture in the polythene bag storage kept inside the jute bag with neem treatment increased from 10.90% to 11.13% while moisture in plastic bag storage with neem treatment increased from 10.90% to 11.21%. Moisture content variation in jute bag with chemical/biological treatment was maximum. Moisture content in jute bags with neem treatment increased from 10.90% to 11.28% (w.b.) while moisture in jute bag with chemical treatment increased from 10.90% to 11.31% (w.b.).

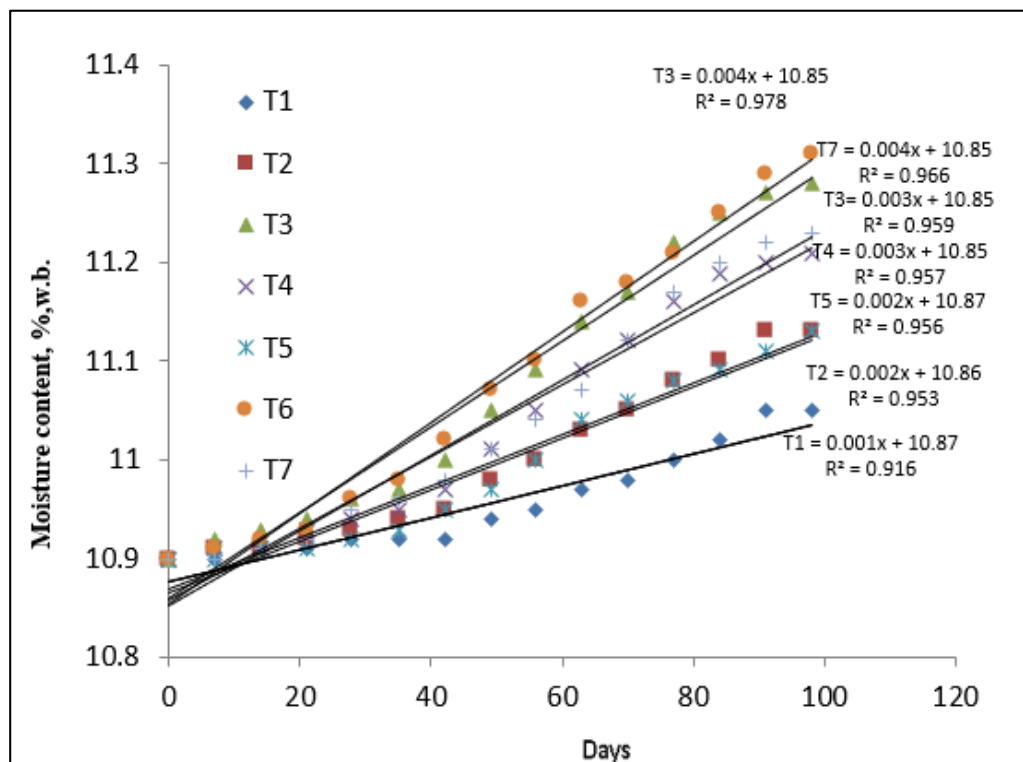


Fig 1: Variation in moisture content with storage duration in experimental samples

The highest moisture content 11.31% was found in Jute bag treated with Aluminium phosphide and the lowest moisture content was observed to be 11.05% in hermetic grain bag kept inside the jute bag in untreated condition when stored at room temperature in 98 days. Behaviour of wheat stored in hermetic grain bags appear was different from the rest of the treatments. The marginal increase in moisture content in all the treatments was due to respiration of grain and the increased relative humidity with storage duration. It was also seen that the moisture increased initially slowly upto 28 days of storage period and then it increased rapidly as relative humidity increases day-by-day. The least variation in moisture content in hermetic storage bags is due to generation-of the aerobic metabolism of insect pests and

microorganisms-of an oxygen-depleted and carbon dioxide-enriched inter-granular atmosphere of the storage ecosystem. The hermetic storage bags showed a safe, cost-effective storage method that controls insect infestations in addition to preserving the quality of grains.

Germination percentage

The variation in germination percentage during the storage of the wheat in different storage modes are shown in Fig 2. In the beginning, the germination of wheat was 92%. The germination percentage was good during the initial days. In the end, the germination was least in jute bag both treated with neem and Aluminium phosphide.

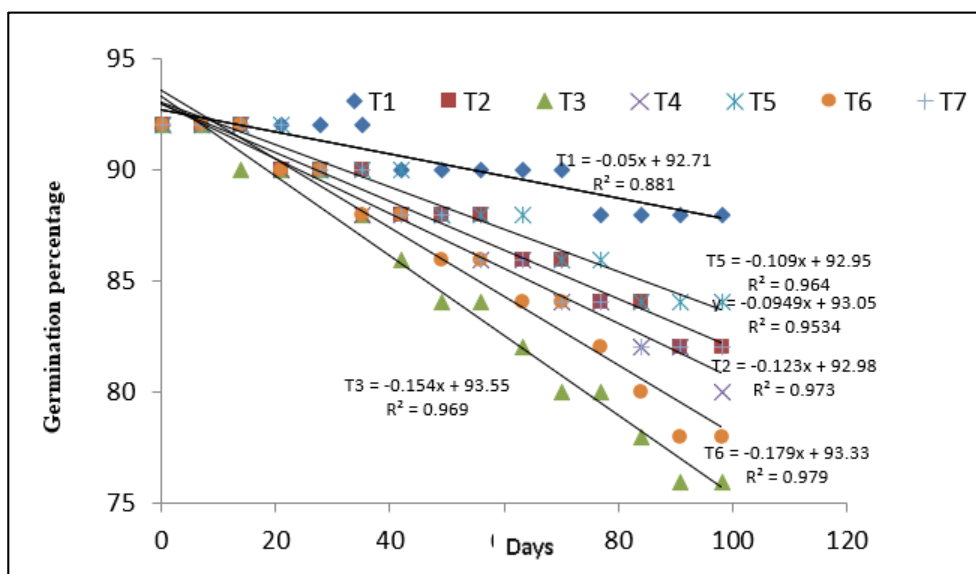


Fig 2: Variation in germination percentage of wheat grain in different storage bags

The germination percentage of wheat seed in the hermetic grain bag kept inside the jute bag decreased from 92% to

88%, germination percentage in the polythene bag kept inside the jute bag with neem treatment decreased from 92% to 82%,

germination percentage in plastic bag storage with neem treatment decreased from 92% to 80% and germination percentage in jute bag with neem treatment decreased from 92% to 76%. Germination percentage in the polythene bag kept inside the jute bag with Aluminium phosphide treatment decreased from 92% to 84%, germination percentage in plastic bag storage with Aluminium phosphide treatment decreased from 92% to 82% and germination percentage in jute bag with Aluminium phosphide treatment decreased from 92% to 78%. In hermetic grain bag kept inside the jute bag,

the germination percentage decrease was minimum while in jute bags with neem treatment the germination percentage variation was maximum after storing the wheat seed for 98 days.

Water activity

The variation between water activity of wheat in hermetic bag kept inside the jute bag, polythene bag kept inside the jute bag, plastic bag, and jute bag storage with storage period days are shown in Figure 3.

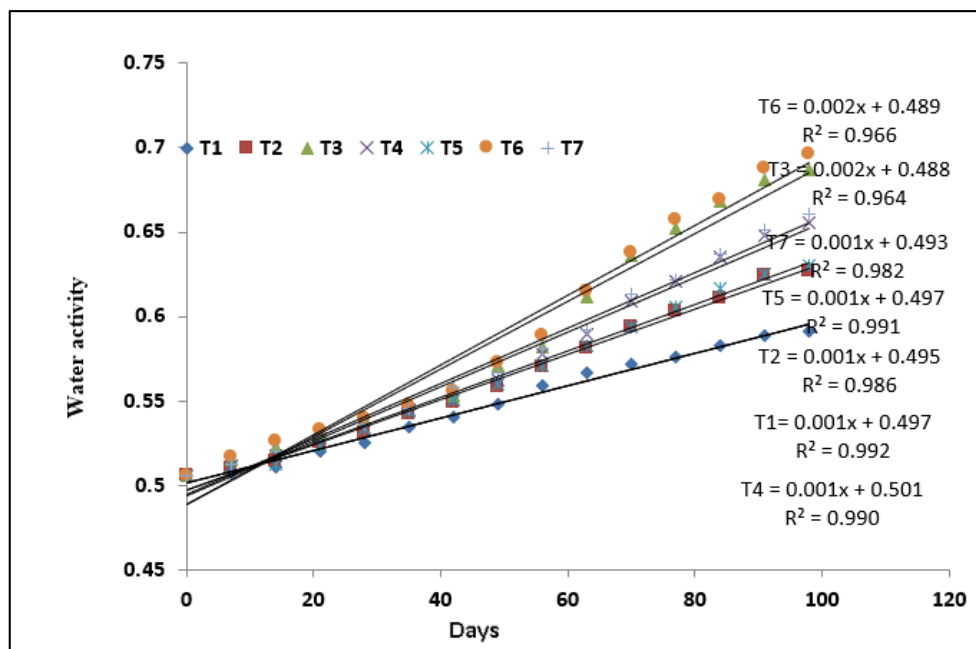


Fig 3: Variation in water activity with storage duration in experimental samples

The water activity of the grain was initially at 0.506 for all untreated wheat samples under study. The highest water activity value was 0.688 in case of jute bag while lowest water activity was 0.589 in case of hermetic grain bag which was kept inside the jute bag while storing at room temperature after 98 days of storage period. The water activity of untreated wheat seed in the hermetic grain bag kept inside the jute bag increased from 0.506 to 0.591, water activity in the polythene bag storage kept inside the jute bag with neem treatment increased from 0.506 to 0.627, water activity in plastic bag storage with neem treatment increased from 0.506 to 0.656 and water activity in jute bag with neem treatment increased from 0.506 to 0.687. Water activity in the polythene bag storage kept inside the jute bag with Aluminium phosphide treatment increased from 0.506 to 0.630, water activity in plastic bag storage with Aluminium phosphide treatment increased from 0.506 to 0.661 and water activity in jute bag with Aluminium phosphide treatment increased from 0.506 to 0.696 after 98 days of storage period.

The elevation in water activity with storage period may be due to increase in moisture content owing due to increased in relative humidity during storage period.

Determination of weight of 1000 seeds

The variation between 1000 grain weight in hermetic grain bag kept inside the jute bag, polythene bag kept inside the jute bag, plastic bag, and jute bag storage with storage period in days are shown in Figure 4.

This parameter behaves in same manner as the change in moisture content with storage period. If the grain gained moisture, the 1000 grain weight increased and vice-versa.

The 1000 grain weight of untreated wheat seed in the hermetic grain bag kept inside the jute bag increased from 40.4 gm to 42.6 gm, 1000 grain weight in the polythene bag storage kept inside the jute bag with neem treatment increased from 40.4 gm to 44.4 gm, 1000 grain weight in plastic bag storage with neem treatment increased from 40.4 gm to 44.9 gm and 1000 grain weight in jute bag with neem treatment increased from 40.4 gm to 47.2 gm. 1000 grain weight in the polythene bag storage kept inside the jute bag with Aluminium phosphide treatment increased from 40.4 gm to 44.5 gm, 1000 grain weight in plastic bag storage with Aluminium phosphide treatment increased from 40.4 gm to 45.3 gm and 1000 grain weight in jute bag with Aluminium phosphide treatment increased from 40.4 gm to 47.5 gm, after 98 days of storage period.

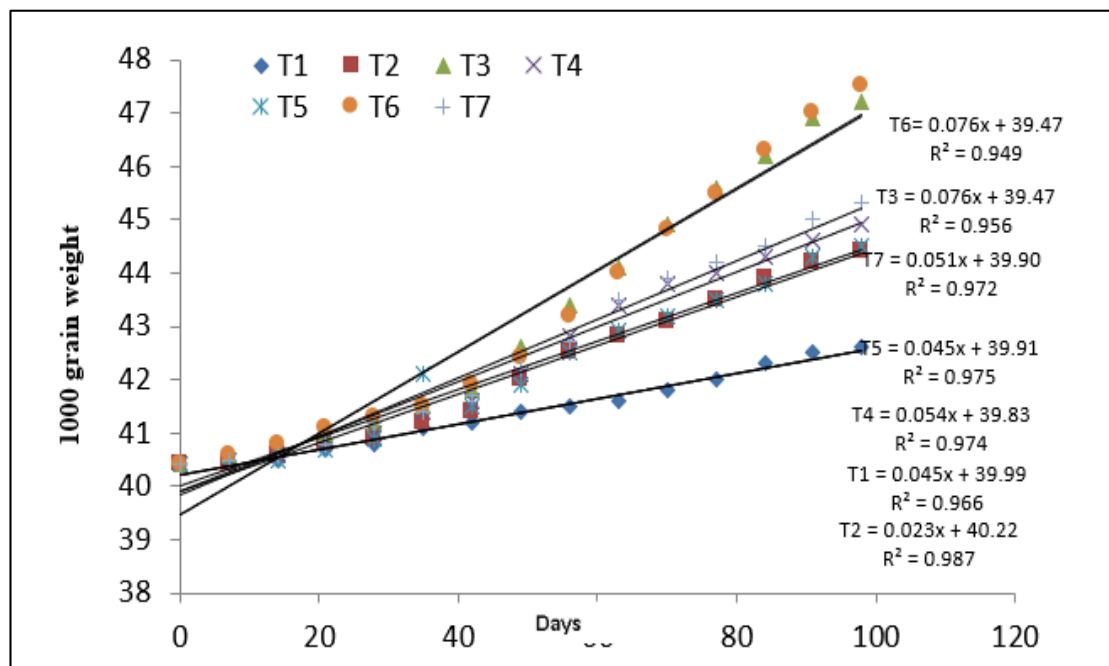


Fig 4: Variation in 1000 grain weight with days in different storage bags for wheat grain

The increasing pattern of 1000 grain weight with storage period may be due to increase in moisture content owing due to increased in relative humidity during storage period.

Colour index

The colour index of the wheat grain was initially recorded to be 56.10 for all storage treatments. The colour index does not showed an increasing trend showing increase in values of colour index in all the storages modes (Figure 5).

The total colour index of wheat in the hermetic grain bag kept inside the jute bag changes from 56.10 to 56.55, total colour index in the polythene bag storage kept inside the jute bag with neem treatment changes from 56.10 to 58.73, total colour index in plastic bag storage with neem treatment changes from 56.10 to 55.86 and total colour index in jute bag with neem treatment changes from 56.10 to 56.44.

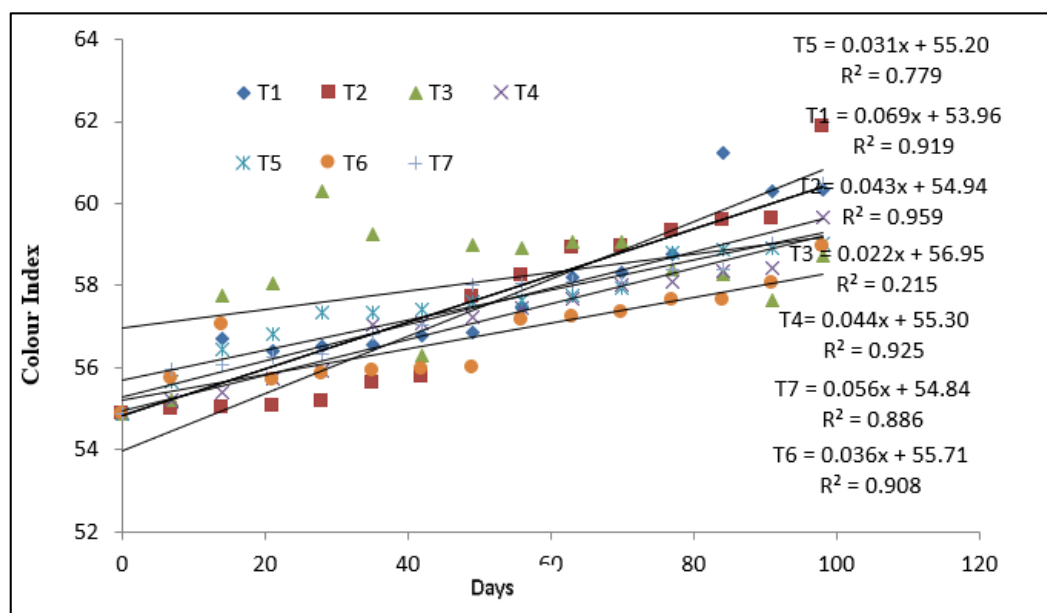


Fig 5: samples Variation of colour index with days in different storage bags for untreated and treated wheat grain

Total colour index in the polythene bag storage kept inside the jute bag with Aluminium phosphide treatment changes from 56.10 to 55.78, total colour index in plastic bag storage with Aluminium phosphide treatment changes from 56.10 to 57.04 and total colour index in jute bag with Aluminium phosphide treatment changes from 56.10 to 55.07, after 98 days of storage period.

Percentage Grain Damage

The variation in percentage grain damage during the storage of the wheat in different storage modes are shown in Table 1. In the beginning, there is no any visible damage found in the wheat sample. In the end, there are no any visible damage was observed for wheat samples under hermetic bag storage mode for 98 days storage period. The percentage grain damage of untreated wheat seed in the hermetic grain bag kept inside the jute bag was 01%, percentage grain damage in the polythene

bag kept inside the jute bag with neem treatment was 08%, percentage grain damage in plastic bag storage with neem

treatment was 11% and percentage grain damage in jute bag with neem treatment was 16%.

Table 1: Damaged Grain Percentage (%)

Storage Treatment	Days														
	0	7	14	21	28	35	42	49	56	63	70	77	84	91	98
Jute+sgb (No treatment)	00	00	00	00	00	00	01	01	01	01	01	01	01	01	01
Jute+poly (neem)	00	00	01	01	02	02	03	03	04	04	05	06	06	07	08
Jute (neem)	00	01	02	02	03	04	06	07	08	10	10	12	13	15	16
Plastic (neem)	00	00	01	01	02	03	04	05	06	06	08	08	09	09	11
Jute+poly (sulphash)	00	00	01	01	01	02	02	03	03	04	04	05	05	06	06
Jute (sulphash)	00	01	01	02	02	03	04	05	06	08	09	09	11	11	13
Plastic (sulphash)	00	00	01	01	02	02	04	04	05	05	06	06	08	08	09

Percentage grain damage in the polythene bag kept inside the jute bag with Aluminium phosphide treatment was 06%, percentage grain damage in plastic bag storage with Aluminium phosphide treatment was 09% and percentage grain damage in jute bag with Aluminium phosphide treatment was 13%. In hermetic grain bag kept inside the jute bag, the percentage grain damage was least as compared to all other storage modes after storing the wheat seed for 98 days.

Conclusion

A comparative study on storage behavior of wheat in different storage bags was made to assess the qualitative and quantitative loss and to validate the advantages of hermetic super grain bags over the conventional storage bags used in the region. Hence, a comparative study on storage behavior of wheat in different storage bags was taken and following consideration is drawn from the study, The variation in grain moisture content, water activity and germination percent of wheat was least in the hermetic grain bag while maximum in Jute bag. Germination percentage of wheat stored was maximum in super grain bag throughout the storage period than other storage modes/treatments. The variation in colour index was least in super grain bag showing the minimal effect of ambient condition to the stored wheat grain. Wheat can be stored under ambient conditions up to 3 months in hermetic storage bag with minimum qualitative and quantitative loss. There is no requirement of any chemical treatment of grains stored in hermetic super bags as the micro environment developed is sufficient enough to restrict the growth of pests, insects and micro-organism.

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