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Asha Kumari
Ex-M. Tech. Student, Department of Processing & Food Engineering College of Agricultural Engineering, Dr. Rajendra Prasad Central Agricultural University Pusa, Samastipur, Bihar, India

Mukesh Shrivastava
Professor & Head, Department of Processing & Food Engineering College of Agricultural Engineering, Dr. Rajendra Prasad Central Agricultural University Pusa, Samastipur, Bihar, India

Correspondence
Asha Kumari
Ex-M. Tech. Student, Department of Processing & Food Engineering College of Agricultural Engineering, Dr. Rajendra Prasad Central Agricultural University Pusa, Samastipur, Bihar, India

Variation in grain damage of green gram stored in hermetic and other bags

Asha Kumari and Mukesh Shrivastava

Abstract
A study has been conducted to see the effect of storage duration and other factors on grain damage in Green gram stored in hermetic and other bags. Green gram (*Vigna radiate*) grains were procured from local market, cleaned and graded by two screen cleaner-cum-grader. Storage study was conducted by storing large sized green gram grains in 4 types of bags (jute, plastic, polythene, hermetic) without and with treatment (aluminium phosphide tablets) at 3 different initial moisture contents (12.34, 14.07, 16.04 % w.b.). Total 21 such bags having different treatment combinations were kept in laboratory for 33 weeks. Daily observation of ambient temperature and relative humidity was taken throughout the study period. Weekly observations of moisture content were recorded for 27 (jute bags) to 33 weeks (hermetic bags). It was observed that grain damage goes on increasing with advancement of storage duration across all 21 experimental combinations. The overall variation range for grain damage was found between 2.33 – 78.67 %. Variation was observed more in case of untreated samples as compared to treated samples. Hermetic bags stored green gram was found better with minimum increase in grain damage (2.33 to 20.00 %) even after 33 weeks of storage duration. Statistical analysis through UNIANOVA revealed that initial moisture content emerged as most significant independent variable to affect grain damage. The interaction of bags*imc significantly affected grain damage. Hence the hermetic bag could be recommended for storing green gram safely for longer duration without affecting its quality.

Keywords: Green gram, hermetic bag, jute bag, plastic bag, polythene bag, treated

Introduction

Around 65% of India's population is dependent upon agriculture and allied sectors. Various cereals (wheat, rice etc.), pulses (pigeon pea, gram etc.) and oilseeds (groundnut, soybean) are produced largely in India. India is the world's largest producer and consumer of pulses accounting about 27% of the total production and about 30% of total consumption in world. Total production of pulses in India during the year 2013-14 was 18.5 million tons. In the year 2015-16, the pulse production in Bihar has been estimated as 7.35 *lakh* tons, out of which green gram shared 1.558 *lakh* tons.

Post-harvest Food Loss (PHL) is defined as measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest till its consumption or other end uses. Post harvest losses are due to poor production practices, poor post-harvest management practices, lack of grading at farm level, poor packaging, poor transportation, multiple handling, and poor marketing system. Reduction of pre-harvest, harvest and post-harvest losses is indeed a complementary means of increasing the food availability. 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.

A method considered for the prevention of storage losses in 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/bag. If the gas exchange is low enough, living organisms such as insects within the container/bag will deplete oxygen and produce carbon dioxide until they die or become inactive due to the low oxygen. 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 grain preservation. Hermetic storage is capable of maintaining relative humidity that preserves grain moisture and prevents mold growth. Hermetic bags need to be validated for its effectiveness in hermetic storage of food grains under Bihar conditions. In response to requests by farmers, traders and private seed companies to determine the effectiveness of hermetic bags for storage of cereals/pulses, a comparative study on storage behavior of green gram different storage bags was made to assess the qualitative and quantitative loss and to validate the advantages of hermetic bags in green gram storage over the conventional storage bags used in the region.

Materials and methods

Sample preparation and treatment

Fresh and healthy green gram pulse grains were procured from local farmer at Ratwara village of Muzaffarpur district in Bihar. Cleaning and grading of grains was done in two screen seed cleaner-cum-grader using top screen of 4.0 mm and bottom screen of 2.5 mm round holes. Total 210 kg cleaned and graded green gram grains of 2.64 mm Ø size with moisture content of 12.05 % w.b. were available for storage study. Grains were weighed on a digital platform type balance (WENSER) having 150 kg capacity and 0.01 kg sensitivity.

The fumigant (Aluminium Phosphide) popularly known as sulphas was used for the chemical treatment whose molecular formula is AlF, molecular weight is 57.955 gm.mole^{-1} and density is 2.85 gm.cm^{-3}. Half sulphas tablet weighing 0.93 g kept inside a piece of muslin cloth was placed in the centre of the bag and bag-mouth was closed by tightly twisting the free portion and then tying it by plastic rope.

Experimental Variables

Independent variables

1.	Type of storage bags	4 types [Jute (JUT), Plastic (PLS), Polythene (PLY), Hermetic (HER)]
2.	Initial moisture content (IMC) % w. b.	3 levels [IMC1-12.32 %, IMC2-14.04%, IMC3-16.04% w.b.]
3.	Treatment	2 levels [Treated chemically (T), Untreated (UT)]
4.	Storage duration (weeks)	28 to 34 levels [Jute bags – 0 to 27 weeks, Plastic bags 0 to 29 weeks, Polythene bags 0 to 31 weeks, Hermetic bags 0 to 33 weeks]

Dependent variables

- Grain damage

Observations

- Ambient temperature ºC (Daily)
- Ambient R.H., % (Daily)

Experimental design

Factorial - 4 types of bags × 2 types of treatment × 3 levels of IMC = 24 Combinations.

But the Hermetic bags were used to store samples without any treatment only, so the total combinations reduced to 21 as detailed below:

- 3 JUT bags – T – with IMC1, IMC2, IMC3
- 3 PLY bags – T – with IMC1, IMC2, IMC3
- 3 PLS bags – T – with IMC1, IMC2, IMC3
- 3 JUT bags – UT – with IMC1, IMC2, IMC3
- 3 PLY bags – UT – with IMC1, IMC2, IMC3
- 3 PLS bags – UT – with IMC1, IMC2, IMC3
- 3 HER bags – UT – with IMC1, IMC2, IMC3

Experimental Methodology

After determining moisture content of cleaned and graded lot of green gram grains as 12.05% w.b., the whole lot was subdivided in three sub-lots. Required amount of water was added in two sub-lots which were left for tempering for 24 hours to adjust the moisture within the grain heap for getting two more desired levels of moisture contents. The initial moisture content of all three lots was determined again which were found as 12.34%, 14.07%, 16.04%w.b. Then green gram grains were stored in 21 bags as per experimental design. The size of hermetic/polythene bag was 112×61 cm, and of jute/plastic was 83×55 cm (having capacity of 50 kg each). For treatment of samples, half tablet (0.93g) of sulphas tied in a small piece of muslin cloth was kept in stored grains. The mouth of each bag was tied with the help of plastic rope after evacuating air above the stored grains out of the bag. For observations, samples were drawn from each bag randomly every week. Observations were continued for 27-33 weeks for different bags depending upon the condition of resultant grains.

Determination of moisture content

The moisture content of sample was determined by standard hot air oven method. The samples were dried in hot air oven at 105±2ºC for 24 hours. The moisture content of sample was determined in accordance with AOAC method (Anonymous, 1990) using following formula:

$$MC = \frac{w_m}{w_{m+w_d}} \times 100$$

Where,

MC =Moisture content, % w.b.

W_m =Weight of the moisture evaporated, g

W_d = Weight of dried sample, g

Determination of grain damage

At the end of every week of storage period, random samples of 100 grains were drawn from each bag and each sample was visually analysed for grain damage by insect and pests. Grain damage was expressed in percent.

Recording of observations

The ambient temperature and relative humidity were recorded by portable digital temperature/relative humidity meter (ZEAL, 0.1ºC, 0.1%). Observations were taken on daily basis during entire period of experimental storage in near vicinity of storage bags.

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Results & discussion

The summarized overall variation in grain damage with minimum and maximum values under each experimental combination have been presented in Table 1. It reveals that the grain damage of the grain was initially in the range of 2.33 to 3.12 % for three initial moisture contents (IMC) which went up in the range of 12.00 to 78.67 % after 33 weeks of storage. The highest grain damage value was observed as 78.67 % for the experimental combination of JUT/UT/IMC3.

The grain damage of untreated Green gram grain in the jute bag was increased from 2.33 to 78.67 % across all IMCs after 27 weeks of storage. Similarly grain damage of treated Green gram grain in the jute bag was increased from 2.33 to 74.00% across all IMCs after 27 weeks of storage. The grain damage of untreated Green gram grain in the hermetic (HER) bag was increased from 2.33 to 20.00% across all IMCs after 33 weeks of storage. The elevation in grain damage with storage period may be due to increase in moisture content owing due to variation in temperature and relative humidity during storage period.

Fig. 1 reveals that grain damage had a general increasing trend across all experimental combinations with advancement of storage duration. Untreated Green gram grains stored in HER bags had lowest grain damages at all IMCs as compared to polythene (PLY) bags, plastic (PLS) bags and jute (JUT) bags in that order. Similarly treated grains behaved in the same manner across all combinations. The grain damages were lower at IMC1 as compared to IMC3 at all experimental combinations.

Table 1: Summarized overall variation in grain damage for all experimental combinations

Treatment Combination	Max. Value (week no)	Min. Value (week no)
JUT/T/IMC1	56.67 (27)	2.33 (0)
JUT/UT/IMC1	63.67 (27)	2.33 (0)
PLS/T/IMC1	45.33 (29)	2.33 (0)
PLS/UT/IMC1	52.53 (29)	2.33 (0)
PLY/T/IMC1	25.00 (31)	2.33 (0)
PLY/UT/IMC1	31.00 (31)	2.33 (0)
HER/UT/IMC1	12.00 (33)	2.33 (0)
JUT/T/IMC2	59.67 (27)	2.55(0)
JUT/UT/IMC2	68.33 (27)	2.55 (0)
PLS/T/IMC2	49.33 (29)	2.55 (0)
PLS/UT/IMC2	54.33 (29)	2.55 (0)
PLY/T/IMC2	28.67 (31)	2.55 (0)
PLY/UT/IMC2	33.00 (31)	2.55 (0)
HER/UT/IMC2	16.00 (33)	2.55 (0)
JUT/T/IMC3	74.00 (27)	3.12 (0)
JUT/UT/IMC3	78.67 (27)	3.12 (0)
PLS/T/IMC3	54.67 (29)	3.12 (0)
PLS/UT/IMC3	59.33 (29)	3.12 (0)
PLY/T/IMC3	34.00 (31)	3.12 (0)
PLY/UT/IMC3	39.33 (31)	3.12 (0)
HER/UT/IMC3	20.00 (33)	3.12 (0)

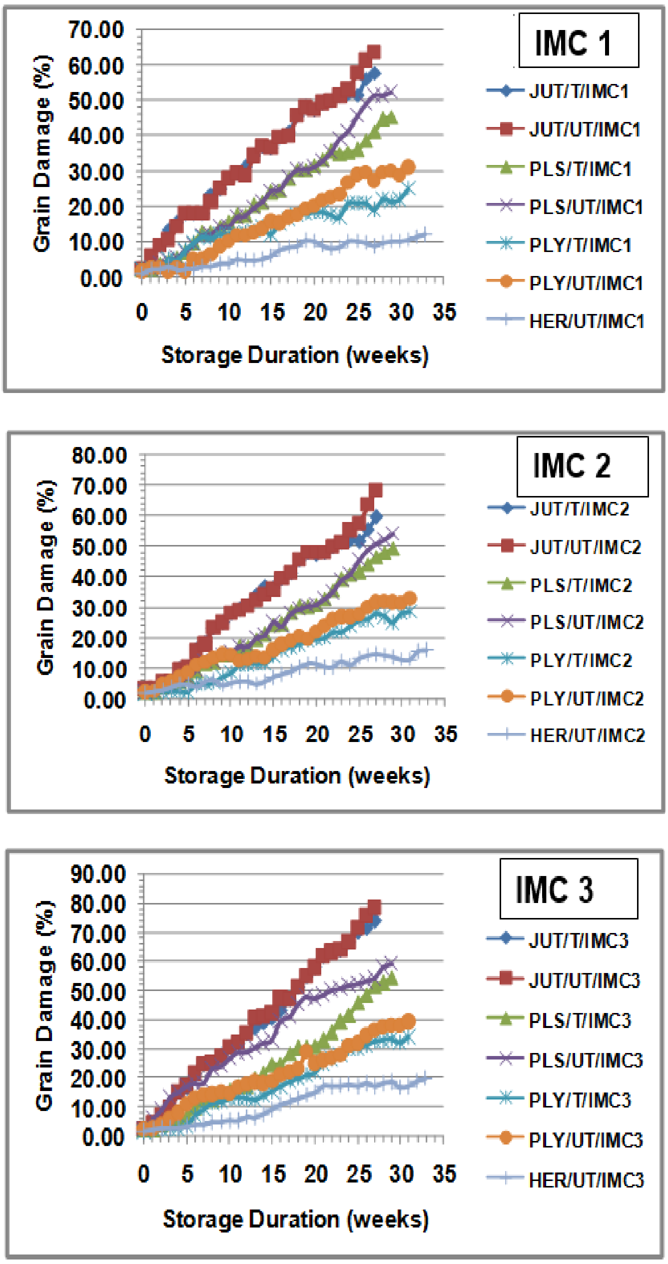

Fig 1: Variation in Grain Damage with storage duration for different bags and treatment at three dirrerent initial moisture contents.

Table 2: UNIANOVA for effect of independent variables on grain damage

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	733909.595[a]	641	1144.945	13.519	.000
Intercept	3426880.816	1	3426880.816	4.046E4	.000
Bags	28677.572	3	9559.191	112.868	.000
Trt	192.848	1	192.848	2.277	.132[ns]
Imc	106277.924	2	53138.962	627.426	.000
Week	447874.375	33	13571.951	160.248	.000
bags * trt	189.197	2	94.598	1.117	.328 [ns]
bags * imc	33975.112	6	5662.519	66.859	.000
bags * week	13661.483	87	157.029	1.854	.000
trt * imc	1180.871	2	590.435	6.971	.001
trt * week	1310.834	31	42.285	.499	.991 [ns]
imc * week	9354.743	66	141.739	1.674	.001
bags * trt * imc	1639.589	4	409.897	4.840	.001
bags * trt * week	4010.248	56	71.612	.846	.784 [ns]
bags * imc * week	25781.522	174	148.170	1.749	.000
trt * imc * week	2615.911	62	42.192	.498	1.000 [ns]
bags * trt * imc * week	5324.173	112	47.537	.561	1.000 [ns]

Error	108661.833	1283	84.694		
Total	4735748.000	1925			
Corrected Total	842571.429	1924			
a. R Squared =.871 (Adjusted R Squared =.807) ns = non-significant					

Table 2 shows UNIANOVA for main factors effect and their interaction effect on grain damage for the entire experiment. It reveals that bags, imc, weeks, and almost half of the interactions had a significant effect on grain damage, while the other half interactions had non-significant effect on grain damage. The imc having highest F-value affected grain damage the most followe by weeks, bags and trt. The interaction of bags*imc was the most important interaction which affected germination the most. Among main effects the trt had a non-significant effect.

Conclusion

The grain damage had a general increasing trend across all experimental combinations with advancement of storage duration. Untreated Green gram grains stored in HER bags had lowest grain damage at all IMCs compared to PLY bags, PLS bags and JUT bags in that order. Similarly treated grains behaved in the same manner across all combinations. The grain damage were lowe at IMC1 as compared to IMC3 at all experimental combinations. The hermetic bags performed better allowing minimum grain damage as compared to other types of bags. Hence the hermetic bags could be recommended for storing green gram safely for longer duration without affecting its quality.

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