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Evaluation of Triple Layer Hermetic Bags for Safe Storage of Seeds by the Small Holding Farmers in Anantapuramu District of Andhra Pradesh

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ABSTRACT: Post-harvest storage of seeds constitutes a major challenge for farmers in the rural areas of the Anantapuramu district as insect pests cause major losses during grain storage. Farmers use several storage technologies but most of them are not effective. During storage legumes and oil seeds are more vulnerable to insects which can cause discoloration, damage and/or weight loss of the product. Hermetic storage bags have been disseminated to prevent grain storage losses and excessive insect infestation. We carried out research in 5 villages with 5 farm families of the Anantapuramu district during 2018-19 to evaluate the performance of hermetic triple layer bags for the preservation of pulses (pigeon pea and greengram) groundnut for about four months. The assessed parameters were percent weight loss, percent grain damage and percent germination. The study revealed that the percent grain damage was 2.3 and the percent weight loss of stored greengram was found to be 1.13 after the completion of four months of storage. By using two different storing systems after four months revealed that grain damage and weight loss were31.61% and 13,50% respectively in pigeonpea, 13.73% and 7.91% respectively in greengram and 23.94% and 11.84% respectively in groundnut pods after completion of four months of storage in gunny bags. It is also evident that the germination capacity of seeds stored in gunny bags is also reduced when compared to seeds stored in hermetic bags. Our research findings suggest the advantages of using triple-layer bags over gunny bags and their suitability for small and marginal farmers in developing countries.

Keywords: Triple layer hermetic bag, percent grain damage, percent weight loss, germination percent.

INTRODUCTION

Agriculture is the backbone of the Indian economy and currently, this sector contributes to about 18% of India's GDP and around 50% of the population is dependent upon agriculture either directly or indirectly for its livelihood. India is one of the largest producers of over 80% of agricultural products. But largely due to storage inadequacies, most produce is prone to post-harvest losses. While post-harvest losses vary depending on crops, agricultural practices, climate, etc., storage is usually the primary reason in most cases. Most harvested grains are stored in traditional structures without any scientific design, and cannot protect crops against pests and decay. As a result, a bulk of stored grains and seeds were exposed to insect infestation, rotting and mold growth causing qualitative and quantitative losses. In India, around 40% of the total produce, is lost in post-harvest storage. Post-harvest food grain losses due to insects and molds have been estimated to be 10-15% (Grolleaud, 2002). Food losses in weight or volume are easy to measure but changes in grain or seed quality are difficult to assess and depend on whether the grain is for humans or for seed. Qualities such as color, flavor, or nutritional value govern consumer acceptance of grains and factors such as possible mycotoxin contamination can affect safety (Ekpa *et al.*, 2019). In the case of seed, germination percentage and seedling viability are the major concerns (Boxall, 2001).

Farmers most often struggle to prevent losses in stored grains and seeds which may affect their ability to maintain quality for consumption as well as planting. Due to lack of storage technology, most farmers decided to sell immediately after harvest to avoid storage pest losses (Barrett *et al*., 2010). Hermetic storage is a technology that enables farmers to store

their own seed for long periods without loss due to insects and without using any insecticides. The technology consists of enclosing seeds in air-tight containers that prevent or minimize gas exchange. Insect aerobic respiration depletes O_2 and increases CO_2 (Murdock *et al.,* 2012). There is no need for insecticides. Additionally, hermetic storage can impede the growth of fungi as these organisms also need oxygen to proliferate (Quezada *et al.,* 2006). This technique can maintain the seed quality of seed as well as grains for long-duration storage.

Majority of farmers in the Anantapuramu district store harvested produce such as paddy, pulses and groundnut at the household level in conventional gunny bags and polypropylene bags after sun drying. Hence the present study was under taken to compare traditional storage systems (polyethylene bag) along with hermetic storage technology (PICS bag) for determining the best storage technology for small holding farmers in the Anantapuramu district.

MATERIALS AND METHODS

On Farm Trial (OFT) was conducted by Krishi Vigyan Kendra, Reddipalli, Anantapuramu District of Andhra Pradesh during 2018-19 on evaluation of triple layer hermetic bags over gunny bags. A total of five locations were selected in Raghavampalli, Chakrayapeta, Peravali, Chamaluru and Mudigubba. Ten households were randomly chosen to test Hermetic bags based on the willingness of farmers to participate in the experiment. Groundnut, Redgram and Greengram were stored in hermetic bags for assessing their quality after four months of storage. The seeds stored in triple-layered hermetic bags were compared with conventional bags (Gunny bags). After harvesting, seeds of Paddy, Groundnut and Redgram were cleaned and sundried. Then the seeds were weighed and stored in gunny bags and Triple layered hermetic bags for four months respectively in five locations. Seed samples were drawn from the Triple layered Hermetic bags as well as from the gunny bags at monthly intervals and data on grain damage (%), weight loss (%) and germination (%) were observed. Accordingly, triple-layered bags were distributed to each farmer. Initial data such as percent germination, pest infestation, 100 seed weight and insect damage were collected one day prior to the start of the experiment. Final data was recorded on all these parameters at the end of each month upto four months storage period.

Grain damage (%). At the end of every month of the storage period, random samples of 100 grains were drawn from each bag and each sample was visually analyzed for grain damage by insects and pests. Grain damage was expressed in percent.

Grain damage (%) = [Number of damaged grains/Total number of grains exposed] × 100

Weight loss (%). The percent weight loss was calculated using initial and final grain weight measurements. Weight loss of grains was computed by following the formula suggested by Harris and Linblad (1978).

Weight Loss (%) = [(Initial Weight − Final Weight)/Total weight of taken grains] × 100

Germination Test. Germination percentage was determined on sand media in a plastic box**.**

RESULTS AND DISCUSSION

Pulses (Pigeonpea and Greengram) and groundnut pods stored for 4 months in triple-layer hermetic bags were compared to the pulses and groundnut pods stored in gunny bags. The data furnished in Table 1 revealed that grain damage percent and weight loss percent were nil or negligible in pigeonpea seeds stored in triple-layer hermetic bags (Table 1). The highest percent of grain damage and percent weight loss was found in Pigeonpea seed samples from the gunny bags, particularly after 4 months of storage at 31.61 and 13.50 respectively. While germination was found to be 87.9% in the 1st and 2nd months of hermetic bag storage which was reduced to 84, 9% after 4 months of storage. 81.1% germination was found in gunny bags during 1st month but a tremendous drop down to 72.6% was observed after four months of storage in gunny bags.

Table 1: Percentage evaluation of grain damage, weight loss and germination in pigeonpea.

Pigeonpea	1st Month		2nd Month		3rd Month		4th Month	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Grain damage (%)	-	3.46	-	9.30	-	18.4	-	31.61
Weight loss (%)	-	1.20	-	8.91	-	11.28	-	13.50
Germination %	87.9	81.1	87.8	76.2	86.7	75.4	84.9	72.6

T_1 – Triple Layer Hermetic Storage bag, T_2 – Gunny bag

Percent germination of greengram seed was recorded at 91.2 after one month of storage in gunny bags which was drastically reduced to 76.5 percent after four months of storage. Whereas, 90.2 percent germination was recorded with greengram seed stored under triple-layer hermetic bags even after four months of storage. Grain damage percent was also nil or negligible in the greengram stored with triple layer hermetic bags (Table 2) upto the third month and a very low percent of infestation (2.3%) was observed with 1.13% percent weight loss after four months of storage. Whereas the greengram seed stored in gunny bags was damaged to

13.73%, a percent weight loss of 7.91% was observed after four months of storage.

Table 2: Percentage evaluation of grain damage, weight loss and germination in greengram.

Greengram	1st Month		2nd Month		3rd Month		4th Month	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Grain damage (%)	-	1.82	-	3.52	-	8.2	2.3	13.73
Weight loss (%)	-	0.62	-	3.25	-	5.37	1.13	7.91
Germination %	94.9	91.2	93.2	87.3	92.6	80.8	90.2	76.5

T_1 – Triple Layer Hermetic Storage bag, T_2 – Gunny bag

It is evident from Table 3 that the percent of pod damage in groundnut was increased in gunny bags from 1.23 to 23.94 from 1st month to 4th month of storage. As a result of pod damage, the weight loss in groundnut pods also increased from 4.3% to 11.84% from 1st month to 4th month of storage. While weight loss percent and pod damage percent were nil in groundnut pods stored under triple-layer hermetic bags. The percent germination of groundnut pods stored with triple-layer hermetic bags and gunny bags was recorded at 92.0 and 89.1 after one month of storage. Whereas, the germination was reduced to 74.2 percent in groundnut after four months of storage, against 87.9 percent germination recorded in triple layer hermetic bag storage system.

Table 3: Percentage evaluation of grain damage, weight loss and germination Groundnut.

Groundnut pods	1st Month		2nd Month		3rd Month		4th Month	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Pod damage (%)	-	1.23	-	5.39	-	12.6	-	23.94
Weight loss (%)	-	4.32	-	7.60	-	8.93	-	11.84
Germination %	92.0	89.1	92.0	85.4	90.6	81.7	87.9	74.2

T_1 – Triple Layer Hermetic Storage bag, T_2 – Gunny bag

Our results establish that triple-layered bags are effective compared to gunny bags at suppressing storage pests thereby maintaining quality parameters of seed such as germinability and seed weight. According to (Freitas *et al.,* 2016), hermetic storage inhibits the development of insects thus preventing damage such as weight loss. This may be because the bags were airtight and sealed, which suffocates the insects by restricting the availability of oxygen and increasing the carbon dioxide concentration in bags (Murdock *et al.,* 2012). A high level of infestation was also observed in stored wheat when preserved in gunny bags (Singh *et al.,* 2001). Gunny bags caused better aeration for the stored insects due to their high porosity, which increased the moisture content of the grains and thereby higher infestation (Ali *et al.,* 2009). Thus, the present findings of a higher percentage of grain damage gunny bags were well explained and supported above. Apart from killing the infested insects, the triple-layered plastic bags were found to protect the seed embryo which was evident by the work of Omondi *et al.* (2011) who reported that the seeds stored in triple-layer plastic bags maintained the germination percentage of up to 85 percent when stored for a period of 9 months, compared to traditionally used storage gunny bags where the germination percentage was reduced to 14.76 percent within 3 months.

CONCLUSIONS

Triple-layer hermetic bags work in an eco-friendly manner as it does not involve the use of insecticides for managing the infestation by providing a modified environment with depleted levels of oxygen level. Hermetic storage is a cost-effective, durable and sustainable technique to store seed material for small and marginal farmers for the next season. Further pigeonpea, greengram and groundnut stored in triple-layer bags were found better in weight loss, germination quality and minimum pest infestation than traditional storage structures like gunny bags.

FUTURE SCOPE

Safe and scientific storage structures need periodic training and sensitization activities for farmers to improve awareness and ultimately adoption for promoting safe storage of seed.

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Conflict of Interest. None.

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