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Dr. K Bhagya Lakshmi
SMS (Home Science), KVK, Amadalavalasa, Srikakulam district, Andhra Pradesh, India

Dr. D Chnnam Naidu
Programme Coordinator, KVK, Amadalavalasa, Srikakulam district, Andhra Pradesh, India

Ch Sunitha
SMS (Horticulture), KVK, Amadalavalasa, Srikakulam district, Andhra Pradesh, India

Dr. G Chitti babu
SMS (Plant Protection), KVK, Amadalavalasa, Srikakulam district, Andhra Pradesh, India

Corresponding Author:
Dr. K Bhagya Lakshmi
SMS (Home Science), KVK, Amadalavalasa, Srikakulam district, Andhra Pradesh, India

Triple layered hermetic bags for storage of pulses by the small holding farmers in Srikakulam district of Andhra Pradesh

Dr. K Bhagya Lakshmi, Dr. D Chnnam Naidu, Ch Sunitha and Dr. G Chitti babu

Abstract
Reducing post-harvesting losses is an enduring problem for the farmers in India and other developing countries. Losses during storage account for the maximum portion of post harvesting losses. In India majority of the farmers belong to the small and marginal farmers, where the availability of infrastructure facilities are meager at farmer's level. Farmers generally store the harvested produce in gunny bags or polypropylene bags, which may not provide safe and conducive environment from pests and insects. Cost effective and environment friendly storage technologies need to be introduced to the farmers for reducing the storage losses at field level. By considering the immense need for preventing storage losses, On Farm Trial (OFT) on assessment of triple layer hermetic bags was conducted by Krishi Vigyan Kendra, Amadalavalasa from 2017-2018. A total number of 5 locations (5 farm families) in Nimmatorlavada, Divanjipeta, Kongaram villages were selected for the study. Black gram and Green gram were stored in triple layer hermetic bags for assessing the quality of pulses after 4 and 6 months of storage. The study revealed that the the mean number of adult insects found in black gram stored in conventional bags were 17.00 and hermetic bags were 2.60.The mean number of insects in green gram stored in hermetic bags were 3.00 after six months of storage. the percentage of damage in pulses stored using two different storing systems after six months revealed that the number of bored grains in black gram was 28.32 per cent in conventional bags used by farmers practice and green gram. Whereas the number of bored grains percentage is found to be nil in many locations in both black gram and green gram.

Keywords: Post Harvesting Losses, Storage Losses, Triple Layer Hermetic bags, Germination percentage

Introduction
Harvested agricultural produce has to go through different post harvesting practices such as drying, threshing, winnowing, bagging, transportation, storage and processing before usage and marketing by the farmer. Though the agricultural produce is prone to losses in all the above stages, storage losses account for major fraction of losses in India. Several studies reported that most of the losses during storage are caused by insects, moulds, rodents and birds,which result in weight loss, mould development, reduction in germination in seeds, loss in nutritive value and market value. In India, the post harvesting losses of food grains account to more than 20 million tones which is approximately 10% of the total food grains produced, which is equivalent to the total food grains produced annually in Australia (Basavaraja *et al*., 2007) [1].

Majority of the farmers in srikakulam district are small and marginal farmers and they generally store the harvested produce such as paddy, pulses, maize, groundnut, sesame at household level in conventional gunny bags and polypropylene bags after sun drying. Nearly 60-70 percentage of grains in are stored at household level for family consumption or seed purpose. These conventional storage bags without scientific technology cannot provide protection from rodents, insects and moulds. The issue of ineffective and inefficient storage system is largely due to the use of traditional or improved traditional storage structures which lacks capacity, durability and efficiency for providing safe storage for grains. In conventional storage majority of the farmers use pesticides and fumigants indiscriminately to control pests and moulds, which are hazardous to health and environment. This condition demands for implementation extension activities for popularization of suitable cost effective storage technologies. Triple layered hermetic bags provide an affordable storage solution for small and marginal farmers. The triple layered hermetic bags consist of two plastic bags with 100-µm thickness (made of polyethylene) put inside the third woven polythene bag. The pulses were stored without use of any type of insecticide or chemical treatment.

Triple layer hermetic bags are improved storage bags which consists of three bags one is inserted into another, which provides air tight or sealed environment to the stored grains. Its basic principle is the generation of oxygen depleted, carbon dioxide and nitrogen enriched interstitial atmosphere caused by either the natural respiratory activities of living organisms in the bulk, or enhanced and accelerated by artificial means in an air tight storage structure (Jonfia, 2010) [2].

In view of the above facts, Krishi Vigyan Kendra, Amadalavalasa conducted an on -farm trial on Assessment of Triple layer hermetic bags for storage of grains by small holder farmers in the year 2017-2018. The main objective of the study was To Assess the efficacy of Triple Layer Hermetic bags for storage of pulses.

Materials and Methods

The present study was conducted by Krishi vigyan Kendra, Amadalavalasa of Srikakulam District, Andhra Pradesh in the year 2017-18. A total number of 5 locations (5 farm families) in Nimmatorlavada, Divanjipeta, Kongaram villages were selected for the study. Black gram and Green gram were stored in hermetic bags for assessing the quality of pulses after 6 months of storage. The pulses stored in triple layered hermetic bags were compared with the conventional bags (Gunny and polypropylene bags). After harvesting, black gram and green gram were cleaned, sundried up to 13% moisture content. Then the pulses were weighed and stored in conventional bags and Triple layered hermetic bags in for six months respectively in five locations.

Triple layered hermetic bags The sun dried pulses were poured in the inner most bag of triple layered hermetic bag then pressed gently to remove the air and bend like "U" shape and secured tightly with a rope. Then the second and third layers were tightened to create hermetic conditions.

The same thing was done for polypropylene bags. The pulses were stored from the month of March 2017 to August 2017. A total number of 20 samples comprises of 10 black gram (5 from hermetic bags and 5 conventional bags) and 10 green gram (5 from hermetic bags and 5 from conventional bags) were taken for assessment in the present study. The quality of the pulses in terms of infestation, Damage of grains, was assessed before and after storage of pulses. Data collected on infestation, damage of gains was assessed before and after storage of pulses for six months in hermetic bags and conventional bags.

a) Insect infestation: at the beginning of the experiment, 3 samples of 500gms of pulses per bag was collected using random sampling method. Then the samples were sieved to separate the insects. The same thing was repeated after six months of storage in hermetic bags and conventional bags. The insect infestation was assessed before and after storage of pulses in hermetic bags as well as conventional bags for six months.
b) Percent of damage: - One hundred seeds were selected randomly from each bag and number of bored grains in the total sample was counted. The no of seeds damaged were determined initially and after six months of storage.

$$\text{Percent of damage} = \frac{\text{Nb X 100}}{\text{Nt}}$$

Nb = Number of bored grains
Nt = Total number of grains in the sample

Results and Discussion

The pulses stored for six months in hermetic bags were compared to the pulses stored Conventional bags. It is evident from the table.1 that the mean number of adult insects found in black gram stored in conventional bags were 17.00 per 500 gms. Whereas the adult insects found in black gram stored in conventional bags were 17.00 per 500 gms. Whereas the mean number of insects in black gram stored in hermetic bags were 1.00 per 500 gms after six months of storage. This may due to the fact that, as the bags were airtight and sealed which suffocates the insects by restricting the availability of oxygen and by increasing the carbon dioxide concentration in bags. The results are inconformity with the results indicated by (Murdock *et al*., 2012) [3], (Michael K. Ndegwa 2016) [3] and (Asha Kumari and Mukesh Shrivastava 2018)

Table.1: Insect infestation in black gram stored using two different storing systems after Six months in Five Locations 2017-18.

Locations	Name of the Village	Name of the seed	Type of storage			
			Polypropylene bags		Hermetic bags	
			No of insects /500 gms		No of insects /500 gms	
			Initial	Final (After six months)	Initial	Final (After six months)
Location -1	Nimmatorlawada	Black gram	0.00	21.0	0.00	2.0
Location -2	Divanjipeta	Black gram	0.00	12.0	0.00	0.0
Location -3	Divanjipeta	Black gram	0.00	24.0	0.00	3.0
Location-4	Divanjipeta	Black gram	0.00	17.0	0.00	0.0
Location -5	Kongaram	Black gram	0.00	12.0	0.00	0.0
Mean			0.00	17.00	0.00	1.00

It is evident from the table-2 that the number of insects are relatively high (29.0) in green gram stored in conventional bags as commonly practiced by the farmers when compared to hermetic bags (1.4). The hermetic bags are made of plastic with low permeability to atmospheric gases, respiration by the grain, insects and fungi lead to a reduction in oxygen and an increase in carbon dioxide with in the hermetic bag (Murdock *et al*., 2012) [3]. Findings are inconformity with the results obtained by L. Amadou *et al.,* (2016) [3], Mutambuki *et al*, (2019) [6] and Kimondo *et al.,* (2019) [6] who used hermetic bags for storage of hibiscus sabdariffa grain.

Table.2: Insect infestation in Green gram stored using two different storage systems after Six months in five Locations 2017-18.

Locations	Name of the Village	Name of the seed	Type of storage			
			Polypropylene bags		Hermetic bags	
			No of insects /500 gms		No of insects /500 gms	
			Initial	Final	Initial	Final
Location - 1	Nimmatorlawada	Green gram	0.00	31.0	0.00	3.0
Location - 2	Divanjipeta	Green gram	0.00	29.0	0.00	2.0
Location- 3	Divanjipeta	Green gram	0.00	32.0	0.00	0.0
Location - 4	Divanjipeta	Green gram	0.00	32.0	0.00	2.0
Location - 5	Kongaram	Green gram	0.00	21.0	0.00	0.0
Mean			0.00	29.0	0.00	1.4

It is evident from the table 3 and 4 that the percentage of damage in pulses stored using two different storing systems after six months revealed that the number of bored grains in black gram and green gram in conventional bags was 34.4 per cent and 38.8 per cent after six months of storage. Whereas the number of bored grains percentage is found both in black gram and green gram was 1 to 1.2 percent in hermetic bags.

Table 3: Percentage of damage in pulses stored using two different storing systems after six months in Five Locations during 2017-18.

Locations	Name of the Village	Name of the seed	Type of storage			
			Conventional bags		Hermetic bags	
			No. of bored seeds (%)		No. of bored seeds (%)	
Location -1	Nimmatorlawada	Black gram	0.00	33.0	0.00	2.0
Location -2	Divanjipeta	Black gram	0.00	31.0	0.00	3.0
Location -3	Divanjipeta	Black gram	0.00	25.0	0.00	0.0
Location-4	Divanjipeta	Black gram	0.00	45.0	0.00	0.0
Location -5	Kongaram	Black gram	0.00	38.0	0.00	0.0
Total			0.00	34.4	0.00	1.0

Table 4: Percentage of damage in green gram stored using two different storing systems after Six months in Five Locations during 2017-18.

Locations	Name of the Village	Name of the seed	Type of storage			
			Conventional bags		Hermetic bags	
			No. of bored seeds (%)		No. of bored seeds (%)	
Location -1	Nimmatorlawada	Greengram	0.00	36.0	0.00	4.0
Location -2	Divanjipeta	Greengram	0.00	34.0	0.00	2.0
Location -3	Divanjipeta	Greengram	0.00	29.0	0.00	0.0
Location-4	Divanjipeta	Greengram	0.00	51.0	0.00	0.0
Location -5	Kongaram	Greengram	0.00	44.0	0.00	0.0
Total			0.00	38.8	0.00	1.2

Conclusion

Storage losses account for huge fraction of post harvesting losses in pulses due to pests and mycotoxins produced by moulds. Pulses need to be stored in a safe and scientific method to reduce storage losses. Nevertheless, majority of the farmers in the district are small and marginal farmers store harvested produce at household level without using of proper scientific storage methods. The results of the investigation indicating that the considerable insect infestation and percent damage was found in conventional storage bags used by the farmers when compared to hermetic bags. Hence, safe and scientific storage structures need to be promoted by the extension agencies for reducing the post harvesting losses in pulses.

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