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SVS Gopala Swamy
Post-Harvest Technology Centre, Bapatla, Guntur Dt. Andhra Pradesh, India

B John Wesley
Post-Harvest Technology Centre, Bapatla, Guntur Dt. Andhra Pradesh, India

D Sandeep Raja
Post-Harvest Technology Centre, Bapatla, Guntur Dt. Andhra Pradesh, India

S Vishnuvardhan
Post-Harvest Technology Centre, Bapatla, Guntur Dt. Andhra Pradesh, India

Correspondence
SVS Gopala Swamy
Post-Harvest Technology Centre, Bapatla, Guntur Dt. Andhra Pradesh, India

Feasibility of sand layer technique for small scale storage of pulses seed

SVS Gopala Swamy, B John Wesley, D Sandeep Raja and S Vishnuvardhan

Abstract

The pulse beetles, *Callosobruchus sp*, have been recognized as major post-harvest insect pests of stored pulses in tropical and subtropical countries whose damage leads to qualitative and quantitative deterioration making them unfit for sowing or human consumption. Taking into consideration of the insects' behaviour to seek the top surface in a storage bin for mating and egg laying even though they emerge from the grain far below, the technique of sand layer of 3 cm over the grain surface was developed to prevent bruchid infestation. Slight modification was made to this technique and tested for storage of various pulses meant for seed purpose at Post Harvest Technology Centre, Bapatla. The germination of blackgram, greengram and pigeonpea seed irrespective of the variety was retained even after nine months of storage under sand layer in the modified bins compared to the seed stored conventionally in gunny bags. Storage conditions in the modified system did not show any deleterious effect on viability of seeds and there was no cross infestation of bruchids as the sand layer successfully prevented their entry. This may be a simple and cheaper technique which can help small and marginal farmers to store their seed material in quantities sufficient for their land holdings till the next season with minimum expenditure and without any loss in weight and germination due to bruchid infestation.

Key words: Pulse beetle, pulses seed, sand layer, seed storage, germination

1. Introduction

India is the world's largest producer and consumer of a wide variety of grain legumes such as chickpea, pigeonpea, blackgram, greengram, and lentil. Pulses are referred as the second most important food source after cereal grains as they are cheapest and richest source of plant protein in the daily diet of most vegetarian population of India and also described as poor man's meat. Although about 22.95 million tonnes of pulses was produced during 2016-17 from an area of 29.47 million hectare [1] including the area newly brought in to pulse crop cultivation, India had to import about 50.8 lakh tonnes of pulses to meet the domestic requirement and buffer maintenance which emphasizes the need of increased production and productivity of pulses by more intensive technological interventions. On the other hand, the extensive post-harvest losses of pulses both in terms of quantity and quality impact their availability and acceptability. According to the latest study, the overall quantitative total harvest and post-harvest losses for pulses at national level ranged from 6.36% (pigeonpea) to 8.41% (chick pea) while losses during storage ranged from 1.18% (chickpea and blackgram) to 1.67% (pigeonpea) [2]. The losses may also be attributed to prolonged insect infestation which can occur at any stage during the harvest, storage, transport and handling. The pulse beetles, *Callosobruchus sp* (Coleoptera: Chrysomelidae), have been recognized as major post-harvest insect pests of stored pulses in tropical and subtropical countries [3]. Though infestation occurs primarily in the field itself and later under stored condition through cross-infestation, which can be noticed only after emergence of adult insects as the larval development and pupation are completed entirely within a seed and by then the produce has been damaged to a maximum extent. The pulse bruchids can cause damage as high as 50 percent or more as reported in case of lentils [4], or even 100 percent as reported for chickpeas [5]. The short life cycle and high rate of multiplication of bruchids; up to 30 fold increase in population with every generation that lasts for about four weeks under ideal conditions [6], leads to qualitative and quantitative deterioration of stored pulses making them unfit for sowing or human consumption.

For achieving self-sufficiency in pulses with projected requirement of 27.5 MT by the year 2025, apart from productivity enhancement, an additional area of about 3-4 M ha has to be brought under pulses; which is possible only when quality seed is available at the disposal of small and marginal farmers. Since seeds are the main genetic linkage between two generations of a plant species, they should be stored in such a manner, that its germination capacity, viability and vigour should not decline till it is planted in the next season. The AICRP on Post harvest Technology, University of Agricultural Sciences, Bangalore has developed a simple, cheap and low cost non-chemical method of storing pulse grains safely for a longer period which involves an extended sun-drying of grains to remove the field infestation followed by placement of a sand layer of 3 cm thick above the grain mass held in a plastic or metal bin with a air-tight lid to prevent any possible cross-infestation [7]. The instinct of the beetles is to seek always the top surface in a storage bin for mating and egg laying even though they emerge from the grain far below. Taking this into consideration, sand layer was chosen to disrupt the insects' behaviour. The effectiveness of this technique in prevention of bruchid infestation was successfully demonstrated [8-10]. However, if the storage of pulses is for sowing in the next season, there is a concern that the seed may lose germination due to heat built up consequent to the seed respiration in the tightly closed plastic container. Keeping this in view, slight modification was made to the sand layer technology and tested for storage of various pulses meant for seed purpose.

2. Materials and Methods

After the observance of good retention of germination (> 85%) of blackgram (LBG 752) even after 18 months of storage with surface sand layer in small plastic jar (3 kg) in a preliminary laboratory experiment, the containers capacity was scaled up. Plastic drums of (50 liter capacity) were used for storage of pulses seed and they were provided with small holes at one inch above the bottom line and secured with nylon net only to allow aeration (Figure 1). River sand was collected, sun dried and cooled to ambient temperature and then passed through 1.7 mm sieve to remove pebbles. Sand was placed inside the container as a bottom layer (approx. 3 cm thick) so as to cover the holes, on which about 45 kg of pulses seed was kept. Again on the surface of the seed, another layer (3 cm thick) of sand was placed and covered with perforated plastic lid. This whole setup was made to prevent the insect entry and allow sufficient air required for seed respiration so that seed germination may not be affected. Similarly, the experiments were conducted with blackgram, greengram and pigeonpea seed for two consecutive years 2016 - 17 and 2017-18. Each crop seed produce was tested with modified setup at three different locations as per the availability *i.e.*, at Post Harvest Technology Centre (PHTC), Bapatla, Guntur District, Regional Agricultural Research Station (RARS), Lam, Guntur district; Agricultural Research Station (ARS), Ghantasala, Krishna district; Krishi Vigyan Kendra (KVK), Garikapadu, Krishna district and Agricultural Research Station (ARS), Darsi, Prakasam district, Andhra Pradesh. Before the experiment was initiated, carryover of the field infestation was removed by sun drying of freshly harvested pulses seed for 3-5 days and the moisture content was also brought to safer levels (8-10 percent). For comparison, pulses seed of same variety was also kept filled in jute sacks and stacked on wooden pallets as normal storage, however, they received periodical surface treatments with chemical insecticides. Seed samples were drawn from the seed sandwiched between sand layers in the plastic containers as well as from the jute bags at three months interval and data on grain damage (%) and germination (%) were observed.

3. Results and Discussion

The results indicated that germination of all the pulses stored under sand layer in the modified plastic drums was retained safe for storage period of more than six months compared to those stored in gunny bags maintained under protected conditions. During 2016-17, the mean germination of blackgram seed after six months of storage in the modified set up was 98.5 percent, while it was 95.0 percent in conventional method of storage *i.e*., in gunny bags (Table 1). Similarly, the percent germination of greengram stored with sand layer in the modified bin and in gunny bags was 99.22 and 84.0 respectively. Whereas, the mean germination was reduced to 48.66 percent in pigeonpea stored conventionally, against 92.33 percent germination recorded with pigeonpea stored under sand layer in the modified bin even after six months. At one location, where the seed was stored in gunny bag without any protection complete damage due to bruchids was observed and the germination percent was zero.

Similarly, during 2017-18, the germination of the three different pulses irrespective of the variety was retained even after nine months of storage under sand layer in the modified bins compared to the seed stored conventionally in gunny bags (Table 2). The mean percent germination of blackgram stored with sand layer in the modified bin and in gunny bags was 92.67 and 74.78 respectively. Whereas, the mean germination was reduced to 56.67 percent in greengram after nine months of conventional storage, against 84.0 percent germination recorded with modified set up. Percent germination of pigeonpea seed recorded at 83.78 after three months of storage in gunny bags was dropped down to 49.66 percent after nine months. Whereas, 90.33 percent germination was recorded with pigeonpea seed stored under sand layer in the modified containers even after nine months. Grain damage percent was also nil or negligible in the pulses stored with sand layer (Table 3). Whereas the pulses seed stored in gunny bags were damaged by bruchids inspite of regular insecticide applications. Greengram suffered more damage (36.50%) compared to other two pulses. Similarly, pigeonpea under unprotected conditions also recorded more damage (51.0%). The differences in grain damage as well as germination among different locations particularly for the pulses stored in gunny bags were due to varied levels of cross infestation and grain protection measures taken in those storage facilities. Storage conditions in the modified system did not show any deleterious effect on viability of seeds and inspection of the grain was not difficult. Though the experimental set up was placed in the seed godowns where huge bulks of pulses seed was stored, there was no cross infestation by bruchids as the sand layer successfully prevented their entry. The results are in conformity with the earlier reports [9, 10].

Instead of plastic drums, large sized earthen pots also can be used as micro pores will suffice for the gaseous exchange of the seed material. The percent germination of blackgram and greengram was found unaffected after nine months of storage in earthen pots (30 l capacity) with sand layer technique and there was no grain damage (Table 4). Whenever seed is required for sowing, sand can be separated out using 1.7 mm sieve. After every time of use, ensuring replacement of 3 cm sand layer on the grain surface is very important to avoid further cross infestation of pulse bruchids. Pulse grains treated by this method can be effectively stored for any length of time as long as the sand layer is not disturbed and grains are not exposed [11]. Although several management options including environmental manipulations to discourage growth, development and reproduction of storage insect pests [12] have been developed globally and proved effective, the availability of low cost and effective storage structures and technology interventions can play a critical role in reducing post-harvest losses and increasing small holding farmers' revenues [13].

4. Conclusion

This may be a simple and cheaper technique which can help small and marginal farmers to store their seed material for the next season with minimum expenditure and without any loss in weight and germination due to bruchid infestation. Recommended seed rate per hectare for blackgram crop is 20 kg in uplands and 35-40 kg in rice fallows in Andhra Pradesh conditions. For greengram crop, the recommended rate is 15 kg and 25-30 kg per hectare in uplands and in rice fallows respectively. For pigeonpea, the seed rate of 10-12 kg per hectare is recommended. Hence, following this system of storage, small and marginal farmers can safely store the pulses seed material in quantities sufficient for their land holdings without losing viability till the next season. This method is highly indigenous and necessary modifications can be done using locally available material. Thus, sand layer over the grain surface has considerable potential as an alternative to chemical grain protectants and it is very cheap and easy to apply.

Table 1: Germination (%) of seed pulses stored using two different systems after six months (2016-17)

Pulses (Variety)/Place	**Storage system**	
	Modified Plastic drum with sand layer	**Gunny bag**
Blackgram (LBG 752)		
PHTC, Bapatla	99.0	93.0
ARS, Ghantasala	98.0	97.0
Mean	98.5	95.0
Greengram (LGG 460)		
PHTC, Bapatla	100.0	99.0
RARS, Lam	100.0	57.0
ARS, Ghantasala	97.67	96.0
Mean	99.22	84.0
Pigeonpea (LRG 41)		
RARS, Lam	96.67	84
KVK, Garikapadu	91.0	62
ARS, Darsi	89.33	0
Mean	92.33	48.66

Table 2: Germination percent of different seed pulses stored under sand layer (2017-18)

Pulses / Place (variety)	**Modified system**	**Gunny bag**	**Modified system**	**Gunny bag**	**Modified system**	**Gunny bag**
	After 3 Months		**After 6 Months**		**After 9 Months**	
Blackgram						
RARS, Lam (LBG 752)	95.67	81.0	95.33	75.33	95.33	70.0
ARS, Ghantasala (LBG 752)	87.67	87.33	87.33	80.0	87.0	63.33
KVK, Garikapadu (GBG 1)	97.0	95.33	96.67	91.0	95.67	91.0
Mean	93.45	87.89	93.11	82.11	92.67	74.78
Greengram						
RARS, Lam (LGG 574)	97.33	95.33	96.67	83.33	96.33	68.0
ARS, Ghantasala (LGG 460)	74.67	72.33	72.67	64.33	71.67	45.33
Mean	86.0	83.83	84.67	73.83	84.0	56.67
Pigeonpea						
RARS, Lam (LRG 52)	96.67	94.67	92.67	89.67	92.33	88.33
KVK, Garikapadu (TRG 59)	91.0	90.0	90.33	60.0	86.67	47.33
ARS, Darsi (LRG 41)	94.67	66.67	92.33	41.0	92.0	13.33
Mean	94.11	83.78	91.78	63.56	90.33	49.66

Table 3: Grain damage (%) of different seed pulses stored under sand layer (2017-18)

	Modified system	**Gunny bag**	**Modified system**	**Gunny bag**	**Modified system**	**Gunny bag**
	After 3 Months		**After 6 Months**		**After 9 Months**	
Blackgram						
RARS, Lam (LBG 752)	0.0	1.33	0.0	5.0	0.33	10.33
ARS, Ghantasala (LBG 752)	0.0	0.67	0.0	1.0	1.0	1.0
KVK, Garikapadu (GBG 1)	0.0	0.33	0.0	1.0	0.0	3.0
Mean	0.0	0.78	0.0	2.33	0.44	4.78
Greengram						
RARS, Lam (LGG 574)	0.0	2.33	0.0	12.67	0.67	51.33
ARS, Ghantasala (LGG 460)	0.0	16.67	0.0	19.33	0.0	21.67
Mean	**0.0**	**9.50**	**0.0**	**16.0**	**0.34**	**36.50**
Pigeonpea						
RARS, Lam (LRG 52)	0.0	0.0	0.33	1.0	0.33	2.33
KVK, Garikapadu (TRG 59)	0.0	0.33	0.0	0.67	0.67	10.67
ARS, Darsi (LRG 41)	0.33	4.67	0.67	40.33	0.67	51.0
Mean	0.11	1.67	0.33	14.0	0.56	21.33

Table 4: Germination (%) and damage (%) of pulses seed stored in earthen pot with sand layer and gunny bag (2017-18)

Produce (variety)/ Storage system	Germination (%)			Grain damage (%)		
	After 3 Months	After 6 Months	After 9 Months	After 3 Months	After 6 Months	After 9 Months
Blackgram (LBG 752)						
Earthen pot with sand layer	96.67	96.0	95.67	0.0	0.0	0.0
Gunny bag	45.0	40.67	17.67	24.0	26.67	42.0
Greengram (GGG 1)						
Earthen pot with sand layer	95.33	89.0	54.67	0.0	0.0	0.0
Gunny bag	91.0	81.67	35.67	2.33	6.33	12.67

Fig 1: Modified plastic drum for storage of pulses seed

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