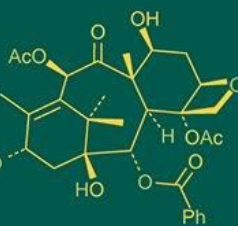
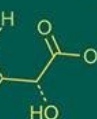


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Comparison of Farmers practice with Triple Layer PICS bag for Storage

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Abstract

The experiment was laid out in by Factorial CRD with two factors: four types of bags (Factor A) *i.e* jute bag, polythene bag, triple layered PICS bag and jute bag treated with chloropyriphos and three storage periods (Factor B) *i.e* 2, 4 and 6 months. Each treatment contained healthy dolichos bean seed with 10% of seed with artificial infestation of bruchid *Callosobruchus theobromae*. Results on moisture content showed that there was no decrease in moisture content in triple layer PICS bag (10.23, 10.41 and 10.46), Germination per cent in triple layer PICS bag (93.67, 93.33 and 93.00), test weight of 100 seeds revealed that the triple layer PICS bag (23.48, 23.42 and 23.41) at 2, 4 and 6 months storage respectively recorded less loss in test weight compared to other storage bags. After 2-, 4- and 6-months storage period, in triple layer PICS bag the protein content (%) (38.917, 38.50 and 37.76) and carbohydrate content (%) (19.37, 19.26 and 19.24) were high. The mean fat content (%) recorded was highest in jute bag (1.25) and lowest in triple layer PICS bag (0.63). Lowest bruchid infestation was recorded in triple layer PICS bag (13.27, 13.35 and 13.38), the low oxygen level (%) were recorded in triple layer PICS bag (11.27, 7.17 and 6.10) and high level (%) of carbon dioxide (6.77, 8.47 and 11.83) at 2-, 4- and 6-months storage creating hypoxia and hypercarbia conditions. No change in temperature and high relative humidity in triple layer PICS bag was recorded (60.5, 61.0 and 62.0) at 2-, 4- and 6-months storage compared to all other types of storage bags. The benefit cost ratio calculated for all the treatments showed that triple layer PICS bag (1.27) at 6 months storage period has highest benefit cost ratio.

Keywords: PICS bag, Jute bag, Polythene bag, Storage, Hypoxia, Hypercarbia

1. Introduction

Dolichos bean (*Lablab purpurea* L.) also known as Dolichos bean or hyacinth bean belongs to family Fabaceae and is native to India and mainly cultivated as an intercrop with cereals. In South India this crop is mainly cultivated for its fresh green pods which are used as vegetable and its dry seeds, which are used for various preparations of various dishes. The other plant parts a used are also used as fodder for livestock. The green pods are rich in vitamin A, vitamin C, protein, iron and calcium. The dried seeds are high in protein, carbohydrates and fat. Dolichos bean major producing states are U.P, Telangana, M.P, West Bengal, Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Haryana and Kerala.

The nutritive value of Dolichos bean is higher than that of French bean as stated by Aykroyd, 1963. The mature seeds contain a high amount of protein (Schaaffhausen, 1963). The crop can suffers losses both during cultivation and while storage. Infestation by bruchids makes the pulses unfit for consumption due to presence of excreta and metabolic by- products such as uric acid which can cause fungal infections in the grains (Gowda and Kaul, 1982). Most pulses are vulnerable to pulse beetles primarily mainly due to poor management practices and lack of resistant varieties against bruchids. If proper precautions are not taken, the damage caused by bruchids can reach up to 100%.

Purdue Improved Crop Storage (PICS) bag is a straight forward and effective method for minimizing grain loss due to insects during storage after harvest. The technology was originally designed for storing cowpea in West Africa this technology is now utilized for various cereal and legume crops like maize, beans, sorghum, mung bean, pigeon pea, wheat and rice. It has been adapted in numerous countries spread to many countries across Sub-Saharan Africa and Asia. Since 2007, the distribution of PICS bags has been extensive. However. Despite this, the 3.5 million PICS bags used so far have contributed to only 1600

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tons of plastic (Ogunniyi, 1990) ^[4]. PICS bags are made of two layers of high-density polyethylene (HDPE, 80µ thick) inner bags and a single polypropylene (PP) woven outer bag (Baributsa *et al.*, 2012) ^[5], they offer significant protection of cowpea grain against bruchid seed beetles in West Africa (Murdock *et al.*, 2012; Baoua *et al.*, 2012, 2013) ^[5, 7, 8]. The effectiveness of triple layer PICS technology is due to its airtight nature. Threshed grain is placed into HDPE bags with a capacity of 50-100 kg and walls 80µ thick, making sure the bag is filled properly without air pockets, leaving a 20 to 30 cm neck.

PICS bags function similar to other hermetic storage systems such as sealed steel drums (Seck *et al.* 1996) ^[10] as insects breathe oxygen and consume it in an airtight environment, also increasing the level of CO₂. Once the oxygen level in the container drops significantly, the insect stops feeding and become inactive (Margam, 2009) ^[11]. This inactivity halts their growth and development and subsequently, their ability to reproduce. This leads to suppression of the pest population. During the period of oxygen deficiency, the insects start dying with early stage larvae and pupae being especially vulnerable. Farmers can use PICS bags for at least three years to store produce (Baributsa *et al.*, 2014; Moussa *et al.*, 2014) ^[6, 12]. PICS bags that have been used for several years are still as effective as new ones (Baoua *et al.*, 2012) ^[5]. When PICS bags lose their air tight seal, farmers can still use them for storing crops that are less prone to pest infestation (Baributsa *et al.*, 2014) ^[6].

2. Materials and Methods

2.1. Location of work

The present investigation was carried out at College of Horticulture, Rajendranagar, Hyderabad, Telangana.

2.2. Dolichos Bean Seeds

Approximately 180 kg of dried dolichos bean seeds of leading commercial variety RND-1 with initial seed moisture of 10% were obtained from National Seed Corporation.

2.3. Storage Bags

Four different types of storage bags *viz.*, (i) Jute bags (ii) Polythene bags (iii) Triple layered plastic bags (PICS) and (iv) Jute bags treated with Cholorpyrifos were used for evaluating their efficacy in managing dolichos bean bruchid.

2.4. Dolichos Bean Bruchids (*Callosobruchus theobromae*)

Initial culture of dolichos bean bruchid, *C. theobromae*, were collected from naturally infested dried dolichos bean seeds stored in the godowns in the market. The bruchid population was then multiplied under laboratory conditions. The fully multiplied inoculum of seeds with live adults and seeds covered with creamy eggs is used for the experiment for initial 10% infestation i.e, 500 g infested seed with 4.5 kg healthy dolichos bean seed for each treatment.

2.5. Mean temperature and relative humidity

Mean temperature and relative humidity and dew points within the sealed bags were automatically recorded every hour from the beginning of the experiment till the end of the experiment, over a period of six months by placing the programmed data loggers (Lascar model EL-USB-2, Whiteparish, Wiltshire, Great Britain) in the storage bags. The meteorological data pertaining to mean minimum and maximum temperatures, relative humidity and rainfall in weekly averages during the period of experiment was recorded at ARI, Meteorological Station, Rajendranagar.

3. Lay out of experiment

The treatments used were T₁: Jute bag+5 kg dolichos bean seeds @10% moisture stored for 2 months; T₂: Jute bag+5 kg dolichos bean seeds @10% moisture stored for 4 months; T₃: Jute bag+5 kg dolichos bean seeds @10% moisture stored for 6 months; T₄: Polythene bag+5 kg dolichos bean seeds @10% moisture stored for 2 months; T₅: Polythene bag+5 kg dolichos bean seeds @10% moisture stored for 4 months; T₆: Polythene bag+5 kg dolichos bean seeds @10% moisture stored for 6 months; T₇: Triple layer PICS bag+5kg dolichos bean seeds @10% moisture stored for 2 months; T₈: Triple layer PICS bag+5 kg dolichos bean seeds @10% moisture stored for 4 months; T₉: Triple layer PICS bag+5 kg dolichos bean seeds @10% moisture stored for 6 months; T₁₀: Jute bag treated with insecticide +5 kg dolichos bean seed @10% moisture stored for 2 months; T₁₁: Jute bag treated with insecticide +5 kg dolichos bean seeds @10% moisture stored for 4 months and T₁₂: Jute bag treated with insecticide +5 kg dolichos bean seeds @10% moisture stored for 6 months. The experiment conducted in CRD.

4. Methodology

Initial data on test weight (g), germination per cent (%), moisture content (%), damage of seeds by bruchid and composition of biochemical constituents *viz.*, carbohydrate content (%), fat content (%) and protein content (%) were recorded for the dolichos bean seeds with 10% moisture content just a day before the setting up of the experiment. After the experiment was set up, all the bags were closed and the data on various parameters pertaining to insect damage, seed characteristics and changes in biochemical composition of dolichos bean seeds stored in different bags was recorded at every two months interval, starting initial, two months interval, four months interval and six months interval.

4.1. Oxygen (O₂) and Carbon dioxide (CO₂) concentrations

Oxygen (O₂) and Carbon dioxide (CO₂) concentrations were recorded using a Mocon PAC Check 183 Model 325 head space analyzer (Mocon, Minneapolis, MN, USA).

4.2. Comparison of jute bag (Farmers practice) with triple layer PICS bag (improved storage practice)

Table 1: Effect of Storage Period and Storage Containers on Quality Parameters of Dolichos Bean Seeds

S. No.	Storage period	Parameter	Initial value	Jute bag (Farmers' practice)	Triple-layer PICS bag	Advantage of PICS bag over jute bag
1	2 months	Moisture content (%)	10.00	8.60	10.23	1.63 (18.95%)
2	2 months	Germination (%)	95.00	85.33	93.67	8.34 (9.77%)
3	2 months	Test weight (g)	23.60	20.23	23.48	3.25 (16.06%)
4	2 months	Protein content (%)	40.00	18.72	19.37	0.65 (3.47%)
5	2 months	Carbohydrate content (%)	20.04	35.94	38.92	2.98 (8.29%)
6	2 months	Fat content (%)	1.00	1.48	0.61	PICS bag showed lower fat content than jute bag
7	2 months	Bruchid infestation (%)	0	25.91	13.27	12.64 (48.78%); infestation lower in PICS bag
8	4 months	Moisture content (%)	10.00	8.52	10.41	1.89 (22.18%)
9	4 months	Germination (%)	95.00	84.00	93.33	9.33 (11.10%)
10	4 months	Test weight (g)	23.60	18.83	23.42	4.59 (24.37%)
11	4 months	Protein content (%)	40.00	18.50	19.26	0.76 (4.10%)
12	4 months	Carbohydrate content (%)	20.04	34.85	38.51	3.66 (10.50%)
13	4 months	Fat content (%)	1.00	1.41	0.61	PICS bag showed lower fat content than jute bag
14	4 months	Bruchid infestation (%)	0	27.94	13.35	14.49 (51.86%); infestation lower in PICS bag
15	6 months	Moisture content (%)	10.00	8.45	10.46	2.01 (23.78%)
16	6 months	Germination (%)	95.00	82.67	93.00	10.33 (12.49%)
17	6 months	Test weight (g)	23.60	18.41	23.41	5.00 (27.15%)
18	6 months	Protein content (%)	40.00	18.12	19.24	1.12 (6.18%)
19	6 months	Carbohydrate content (%)	20.04	33.88	37.76	3.88 (11.45%)
20	6 months	Fat content (%)	1.00	0.86	0.67	PICS bag showed lower fat content than jute bag
21	6 months	Bruchid infestation (%)	0	31.47	13.38	18.09 (57.48%); infestation lower in PICS bag

The data on the moisture content showed that the triple layer PICS bag has highest moisture content (10.37%). It maintained the moisture content with in the bag while the other bags which caused reduction in moisture content with environmental changes. The best germination per cent was recorded in triple layer PICS bag (93.3%) compared to all other types of storage bags. As the infestation levels in the triple layer PICS bag was less and quality of seed was good, hence showed good germination percentage. The test weight of 100 randomly selected dolichos bean seed was recorded maximum in triple layer PICS bag (23.44 g). The seed with less damage per cent and good quality in triple layer PICS bag contributed for highest test weight. The maximum carbohydrate content (%), was reported in triple layer PICS bag (19.29%), as the damage was less on seed due to bruchid infestation. The carbohydrate content was retained as in initial before experimentation in the triple layer PICS bag treatment compared to all other treatments. The protein content (%) was recorded maximum in the triple layer PICS bag (38.40%) compared to all other storage bags, as the damage due to bruchid infestation on seed was less. The study revealed that the increased fat content in the jute bag (1.25%) was increased followed by jute bag treated with insecticide with (1.21%). The least fat was observed in PICS bag. The inconsistency of fat content over periods of storage was reported.

The O₂ level was reported in the PICS bag (8.18%) which was not congenial to pest for its survival and lead to death of pest and arrested the further damage of seeds in the bags. The CO₂ level in the PICS bag were highest compared to other types of bags i.e, (9.02%) and increased with increased duration of storage creating hypercarbia conditions which had harmful effects on the pest survival. Hence caused the death of pest and no further damage of seeds was observed. The least bruchid damage was observed in PICS bag (13.33%) followed by jute insecticide treated bag (10.09%).

Due to hypoxia and hyper carbia the death of pest occurred in the triple layer PICS bag. Hence the damage was controlled. PICS bag not only controlled the infestation in the bag but also prevented the further infestation of pest on remaining healthy seed in the bag as it has triple layers.

The B:C ratio of different treatments showed the maximum B:C ratio in the PICS bag as the infestation was less, the quality of seed was high compared to other storage bags used. Even though the initial cost of bag was high in PICS bag but there was no additional cost of chemical are required as in the jute bag treated with insecticide. Hence there was no further damage of seed with increased duration of storage. After the periods of storage, the quality of seed fetched the premium price in the market. The PICS bag can also use for multiple times over seasons without any damage is added advantage. The mean temperature (OC) in PICS bag (27.0 OC) was recorded, which is same to that of initial temperature. The mean temperature was maintained constant (27.0 OC) from initial to 2, 4 and 6 months storage period in PICS bag. In all other types of storage bag the temperature was changed according to the season. The relative humidity (%) in PICS bag was recorded high (61.2%) irrespective of storage periods, comparing with other types of storage bags. The jute bag, polythene bag and jute bag treated with insecticide due to their porosity provide only slight restriction of air movement across the walls of bag.

Results are similar to study conducted by Sudini *et al.* 2015)^[13]. Njoroge *et al.* (2017)^[14] revealed Effects of hermetic storage on insect pest activity and mortality over time, oxygen levels, acoustic signal and observations of visual movement were recorded with adult *Sitophilus oryzae* (L.). Marco *et al.* (2014)^[15] studied the required storage to favor O₂ depletion and CO₂ increment for elimination of common bean weevil *Acanthoscelides obtectus*. Damage in non-hermetic storage (51.1%) and in hermetic storage (8.9-

9.7%), where O₂ and CO₂ levels which did not allow the development and damage by bean weevil.

5. Conclusion

The PICS bag is not influenced by the surrounding environmental conditions and maintain the moisture content of the produce stored in the bag and no further loss of moisture to the seed. PICS bag created the hypercarbia and hypoxia conditions within the bag and lead to mortality of pes creating reduced the damage to seed and help in maintaining the good germination per cent, test weight, protein content and carbohydrate content with in the seeds stored in the bag. PICS bag resulted in complete mortality of bruchids in bag and no further loss of seed that was stored for longer duration. The bruchid required certain amount of oxygen for its growth, development and completion of its life cycle. Creation of hypercarbia and hypoxia conditions lead to mortality of the insect. It is concluded that the PICS bag as chemical free hermetic technology is efficient and managed the moisture content (%), germination per cent (%), test weight (g), quality (protein content (%), carbohydrate content (%) and fat content (%) and pulse beetle (*Callosobruchus theobromae*) compare to other traditional storage bags.

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