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Economic of different botanicals used for management of pulse beetle

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Abstract
An experiment was conducted to test the efficacy of botanicals against pulse beetle in stored green gram at the laboratory of AICRP on PHET and Seed Technology Research Unit (STRU), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) during the month of June to January in the year 2016-17. Eight treatments including untreated control, comprising of clove powder (3g/kg grain), tulasi leaf powder (3g/kg), black pepper powder (3g/kg), *Acorus calamus* rhizome powder (10g/kg), sesame oil (5ml/kg), soybean oil (5ml/kg), castor oil (5ml/kg) were used against adult pulse beetle, *Callosobruchus chinensis* on green gram seed. All the botanicals recorded minimum percent seed infestation and percent seed weight loss than the untreated control over the six months of storage period. Among all the treatments *Acorus calamus* rhizome powder @10 g/kg seed and Black pepper powder @ 3g/kg seed was found significantly superior over the rest of treatments in respect to recording minimum percent seed infestation and seed weight loss. However, while taking the avoidable per cent seed infestation, along with the economics in consideration, soybean oil @ 5ml /kg seed and castor oil @ 5ml /kg seed were found effective and cheaper in respect of management of pulse beetle in stored green gram than other botanicals.

Keywords: Botanicals, pulse beetle, economic details, percent seed weight loss, percent seed infestation

Introduction
Pulses are the protein rich food crops that improve the human diets, while their cultivation benefits the health of the soil through their unique ability to fix nitrogen in soil. In addition, several pulse crops are resilient to adverse climatic conditions such as drought, and grow in the dry regions of the world. Pulses play significant roles in both in human diet and in agriculture, and contribution to sustainable farming. The united nations general assembly declared 2016 as the international year of pulses (IYP). IYP 2016 aims to heighten public awareness of the nutritional benefits of pulses as part of a sustainable food production system, aimed towards ensuring food and nutrition security. India is the largest producer as well as consumer of pulses in the world. Pulses in India have long been considered as the poor man's only source of protein. They are the principal source of dietary proteins in a vegetarian country like India.
Marginal increase in production in the last 4 decades, and astronomical losses during post-harvest storage, attributable to the pulse beetle (PB) *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae) (Mendki *et al*., 1999), are other possible reasons for importing pulses [7]. Globally, 840 million people are undernourished mainly on account of inadequate intake of proteins, vitamins and minerals in their diets. The reason for that is out of total 12.6 million tonnes, 8.5 per cent is lost due to the non-availability of proper storage facilities with the farmers and vulnerability of pulses to store grain pests.
Callosobruchus spp. are important pests of pulses. In tropical developing countries, where legume seeds are often the main source of protein in the human diet, the losses caused by these insects are of major significance. Infestation may start in the pods before harvest and carry over into storage where substantial losses may occur**.** In India, there are about 200 species of pest insects which cause damage to stored grains and grain products in storage. *Callosobruchus chinensis* is a major, economically important pest of all pulses and causes 40-50% losses of pulses in storage (Gosh and Durbey, 2003) [6]. Knowledge of the host range and biology of the pest species are essential to minimize the incidence. Pesticides are the most powerful tool available for pest control, despite these credentials, the long and indiscriminate use of pesticides has been found ecologically unsound. Insecticides were found to cause toxic effects on the produce intended for consumption. So it is also not safe to mix insecticide with

food grain for protection against insects (Bekele *et al*., 1995) [2]. At the same time plant-derived materials are more readily biodegradable, relatively specific in the mode of action and easy to use (Das, 1986); they are environmentally safe, less hazardous, less expensive and readily available [4]. Some are less toxic to mammals, may be more selective in action, and may retard the development of resistance. Therefore, plant materials should be explored to protect stored products against pest infestation. Keeping all those things in the view the following investigation "Evaluation of different botanicals against pulse beetle (*Callosobruchus* spp.) in stored mung bean" has been undertaken, to prevent the *Callosobruchus chinensis* infestation during pulse seed storage.

Materials and methods

A Laboratory experiment was conducted on "Effects of botanicals on Egg laying and adult emergence of pulse beetle (*Callosobruchus* spp.) in stored Green gram" at the laboratory of AICRP on PHET and Seed Technology Research Unit (STRU), Dr. P.D.K.V. Akola (M.S) under laboratory conditions lasting for a period of 180 days during year 2016-17.

Table 1: Treatment details

Sr. No.	Treatment	Dose/kg seed
1.	Clove powder	3 g
2.	Tulasi leaf powder	3 g
3.	Black pepper seed powder	3 g
4.	*Acorus calamus* rhizome powder	10 g
5.	Sesame seed oil	5 ml
6.	Soybean oil	5 ml
7.	Castor oil	5 ml
8.	Untreated control	-

Rearing of test Insect in the laboratory

To obtain adequate culture of *Callosobruchus chinensis* the adults were collected from the Pulses Research Unit, Dr. PDKV, Akola along with pulses on which eggs were laid by pulse beetle and released into plastic container contains healthy green gram seed. The top was covered with muslin cloth secured firmly by rubber band. After emergence of new adults, the beetles were introduced in to green gram variety Kopergaon. Some adults were transferred into another set of containers containing fresh green gram seed and such procedure was repeated to mention the culture throughout the period of research. These cultures were grown in laboratory under ambient conditions.

External determination of male and female bruchids

Males and females can be identified on the basis of their antennae. Males are having strongly serrate antennae and pygidium without dark patches. While females are having weakly serrate antennae and pygidium with two dark patches, one on each side of the mid-line. Generally female is slightly larger than male. The length of male adult measured with an average 3.25 ± 0.23 mm and breadth is 2.16 ± 0.05 mm whereas the length and breadth of female adult measured with an average 3.60 ± 0.08 mm and 2.02 ± 0.04 mm respectively (Devi and Devi, 2013) [5].

Application of treatment

Mass culture of *C. chinensis* was maintained in the laboratory for experimental purpose. One kg of freshly harvested certified seed with very high percentage of germination and low moisture content (<10%) was taken for each treatment. Required quantity of botanicals and oils were taken, to treat the seed with oil and powder of various plant products. 1000 g of seeds for each treatment were filled in high density polythene bag of 2 kg capacity and the plant products were mixed thoroughly by shaking the polythene bag. The procedures were repeated thrice for each treatment. Then the one kg of treated seed was packed in four kg capacity plastic container and was stored under ambient condition.100 g of green gram seed were taken out from treated seed in to the plastic container of 250 ml capacity, to study the different observation and 5 pairs of adult bruchid (newly emerged) were released in 100 g treated sample and the observations were recorded in each month. The observations were recorded at monthly interval on per cent seed infestation and per cent seed weight loss.

Methods of recording observation

Per cent seed infestation

Number of seeds damaged by pulse beetle was recorded and per cent infestation was calculated with the help of following formula.

$$\text{Per cent seed infestation} = \frac{\text{No. of damaged seed}}{\text{Total no. of seed / 100 g}} \times 100$$

Per cent seed weight loss

Number of damaged and healthy seeds, their weight was recorded and per cent seed weight loss was calculated statistically with the help of following formula given by (Dabi *et al*. 1979) [3].

$$\text{Per cent seed weight loss} = \frac{\text{I-F}}{\text{I}} \text{X100}$$

Where,
I = Initial weight of seeds,
F= Final weight of seeds

Result and discussion

The result presented in table 2 and 3 revealed that treatment with Acorus calamus rhizome powder @ 10 g/kg seed and black paper powder @ 3 g/kg seed and clove powder @ 3 g/kg seed were found best protectants which prevented the seed infestation and seed weight loss up to six months storage period. While untreated seeds are adversely affected in all respects. These findings derive support from Zia *et al*. (2011) reported all treatments caused significant decrease in no of holes made per grain by the beetle compared to control. Yet black pepper (*Piper nigrum*) caused highly significant decrease in number of holes for grain (0.06) [8]. Baral (2002) also reported weight loss was nil in case of *A. calamus* treated chickpea seed [1].

Table 2: Effect of botanicals on per cent seed infestation of *Callosobruchus chinensis* on green gram seeds.

Sr. No.	Treatments	Doses g or ml /kg seed	Per cent seed infestation					
			In 1st month	In 2nd month	In 3rd month	In 4th month	In 5th month	In 6th month
1	Clove powder	3 g	0.48 (0.69)	0.68 (0.82)	1.45 (1.20)	2.03 (1.42)	2.27 (1.51)	3.18 (1.78)
2	Tulasi leaf powder	3 g	0.74 (0.86)	1.22 (1.11)	2.42 (1.55)	3.24 (1.80)	3.54 (1.88)	4.68 (2.16)
3	Black pepper seed powder	3 g	0.31 (0.55)	0.62 (0.78)	1.10 (1.05)	1.62 (1.27)	1.96 (1.40)	3.37 (1.83)
4	*Acorus calamus* rhizome powder	10 g	0.18 (0.42)	0.48 (0.69)	0.89 (0.94)	1.24 (1.11)	1.71 (1.31)	2.60 (1.61)
5	Sesame seed oil	5 ml	0.65 (0.80)	1.07 (1.03)	1.46 (1.21)	2.92 (1.71)	2.86 (1.69)	3.91 (1.97)
6	Soybean oil	5 ml	0.71 (0.84)	1.19 (1.09)	2.10 (1.45)	3.09 (1.76)	3.38 (1.84)	4.18 (2.04)
7	Castor oil	5 ml	0.57 (0.75)	0.95 (0.97)	1.22 (1.11)	1.97 (1.40)	2.45 (1.56)	3.33 (1.82)
8	Untreated / control		13.25 (3.64)	13.58 (3.68)	14.17 (3.76)	14.72 (3.84)	15.13 (3.89)	15.55 (3.94)
	F' test		Sig.	Sig	Sig.	Sig.	Sig.	Sig.
	SE(m) ±		0.06	0.05	0.05	0.03	0.04	0.06
	CD at 5 %		0.17	0.15	0.14	0.10	0.12	0.18
	CV		9.26	6.87	5.19	3.21	3.57	4.81

Figures in parenthesis are corresponding square root transformation value

Table 3: Effect of botanicals on per cent weight loss of green gram seeds infested by *Callosobruchus chinensis*

Sr. No.	Treatments	Doses g or ml /kg seed	Per cent seed weight loss					
			In 1st month	In 2nd month	In 3rd month	In 4th month	In 5th month	In 6th month
1	Clove powder	3 g	0.11 (0.78)	0.14 (0.80)	0.19 (0.83)	0.26 (0.87)	0.35 (0.92)	0.52 (0.01)
2	Tulasi leaf powder	3 g	0.42 (0.96)	0.45 (0.98)	0.95 (1.21)	1.09 (1.26)	1.25 (1.32)	1.58 (1.44)
3	Black pepper seed powder	3 g	0.02 (0.72)	0.04 (0.73)	0.10 (0.77)	0.20 (0.83)	0.28 (0.88)	0.48 (0.99)
4	*Acorus calamus* rhizome powder	10 g	0.01 (0.71)	0.02 (0.72)	0.06 (0.75)	0.14 (0.80)	0.21 (0.84)	0.41 (0.95)
5	Sesame seed oil	5 ml	0.27 (0.88)	0.31 (0.90)	0.37 (0.93)	0.44 (0.97)	0.54 (1.02)	0.74 (1.11)
6	Soybean oil	5 ml	0.35 (0.92)	0.39 (0.94)	0.45 (0.97)	0.54 (1.02)	0.64 (1.07)	0.85 (1.16)
7	Castor oil	5 ml	0.19 (0.83)	0.23 (0.85)	0.29 (0.89)	0.37 (0.93)	0.45 (0.97)	0.65 (1.07)
8	Untreated / control	-	2.24 (1.66)	3.24 (1.93)	3.95 (2.11)	5.07 (2.36)	6.09 (2.57)	7.43 (2.82)
	F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	SE(m) ±		0.00	0.01	0.02	0.03	0.03	0.04
	CD at 5 %		0.01	0.02	0.05	0.09	0.08	0.13
	CV		0.69	1.34	2.70	4.59	3.70	5.65

Figures in parenthesis are corresponding Square root (x+0.5) transformation value

Considering cost of inputs for different treatments and corresponding avoidable per cent seed infestation, economically best treatment were worked out at prevailing market rates and data presented in table 4.

Table 4: Economics of different treatments

Sr. No.	Treatments	Qty. of botanicals req./Kg seed	Qty. of botanicals req./Quintal seed	Cost of treatment per Quintal seed		Total cost (Rs.)	Per cent seed infestation (cumulative mean taken)	Avoidable per cent seed infestation over control
				Cost of botanicals (Rs.)	Cost of application			
1	Clove powder	3 g	300 g	270	20	290	1.68	12.72
2	Tulasi leaf powder	3 g	300 g	72	20	92	2.64	11.76
3	Black pepper seed powder	3 g	300 g	360	20	380	1.50	12.9
4	*Acorus calamus* rhizome powder	10 g	1 kg	700	20	720	1.18	13.22
5	Sesame oil	5 ml	500 ml	135	20	155	2.15	12.25
6	Soybean oil	5 ml	500 ml	40	20	60	2.44	11.96
7	Castor oil	5 ml	500 ml	70	20	90	1.75	12.65
8	Untreated control	----	-----	-----	-----	-----	14.40	-----

Cost of raw materials
Dried clove with stem –Rs.900/kg
Sesame oil –Rs.270/L
Soybean oil- Rs.80/l
Tulasi leaf powder - Rs. 240/kg
Castor oil- Rs.140/L
Black pepper- Rs. 1200/kg
Labour charges: Rs. 20 (cost of application/quintal seed)
Acorus calamus rhizome (Vekhand) powder- Rs.700/Kg

The result on the economics of various treatments revealed that the treatments, when considering the avoidable per cent seed infestation, the best treatment was *Acorus calamus* rhizome powder @ 10 g/kg seed followed by black pepper powder @ 3 g/kg seed, clove powder @ 3 g/kg seed, castor oil @ 5 ml/kg seed, sesame oil @ 5 ml/kg seed, soybean oil @ 5 ml/kg seed and tulasi leaf powder @ 3 g/kg seed. However, the cheaper treatment in order were soybean oil @ 5 ml/kg seed, castor oil @ 5 ml/kg seed, tulasi leaf powder @ 3 g/kg seed, sesame oil @ 5 ml/kg seed, clove powder @ 3 g/kg seed, black pepper powder @ 3 g/kg seed and *Acorus calamus* rhizome powder @ 10 g/kg seed for management of pulse beetle.

Conclusion

On the basis of observation recorded on per cent infestation and per cent weight loss in stored green gram. It is concluded that- all the treatments were found effective over untreated control.

Acorus calamus rhizome powder @10 g/kg seed and Black pepper powder @ 3g/kg seed was found significantly superior over the rest of treatments in respect to recording minimum seed infestation. However, while taking the avoidable per cent seed infestation, along with the economics in consideration, soybean oil @ 5ml /kg seed and castor oil @ 5ml /kg seed were found effective and cheaper in respect of management of pulse beetle in stored green gram. However, deleterious effects of treatments were not observed on seed germination and seed vigour of stored green gram.

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