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Effects of botanicals on egg laying and adult emergence of pulse beetle in stored green gram

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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 botanicals recorded lower rate of oviposition and adult emergence than the untreated control. Significantly minimum number of egg laying found in treatments *Acorus calamus* rhizome powder (19.00 eggs/ 100 g seed) and black pepper powder (27.00 eggs/100g seed). Similarly as in case of egg laying, same effect was shown by *Acorus calamus* rhizome powder and black pepper powder in minimal adult emergence. Minimum number of adult emergence was recorded in *Acorus calamus* rhizome powder (4.00 adults/100 g seed) and in black pepper powder (7.00 adults/100 g seed). The order of remaining treatments to record minimum number of egg laying and adult emergence were clove powder, castor oil, sesame oil, soybean oil, and tulasi leaf powder in first month and similar order of effectiveness of botanicals found even after six months.

Keywords: Pulse beetle, green gram, botanicals, oviposition, and adult emergence

1. Introduction
Pulses are very important crop for India. They are a staple source of protein and fiber for indians-the majority who are vegetarian. They are even low in fat. These are truly some of the best crops in the world. These crops grow quickly, generate good profit for farmers and contribute to agricultural and environmental sustainability. 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 [6]. 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) [4]. 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) [1]. 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 [2]. 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 "Effects of botanicals on oviposition and adult emergence of pulse beetle (*Callosobruchus* spp.) in stored mung bean" has been undertaken, to prevent the *Callosobruchus chinensis* infestation during pulse seed storage.

2. 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.

2.1 Rearing of test Insect in the laboratory

To obtain adequate culture of *Callosobruchuschinensis* 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.

2.2 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) [3].

2.3 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 mortality, per cent seed infestation, per cent seed weight loss, seed germination and seed vigour.

2.4 No. of eggs laid

After 14 days of release of insects, the plastic container of 250 ml capacity were observed and eggs present on these grains were counted and recorded.

2.5 No. of adults emerged

After 20 days of release of insects, the plastic container of 250 ml capacity was observed daily for the number of adult emerged till no emergence.

The test insects were released in the starting of 1st month (July), in 2nd month (Aug.), in 3rd month (Sept), in 4th month(Oct.), in 5th month(Nov.) and in 6th month(Dec.) in 100 g (in small plastic container of 250 ml capacity) stored green gram seeds which were treated initially with botanicals. After 14 days of release of insects, the plastic container of 250 ml capacity were observed and eggs present on these grains were counted and recorded. Similarly after 20 days of release of insects, the plastic container of 250 ml capacity was observed daily for the number of adult emerged till no emergence.

Table 1: Treatments 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	-

3. Results and Discussion

Results presented in table 2 revealed that all treatments were found statistically superior over untreated control. Significantly minimum no. of eggs found in *Acorus calamus* rhizome powder @ 10 g/kg treated seed (19.00 eggs/100 g seed), followed by in black pepper powder @ 3 g/kg treated seed (27.00 eggs/100g seed), clove powder @ 3 g/kg treated seed (28.33.00 eggs/100g seed), castor oil @ 5 ml/kg treated seed (33.33 eggs/100g seed), sesame oil @ 5 ml/kg treated seed (36.33 eggs/100g seed), soybean oil @ 5 ml/kg treated seed (43.33 eggs/100g seed), tulasi leaf powder @ 3 g/kg treated seed (49.00 eggs/100g seed) and in untreated control (280.00 eggs/100g seed) in first month. While after 6 months, cumulative mean of average no. of egg laid (of entire six months data) was derived and it was found that similar order of effectiveness of botanicals on average no. of egg laid by pulse beetle even after six months.

Result presented in table 3 revealed that significantly minimum no. of adults emerged in *Acorus calamus* rhizome powder @ 10 g/kg treated seed (4.00), followed by in black pepper powder @ 3 g/kg treated seed (7.00), clove powder @3 g/kg treated seed (10.67), castor oil @ 5 ml/kg treated seed (12.67), sesame oil @ 5 ml/kg treated seed (15.00), soybean oil @ 5 ml/kg treated seed (15.67), tulasi leaf powder @3 g/kg treated seed (16.33) and in untreated control (265.00) in first month, While after 6 months, cumulative mean of average no. of adults emerged (of entire six months data) was derived and it was found that similar order of effectiveness of botanicals on average no. of adults emergence even after six months.

These findings derive support from Shivanna *et al.* (1994) reported sweet flag at all dosage levels (0.5, 1.5, 2.5g/ 50g of seed reduced the egg laying considerably. The average

fecundity in sweet flag treated seed ranged from 5-8 eggs and tulsi treated seed at all 3 dosage levels (0.5, 1.5, 2.5 g/ 50g seed) has recorded maximum number of eggs(200) which are on par with untreated check. They also concluded that oviposition and adult emergence is minimum in grains treated with sweet flag and maximum in grains treated with tulasi leaf powder [9]. Similarly, Meghwal *et al.* (2007) reported minimum number of (6 to 8 eggs/100 g seed) egg laying of pulse beetle in the grains treated with *Acorus calamus* rhizome powder @ 10 g/kg seed [5]. Moreover, Ravi *et al.* (2008) reported the number of adult emerged/100 g seeds after 120 days after storage was minimum in seed treated with sweet flag rhizome powder in tablet form at 15% conc. with 21.88 adults/100 g seeds [7]. Saiful *et al.* (2013) who found that black pepper powder @ 5 g/kg seed were found most effective in checking egg laying [8].

Table 2: Effect of botanicals on egg laying of *Callosobruchus chinensis* (L.) on stored green gram seeds.

Sr. No.	Treatments	Doses g or ml /kg seed	Average no. of egg laid after 14 days of beetles release					
			In 1st month	In 2nd month	In 3rd month	In 4th month	In 5th month	In 6th month
1	Clove powder	3 g	28.33 (1.45)	38.33 (1.58)	46.33 (1.66)	51.67 (1.71)	56.33 (1.75)	90.00 (1.95)
2	Tulasi leaf powder	3 g	49.00 (1.69)	60.00 (1.78)	68.33 (1.83)	77.00 (1.89)	82.67 (1.92)	117.67 (2.07)
3	Black pepper seed powder	3 g	27.00 (1.43)	33.33 (1.52)	40.00 (1.60)	46.33 (1.66)	53.33 (1.73)	88.33 (1.95)
4	*Acorus calamus* rhizome powder	10 g	19.00 (1.28)	28.33 (1.45)	34.67 (1.54)	42.33 (1.63)	48.00 (1.68)	77.33 (1.89)
5	Sesame seed oil	5 ml	36.33 (1.56)	47.00 (1.67)	56.00 (1.75)	63.67 (1.80)	70.33 (1.85)	106.00 (2.02)
6	Soybean oil	5 ml	43.33 (1.63)	54.67 (1.74)	63.67 (1.80)	72.67 (1.86)	79.67 (1.90)	118.67 (2.07)
7	Castor oil	5 ml	33.33 (1.52)	43.33 (1.64)	49.67 (1.70)	55.00 (1.74)	64.00 (1.81)	93.33 (1.97)
8	Untreated / control	-	280 (2.45)	286.67 (2.46)	298.33 (2.47)	309.33 (2.49)	317.67 (2.50)	326.00 (2.51)
	F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	SE(m) ±		0.03	0.02	0.02	0.02	0.01	0.02
	CD at 5%		0.08	0.07	0.07	0.06	0.04	0.06
	CV		2.87	2.39	2.15	1.89	1.32	1.63

Figures in parenthesis are corresponding logarithmic transformation value

Table 3: Effect of botanicals on adult emergence of *Callosobruchus chinensis* (L.) on stored green gram seeds

Sr. No.	Treatments	Doses g or ml /kg seed	Average adult emergence					
			In 1st month	In 2nd month	In 3rd month	In 4th month	In 5th month	In 6th month
1	Clove powder	3 g	10.67 (1.02)	15.00 (1.16)	32.00 (1.50)	44.67 (1.65)	50.00 (1.70)	70.00 (1.84)
2	Tulasi leaf powder	3 g	16.33 (1.21)	27.00 (1.43)	53.33 (1.73)	71.33 (1.85)	78.00 (1.89)	103.00 (2.01)
3	Black pepper seed powder	3 g	7.00 (0.83)	14.00 (1.15)	24.33 (1.39)	36.00 (1.56)	43.33 (1.64)	74.33 (1.87)
4	*Acorus calamus* rhizome powder	10 g	4.00 (0.59)	10.67 (1.02)	19.67 (1.29)	27.33 (1.43)	37.67 (1.58)	57.33 (1.76)
5	Sesame seed oil	5 ml	15.00 (1.16)	23.67 (1.37)	32.33 (1.51)	64.33 (1.81)	63.00 (1.80)	86.00 (1.93)
6	Soybean oil	5 ml	15.67 (1.18)	26.33 (1.42)	46.33 (1.67)	68.00 (1.83)	74.00 (1.87)	92.67 (1.97)
7	Castor oil	5 ml	12.67 (1.09)	21.00 (1.32)	27.00 (1.43)	43.33 (1.64)	54.00 (1.73)	73.33 (1.86)
8	Untreated / control	-	265.00 (2.42)	271.67 2.43	279.00 (2.45)	294.33 (2.47)	302.67 (2.48)	311.00 (2.49)
	F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	SE(m) ±		0.07	0.05	0.03	0.02	0.02	0.03
	CD at 5%		0.21	0.14	0.08	0.05	0.06	0.08
	CV		10.00	5.63	2.79	1.73	1.91	2.24

Figures in parenthesis are corresponding logarithmic transformation value

4. Conclusion

We have found that botanicals are safer, cheaper and preferable for preventing *Callosobruchus chinensis* infestation over a six month of period in stored mung bean.

From the present study, it can be concluded that *Acorus calamus* rhizome powder @ 10g/kg green gram seedand black pepper powder @ 3g/kg green gram seed recorded minimum number of oviposition and adult emergence and can be used for successful protection of green gram seeds up to six months of storage, i.e minimum number of egg laying found in treatments *Acorus calamus* rhizome powder (19.00 eggs/ 100 g seed) and black pepper powder (27.00 eggs/100g seed).

Similarly as in case of egg laying, same effect was shown by *Acoruscalamus* rhizome powder and black pepper powder in minimal adult emergence, i.e. minimum number of adult emergence was recorded in *Acoruscalamus* rhizome powder (4.00 adults/100 g seed) and in black pepper powder (7.00 adults/100 g seed).

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