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Evaluation of Biopesticide Formulations on Percent Adult Mortality and Fecundity of Pulse Beetle in Redgram

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ABSTRACT *Among the Insect pests of stored grain legumes, Callosobruchus chinensis L. and Callosobruchus maculatus F. are the most important with considerable levels of damage being done to stored commodities. The present investigations was found that among all the bio pesticide formulations Wettable Powder formulation of Bacillus thuringiensis shows the highest per cent of adult mortality and lowest fecundity and highest Per cent Ovipositional Difference (POD) followed by others.*

KEYWORDS : Biopesticide Formulations, Pulse Beetle, Per cent Adult Mortality, Fecundity and Redgram

INTRODUCTION

Pulses have been considered as the poor man's meat which play an important role in food categories that have been extensively used as staple foods to cover basic protein and energy needs throughout the history of humanity(Sharma, 1984). The global pulse market is estimated at 60 million tonnes. In the world, pulses are grown by 171 countries. India is the world's largest producer and the largest consumer of pulses.A large amount (15-20 per cent) of agricultural production in the world is lost every year due to insect infestation. Out of this, 8 per cent production is lost every year due to insect infestation alone in storage. In India, losses caused by insects accounted for 6.5 per cent of stored grain (Raju, 1984).The damage in storage of pulses is more crucial than in the field (Hill, 1987: Yamamato, 1990). Rahman (1971) reported 12 per cent loss due to pulse beetle infestation in pulses stored in warehouse. According to Southgate (1979) there are 1300 species of bruchids belonging to 56 genera in 5 sub-families in the world, and in India 97 species of bruchids in 11 genera have been recorded. In India, two species named *Callosobruchus maculatus* F. and *Callosobruchus chinensis* L.are commonly known as pulse beetles(NRI, 2003).

MATERIALS AND METHODS

Insect culture

The pulse beetle, *Callosobruchus chinensis* L.(Bruchidae: Coleoptera) was used as a test insect, as it is the major storage pest of pigeonpea in India, attacking different pulses under field and storage conditions accounting for huge losses.

Lab culture of *Callosobruchus chinensis* L. was carried out on chick pea seed to obtain inoculum cultures. The infested seed kept in plastic container and covered with muslin cloth till the emergence of adults. Healthy adults emerging from the container were shifted to another plastic container, provided with clean chickpea seeds for oviposition and maintained at 25±5°C temperature and 65 percent relative humidity in BOD incubator. The container was not disturbed till the emergence of the adults. Freshly emerging subsequent generations were used for further experiments.

Identification of the test insect

The adult beetles were identified as per the key given by Vats (1974) and Begum *et al*., (1982). The adults are2-3 mm long brownish beetles. Antennae are pectinate in male and slightly serrate in female. Abdomen is not covered by the elytra in case of females.

Mortality Studies

Different biopesticides were evaluated at doses of 0 (control), 8 g/kg seed in Wettable powder formulations and 8 ml/kg seed in Oil based formulations in separate transparent plastic containers having 500 ml capacity. The required amount of biopesticides were mixed thoroughly with 100 g of seeds of different pulses. Ten pairs of 0-24 hour's old adults were released into each container and the containers were capped. The number of dead beetles were recorded after 24, 48 and 72 hours of treatment respectively. Mortality was considered when the beetle did not respond to gentle pressure using a fingertip. After each counting, dead bruchids were removed.

Fecundity Studies

About 100g of the treated seeds of different pulses as per the treatment concentrations of test bio pesticides were kept on transparent plastic containers. Ten pairs of 0-24 hour's old adults (10 males + 10 females) were released in each container and kept undisturbed for seven days allowing to lay the eggs. After 7 days number of eggs laid were recorded and percentage of oviposition was calculated. Percent ovipositional difference (POD) was calculated by using the formulae.

$$POD = \frac{Cs - Ts}{Cs} \times 100$$

Cs – No. of eggs laid on control seeds
Ts – No. of eggs laid on treated seeds

RESULTS AND DISCUSSION

1. MORTALITY STUDIES

At 24 hour after treatment

During the experimentation it has been found that among all the treatments Wettable Powder (WP) formulation of *B. thuringiensis*fared better in controlling *Callosobruchus chinensis* with per cent adult mortality (18.33%) is on par with WP formulations of*V. lecanii*, *M. anisopliae* and *B. bassiana*. This was followed by WP formulation of*M. anisopliae* and *B. bassiana* where the per cent adult mortality is (16.67%) which is on par with WP formulation*B. thuringiensis*. Among all the treatments Oil formulation of *V. lecanii* is found to be least effective with per cent adult mortality (6.67%) which is significantly different from untreated control (0.00%).

At 48 hour after treatment

The data revealed that after treatment application it has been found that among all the treatments Wettable Powder (WP) formulation of *B. thuringiensis* isbetter in controlling *Callosobruchus chinensis* with per cent adult mortality (30.00%) on par with WP formulations of*V. lecanii*, *M. anisopliae* and *B. bassiana*. This was followed by WP formulation of*M. anisopliae* and *B. bassiana* where the per cent adult mortality is (26.67%) which is on par with WP formulation*B. thuringiensis*. Among all treatments Liquid (Liq.) formulation of *B. thuringiensis,* Oil formulations of *V. lecanii*, *M. anisopliae* and *B. bassiana* are found to be least effective with per cent adult mortality (13.33%) which is almost significantly different from untreated control (0.00%).

At 72 hour after treatment

The results revealed that among all the treatments Wettable Powder (WP) formulation of *B. thuringiensis* faredbetter in controlling *Callosobruchus chinensis* with per cent adult mortality (46.67%) is on par with WP formulations of*M. anisopliae* and *B. bassiana*. This was followed by WP formulation of*M. anisopliae*were the per cent adult mortality is 43.33%, which is on par with WP formulation*B. thuringiensis*. Among all treatments Oil formulation of *V. lecanii* is found to be least effective with per cent adult mortality (25.00%) which is almost significantly different from untreated control (0.00%).

Table 1. Effect of biopesticidal formulations on per cent mortality of *Callosobruchus chinensis* in Redgram at different Hours After Treatment.

S. No.	Treatments	Adult mortality (%) after		
		24 hours	48 hours	72 hours
1	T1 Metarhizium anisopliae -WP	16.67^{c} (4.19)	26.67^{c} (5.26)	43.33^{c} (6.66)
2	T2 Verticillium lecanii -WP	13.33^{c} (3.77)	21.67^{c} (4.76)	31.67^{b} (5.70)
3	T3 Beauveria bassiana -WP	16.67^{c} (4.19)	26.67^{c} (5.26)	41.67^{c} (6.53)
4	T4 Bacillus thuringiensis -WP	18.33^{c} (4.39)	30.00^{c} (5.56)	46.67^{c} (6.90)
5	T5 Bacillus thuringiensis –Liq.	8.33^{b} (3.03)	13.33^{b} (3.77)	30.00^{b} (5.56)
6	T6 Metarhizium anisopliae –Oil	8.33^{b} (3.03)	13.33^{b} (3.77)	26.67^{b} (5.26)
7	T7 Verticillium lecanii – Oil	6.67^{b} (2.74)	13.33^{b} (3.77)	25.00^{b} (5.08)
8	T8 Beauveria bassiana – Oil	8.33^{b} (3.03)	13.33^{b} (3.77)	30.00^{b} (5.56)
9	T9 Control	0.00^{a} (0.70)	0.00^{a} (0.70)	0.00^{a} (0.70)
10	CD at 5%	0.71	0.59	0.65
11	SE(m)±	0.24	0.20	0.22

Figures in parenthesis are square root transformed values.

The values denoted by a common letter are not significantly different from each other as per DMRT.

2. FECUNDITY STUDIES

During the experimentation it has been found that among all the treatments WP formulation of *B. thuringiensis* faredbetter in controlling *Callosobruchus chinensis* with lowest fecundity (36.33) is on par with WP formulations of*M. anisopliae*, *B. bassiana*. This was followed by WP formulation of*M. anisopliae* where the fecundity is (38.67) which is on par with WP formulation*B. bassiana*. Among all treatmentsOil formulation of *V. lecanii*is found to be least effective with fecundity (115.33) which is almost significantly different from untreated control (263.00).

During the experimentation it has been found that among all the treatments WP formulation of *B. thuringiensis* faredbetter in controlling *Callosobruchus chinensis* with Per cent Ovipositional Difference (POD) (86.20%) which is on par with WP formulations of*M. anisopliae*, *B. bassiana*. This was followed by WP formulation of*M. anisopliae* where the POD (85.28%) which is on par with WP formulation*B. thuringiensis*. Among all treatmentsOil formulation of *V. lecanii* is found to be least effective with POD (56.10%) which is almost significantly different from untreated control (0.00%).

Table 2. Effect of biopesticidal formulations on Fecundity and Per cent ovipositional difference of *Callosobruchus chinensis* in Redgram at 7 Days After Treatment.

Sr. No.	Treatments	No. of eggs laid	POD (%)
1	T1 *Metarhizium anisopliae* -WP	38.67^{a} (6.29)	85.28^{f} (9.28)
2	T2 *Verticillium lecanii* -WP	88.00^{bc} (9.43)	66.55^{d} (8.21)
3	T3 *Beauveria bassiana* -WP	45.33^{a} (6.76)	82.65^{f} (9.14)
4	T4 *Bacillus thuringiensis* –WP	36.33^{a} (6.09)	86.20^{f} (9.33)
5	T5 *Bacillus thuringiensis* –Liq.	75.00^{b} (8.71)	71.49^{e} (8.51)
6	T6 *Metarhizium anisopliae* –Oil	82.33^{b} (9.12)	68.69^{de} (8.34)
7	T7 *Verticillium lecanii* – Oil	115.33^{d} (10.78)	56.10^{b} (7.55)
8	T8 *Beauveria bassian*a – Oil	101.00^{cd} (10.09)	61.59^{c} (7.91)
9	T9 Control	263.00^{e} (16.24)	0.00^{a} (0.70)
10	CD at 5%	0.75	0.25
11	SE(m)±	0.25	0.08

Figures in parenthesis are square root transformed values.

The values denoted by a common letter are not significantly different from each other as per DMRT (Duncan's Multiple Range Test).

Among the different treatments ofbio pesticide formulations are used to evaluate the per cent adult mortality of pulse beetle at different hours after treatment and by comparing the number of eggs laid and Percent Ovipositional Difference (POD) of pulse beetle, *C. chinensis* at 7days after treatment among all the bio pesticides, WP formulation of *B. thuringiensis*shows the highest per cent adult mortality and lowest fecundity and highest PODfollowed by others, this may be due to the binding affinity of Bt toxin to targeted sites (as this toxin jeopardize the alimentary system) of the pulse beetle or may be due to the presence of novel crystal proteins which exhibit insecticidal activity against the pulse beetle. These findings are in conformity with works of Abdur and Bhuiyan (2012) for pulse beetle (*C. chinensis*), Malik and Nazir (2012)) for *Tribolium castaneum*.

The findings of the present investigations indicate that biopesticidal formulations might be useful as insect control agents for the commercial use.The WP formulation of *B. thuringiensis*was the most effective among the different bio pesticides. To minimize the severe damage caused by insect pests, bio pesticide formulations proved to be highly effective against stored insects.Further research is required to explore some new bio pesticide formulations, which can, more efficiently, be utilized for the food-safety purpose and to overcome the dilemma of health hazards and environmental pollution.

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