Studies on relative toxicity of biopesticides to *Helicoverpa armigera* (Hubner) and *Maruca vitrata* (Geyer) on pigeonpea (*Cajanus cajan* L.)

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ABSTRACT

An experiment conducted during Kharif, 2010 to evaluate the efficacy of different biopesticides against gram pod borer *Helicoverpa armigera* (Hubner) and legume pod borer, *Maruca vitrata* (Geyer) on pigeon pea revealed that there is no significant difference between the treatments against pod damage due to gram pod borer, *H. armigera* since the population and thereby pod damage was very low during the season. The untreated check has recorded only 1.63% pod damage due to *Helicoverpa*. The per cent inflorescence damage due to legume pod borer was lowest in spinosad 45% SC @ 73 g a.i/ha (4.74%), followed by *Bacillus thuringiensis*-1 @ 1.5 kg/ha (10.52%) and *Beauveria bassiana* SC formulation @ 300mg/Lt (14.15%) with 80.9, 57.6 and 42.9 per cent reduction over control respectively as against control (24.79%). The pod damage due to Maruca was the lowest in spinosad (17.38%), followed by *Bt*.-1 (27.57%) and *B. bassiana* SC formulation @ 300 mg/lt (33.82%) as against control (45.84%) with 62.1, 39.9 and 26.2 per cent reduction over control respectively. The highest grain yield was recorded in spinosad 45% SC @ 73 g.i/ha treated plots (831.0 kg/ha), followed by *Bt*.1 @ 1.5 kg/ha (743.1 kg/ha) and *B. bassiana* SC formulation @ 300mg/Lt (694.4 kg/ha) with 104.0, 82.4 and 70.5 per cent increase over control respectively as against the minimum yield of 407.4 kg/ha in the untreated check.

Keywords: *Bacillus thuringiensis*, *Beauveria bassiana*, *Helicoverpa armigera*, insecticides, *Maruca vitrata*, NSKE 5%, microbials, pigeonpea, spinosad

INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) is a tropical grain legume mainly grown in India and ranks second in area and production and contribute about 90% of the world's pulse production. In India, pigeonpea is grown in 4.42 million ha with an annual production of 2.89 million tonnes and 655 kg ha^{-1} of productivity. In Andhra Pradesh, it is cultivated in an area of 6.38 lakh ha with 2.65 lakh tonnes of production and with productivity of 415 kg ha^{-1} (AICRP Report, 2012). It is attacked by more than 250 species of insects, of which gram pod borer, *Helicoverpa armigera* and legume pod borer or spotted pod borer, *Maruca vitrata* are the most important polyphagous pests in both tropics and sub-tropics because of their extensive host range, destructiveness and distribution on cowpea, mungbean, urdbean and field bean (Shanower *et al.*, 1999). *Helicoverpa* causes heavy loss up to 60% with an annual loss estimated to be US $ 400 million in pigeonpea (Anonymous, 2007). The loss caused due to Maruca was estimated to be about 84 per cent (Dharmasena *et al.*, 1992) accounting to US $ 30 million (Saxena *et al.*, 2002). Maruca is basically a hidden pest and completes its larval development inside the web formed by rolling and tying together leaves, flowers, buds and pods. This typical concealed feeding protects the larvae from natural enemies, human interventions or other adverse factors including insecticides (Sharma, 1998). It is essential to kill the first instar larvae during the period when they hatch and till they enter the flowers and buds. Management of pod borer complex in pigeonpea relies heavily on insecticides, often to the exclusion of other methods of control. Considerable numbers of insecticides have been tested and few of them found effective against the pod borers in pigeonpea (Yadav and Dahiya, 2004). Reports of high level of resistance to the conventional insecticides in *H. armigera* have resulted in renewed interest in the research for exploring the opportunities of using biopesticides. Biopesticides such as *Bacillus thuringiensis* (Berliner) (*Bt*), *Beauveria bassiana,* NSKE 5% etc. can provide an alternative, more environmentally friendly option to control these insect pests (Jeyarani and Karuppuchamy, 2010). Keeping in view, the present study was undertaken to evaluate the bio efficacy of certain biopesticides against the pod borers in pigeonpea ecosystem.

MATERIALS AND METHODS

The experiment was conducted during Kharif, 2010 at Regional Agricultural Research Station, Lam, Guntur. *Beauveria bassiana* SC formulation @ 250 mg/lit and 300 mg/lit, *B. bassiana* W.P @ 1.0 kg/ha and 1.5 kg/ha, NSKE 5%, *Bt*-1 @ 1.5 kg/ha, Spinosad 45% SC @ 73 g a.i/ha along with an untreated control (Table 1) tried against pod borer complex on a pigeonpea cv. ICPL 85063 (Lakshmi). There were three replications. (4 rows, 5m long in each replication) in a randomized block design (RBD). The seeds were sown at a depth of 5cm below the soil surface in black cotton soils with the help of "gorru" behind the cattle pair with 180cm spacing between rows. Immediately after sowing, guntaka was run over the seeds to cover the seeds with soil. Thinning was done 20 days after seedling emergence by retaining one seedling per hill at a spacing of 20cm between the plants. Normal agronomic practices were followed for raising the crop (Basal fertilizer N: P: K: 20:50: 0 kg/ha). Intercultural and weeding operations were carried out as needed. Three sprays were applied at 20 days interval starting from 50% flowering with hand operated knapsack sprayer with a spray volume of 500 L/ ha. Twenty five inflorescences (30cm length) were selected at random in each plot from the middle two rows for the observations on per cent inflorescence damage due to *Maruca vitrata*. At maturity, the number of pods showing *Helicoverpa* and *Maruca* damage were recorded and expressed as a percentage of the total number of pods. All the pods were then threshed and grain yield was recorded after discarding the damaged grains. All the above data were subjected to RBD analysis using AGRES package (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results showed that there is no significant difference between the treatments against *H. armigera* since the population and there by pod damage was low during the season. The untreated check has recorded only 1.63% pod damage due to *Helicoverpa*. All the treatments significantly reduced the inflorescence as well as the pod damage due to legume or spotted pod borer. However, spinosad 45% SC followed by *Bt*-1 and *B.bassiana* SC formulation with 80.9, 57.6 and 42.9 per cent reduction over control respectively were found to be superior in reducing the inflorescence damage due to spotted pod borer larvae as against the control check. Similarly, the pod damage was low in spinosad 45% SC, followed by *Bt*-1 (27.57%) with 62.1 and 39.9 per cent reduction over control respectively, while 45.84% damage was noticed in the untreated control. Highest grain yield was recorded in spinosad 45% SC @ 73 g.i/ha treated plots (831.0 kg/ha), followed by *Bt*.1 @ 1.5kg/ha (743.1kg/ha) and *B.bassiana* SC formulation @ 300 mg/lt (694.4 kg/ha) with 104.0, 82.4 and 70.7 per cent yield increase over control respectively as against the minimum yield of 407.4 kg/ha in the untreated check. Thus, in the present studies it was found that spinosad 45 % SC @ 73 g a.i/ha, followed by *Bt*-1 @ 1.5 kg/ha and *B. bassiana* SC formulation @ 300 mg/lt were found effective against *M. vitrata*. High efficacy of microbial formulations of bacteria and fungi over synthetic insecticide in the present studies was not observed probably due to lack of high humidity conditions in field as required for the growth of the microbes.

The results are in agreement with the findings of Srinivasan and Durairaj (2007) who showed that the least *Helicoverpa* larval population of 2.0/ plant with spinosad 45 SC (73 g a.i/ha) treatment as against a maximum population of 6.7/plant in the untreated control. Rao *et al.* (2007) reported that pod damage due to legume pod borer, *M. vitrata* was lowest in plants sprayed with spinosad and also registered lowest seed damage

Table 1. Evaluation of different microbials against pod borer complex in pigeonpea

Treatment	Dose	Inflorescence damage (%)	Reduction over control (%)	Pod damage (%)			Yield (kg/ha)	Increase over control (%)
				Helicoverpa	*Maruca*	Reduction over control (%)		
B. bassiana **SC formulation**	250mg/lt	16.43	33.7	1.99	39.01	14.9	560.2	37.5
B. bassiana **SC formulation**	300mg/lt	14.15	42.9	1.84	33.82	26.2	694.4	70.5
B. bassiana **W.P**	1.0kg/ha	19.83	20.0	1.10	43.93	4.2	581.0	42.6
B. bassiana **W.P**	1.5 g/ha	18.14	26.8	1.71	41.54	9.4	678.2	66.5
NSKE	25 kg/ha	21.67	12.6	1.55	43.56	5.0	509.3	25.0
***Bt*-1**	1.5 g/ha	10.52	57.6	1.31	27.57	39.9	743.1	82.4
Spinosad 45% SC	73g.i/ha	4.74	80.9	1.66	17.38	62.1	831.0	104.0
Control		24.79	-	1.63	45.84	-	407.4	-
SEM		2.273	-	0.787	2.882	-	47.02	-
C.D		6.89	-	NS	8.74	-	142.62	-
CV(%)		17.0	-	19.1	13.5	-	13.0	-

NS: Non Significant

(3.9) and highest grain yield (795 kg/ha). Mittal and Ujagir (2005) reported that lower numbers of *H. armigera* and lower pod damage were recorded in spinosad 90g, spinosad 73g, spinosad 56g and spinosad 45g a.i/ha, compared to other standard insecticides and untreated control.

The low efficacy of the biopesticides over synthetic insecticides in the present findings was also reported by Ankali *et al*. (2010) and Ankali *et al.* (2011). They reported that spinosin showed cent per cent mortality of *M. vitrata* larvae at 7 DAT, whereas *B. thuringiensis* and NSKE showed only 70 per cent mortality. Sushil Kumar Chauhan and Roshan Lal (2009) observed that lower pod damage due to *H.armigera* was recorded in endosulfan than *B. thuringiensis* var. *kurstaki* in pigeonpea. Jayashri *et al*. (2008), Mohapatra and Srivastava (2008), Singh and Yadav (2006) and Gundannavar *et al.* (2004) also found that per cent pod and grain damage due to *H. armigera* at harvest was the lowest in spinosad and reported that all the chemical insecticides were superior over the biopesticides with high yields and benefit: cost (BC) ratio. Sunitha *et al.* (2008) reported that spinosad was effective against 3rd instar larvae of *Maruca vitrata*. The two biopesticides, namely *Bacillus thuringiensis* and *Metarhizium anisopliae* were moderately effective while botanical pesticide, neem fruit extract was ineffective. Nahar *et al.* (2004) reported that *B. bassiana* preparation was less effective (51.25% efficacy) against *H. armigera* in pigeonpea. Reddy *et al.* (2001) found that combination of *B. thuringiensis* (Dipel) and deltamethrin (0.004% or 0.002%) was most effective in reducing the damage due to pod borers in pigeonpea with highest net profit. Minja *et al*. (2000) reported that Neem extract and *B. thuringiensis* were not as effective as the synthetic insecticides. Prabhakara and Srinivasa (1998) reported that the *Bt* formulations caused only 58.72% mortality of third instar larvae after one day of application, while endosulfan and methomyl accounted for 82-90% mortality.

In contrast to the present findings Bhushan *et al.* (2011) reported that Neem seed kernel extract (NSKE 5%) was found most effective in reducing the *Helicoverpa* larval population and pod damage. Similarly, Thilagam and Kennedy (2007) reported that *Bacillus thuringiensis* var. *kurstaki* based product (Spic-Bio Reg.) @ 2.5 l/ha was the best treatment, recording lesser *H. armigera* larval population (0.7/plant). Bhushan and Nath (2006) reported that the pod damage inflicted by *H. armigera* was recorded minimum with the application of NSKE followed by *Bt* and endosulfan at an interval of 20 days from the pod initiation stage onwards. Mohapatra and Srivastava (2002) reported that *Bt* provided good protection and registered significantly lesser incidence of *M. vitrata* larvae and higher yield over control. Kulat and Nimbalkar (2000) reported that *Bt*k, *Bt*k alternated with endosulfan, and endosulfan alone was the most effective in the reduction of larval population (49.48, 49.01 and 45.02% respectively). Manjula and Padmavathamma (1996) also reported that *B. thuringiensis* and *B. bassiana* were effective against *Maruca testulalis.*

Thus, from the present findings it was concluded that new generation insecticide spinosad 45% SC @ 73 g a.i/ha should be alternated with the biopesticides like *B. thuringiensis @ 1.5 kg/ha or B.bassiana* @ 300 mg/lt for effective management of pod borer complex along with an increased yield and also to avoid development of resistance in pigeonpea ecosystem.

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