Bio-Efficacy of Caterpilin (Bacillus thuringiensis var-ukrstate) Against Pod Borer (Helicoverpa armigera) Infesting Pigeon Pea

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ABSTRACT

The pod borer (Helicoverpa armigera) is a key Lepidoptera pest of pigeon pea in Maharashtra and Karnataka state. Bio-efficacy of Caterpilin (Bacillus thuringiensis i.e.Bt) alongwith chemical insecticides was evaluated against pod borer during kharif season at University of Agricultural Sciences, Dharwad. Results compiled revealed that Pop (Chemical insecticide) + Caterpilin (Bt) @ 1.0 g/L treatment to be more promising in controlling larval population of pod borer over control during first spray (49.13 to 66.84%), second spray (48.97 to 59.68%) and third spray (43.33 to 63.98%). Similarly, the above treatment recorded maximum reduction in pod damage (49.54%) and seed damage (50.52%) with increase in yield upto 96.21% over control and 30.44% over chemical (Pop) treatment. Similarly, spraying of Caterpilin (Bt) did not show any phytotoxic effect on pigeonpea crop.

Keywords: Pigeonpea, Cajanus cajan, Bt, Bacillus thuringiensis, Pod borer, Helicoverpa armigera, Yield.

I. INTRODUCTION

The origin of pigeon pea [Cajanus cajan, (limn) Millsp] is not known with certainty. However, Benthan and de Candolle gave it an African origin. Vavilov observed enough variability in his collections from India and was of the firm opinion that the genus Cajanus originated in the Hindustan center. Presently, Peninsular India is considered as the center of origin of pigeon pea. From there it is supposed to have moved to East Africa and further to the Nile and West Africa. Though over 90% of the world’s pigeon pea is produced in India, there are as many as 58 countries in the world where pigeon pea is grown. In India it is cultivated as an annual crop but in other countries it is grown as a perennial crop where pods are harvested at regular intervals. In India, Maharashtra, Uttar Pradesh and Madhya Pradesh together occupy major area under pigeon pea and contribute 75% of the total production. Pigeon pea is the second most important grain legume of India after chickpea with the production of 2.65 million tonnes from 4.04 million hectares area with an average productivity of 656 kg/ha (Anonymous, 2012).

Pigeon pea is an important crop in semiarid tropical and subtropical farming systems, providing high quality vegetable protein, animal feed, and firewood. Pigeon pea is attacked by over 200 species of insects (Reed et. al. 1990). Few pests, however, can be devastating in epidemic situations. Insect pest feeding on flowers, pods and seeds are the most important biotic constraint affecting pigeon pea yields. Among the insects feeding on reproductive parts, gram pod borer (Helicoverpa armigera), blue butterfly (Euchrypsop cnejus), tur plume moth (Exelastis atomosa) and tur pod fly (Melanagromyza obtusa) causes heavy damage to pods resulting in extensive loss in the grain yield (Patel et. al. 2015; Shanower et. al. 1999).

Traditional control of economically important insect pests has relied mostly on chemical insecticides. However, their broad activity spectrum and the accumulation of persistent residues have increased the demand for environmentally friendly alternatives. Since, Helicoverpa armigera has developed high levels of resistance to insecticides; it has become difficult to control this pest on pigeon pea and several other crops with conventional insecticides (Kranthi et. al. 2002; Sharma, 2005). Hence, there is a need to develop alternative methods to minimize extent of losses. Recently, attempts are also being made on the use of safe chemicals like microbial pesticides to reduce the toxic effects of chemicals and prevent the environmental pollution. In recent years microbial insecticides have become a viable alternative to control lepidopteran pests. Bio-pesticides such as Bacillus thuringiensis (Bt), Beauveria bassiana, etc. can provide an alternative and environment friendly option to control these insect pests. Hence, attempt was made in the present investigation to carry out preliminary investigations on their bio-efficacy for control of pod borer in pigeon pea.

II. MATERIALS AND METHODS

The present study was carried out at Department of Entomology, Institute of Organic farming, University...
of Agricultural Sciences, Dharwad, Karnataka State. The recommended pigeon pea variety, Maruti was grown by following the recommended agronomic practices. The crop was raised in 5 x 4 m. plots with plant to plant spacing of 30 cm and row to row spacing of 90 cm. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The treatment details are as follow:

| Sl. No. | Treatments | Dosage/L |
|--------|------------|----------|
| 1      | Package of Practice (POP) Thiodicarbon 0.6 g/l - NSKE 5% - HaNPV 100 LE (1.00 ml/l) | At actual dosage |
| 2      | POP (Chemical) + Caterpilin | POP + 0.25g/Caterpilin |
| 3      | POP (Chemical) + Caterpilin | POP + 0.50g/Caterpilin |
| 4      | POP (Chemical) + Caterpilin | POP + 1.00g/Caterpilin |
| 5      | Half dose POP (Chemical) + Caterpilin | ½ POP + 0.25g/Caterpilin |
| 6      | Half dose POP (Chemical) + Caterpilin | ½ POP + 0.50g/Caterpilin |
| 7      | Half dose POP (Chemical) + Caterpilin | ½ POP + 1.00g/Caterpilin |
| 8      | Untreated control (Water spray) | - |

Caterpilin contains *Bacillus thuringiensis* var. kurstaki strains evaluated at three different doses i.e. 0.25 g/L, 0.50 g/L and 1.00 g/L along with chemical insecticides (POP) and 1/2 POP and an untreated control. Total three sprays were applied during the crop seasons. Foliar spray of Caterpilin (Bio-insecticide) treatments was given after 50% flowering coinciding with the pest incidence. The spray mixture of each treatment was prepared by mixing the required quantity of the formulations in water to make it equivalent to 250 l/ha. The spray mixtures were freshly prepared for each treatment. The population of *H.armigera* was recorded on five randomly selected plants in each plot before spray and subsequent observations were recorded after 7 and 14 days after spraying on same plants. Observations were recorded on No. of larvae/plant, percent reduction of larvae over control, pod damage %, seed damage % and yield. The data obtained were subjected to square root and are transformations and statistically analyzed as per the method suggested by Panse and Sukhatme (1985).

### III. RESULTS AND DISCUSSION

Observations recorded on number of larvae/plant on one day before spray, 7 days and 14 days after first, second and third spray was recorded and presented in Table-1. Similarly, % reduction of pod borer on 7th and 14th days after three spraying is presented in Table-2 and pod damage %, seed damage % and yield (kg/ha) is presented in Table-3 and figures 1 to 3. Only significant findings are presented and discussed below:-

#### i) Number of larvae/plant

The experiment was conducted to assess the bio-efficacy of Caterpilin (*Bacillus thuringiensis*) against pod borer infesting pigeon pea. Data presented in Table-1 indicated that there was no any difference in no. of larvae/plant in all the treatments where Caterpilin and chemical spraying was done. The results pertaining to the bio-efficacy indicated that T-4 treatment (POP + Caterpilin @ 1.0 g/L) recorded significantly lower number of larvae population during first, second and third spray (3.22 to 1.88), (3.23 to 2.31) and (3.40 to 2.19) respectively. Similarly, the T-4 treatment recorded significantly less larvae population than POP (Chemicals) treatment. In general, the higher doses of Caterpilin with combination of POP were more effective as compared to half doses of Caterpilin with combination of POP. In fact T-4 and T-3 were significantly superior to check. Similarly T-8 (control) treatment registered significantly highest larvae population in all the three sprays (6.33 to 5.67), (6.33 to 5.73) and (6.00 to 6.08) respectively.
ii) Percent reduction of pod borer over control

With respect to percent reduction of pod borer (Helicoverpa armigera), treatment No. T-4 (POP - Package of practice + Caterpilin @ 1.0 g/L) had recorded highest percent reduction over control i.e. (49.13 to 66.84), (48.97 to 59.68) and (43.33 to 63.98) during first, second and third spray respectively which was followed by T-3 (POP + Caterpilin @ 0.5 g/L) i.e. (33.70 to 54.67), (34.12 to 41.88) and (33.33 to 50.65) treatment. Untreated crop registered significantly lowest percent reduction (T-8) during all the three sprays. Thus, in bioefficacy the product (Caterpilin) at higher dose i.e. 1.0 g/L with combination of POP was more effective against pod borer of pigeon pea.

![Graph showing percent reduction of H.armigera over control]

| Treatment | % Reduction of H.armigera over control |
|-----------|---------------------------------------|
| 1         | 24.83                                 |
| 2         | 35.19                                 |
| 3         | 50.65                                 |
| 4         | 63.98                                 |
| 5         | 12.33                                 |
| 6         | 27.14                                 |
| 7         | 33.71                                 |
| 8         | 0.009                                 |

iii) Effect of pod damage (%) and seed damage (%)

Result presented in Table-3 in respect of pod and seed damage percentage indicated that the lowest pod and seed damage (32.13% and 28.04%) was recorded in the T-4 (POP - Chemical + Caterpilin @ 1.0 g/L) and T-3 (POP - Chemical + Caterpilin @ 0.5 g/L) treatment respectively which were significantly superior over other treatments. These two treatments (T-4 and T-3) treatments recorded significantly less pod and seed damage than T-1 (POP-chemical) treatment. Other treatments are (T-1, T-2, T-5, T-6 and T-7) shown significantly less pod and seed damage than control (T-8) treatment. However, T-8 (control) treatment recorded highest pod damage (63.87%) and seed damage (56.67%) percentage. Similarly, T-4 treatment recorded highest reduction in pod damage % (49.54%) and seed damage % (50.52%) over control treatment.

![Graph showing pod damage]

| Treatment | Pod Damage |
|-----------|------------|
| 1         | 41.67      |
| 2         | 41.33      |
| 3         | 36.15      |
| 4         | 32.13      |
| 5         | 43         |
| 6         | 42         |
| 7         | 41.55      |
| 8         | 63.67      |

![Graph showing seed damage]

| Treatment | Seed Damage |
|-----------|-------------|
| 1         | 35.67       |
| 2         | 37.6        |
| 3         | 34.48       |
| 4         | 28.04       |
| 5         | 41.56       |
| 6         | 39.05       |
| 7         | 35.5        |
| 8         | 56.67       |
iv) Yield (kg/ha)

Significant differences were noticed in yield due to spraying of Caterpilin (BT-Bacillus thuringiensis) as compared to the control yield. Seed yield ranges from 541 kg/ha (T-8, control) to 1061.5 kg/ha (T-4 i.e. POP + Caterpilin @ 1.0 g/ha) which is 96.21% higher than the control treatment. Similarly, all the treatments recorded significantly higher yield than control treatment. T-4 treatment gave significantly higher yield of 1061.5 kg/ha followed by T-3 (932.3 kg/ha), T-2 (829.0 kg/ha), T-1 (814.4 kg/ha), T-7 (905.3 kg/ha), T-6 (742.4 kg/ha) and T-5 (717.9 kg/ha) treatment. Similarly, T-4 treatment gave 96.21% higher yield than control treatment followed by T-3 (72.33%), T-2 (53.23%) and T-1 (53.54%) treatment. Likewise, T-4 and T-3 treatments gave 30.44% and 14.48% more yield respectively over POP (Full chemical dose) treatment (T-1).

![Yield Chart]

| Treatment | Yield (kg/ha) |
|-----------|--------------|
| 1         | 814.4        |
| 2         | 829          |
| 3         | 932.3        |
| 4         | 1061.5       |
| 5         | 717.9        |
| 6         | 742.4        |
| 7         | 805.3        |
| 8         | 541          |

v) Influence of Caterpilin (Bt) on phytotoxicity

The visual phytotoxicity of pigeon pea plant revealed that the plants sprayed with Caterpilin (T-2 to T-7) have shown ‘O’ visual phytotoxic effect i.e. injury on leaf tip and leaf surface, vein clearing, necrosis, wilting, and epinasty/hyponasty on crop health of pigeon pea crop. In the present study it is significant to note that T-4 (POP-chemical + Caterpilin @ 1.0 g/L) treatment to be more promising since they reduced highest % reduction of larvae population over control i.e. 49.13 to 66.84%, 48.97 to 59.68% and 43.33 to 63.98% during first, second and third sprays. Similarly, T-4 treatment recorded maximum reduction in pod damage (49.54 %) and seed damage (50.52%) reduction over control with increase in yield upto 96.21% over control treatment and 30.44% over POP (chemical) treatment.

Similar results were studied by Reddy et al. (2001) and reported that B. thuringiensis (Dipel) was effective in reducing the damage due to pod borers. Thakre et al. (2003) reported B. thuringiensis when used at 1000 g/ha reduced pod damage caused by Lepidopteran pests and also by the pod borer complex better than neem seed extract at 5% and neem leaf extract at 5%. The results of Sunil et al. (2004) against pod borer indicated Dipel 8L (B. thuringiensis var. kurstaki) in combination with fresh neem leaf extract was effective in controlling H. armigera on pigeon pea. The highest yield was recorded in indoxacarb treatment followed by DOR Bt at 1.5 kg/ha with 895 kg/ha as against control 599 kg/ha (Tavaragondi and Murali, 2014). They also reported that B. thuringiensis could be used effectively for the management of pod borers in pigeon pea.

Bacillus thuringiensis is an important entomopathogenic organism in protection against defoliating pests in Lepidoptera (Frankenhuyzen, 1993 and 1995). The present findings are in conformity to the previous studies reporting that the biopesticide like B. thuringiensis @ 1.5 kg/ha was effective for the management of pod borer complex in pigeon pea (Sreekantha and Seshamahalakshmi, 2012). Similar results were also reported by Mahapatra and Srivastava (2002) and reported Bt. provide good protection and registered significantly lesser incidence of pod borer larvae and higher yield over control. Bacillus thuringiensis var. kurstaki based product @ 2.5 l/ha was the best treatment and recording lesser H. armigera larval population (0.7/plant) in pigeon pea (Thilagam and Kennedy, 2007). The pod damage caused by H. armigera was recorded to be minimum with the application of NSKE followed by Bt at an interval of 20 days from the pod initiation stage onwards (Bhushan and Nath, 2006). Similarly, combination of B. thuringiensis (Dipel) and Destamethrin (0.004% or 0.002%) was the most effective in reducing the damage due to pod borers in pigeon pea with highest net profit (Reddy et. al. 2001). Similarly, the biopesticide Bt was moderately effective against pigeon pea pod borer (Sunditha et al. 2008). Besides B. thuringiensis and B. bassiana were effective against spotted pod borer (Marucacatustaluis) in pigeon pea (Manjula and Padmavathamma, 1996). However, B. bassiana preparation was observed to be less effective against H. armigera in pigeon pea (Nahar et. al. 2004).
Table 1: Bio-efficacy of Caterpilin against pod borer, *Helicoverpa armigera* infesting pigeon pea

| Tr. No. | Treatments | I \(^{st}\) spray | II \(^{nd}\) spray | III \(^{rd}\) spray |
|---------|-------------|--------------------|-------------------|-------------------|
|         |             | Number of larvae/plant |                  |                   |
|         |             | DBS 7 DAS 14 DAS | 7 DAS 14 DAS | 7 DAS 14 DAS |
| 1       | Package of Practice (POP) | 6.33a (2.61) | 5.33cd (2.41) | 3.97d* (2.11) | 5.00cd* (2.35) | 4.33cd* (2.20) | 4.90cd* (2.32) | 4.57d* (2.25) |
|         | Thiodicarb 0.6 g/l - NSKE 5% -*HaNPV* 100 LE (1.00 ml/l) | | | | | | | |
| 2       | POP (Chemical) + Caterpilin 0.25 g/l | 6.00a (2.54) | 4.33abc* (2.20) | 3.30c** (1.95) | 4.51bc* (2.24) | 3.97bc* (2.11) | 4.45bc* (2.22) | 3.94c** (2.11) |
| 3       | POP (Chemical) + Caterpilin 0.50 g/l | 6.33a (2.61) | 4.20ab* (2.17) | 2.57b** (1.75) | 4.17b** (2.16) | 3.33b** (1.96) | 4.00b** (2.12) | 3.00b** (1.87) |
| 4       | POP (Chemical) + Caterpilin 1.00 g/l | 6.67a (2.68) | 3.22a** (1.93) | 1.88a** (1.54) | 3.23a** (1.93) | 3.21a** (1.68) | 3.40a** (1.97) | 2.19a** (1.64) |
| 5       | Half dose POP (Chemical) + Caterpilin 0.25 g/l | 5.67a (2.48) | 5.67ab (2.48) | 4.51e* (2.24) | 5.67de (2.48) | 5.33e (2.41) | 5.73ef (2.50) | 5.33e* (2.41) |
| 6       | Half dose POP (Chemical) + Caterpilin 0.50 g/l | 6.00a (2.54) | 5.23cd (2.39) | 4.33cd* (2.20) | 5.33cd* (2.41) | 4.97de (2.34) | 5.67ef (2.48) | 4.43cd* (2.22) |
| 7       | Half dose POP (Chemical) + Caterpilin 1.00 g/l | 5.33a (2.41) | 4.67bcd* (2.27) | 3.40d* (1.97) | 4.67bc* (2.27) | 4.20bcd* (2.17) | 5.33ed* (2.41) | 4.03bc* (2.13) |
| 8       | Untreated control (Water spray) | 6.67a (2.68) | 6.33d (2.61) | 5.67f (2.48) | 6.33e (2.61) | 5.73e (2.50) | 6.00f (2.54) | 6.08f (2.57) |
|         | SEm± | 0.41 | 0.43 | 0.19 | 0.26 | 0.29 | 0.19 | 0.18 |
|         | CD at 5% | NS | 1.30 | 0.58 | 0.79 | 0.88 | 0.57 | 0.55 |

Note: Figures in the parentheses are √X + 0.5 transformed values. DBS = Day Before Spray, DAS = Day After Spray

IV. CONCLUSION

The present study indicated that Caterpilin (*Bacillus thuringiensis*) along with chemical insecticides could be used effectively for the management of pod borer larvae, pod damage, seed damage in pigeon pea. Similarly yield was also increased by 96.21% over control and 30.44% over POP (Chemical insecticides). Similarly, there was no any abnormality and phytotoxic effect observed by spraying Caterpilin on pigeon pea crop.

ACKNOWLEDGEMENTS

The authors are grateful to the Director of Research, University of Agricultural Sciences, Dharwad, Karnataka for providing necessary facilities for carrying out the present study on the farm.

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