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Evaluation of eco-friendly approaches for the management of pod borer complex of pigeonpea [*Cajanus cajan* (L.) Millsp.]

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Abstract
The field experiment conducted to evaluate the relative efficacy of different biopesticides against gram pod borer complex *Helicoverpa armigera* (Hübner) and pod fly, *Melanogromyza obtusa* (Malloch) infesting Pigenopea during Kharif season 2018-19. The population was recorded at different days after spraying of insecticides and it was found that the number of larvae varied non-significantly different from the control in both spray application. The pod borer *H. armigera* was found lowest in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha (6.25%), followed by Azadirachtin 1500 ppm @ 5.0 ml/l (7.33%) and Bt. *kurastaki* @ 1.0 g/l (9.33%) as compared to control (13.89%). Grain damage varied from minimum (8.42%) due to pod fly, *M. obtusa* and pod borer, *H. armigera* (3.35%) Chlorantraniliprole 18.5 SC @ 30 g a.i/ha followed by Azadirachtin 1500 ppm @ 5.0 ml/l (14.25%) as compared to (27.63%) due to pod fly, *M. obtusa* and (13.89%) pod borer, *H. armigera* in untreated control.

Keywords: biopesticides, pod borer, pod fly, pigeonpea and management

1. Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] commonly known as *arhar* or redgram or *tur* is second important pulse crop of the country after chickpea. It is predominantly grown in semi-arid tropics under wide rangeof agro-ecological situations contributing greater than 80% of the total world production (FAO, 2005) [2]. In India, pigeonpea is grown in 5.32 million ha with anannual production of 4.78 milliontonnes and productivity of 909 kg ha whereas inBihar the area, production and highest productivity of pigeonpea is 2.15 lakh ha, 3.29 lakh tonnes and 1532 kg ha^{-1}, respectively (AICRP Report, 2018) [1]. Pigeonpea is a multi-purpose legume, which not only provides food and domestic fuel wood, but also enriches soil by improving water infiltration and conserving valuable nutrients and water. It is a staple diet in most parts of India and is consumed as green peas as well as dry seed (Tabo *et al.*, 1995) [10]. It contains 20-22% protein, 1.2% fat, 65% carbohydrate and 3.8% ash (FAO, 2005) [2]. It also contains thiamine (0.45mg), niacin (2-9mg) and riboflavin (0.19mg). It has better quality of fibre, 7g/100g of seeds (Kandhare, 2014) [4]. Pigeonpea is tasty, not only to people, but also to insect pests and is attacked by a large number of insect pests (Prasad and Singh, 2004) [7]. Amongst many insect pests, the pod borers, *Helicoverpa armigera* (Hübner) and *Melanagromyza obtusa* (Malloch) are of major importance (Srilaxmi and Paul, 2010; Sharma, 2016) [9, 8]. Management of pod borer complex in pigeonpea relies heavily on insecticides, often to the exclusion of other methods of control. Considerable numbers of insecticideshave been tested and few of them found effective against the pod borers in pigeonpea (Yadav and Dahiya, 2004) [11]. 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) [3]. Keeping in view, the present study was undertaken to evaluate the bio efficacy of certain biopesticides against the pod borer complex in pigeonpea ecosystem.

2. Material and Methods

The experiments were carried out under field conditions at the TCA, Dholi, crop research farm, RPCAU, Pusa, Bihar, India during Kharif from July, 2018 to April, 2019 on Pigeonpea variety Bahar in randomized complete block design (RBD) having seven treatments replicated thrice with each plot consisted of 30m^2 (10 rows of 5m, each at 60 cm spacing). To study the efficiency of various bio-pesticides against *H. armigera* and *M. obtusa* on the Pigeonpea were used in each trial. The trial had five biopesticides *viz.*, Bt. *kurastaki* @1.0 g/l, *Beauveria bassiana* @ 5.0 g/l, *Metarhizium anisopliae* @ 5.0 g/l, *Lecanicillium lecanii* @ 5.0 g/l, Azadirachtin 1500 ppm@5.0 ml/l along with Chlorantraniliprole 18.5 SC @ 30 g a.i/ha as a check and control plot. The following observations were made.

Observations on the effect of bio-pesticides on *H. armigera*, and *M. obtusa*of pigeonpea

The larval population of *H. armigera* was observed on pre tagged 5 plants from each plot. Observations were taken at the first day before the third, seventh, tenth and fifteenth days after each spray.

Observations on pod damage at maturity

Pod damage at maturity of the crop was recorded from pods of 5 plants per plot at random in each plot. Two hundred pods were picked out randomly from each replicationat the time of harvest and the per cent pod damage and seed damagewas calculated by the formula as given below.

$$\text{Per cent pod damage (\%)} = \frac{\text{No. of damaged pods}}{\text{Total no. of pods}} \times 100$$

$$\text{Per cent grain damage (\%)} = \frac{\text{No. of damaged grains}}{\text{Total no. of grains}} \times 100$$

Samplepods were examined for the damage of *H. armigera* and *M. obtusa* to differentiate damage of the pod borer and pod fly the following criteria were adopted according to Yadav *et al.* (1988).

1. Healthy clear pods without any external damage symptom.
2. Pods attacked by *H. armigera* having big circular holes without larvae exuviae's on the pods.
3. Pods attacked by *M. obtuse* include dark brown encrustation on the pod wall.
4. Dry pods having small pin head size holes, seeds with stripes and are partially eaten.

Observations on grain yield

The grain yield of different treatments was obtained by harvesting the central rows after leaving the border rows on each side at maturity. After harvesting the grains were dried in open sunlight to stabilize the moisture content. The weight of grain of sample and plot was taken after this period. The total yield per plot included in the yield of sample grains and it was then computed on kg per ha basis.

3. Results and Discussion

The data recorded on larval population of *H. armigera* and *M. obtuse* before first spray, 3 Days after First Spray (DAFS), 7 DAFS, 10 DAFS and 15 DAFS (Table 1). Pre-treatment counts on larval population of *H. armigera* before application of the treatment showed that there were 2.00-3.40 per five plants. The minimum number of *H. armigera* larvae per plant was recorded as 1.40 on 3rd days after spray with Chlorantraniliprole 18.5 SC @ 30 g a.i/ha which was significantly at par with Bt. *kurastaki* @1.0 g/l, Azadirachtin 1500 ppm@5.0 ml/l and *Metarhizium anisopliae* @ 5.0 g/l. at 7th, 10th and 15th day after spray minimum number of larvae per plant was significantly lower in all the treatments over control.

The data recorded on percent pod damage due to *H. armigera*is presented in (Table 1). The percent pod damage due to *H. armigera* showed significant differences among treatments. In case of *H. armigera*, the Chlorantraniliprole 18.5 SC @ 30 g a.i/ha showed significantly reduced (6.25%) per cent pod damage followed by Azadirachtin 1500 ppm@5.0 ml/l (7.33%) and Bt. *kurastaki* @1.0 g/l (9.33%) as compared to control (14.49%). In case *M. obtusa* showed that per cent pod damage varied significantly from minimum (19.50% %) in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha followed by Azadirachtin 1500 ppm@5.0 ml/l (28.83%) and Bt. *kurastaki* @1.0 g/l (31.33%) to maximum (41.20%) in *Metarhizium anisopliae* @ 5.0 g/l in comparison to control (64.66%). Grain yield varied from maximum of 1553.50 kg/ha in Chlorantraniliprole 18.5 SC @ 30 g a.i/ha followed by1249.00 kg/ha in Azadirachtin 1500 ppm@5.0 ml/l as compared to 688.00kg/ha in untreated control.

The results are in agreement with the findings of Patange and Chiranjeevi (2017) [5] studied the effect of certain insecticides against pod borer complex infesting pigeonpea and showed rynaxypyr 18.5 SP @ 30 g a.i./ha was most effective insecticide in minimizing the larval population of pigeonpea pod borers *viz* ; gram pod borer, plume moth and pod fly. The treatment application of rynaxypyr 18.5 SP @ 30 g a.i. per ha shown the lowest pod damage (5.59 per cent) due to pigeonpea pod borers and recorded highest gain yield of pigeonpea (7.60 q per ha). Similarly, Patel and Patel (2013) [6] found that chlorantraniliprole @ 30 g a.i./ha was the most effective insecticide against pod borer complex and was followed by chlorantraniliprole + lambda cyhalothrin @ 37.5 g a.i./ha, chlorantraniliprole + lambda cyhalothrin @ 30 g a.i./ha and indoxacarb @ 75 g a.i./ha, respectively. Pillai *et al.* (2013) evaluated the efficacy of different biopesticides against pod borer complex in pigeonpea and reported that NSKE 5% w/v was found to be most effective in reducing the damage caused due to pod fly *i.e.*, 6.78% as against 21.72% in untreated check.

Sreekanth and Seshamahalakshmi (2012) reported that 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 26.2percent reduction over control respectively. The highest grain yield was recorded in spinosad 45% SC @ 73g.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 percent increase over control respectivelyas against the minimum yield of 407.4 kg/ha in the untreated check.

Table 1: Effect of different biopesticides against pod borer complex on pigeonpea

Sl. No	Treatments	Number of *H. armigera* larvae/ 5plant					Mean % Pod damage due to	
		Pre treatment count	3rd days after spraying	7th days after spraying	10th days after spraying	15th days after spraying	*M. obtusa*	*H. armigera*
1.	*Bt. kurastaki* @1.0 g/l	2.20	1.80	2.00	2.00	2.20	31.33	9.33
2.	*Beauveria bassiana* @ 5.0 g/l	3.40	3.40	2.40	2.20	3.00	38.33	13.08
3.	*Metarhizium anisopliae* @ 5.0 g/l	3.20	2.00	2.40	3.00	3.20	41.20	12.33
4.	*Lecanicillium lecanii* @ 5.0 g/l	2.80	3.60	2.60	2.40	2.80	40.33	10.58
5.	Azadirachtin 1500 ppm @5.0 ml/l	2.60	2.00	1.60	1.60	1.60	28.83	7.33
6.	Chlorantraniliprole 18.5 SC @ 30 g a.i/ha	3.20	1.40	1.40	1.60	1.20	19.50	6.25
7.	Untreated control	2.20	5.00	8.80	10.40	11.20	64.66	18.41
SEm±		NS	0.39	0.73	0.90	0.70	1.76	1.45
CD at5%			1.21	2.24	2.77	2.15	5.10	4.46

Table 2: Effect of different biopesticides against pod borer complex on pigeonpea

Sl. No	Treatments	Mean (%) Grain damage due to		Yield (kg/ha)
		M. obtusa	*H. armigera*)	
1.	*Bt. kurastaki* @1.0 g/l	15.53	4.46	1096.0
2.	*Beauveria bassiana* @ 5.0 g/l	18.34	4.74	959.0
3.	*Metarhizium anisopliae* @ 5.0 g/l	16.62	5.05	828.5
4.	*Lecanicillium lecanii* @ 5.0 g/l	15.37	6.37	1124.5
5.	Azadirachtin 1500 ppm @5.0 ml/l	14.25	4.40	1249.0
6.	Chlorantraniliprole 18.5 SC @ 30 g a.i/ha	8.42	3.35	1553.5
7.	Untreated control	27.63	13.89	688.0
	SEm±	2.12	1.46	-
	CD at5%	6.51	4.47	-

4. Conclusion

It can be concluded from the experiment that Azadirachtin 1500 ppm@5.0 ml/l may be recommended for effective and economic control of pod borer complex in pigeon pea. The grain yield recorded by this treatment was 12.49 q/ha and 44.91% more than the control, respectively.

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