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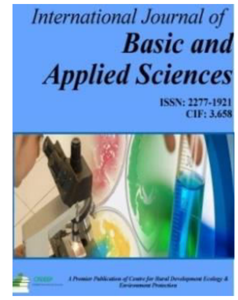

Full Length Research Paper

Evaluation of Biopesticides against Pod Borer Complex on Pigeon Pea at Pantnagar, Uttarakhand, India

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ABSTRACT

Considering the adverse effects of chemicals, various attempts are being made to use of target specific eco-friendly formulations as these are relatively safe and can also minimize the development of resistance in insect pests. In the similar context, the field experiments were conducted on the evaluation of some biopesticides against pod borer complex in pigeon pea during kharif crop seasons, 2018-19 and 2019-20 at G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. In the present study, among the biopesticides applied, Azadirachtin 1500 ppm @ 5 ml/ l was found very effective to minimize the web-counts of spotted pod borer, Maruca vitrata and larval population of Helicoverpa armigera after two sprays during both the years and resulted in the minimum cumulative per cent pod damage (25.50) with the highest grain yield (1110 kg/ha) followed by Bt var. kurstaki @ 1g/ l with per cent pod damage (27.34) and grain yield (1075 kg/ha). However, in case of insecticide application, Chlorantraniliprole 18.5 SC 30g a.i/ha resulted in the lowest mean per cent pod damage (21.00) with grain yield of (1190 kg/ha) in comparison to the lowest grain yield (745kg/ha) was obtained in untreated control. On the other hand, among the biopesticides, the cost benefit ratio was calculated the highest for Bt var krustaki (9.70) followed by Azadirachtin 1500 ppm @ 5 ml/ l (4.99) in comparison to (7.31) with Chlorantraniliprole 18.5 SC 30 g a.i/ha. Thus, it may be concluded that biopesticides can also be incorporated in integrated pest management programme for pigeon pea pod borer complex at Pantnagar, Uttarakhand.

Introduction

Pigeon pea [*Cajanus cajan*(L.) Millsp.], is one of the most important grain legume cropof the tropics and subtropics .) Also known as red gram, arhar, tur and grown for multiple uses, originating in India.In the last five years, productivity of pigeon pea in India has shown an increasing trend (11.42%) from 693 (2009–2013) to 774 kg/ha (2014–2018), however, it is lower by ~10% compared to world productivity (761 kg/ha) in 2009–2013 and 850 kg/ha in (2014–2018) (FAOSTAT, 2020). India contributed about 72% of global Pigeon pea production. Disproportionate yield gaps were noted between potential (2.5–3.0 t /ha) and average (~0.9 t /ha) yields in India, Moreover, disproportionate yield gaps between research plots and in farmers' fields of a given variety are also a major concern in India (Bhatia *et al*., 2006). More than 250 species of insects have been found feeding on Pigeon pea, and out of these some insects can damage the crop consistently. The important pests include, the pod borer, *Helicoverpa armigera* (Hubner), spotted pod borer, *Maruca vitrata* (Geyer), pod bug, *Clavigralla gibbosa* (Spinola) and pod fly, *Melonagromyza obtusa* (Malloch) are the major pest species causing significant damage to pods. The pod borer, *M. vitrata* (Geyer) which is commonly known as legume pod borer, is a serious pest of grain legumes in the tropics and subtropics due to its wide host range anddistribution. The larvae cause damage to the economic plant parts such as flowers, flower buds and immature pods by extensive webbing and contaminate with their excreta so it's very difficult to kill the larvae of *Maruca vitrata* as its feeding behavior is very different. The grain yield loss due to legume pod borer was estimated to be 10.0 to 80.0 per cent in various crops Haripriya and Jeyarani (2019). Another insect of pod borer complex is *Helicoverpa armigera which is* a key pest inflicting 80-90% of loss caused by pod borers. It causes considerable yield loss of 250000 tons of grains/annum worth more than 3750 million rupees per year, (Pandey and Das, 2016)

A number of insecticides have been reported to be effective for controlling of *M. vitrata* and *H. armigera* but at the same time it was seen that high dose of insecticide and using that in improper way leads to the development of resistance due to the chemical pesticides, cause the resurgence of secondary insect pests, degrades the environment, kills natural enemies and causes (Srinivasan *et al*., 2011). Latest studies revealed that due to intensive and indiscriminate use of pesticides the insecticide resistant strains were developed in some field populations of *M. vitrata* (Ulrichs*et al*., 2001; Srinivasan *et al*., 2011). Considering the ill effects of injudicious use of chemicals, attempts are being made to use of target specific eco-friendly plant and animal product based formulations such as neem products, emtomopathogenic fungi, cow urine, bactetrial formulations for management of pests as these are relatively safe and can also minimize the development of resistance in pod borers(Yadav and Singh, 2014). Keeping these points in view and considering the economic importance of pigeon pea, the present study was conducted with an objectives to evaluate the bio-efficacy of some eco-friendly biopesticides on mean population of the pod borer complex along with pod damage caused by them, grain yield obtained and cost benefit analysis of tested biopesticides against pod borer complex on pigeon pea.

Materials and methods

To combat the adverse and ill effects of hazardous insecticides on non-target insects, human being and environment, some of biopescitides were taken to study about their efficacy against pod borer complex on pigeon pea. The field experiments were carried out on the bio efficacy of some biopesticides containing neem based botanical, Azadirachtin 1500 ppm@ 5.0 ml/l, bioagents *viz.B.t* var. *kurstaki*@1.0g/l, *Beauveria bassiana*@5.0 g/l, *Metarhizium anisopliae*@ 5.0 g/l, *Lecanicillium lecanii* along with chemical, Chlorantraniliprole 18.5 SC@30g a.i./ha and untreated control against pod borer complex, *M. vitrata* and *H. armigera* on pigeon pea during kharif crop seasons, 2018-19 and 2019-20 at NEBCRC, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The recommended pigeon pea variety 'PA- 291' was sown as per recommended agronomic practices in seven (07) plots each measuring 4 m x 5 m= 20m^{2}in randomized block design (RBD) with three replications. The interplot space was kept 1.5 m. Two sprays of biopesticides were applied on pigeon pea crop at 10 days interval starting from 50%on the appearance of *Maruca* webbings and *Helivcoverpa* larvae. Total number of webs per plant with regard to *Maruca* and number of larvae per plant with regard to *Helicoverpa* were recorded from 3 randomly tagged plants per replication (total plants 09) at before, 3, 7 and 10 days after spraying.

$$\textit{Percent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

Per cent seed damage caused by pod bugs were recorded separately by randomly collecting 25 pods per replication per treatment and by counting the damaged seeds out of total seeds obtained from 25 pods. Grain yield per plot were recorded at harvest and converted into kg/ha. For recorded grain yield, the grains yield for each treatment was calculated in quintal/ha from each plot. For the observation of increase in grain yield the following formula used:

$$\textit{Grain yield (q/ha)} = \frac{\text{Grain yield (kg/plot)} \times 10000\ \text{m}^2}{\text{Plot size (m}^2\text{)} \times 100}$$

For Cost: Benefit analysis, record of the costs incurred in each treatment and that of control was maintained. Similarly, the price of the harvested grains under each treatment and that of control was calculated at market rate. Benefit-Cost analysis was expressed in terms of Benefit: Cost ratio by using the following formula.

$$\textit{Cost Benefit ratio} = \frac{\text{Net return (Rs/ ha)}}{\text{Cost of treatment (Rs/ha)}}$$

Cost-benefit ratio also be worked out for all treatments. The overall data were pooled and statistically analyzed.

Statistical Analysis

The field based experimental data was analyzed for Randomized Block Design (RBD), analysis of variance after suitable transformations. The per cent data values were analyzed by angular transformation before statistical analysis. The mean number of insects was analyzed by square root transformation with adding factor 1.0.

Results and discussion

Evaluation of biopesticides against pod borer complex on pigeon pea at Pantnagar, Uttarakhand

The cumulative data recorded on the effect of biopesticides on the mean number of web counts of *M. vitrata* in pigeon pea during kharif crop seasons, 2018-19 and 2019-20 is presented in Table 1 revealed that before spray, the cumulative pooled mean number of *Maruca* webs were ranged from 23.89 to 26.79 per plant. After 3rd day of first spraying, the mean number of *Maruca* webs were recorded the least in Chlorantraniliprole 18.5 SC@30g a.i./ha (16 per plant) followed by Azadiractin 1500ppm (19.89 per plant) which was at par with *Bt* var. *kurstaki* (20.06 per plant*)*. After 7days of firstspraying, the mean number of *Maruca* webs were counted comparatively less which was ranged from 13.94 per plant in Azadiractin 1500ppm to 21.50 per plant in *Lecanicillium lecanii* treated pigeon pea. The mean number of *Maruca* webs were recorded the lowest on the 10th day of first spraying which was ranged from 8.95 per plant to 16.94 per plant as against 26.67 per plant in untreated control. The overall mean number of *Maruca* webs per plant were calculated the lowest (12.87) in Chlorantraniliprole 18.5 SC@30g a.i./ha, followed by Azadiractin 1500ppm (14.42) with significantly the highest number of webs (27.48) counted in untreated control. The mean number of *Maruca* webs per plant were comparatively very less before second spray ranged from 13.06 to 23.00 in the treatments as against 29.34 in untreated control. After 3 and 7 days of second spraying, the lowest mean *Maruca* webs per plant were recorded in the to Chlorantraniliprole 18.5 SC@30g a.i./ha (8.33 and 6.61) followed by Azadiractin 1500ppm (9.55 and 8.00) and *B. thuringiensis* var. *kurstaki* (3.84 and 11.89), respectively. Whereas the overall mean population of *Maruca* webs after second spray was observed the minimum in Azadiractin 1500ppm (9.67/plant) followed by *Bt var. krustaki* (13.43/plant) , *Beauveria bassiana* (15.83) in comparison to 8.44/plant in Chlorantraniliprole 18.5 SC@30g a.i./ha and the maximum mean 31.96 *Maruca* webs/plant were recorded in untreated pigeon pea.

Table. 1 Evaluation of biopesticides against spotted pod borer, *Maruca vitrata* in pigeon pea during kharif crop season 2018-19 and 2019-20 at Pantnagar, Uttarakhand

S.No.	Treatments	Dose	Cumulative Pooled data on mean *Maruca* webs/plant									
			I^st^ spray					II^nd^ spray				
			Before spray	3 DAS	7DAS	10DAS	Over all Mean	Before spray	3 DAS	7 DAS	10 DAS	Overall mean
T1	*B.thuringiensis (Bt) var. kurstaki*	1.0g/l	21.11 (4.53)*	20.055 (4.46)	15.22 (3.95)	10.83 (3.44)	15.37 (4.02)	16.39 (4.15)	14.55 (3.94)	13.84 (3.84)	11.89 (3.58)	13.43 (3.80)
T2	*Beauveria bassiana*	5.0 g/l	26.37 (4.94)	25.83 (4.97)	19.56 (4.44)	12.61 (3.69)	19.33 (4.47)	18.67 (4.41)	17.06 (4.23)	15.89 (4.10)	14.55 (3.94)	15.83 (4.10)
T3	*Metarhizium anisopliae*	5.0 g/l	23.89 (4.79)	23.725 (4.86)	18.89 (4.44)	15.22 (4.03)	19.28 (4.49)	21.22 (4.70)	20.28 (4.59)	17.28 (4.26)	15.34 (4.04)	17.63 (4.31)
T4	*Lecanicillium lecanii*	5.0 g/l	26.78 (5.05)	28.44 (5.26)	21.50 (4.67)	16.94 (4.23)	22.29 (4.80)	23.00 (4.88)	23.17 (4.91)	22.11 (4.80)	21.44 (4.73)	22.24 (4.82)
T5	Azadirachtin 1500 ppm	5.0 ml/l	25.50 (4.98)	19.89 (4.45)	13.94 (3.83)	9.44 (3.23)	14.42 (3.89)	16.67 (4.19)	11.45 (3.53)	9.55 (3.24)	8.00 (3.00)	9.67 (3.26)
T6	Chlorantraniliprole 18.5 SC@30g a.i./ha	30 g a.i/ha	26.79 (5.18)	16.00 (4.04)	13.66 (3.75)	8.95 (3.14)	12.87 (3.70)	13.06 (3.74)	10.39 (3.37)	8.33 (3.06)	6.61 (2.76)	8.44 (3.06)
T7	Untreated control	-	26.56 (5.09)	26.88 (5.14)	28.89 (5.33)	26.67 (5.20)	27.48 (5.34)	29.34 (5.45)	30.33 (5.55)	31.83 (5.69)	33.73 (5.85)	31.96 (5.74)
	SEm±		2.27 (0.23)	2.91 (0.22)	3.11 (0.25)	2.93 (0.28)	1.28 (0.14)	2.00 (0.15)	2.63 (0.24)	2.31 (0.20)	2.59 (0.21)	0.79 (0.09)
	CD (0.05%)		NS	NS	NS	10.34 (0.99)	3.98 (0.45)	7.06 (0.54)	9.28 (0.84)	8.16 (0.70)	9.15 (0.73)	2.45 (0.29)
	CV		12.71 (6.59)	17.91 (6.63)	23.40 (8.22)	28.81 (10.26)	11.81 (0.20)	14.32 (4.82)	20.47 (7.85)	19.26 (6.77)	23.02 (7.34)	7.99 (3.84)

**Figures in the parenthesis are square root transformed values with adding factor x+1.0*

The observations made on the efficacy of biopesticides against the cumulative pooled mean population of *H. armigera* in pigeon pea crop are compiled in **Table-2** which clearly showed that larval population of *H. armigera* was observed in the month of November of kharif crop seasons, 2018-19 and 2019-20 and only a single spray of tested formulations was done. Before spray, the larval population was ranged from 5.11 to 6.78 larvae per plant. After 3rd day of spray, chemical, Chlorantraniliprole 18.5 SC@30g a.i./ha reduced the larval population to 2.00 per plant whereas among the eco-friendly formulations, Azadiractin1500ppm gave the lowest mean larval population per plant (2.28) followed by *Bt* var. *kurstaki* (2.83) and *B. bassiana* (3.06) in comparison to *M. anisopliae* (4.56) and *L. lecanii* (5.78) with the highest larval population observed inuntreated control (6.77per plant).

After 7days of spray, the lowest larval population (1.11 per plant) was recorded in to Chlorantraniliprole 18.5 SC@30g a.i./ha followed by Azadirachtin 1500 ppm (1.89 per plant),*B.t* var. *kurstaki*(1.61 per plant) and *B. bassiana* (2.17 per plant).The same trend was observed after 10 days of spray, where the Chlorantraniliprole 18.5 SC@30g a.i./ha gave the lowest larval population (0.66 per plant) followed by Azadiractin 1500 ppm (1.00 per plant) followed by *B.t* var. *kurstaki*(1.22 per plant), *B. bassiana* (1.78 per plant) in comparison to the highest (6.28 per plant) larval population was recorded in untreated control. The overall mean larval population of *H. armigera* per plant was recorded the lowest in to Chlorantraniliprole 18.5 SC@30g a.i./ha(1.26) followed by Azadirachtin 1500ppm(1.72), *Bt* var. *kurstaki*(1.89), *B. bassiana* (2.33), *M. anisopliae* (3.11), *L. lecani* (4.37) as against the highest (6.48 larvae per plant) was recorded in untreated control.

Table- 2 Evaluation of biopesticides against *H. armigera* in pigeon pea during kharif crop seasons 2018-19 and 2019-20 at Pantnagar, Uttarakhand

S. No.	Treatment	Dose	Pooled data mean *Helicoverpa armigera* larvae / plant				
			Before spray	3 DAS	7 DAS	10DAS	Overall mean
1.	*B. thuringiensis (Bt)* var. *kurstaki*	1.0 g/l	5.11 (2.46)*	2.83 (1.95)	1.61 (1.61)	1.22 (1.48)	1.89 (1.68)
2.	*Beauveria bassiana*	5.0 g/l	5.83 (2.61)	3.06 (2.00)	2.17 (1.77)	1.78 (1.65)	2.33 (1.82)
3.	*Metarhizium anisopliae*	5.0 g/l	6.28 (2.69)	4.56 (2.36)	2.50 (1.86)	2.28 (1.80)	3.11 (2.01)
4.	*Lecanicillium lecanii*	5.0 g/l	6.78 (2.78)	5.78 (2.60)	3.94 (2.22)	3.39 (2.10)	4.37 (2.30)
5.	Azadirachtin 1500 ppm	5.0 ml/l	5.56 (2.59)	2.28 (1.81)	1.89 (1.68)	1.00 (1.41)	1.72 (1.64)
6.	Chlorantraniliprole 18.5 SC@30g a.i./ha	30 g a.i/ha	6.78 (2.78)	2.00 (1.73)	1.11 (1.45)	0.66 (1.29)	1.26 (1.49)
7.	Untreated control	-	6.11 (2.65)	6.77 (2.78)	6.39 (2.71)	6.28 (2.70)	6.48 (2.73)
	Sem±		0.40 (0.76)	0.51 (0.11)	0.41 (0.98)	0.18 (0.49)	0.23 (0.54)
	CD (0.05%)		1.38 (0.26)	1.77 (0.37)	1.41 (0.34)	0.62 (0.17)	0.70 (1.67)
	CV		5.11 (2.46)	2.83 (1.95)	1.61 (1.61)	1.22 (1.48)	1.89 (1.68)

**Figures in the parenthesis are square root transformed values with adding factor x+1.0*

The data regarding the damage caused by the pod borer complex, pod bugs and grain yield obtained under biopesticides based trials in pigeon pea is presented in Table- 3. The pod damage caused by *H. armigera* larvae was the lowest ranged from 1.83 per cent in Chlorantraniliprole 18.5 SC@30g a.i./ha to 8.67 per cent in *L. lecanii* against 4.17 -10.17 per cent and 15.00 -20.00 per cent pod damage was caused by *M. vitrarta* and *M. obtusa,* respectively. Among the biopesticides, the cumulative pod damage was calculated the lowest in Azadirachtin 1500ppm(25.00 per cent) followed by *B.t* var. *kurstaki*(27.34 per cent). Among the rest of the treatments, pod damage was ranged from 34.00- 38.17 per cent and 45.34 per cent in untreated control. The lowest per cent seed damage caused by pod bugs was recorded in Azadirachtin 1500ppm (18.09) followed by *Bt* var. k*urstaki* (19.56) in comparison to (16.27%) in Chlorantraniliprole 18.5 SC@30g a.i./ha with the highest damaged seeds (32.07%) were counted in and untreated control

The data collected on the grain yield of pigeon pea as depicted in Table 3, clearly showed that the highest grain yield (1195kg/ha) was obtained from pigeon pea plots treated with Chlorantraniliprole 18.5 SC@30g a.i./ha. The next effective treatments pertaining to yield of pigeon pea were among the biopesticides, Azadirachtin 1500ppm @ 5m/l (1110 kg/ha) followed by *Bt* var. k*urstaki* (1075.00 kg/ha) in comparison to the lowest yield (745.00 kg/ ha).was recorded in untreated control.

Table. 3 Efficacy of biopesticides on pod damage, seed damage and grain yield of pigeon pea during kharif crop seasons, 2018-19 and 2019-20 at Pantnagar, Uttarakhand

S. No	Treatments	Dose	Pod damage (%)			Cumulative pod damage (%)	Seed damage (%)	Grain yield (kg/ha)
			H. armigera	*M. vitrata*	*M. obtusa*			
T1	*B. thuringiensis (Bt) var. kurstaki*	1.0 g/l	3.84 (11.29)*	6.50 (14.76)	17.00 (23.05)	27.34 (31.03)*	19.56 (26.21)*	1075
T2	*Beauveria bassiana*	5.0 g/l	5.50 (13.56)	8.50 (16.94)	20.00 (25.70)	34.00 (35.40)	24.64 (29.62)	1032
T3	*Metarhizium anisopliae*	5.0 g/l	7.00 (15.32)	8.84 (17.28)	18.84 (24.84)	34.67 (35.88)	25.67 (30.38)	995
T4	*Lecanicillium lecanii*	5.0 g/l	8.67 (17.10)	10.17 (18.58)	19.34 (25.02)	38.17 (37.97)	27.18 (31.38)	918
T5	Azadirachtin 1500 ppm	5.0 ml/l	*2.84 (9.58)*	*6.00 (14.17)*	*16.67 (22.93)*	25.50 (29.71)	18.09 (24.99)	1110
T6	Chlorantraniliprole 18.5 SC@30g a.i./ha	30 g a.i./ha	*1.83 (7.70)*	*4.17 (11.77)*	*15.00 (21.45)*	21.00 (26.54)	16.27 (23.62)	1195

T7	Untreated control	-	11.00 (19.35)	11.84 (20.11)	22.50 (27.74)	45.34 (42.26)	32.07 (34.46)	745
	Sem±		0.62 (0.81)	0.21 (0.24)	0.55 (0.67)	0.89 (0.95)	1.20 (0.92)	-
	CD (0.05%)		2.17 (3.14)	0.73 (0.85)	1.94 (2.38)	3.14 (3.35)	4.22 (3.25)	-

**Figures in the parenthesis are angular transformed values*

Economics of various treatments

The data calculated on the economics of various treatments over untreated control for the management of pod borer complex in pigeon pea is presented in Table 4. Among all the treatments, the cost of bio-pesticide was the lowest with *B.t* var. *kurstaki*1.0g/l (Rs. 550.00), followed by *Beaveria bassiana* @ 5.0g/l (Rs.1400.00). Among the eco-friendly treatments, the highest net profit over control was obtained with treatment, *Bt var kurstaki* (Rs.18930/ha) followed by Azadirachtin 1500 ppm (Rs18,874/ha). The highest ICBR was calculated with treatment *Bt var.* k*urstaki* as @1.0g/l (1:9.70) followed by Azadirachtin 1500 ppm @5ml/l(1:4.99), *Beaveria bassiana* @ 5.0g/l (4.68), *M. anisopliae* (1:4.07) in comparison to the less high value (1:7.31) was calculated for chemical, Chlorantraniliprole 18.5 SC@30g a.i./ha treated pigeon pea.

Table 4. Economics of bio-pesticide application over untreated control for the management of pod borers in pigeon pea during kharif crop seasons 2018-20 at Pantnagar, Uttarakhand

S. No.	Insecticide and Dose	Quantity used (ml/l water)	Cost of insecticide (Rs/ha)	Total cost (insecticide + labour)	Grain yield (kg/ha)	Cost of grains (Rs)	Additional yield over control (kg/ha)	Income from additional yield (Rs/ha)	Net profit over control (Rs/ha)	ICBR
T1	*B. thuringiensis* (*Bt.*) var. *kurstaki*	1.0 g/l	550	1950	1126.50	67,590	348	20,880	18,930	9.70
T2	*Beauveria bassiana*	5.0g/l	1400	2800	1044	62,640	265.5	15,930	13,130	4.68
T3	*Metarhizium anisopliae*	5.0g/l	1426	2826	1017.50	61,050	239	14,340	11,514	4.07
T4	*Lecanicillium lecanii*	5.0g/l	1500	2900	912.50	54,750	134	8,040	5,140	1.77
T5	Azadirachtin 1500 ppm	5 ml/l	2376	3776	1156	69,360	377.5	22,650	18,874	4.99
T6	Chlorantraniliprole 18.5 SC@ 30 g a.i/ha (standard check)	0.3 ml/l	1950	3350	1243	74,580	464.5	27,870	24,520	7.31
T7	Untreated control	-			778.5	46,710				

ICBR: Incremental Cost Benefit Ratio; MSP of whole pigeon pea: Rs.60.00/kg ; Total spray solution used per treatment-: 6.0 lt. Sprays done-02; Labour required: 02 per spray =4 Labour cost@ Rs.350/day/labour; Cost of Bt var. kurstaki-Rs 550/kg, Azadirachtin 1500 ppm -Rs 475/lt. Chlorantraniliprole 18.5SC- Rs 13000/lt. ; Beauveria bassiana - Rs 280/lt. , Metarhizium anisopliae - Rs 285/lt., Lecanicillium lecanii – Rs 300/lt.

The relative low efficacy of the biopesticides over synthetic insecticides in the present findings was also reported by Mohapatra and Srivastava, (2002) reported that *Bt* (Biobit) @ 1000 g a.i /ha was effective in controlling *Maruca* pod borer in pigeon pea. Prajapati *et al*. (2003) used neem seed extract, neem oil, neem cake, black pepper and garlic bulb extract with varied doses against the *M. vitrata* attacking cowpea and pigeon pea. Chandrayudu *et al*. (2008) recorded the efficacy of commercial formulation of *Bt* @ 0.0025% in suppression of pod damage due to spotted pod borer in cowpea. Sunitha *et al*. (2008) reported that *Bt* @ 6.7×1011 and *M. anisopliae*@ 1× 106 were moderately effective against *M. vitrata* in pigeon pea at Hyderabad. Sreekanth and Seshamahalakshmi, (2012) evaluated the bioefficacy of different biopesticides against *Maruca vitrata* and found that per cent inflorescence damage was less in due *Bacillus thuringiensis*-1 @ 1.5 kg/ha (10.52%) followed by *Beauveria bassiana* SC formulation @ 300mg/lt (14.15%) with 80.9, 57.6 and 42.9 per cent reduction over control. Pandey and Das, (2016) evaluated biopesticides against gram pod borer and most effective biopesticide recorded was *Beauveria bassiana* @ 1 lt / ha (1x1012 spores/ml) as the lowest larval population (6.68 larvae / 5plants). The highest larval population was recorded in control (12.61 larvae /5 plants). Thilagam *et al.* (2020) reported the most effective biopesticide, *Bt* var. *kurstaki*@ 1 g/litre in reducing the webcounts of spotted podborer in pigeon pea.

Conclusion

In the present investigation, it may be concluded that among the tested biopesticides, Azadirachtin 1500ppm followed by *Bt var. kurstaki* were found quite effective against pod borers, *M. vitrata* and *H. armigera* with the highest grain yield (1156 kg/ha and 1126 kg/ha) and ICBR values (1: 9.70) and (1:4.68), respectively in comparison to other formulations and untreated control. So, these ecofriendly biopesticides can easily be included in integrated pest management for pod borer complex on pigeon pea.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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