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Studies on influence of different entomopathogens against gram podborer, *Helicoverpa armigera* (Hubner) on redgram

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Abstract
Bioefficacy of entomopathogens *viz*., HaNPV, *Bacillus thuringiensis*, *Metarhizium anisopliae*, *Beauveria bassiana*; new generation chemical (Spinosad) and botanical insecticide (NSKE) were evaluated for two seasons during 2018 to 2019 at Annamalainagar, Cuddalore District, Tamilnadu. Pod-dip bioassay studies were carried out in the laboratory and spraying was taken up in the field studies for two seasons. Experimental results indicated that all the treatments had significant effect in minimizing the pest damage ranging from 0.66 to 1.66 larva/five plants after 2 days of second spraying as compared to 1.66 in control. Among all the treatments, Spinosad 45% SC @ 73 a.i/ha was the most effective with minimum population of 0.66 larvae/ha with 60.24 per cent reduction over control, followed by *Bacillus thuringiensis* @ 1.5 kg/ha and NSKE 5%@ 25kg/ha. The number of larvae of *H. armigera* at 6 days after second spray revealed that all the treatments were statistically superior and found effective to decrease the *H. armigera* larval population. The yield obtained from the plots (II season) treated with Spinosad 45% SC @ 73g a.i/ha recorded the highest yield 9.83 q/ha followed by *Ha*NPV @ 250 LE/ha and *Bacillus thuringiensis* @ 1.5 kg/ha which yielded 9.30 and 9. 06 q/ha.

Keywords: bioefficacy, entomopathogen, red gram, *Helicoverpa armigera*

Introduction

Redgram constitute an integral part of Indian agriculture because of their vital role in enriching the human diet as well as soil fertility. India is the largest producer of pulses in the world occupying an area of about 26.16 million hectares, with annual production of 17.11 million tonnes with a productivity of 654 kg/ha (ESI, 2015) [6]. Red gram (*Cajanus cajan*) is an important grain legume and occupies the second largest area among the pulse crops grown in India (PBAS, 2014). Among the insect species infesting pigeon pea, the pod borer complex is reported to reduce the yield up to 27.77 per cent (Abdally and Mukkor, 1987) [1] and among the borers, gram pod borer (*Helicoverpa armigera*) is considered as most destructive. *Helicoverpa armigera* is one of the most important polyphagous pests, which attacks more than 200 plant species throughout the world, and has developed high levels of resistance to most of the chemical insecticides. In India, regular and indiscriminate use of chemical insecticides and the misuse of synthetic pesticides on the crop have led to development of insecticide resistance in target pests, pest resurgence and secondary pest out breaks, loss of bio diversity, environmental pollution & residual toxicity and occurrence of human health hazards. In this context, bio-pesticides such as HaNPV (Entomopathogenic virus), *Bacillus thuringiensis* (Entomopathogenic bacteria), *Beauveria bassiana*, *Metarhizium anisopliae* (Entomopathogenic fungi) can provide an alternative with more environmentally friendly option to control this insect pest (Jayarani and Karuppuchamy, 2010) [7].

Materials and Methods

The present studies entitled, "Influence of different entomopathogens against gram podborer, *Helicoverpa armigera* (Hubner) on redgram" was undertaken at the Department of Entomology during 2018-2019 at experimental farm, Faculty of Agriculture, Annamalai University. Method of bioassay in laboratory included the pod dip bioassay which was followed to evaluate the biopesticides. This experiment was conducted under laboratory conditions with the following six treatments consisting of one viral insecticide (*Ha* NPV) 0.5,1.0, 1.5, 2.0, 2.5 ml/L, a bacterial insecticides (*Bacillus thuringiensis*) 1.0, 1.5, 2.0, 2.5, 3.0 g/L, botanical insecticides (NSKE 5%) 1%, 2%, 3%, 4%, 5% ml/L, entomopathogenic fungus (*Metarhizium anisopliae*, *Beauveria bassiana*) 1.0, 1.5, 2.0, 2.5, 3.0 g/L and a novel insecticides (Spinosad) 0.1, 0.2, 0.3, 0.4, 0.5 ml/L, and every treatment were replicated three times. In each replications, ten separate petridishes were maintained for avoid the cannibalism. Uniform sized pigeon pea pods were surface sterilized in 0.5 per cent sodium hypochlorite, rinsed in sterile water and shade dried. The pods were dipped in respective concentrations of the bio pesticides and insecticides solution for about 30 seconds and the excess fluid was drained off. The test insects were pre-starved for 6 hours. Each petridish having the treated pods were enclosed and the third instar larvae were allowed to feed on the pods @ 1 larva per pod. Mortality was recorded at 24, 48, and 72 hours after treatment. Estimation of insect pest population and pod damage was carried out by following Cherry *et al*., (2000) sampling methods on chickpea was followed to estimate the pod borer complex in pigeon pea at field condition. The larva (*H. armigera*) were counted by means of taking five randomly selected plants in each replication. From each plant twig selected and number of pod borers per twig was recorded. Pod borer damage was recorded by uprooting ten randomly selected plants during harvesting.

Number of pods per plant and number of damaged pods were recorded and expressed as per cent pod damage respectively.

$$\text{Pod damage (\%)}=\frac{\text{Number of damaged pods}}{\text{Total no. of pods observed} \times 100}$$

The pod yield was recorded on the net plot area basis which was later converted to q/ha. The percentage reduction over control was calculated with the following formula.

Per cent reduction = C-T/ C

Where,
C: Percentage pod damage of control or larval population on control
T: percentage pod damage of treated plot or larval population on treatments.
For evaluating the field efficacy of various management practices against pod borer in pigeon pea, 2 field trials were conducted with Co (Rg)7 variety with a plot size of 5m×4m in an RBD.

Results

Effect of spray on larval population of (*Helicoverpa armigera*) (Season I)

Data (Table 1) revealed that all the treatments had significant effect in minimizing the pest population after two days of spray. The larval population ranged from 0.86 to 1.73 per five plants after two days of first spraying as compared to 1.80 in control. Among all the treatments Spinosad 45% SC @ 73g a.i/ha was found most effective, where minimum population of 0.86 larvae/five plants survived with 52.22 per cent reduction over control, followed by *Ha*NPV @ 250 LE/ha. Data (Table 1) revealed that all the treatments had significant effect in minimizing the population of *H. armigera* larvae and it ranged from 0.46 to 0.86 larva/five plants after 2 days of second spraying as compared to 1.53 in control. Among all the treatments the Spinosad 45% SC @ 73g a.i/ha was found most effective, where minimum population of 0.46 larvae/five plants with 69. 93 per cent reduction over control, followed by *Bacillus thuringiensis* @ 1.5 kg/ha and *Ha*NPV @ 250 LE/ha were found effective.

Table 1: Field efficacy of selected biopesticides against *H. armigera* (I Season) (SPRAY I & II)

T. no.	Treatment	PC	I SPRAY				PC	II SPRAY			
			6 DAS*(%R0C)	10 DAS (% ROC)	14 DAS (%ROC)	Mean		6 DAS (% ROC)	10 DAS (% ROC)	14 DAS (% ROC)	Mean
T_1	*Ha*NPV	1.46	0.73 (45.1)	0.26 (80.4)	0.00 (100)	62.9	0.66	0.26 (82.1)	0.13 (91.0)	0.00 (100)	82.53
T_2	*Bt*	1.93	0.40 (69.9)	0.33 (75.1)	0.13 (90.2)	63.5	0.73	0.33 (1.1)	0.13 (91.0)	0.06 (95.4)	81.18
T_3	NSKE 5%	1.53	0.93 (30.0)	0.66 (50.3)	0.26 (80.4)	46.7	1.13	0.53 (63.6)	0.33 (77.3)	0.26 (80.4)	66.33
T_4	*M anisopliae*	1.73	0.80 (39.8)	0.53 (60.1)	0.33 (75.1)	49.8	0.86	0.60 (58.9)	0.26 (82.1)	0.20 (84.9)	67.46
T_5	*B bassiana*	*1.66*	0.53 (60.1)	0.46 (65.41)	0.26 (80.45)	50.17	0.80	0.46 (68.49)	0.26 (82.19)	0.13 (90.22)	73.29
T_6	Spinosad	1.46	0.13 (90.2)	0 (100)	0 (100)	85.6	0.53	0.13 (91.0)	0.00 (100)	0.00 (100)	90.25
T_7	Control	1.80	1.33	1.33	1.33	1.44	1.53	1.46	1.46	1.33	1.44
	S. Ed		0.04	0.04	0.04	0.05	0.04	0.04	0.03	0.02	
	CD@ 5%	-	0.10	0.09	0.04	0.10	0.10	0.09	0.07	0.05	

Values mean of three replications; values in the parentheses are square root transformed $\sqrt{x}$ +1.0; * DAS- Days After Spraying; PC – PreCount; ROC- Reduction Over Control

Effect of Spray on larval population of *H. armigera* (Season II)

The statistically analysed data (Table 2) revealed that all the treatments had significant effect in minimizing the pest population and it ranged from 1.06 to 1.73 larvae/five plants after 2 days of spraying as compared to 1. 86 in control. Among all the treatments Spinosad 45% SC @ 73g a.i/ha was found most effective, where minimum population of 1.06 larvae/five plants survived with 43.01 per cent reduction over control, followed by *Bacillus thuringiensis* @ 1.5 kg/ha. Data (Table 2) showed that at 6 days sfter spray mean number of *H. armigera* larvae ranged from 0.33 to 0.93 larva/five plants. Spinosad 45% SC @ 73g a.i/ha it was found highly effective among all the treatments with o.33 larvae/five plants and 77. 39 per cent reduction over control. The other treatments *Ha*NPV @ 250 LE/ha and *Bacillus thuringiensis* @ 1.5 kg/ha. were also effective. Data revealed that all the treatments had significant effect in minimizing the pest damage and it ranged from 0.66 to 1.66 larva/five plants after 2 days of second spraying as compared to 1.66 in control. Among all the treatments Spinosad 45% SC @ 73 a.i/ha was found most effective and gave minimum population of 0.66 larvae/ha was found more effective and gave minimum population of 0.66 larvae/five plants with 60.24 per cent reduction over control, followed by *Bacillus thuringiensis* @ 1.5 kg/ha and NSKE 5%@25kg/ha were found effective. The number of larvae of *H. armigera* noticed at 6 days after second spray showed that all the treatments were statistically superior and found effective to decrease the *H. armigera* larval population.

Table 2: Field efficacy of selected biopesticides against *H. armigera* (II Season) (SPRAY I & II)

T. no	Treatment	PC	I SPRAY				PC	II SPRAY			
			6 DAS* (%R0C)	10 DAS (% ROC)	14 DAS (% ROC)	Mean		6DAS (%ROC)	10 DAS (% ROC)	14 DAS (% ROC)	Mean
T_1	*Ha*NPV	1.73	0.53 (63.6)	0.13 (91.5)	0.13 (92.1)	63.58	1.66	0.33 (78.4)	0.13 (90.2)	0.00 (100)	67.16
T_2	*Bt*	1.53	0.53 (54.7)	0.26 (83.0)	0.13 (92.1)	63.67	1.26	0.46 (69.9)	0.26 (80.4)	0.13 (91.5)	68.45
T_3	NSKE 5%	1.66	0.93 (36.3)	0.53 (1.23)	0.26 (80.1)	49.18	1.80	0.80 (47.7)	0.46 (65.4)	0.33 (78.4)	54.81
T_4	*M anisopliae*	1. 66	0.86 (41.0)	0.33 (78.4)	0.33 (87.9)	52.59	1.53	0.73 (52.2)	0.53 (60.1)	0.26 (83.0)	50.81
T_5	*B bassiana*	*1.40*	0.73 (50.0)	0.33 (78.4)	0.20 (87.9)	60.27	1.33	0.66 (56.8)	0.40 (69.9)	0.20 (86.9)	58.39
T_6	Spinosad	1.46	0.33 (77.3)	0.00 (100)	0.00 (100)	80.10	1.13	0.13 (91.5)	0.00 (100)	0.009	87.93

										(100)	
T_7	Control	1.86	1.46	1.53	1.66	-	1.66	1.53	1.33	1.53	-
S. Ed		-	0.03	0.02	0.02		-	0.03	0.02	0.02	
CD @ 0.5%		-	0.06	0.04	0.05		-	0.07	0.05	0.06	

Values mean of three replications; values in the parentheses are square root transformed √x +1.0; * DAS- Days After Spraying; PC – PreCount; ROC- Reduction Over Control

Yield Attribute

Among the biopesticides treated plots, foliar application of *Ha*NPV @ 250 LE/ha, *Bacillus thuringiensis* @ 1.5 kg/ha recorded significantly lower pod damage compared to rest of treatments for both the seasons. Significantly lower pod damage was observed in Spinosad (insecticide) treated plot compared to rest of treatments (Table 3). As regard yield attributes it was higher in all treatments than untreated control (6.37 q/ha). Spinosad 45% SC @ 73g a.i/ha recorded the highest yield of 10.12 q/ha. The yield (II season) obtained from the plots treated with Spinosad 45% SC @ 73g a.i/ha recorded the highest yield 9.83 q/ha followed by *Ha*NPV @ 250 LE/ha and *Bacillus thuringiensis* @ 1.5 kg/ha which yielded 9.30 and 9. 06 q/ha (Table 3).

Table 3: Field efficacy of selected biopesticides against *H. armigera* (I &II Season)

Trt. No	Treatment	% Pod Damage			% Reduction over control			Yield q/ha		
		2016/17	2017/18	Mean	2016/17	2017/18	Mean	2016/17	2017/18	Mean
T_1	*Ha*NPV	7.51[b]	7.88[b]	7.69	80.23	78.85	79.5	9.45	9.30	9.37
T_2	*Bt*	8.44[c]	8.96[c]	8.7	77.78	75.95	76.8	9.20	9.06	9.13
T_3	NSKE 5%	12.73[e]	12.63[e]	12.68	66.5	66.11	66.3	8.18	8.04	8.11
T_4	*M anisopliae*	16.01[f]	14.80[f]	15.40	57.86	60.28	59.0	7.4	7.20	7.31
T_5	*B.bassiana*	11.76[d]	10.65[d]	11.20	69.05	71.42	70.2	8.40	8.26	8.33
T_6	Spinosad	6.48[a]	6.00[a]	6.24	82.94	88.07	85.5	10.1	9.83	10.00
T_7	Control	38	37.47	-	-	-	-	6.37	6.13	-
S.Ed		0.37	0.60	-	-	-	-	0.11	0.12	-
C. D @ 5%		0.75	1.20	-	-	-	-	0.23	0.24	-

Values are mean of three replications; values in parentheses are arcsine transformed.

Discussion

In the present study, the crop in the experimental plots showed pod borer right through the field trail. The results are in agreement with findings of Durairaj and Venugopal (1995) [5] who showed that the least *H. armigera* larval population of 2.0/plant with Spinosad 45 SC (73g a.i/ha) treatments as against a maximum population of 6.7/palnt in the untreated control. The low efficacy of the biopesticides over synthetic insecticides in the present findings was also reported by Ankali *et al.*, (2010 & 2011[2, 3]). They reported that Spinosad exhibited 90 per cent mortality of *M. vitrata* larva at 7 DAT, whereas *Bacillus thuringiensis* and NSKE showed only 70 per cent mortality.

In the present investigation, *Ha*NPV was found to be effective in bringing down the *H. armigera* larvae. These findings are in close agreement with Ankali *et al.*, (2011) [3] who reported 3 sprays at weekly interval of *Ha*NPV 375 LE/ha recorded significantly lower population of 0.83/ten plants, also reported it as best as carbaryl 50 WP. The slight variation in the reduction of pod borer population might be due to Abiotic factors or change in locality. The laboratory as well as field studies in pigeon pea have clearly indicated the potential for the use of biocontrol agents in pest management. However, the newer and novel Spinosad has been found to be very promising. While a breakthrough in the production of wheat and rice has been made, we are yet to make a breakthrough in increased production of pulses in our country while breeders agronomist are expected to play an important role in increasing the productivity of pulses; the role of entomologist cannot be ignored. By developing suitable microbial techniques with better persistent action, the pest which devastates the pulse crops can be managed successfully.

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