Plant Archives Vol. 24, No. 1, 2024 pp. 663-668 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.1.090

IMPACT OF ECO-FRIENDLY APPROACHES FOR THE MANAGEMENT OF SPOTTED POD BORER (*MARUCA VITRATA* FAB.) IN *VIGNA RADIATA* (L.) WILCZEK

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(Date of Receiving-25-10-2023; Date of Acceptance-02-02-2024)

ABSTRACT

The field experiment was conducted at Crop Research Centre of S. V. P. University of Ag. & Tech., Meerut, India during Summer-2021 and 2022 in randomized block design with seven treatments (*Bacillus thuringiensis*, *Pongamia* oil, *Verticillium lecanii*, Azadirachtin, *Beauveria bassiana*, Emamectin benzoate and untreated control). The observations were recorded one day before followed by three, seven and ten day after spray of both the year and data thus recorded were analyzed. Least number of the spotted pod borer's larvae were observed in the plot which was treated with the emamectin benzoate @ 5 SG with low per cent of damage which was found to be highly superior over to the *Bacillus thuringiensis* 2×10^{11} spores/ml @1 l/ha. whereas the highest number of the *Maruca* found in the plot treated with *Verticillium lecanii* 1×10^{8} spores/ml @ 2.5 l/ha. The highest yield was obtained from emamectin benzoate (9.41 q/ha), while the lowest yield was calculated in the plot treated with *Verticellium lecanii* (6.33q/ha) followed by the untreated control (4.76 q/ha).

Key words : Bio-efficacy, Damage, *Maruca vitrata*, Biopesticides, Yield.

Introduction

India is one of the largest producer, consumer and exporter of pulses in the world. The most commonly grown pulses in India including chickpea, pigeon pea, black gram, green gram, field bean and pea etc. Among them mungbean or Green gram, *Vigna radiata* (Linn.) Wilczek (Family: Leguminosae, Sub-family: Papilionaceae) is one of the important cash crop (Kumar *et al*., 2023). It occupies the third place after chickpea and pigeon pea in production. The major green gram producing states are M.P., U.P., Maharashtra, Rajasthan, A.P. and Karnataka where pulses are grown in arid and semi-arid region as rainfed crops but in northern part of India, it is mainly grown in summer and *Kharif* season (Radjit and Prasetyawati, 2012). It is highly nutritive crops which contain protein, fat, carbohydrate, Phosphorus, Iron, calcium and vitamin. Mungbean also plays a vital role in enhancing to the soil fertility by improving soil physical properties and also fixes atmospheric nitrogen ranging from 30-74 kg/ha in soil and gives approximately 15 to 20 quintals per hectare plant residue (Anonymous, 2018).

The factor, which can affect the productivity and production of crop, varies according to the climatic condition of different regions but main factor for reduction in the yield are diseases and insect pests which attack the crop and reduce the yield. More than 200 insects from 48 families reported to attack mungbean in the field. Among these insect pest complexes, *Maruca vitrata* is one of the most destructive pests for the legume crops. The larvae of *Maruca* were found to infest the terminal shoots, flower buds and pods of the crop and damage to the reproductive part by binding them together with silken threads and fecal matter (Yadav *et al.*, 2022). These pests damage the inflorescence (21.3%) and pod (13.9%) on the late planting than early shown varieties of green gram (Gahukar and Reddy, 2018). For the identification greenish white colour with brown head and two pairs of dark spots on the back of each segment, can be seen. The ETL and EIL level for the *Maruca* are 0.81 and 1.08 larvae/meter/row, respectively (Zahid *et al.*, 2008).

This insect attacks the plant in both the stages either vegetative or reproductive and cause severe attack (Ahmad *et al.*, 2019). The estimated yield loss caused by *Maruca vitrata* is around 30 million dollars annually in India (Saxena *et al.*, 2002). Availability and use of bio-pesticides are key components in the management of spotted pod borer damage. Its effectiveness is, however, limited for a broad range of reasons, which reduces pesticide exposure. In this study, bio-pesticides were tested against spotted pod borer using various bio-pesticides as well as understand the economics of different bio-pesticides in green gram for the spotted borer.

Materials and Methods

The investigation was conducted at C. R. C. of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.) during *Summer*, 2021 and 2022 to evaluate the bio-efficacy of bio-pesticides against spotted pod borer (*Maruca vitrata*). The crop was grown with 30 × 10 cm^2 row to row and plant to plant distance in RBD design and three replicates. Samrat variety was used for this investigation, which was shown the field at the time of 2 fortnight of March.

Treatments and their application

The details of the treatments are given in Table 1. All the pesticides were applied as a foliar spray. The spraying was done by using knapsack sprayer. The first spray was given after 35 day after sowing when there was sufficient population build up of insect-pest and the second spray was given at 50 days after sowing when the population re-builds up.

The quantity of spray solution was 600 liter per hectare in each spray application. The solution was prepared according to the following formula-

$$V = (C \times A) / \%a.i.$$

Where,

V = Volume of the insecticides

C = Concentration required

A = Amount of spray solution needed

% *a.i.* = Percentage of active ingredient of the insecticides.

Methods of observation

The observations on the larvae of the spotted pod borer were recorded during the crop period. For this purpose, total numbers of pod borers was recorded from randomly selected 5 plants per plot at one day before and 3^{rd}, 5^{th} and 10^{th} days after both sprays through direct visual method. Calculation was done by using the following formula:

$$\text{No. of larva/plant} = \frac{\text{Number of insects on plant}}{\text{Number of plant}}$$

The mean data of reduction percentage for insect population was calculated by the following given formula (Abbott, 1987)

Table 1 : Details of the treatments.

Treatment	Comman name	Trade name	Dose/ha	Source of obtain
T_1	*Bacillus thuringiensis* @ 2×10^{11} spores/ml	Green larvicide	1.0 L	Greenlife Biotech Laboratory, Coimbatore, T. N.
T_2	*Pongamia* oil	*Pongamia* oil	2%	Central Institute of Medicinal and Aromatic Plants, Lucknow
T_3	*Verticillium lecanii* @ 1×10^8 Spores/ml	Vertici	2.5 L	K.N. Biosciences (India) Pvt Ltd., Malkajgiri, Telangana
T_4	Azadirachtin 5% EC	Neemoz	1%	UtkarshAgrochemPvt Ltd Kamrej district, Gujrat
T_5	*Beauveria bassiana* @ 1 × 10^8 spores/ml	-	2.5 L	Bio-control laboratory, SVP University of Ag. & Tech., Meerut
T_6	Emamectin benzoate 5% SG	Mega claim	10 gm *a.i.*	Meghmani organics Ltd, Bharuch, Gujrat
T_7	Untreated control		-	-

$$\text{Reduction percentage} = 100 \times \frac{X - Y}{X}$$

Where,

X = Per cent Living insect in Control

Y = Percent Living insect in treated plot

Yield and incremental cost benefit ratio

For assessing the grain yield weight of healthy and damaged grains were recorded from each plot and converted in to q / ha with the help of following formula

$$\text{Grain yield (q/ha)} = \frac{\text{Weight of grains in Kg/plot} \times 10000}{\text{Plot area in m}^2}$$

The cost: benefit ratio was also calculated by dividing net profit over control by total cost (insecticides and labour charges). The formula for Cost Benefit ratio is

Cost Benefit Ratio

$$= \frac{\text{Net Returns}}{\text{Cost of plant production (Insecticides + Labour charge + Sprayer charge)}}$$

Statistical analysis

The data recorded during the courses of investigation were subjected to statistical analysis using analysis of variance technique (ANOVA) for randomized block design as suggested by Panse and Sukhatme (1978). The data were recorded and transformed as and when required.

Results and Discussion

Pre-treatment

The observation taken day before treatment revealed that the pooled population of spotted pod borer varied from 1.60 to 1.77. The data taken from the experimental field revealed that the population of spotted pod borer was uniform in the field.

First application of different treatments during Summer, 2021 and 2022

Pooled observation on the efficacy of various treatments against the spotted pod borer in the mung bean during both the year, were recorded from the plant, day before treatment, 3, 7 and 10 day after the treatments. The pooled data depicted in Table 2. Observations revealed about the wide distribution of spotted pod borerin the field. The results showed that treatments were significantly effective for the reduction of spotted pod borer in the field.

The observations taken after 3 and 7 day of spray followed similar trends and indicates that all the treatments were found significantly superior over control in minimizing the infestation caused by spotted pod borer. The minimum number of the spotted pod borer recorded in the plot treated with Emamectin benzoate was significantly superior to *Bacillus thuringiensis*. After application, reduction in the population of spotted pod borer was seen. Azadirachtin, Pongamia oil and *Beauveria bassiana* as the next successful order of treatments. The plot treated with *Verticillium lecanii* had the highest number of spotted pod borers among the treated plots but it was not statistically different from the untreated control.

Final observations of the first application indicated that the least population of borer was observed in the plot which was treated with the Emamectin benzoate (0.23) was highly superior to *Bacillus thuringiensis* (0.40). The next effective order of the treatments were Azadirachtin, Pongamia oil and *Beauveria bassiana* while the reduced population of the spotted pod borer was 0.50, 0.57 and 0.70, respectively after the 10 day of spray. Highest number of the spotted pod borer population found in the plot treated with *Verticillium lecanii* (0.77) which was non significantly superior with the untreated control (1.97).

Second application of different treatments during Summer, 2021 and 2022

The trend of effectiveness of the various treatments was almost similar after the second application as in the first application on the reduction of spotted pod borer population. The observation was recorded after 3, 7 and 10 day from the second spray of different treatment is given in Table 2.

The observation taken after 3 day of spray indicates that all the treatments were found significantly superior over control in minimizing the infestation caused byspotted pod borer. The minimum number of the spotted pod borer recorded in the plot treated with Emamectin benzoate (0.73) was significantly superior to *Bacillus thuringiensis* (0.83). After three days of spraying, the reduced spotted pod borer population was 0.97, 1.00 and 1.10, respectively, with Azadirachtin, Pongamia oil and *Beauveria bassiana* as the next successful order of treatments. The plot treated with *Verticillium lecani* had the highest number of spotted pod borers (1.17) among the treated plots but it was not statistically different from the untreated control (2.03).

After seven day of spray, the minimum population of spotted pod borer was observed in the plot, which was treated with the Emamectin benzoate (0.13) was highly superior to *Bacillus thuringiensis* (0.47). After seven days of spraying, the reduced spotted pod borer

Table 2 : Pooled efficacy of different treatments against spotted pod borer, *Maruca vitrata* after application in *Summer*, 2021 and 2022.

Treatments	Name	Dose/ha.	DBT	After 1st Spray			After 2nd Spray			Average reduction
				3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	after 10 DAS
T_1	*Bacillus thuringiensis* @ 2×10^{11} spores/ml	**1 L**	1.70(1.64)*	1.10(1.45)*	0.63(1.18)*	0.40(1.18)*	0.83(1.35)*	0.47(1.21)*	0.20(1.09)*	84.38%
T_2	*Pongamia* oil	**2 %**	1.73(1.65)	1.30(1.52)	0.87(1.37)	0.57(1.25)	1.00(1.41)	0.73(1.32)	0.43(1.20)	73.78%
T_3	*Verticillium lecanii* @ 1×10^{8} Spores/ml	**2.5 L**	1.67(1.63)	1.47(1.56)	1.00(1.41)	0.77(1.33)	1.17(1.47)	0.93(1.39)	0.63(1.28)	63.24%
T_4	Azadirachtin 5% EC	**1 %**	1.70(1.64)	1.20(1.48)	0.73(1.31)	0.50(1.22)	0.97(1.40)	0.60(1.26)	0.33(1.15)	78.20%
T_5	*Beauveria bassiana* @1×10^{8} spores/ml	**2.5 L**	1.77(1.66)	1.43(1.55)	0.93(1.39)	0.70(1.30)	1.10(1.49)	0.87(1.36)	0.57(1.25)	66.75%
T_6	Emamectin benzoate 5SG	**10 gm *a.i.***	1.60(1.61)	0.80(1.34)	0.40(1.18)	0.23(1.11)	0.73(1.32)	0.13(1.06)	0.00(1.00)	94.08%
T_7	Control	-	1.67(1.63)	1.77(1.66)	1.87(1.69)	1.97(1.72)	2.03(1.74)	1.93(1.71)	1.83(1.68)	-0.01%
CD at 5%			N/A	0.17	0.09	0.08	0.14	0.13	0.09	
SE(m)			-	0.06	0.03	0.03	0.04	0.04	0.03	

*Figures in parenthesis are Square root transformed value. DAS = Days after spray, DBS = Day before spray

population was 0.60, 0.73 and 0.87, respectively, with, Pongamia oil and *Beauveria bassiana* as the next successful order of treatments. The plot treated with *Verticillium lecanii* had the highest number of spotted pod borers (0.93) among the treated plots, but it was statistically superior then the untreated control (1.93).

After ten day of spray, the minimum population of spotted pod borer was observed in the plot which was treated with the Emamectin benzoate (0.00) was highly superior to *Bacillus thuringiensis* (0.20). The next effective order of the treatments were Azadirachtin, Pongamia oil and *Beauveria bassiana* while the reduced population of the spotted pod borer was 0.33, 0.43 and 0.57, respectively after the 10 day of spray. Highest number of the spotted pod borer population found in the plot treated with *Verticillium lecanii* (0.63) which was significantly superior with the untreated control (1.83).

The present findings were almost in similar pattern with the findings of Haripriya and Jeyrani (2019), who reported that emamectin benzoate was highly effective against *M. vitrata* followed by azadirachtin. Similarly, Neharkar *et al.* (2018) reported that neem oil @ 2 per cent was observed to be moderately effective as compared all other treatments except control. Vineetha *et al.* (2020) investigated the management of pod borer, *Maruca vitrata* (Fabricius), they revealed that *Bt* formulation followed by *Beauveria bassiana* @ 10^{7} spores/ml of water were the most effective treatments in preventing pod borer infestation as well as controlling number of pod borer larvae.

Per cent reduction of Larvae over control

The pooled data of per cent reduction are presented Table 2. The data on per cent reduction of larvae indicated that highest reduction was recorded from the Emamectin benzoate 5 SG which was 94.08 per cent followed by the *Bacillus thuringiensis* @ 2×10^{11} spores/ml (84.38 per cent), which was significantly most effective among rest of all treatments. The next series of the per cent reduction over control was Azadirachtin 5% EC with 78.20 per cent, Pongamia oil (73.78 Per cent), *Beauveria bassiana* @ 1×10^{8} spores/ml (66.75 Per cent) and least reduction was calculated in the plot treated with *Verticellium lecanii* @ 1×10^{8} Spores/ml, which was (63.24 per cent).

Impact of bio-pesticides on the yield and ICBR

The treated plot resulted (Table 3) significantly higher production ranging between 6.50 to 9.35 q /

Table 3 : Pooled economics of insecticide and bio pesticides (*summer* 2021 and 2022).

Treatments	Dose/ha	Yield(q/ha)	Increased yield over control (q/ha)	% Increased yield over control	Value of increased yield (Rs./ha)	Cost of plant protection (Rs./ha)	Net profit (Rs./ha)	ICBR
***Bacillus thuringiensis* @ 2×10^{11} spores/ml**	**1 L**	8.22(31.40)	3.52	75.00	25470.72	4400.00	21070.72	**4.79**
Pongamia oil	**2 %**	7.45(29.90)	2.75	58.40	19862.82	4700.00	15162.82	**3.23**
***Verticillium lecanii* @ 1×10^{8} Spores/ml**	**2.5 L**	6.50(27.92)	1.80	38.19	12988.62	4000.00	8988.62	**2.25**
Azadirachtin 5% EC	**1 %**	8.36(31.68)	3.66	77.77	26,483.76	10000.00	16,483.76	**1.65**
***Beauveria bassiana* @ 1×10^{8} spores/ml**	**2.5 L**	6.88(28.75)	2.18	46.38	15774.48	4500.00	11274.48	**2.50**
Emamectin benzoate 5 SG	**10 gm *a.i.***	9.35(33.50)	4.65	98.94	33647.40	4880.00	28767.40	**5.89**
Control	-	4.70(23.76)	-	-	-	-	-	-
CD at 5% **SE(m)**		1.60 0.51	- -	- -	- -	- -	- -	- -

ICBR = Incremental cost benefit ratio

Average MSP of Greengram during 2021-2022 = 72.36 INR/kg

Labour Charge = 400/day/labour

Sprayer Charge = 200 INR/Day

ha than untreated control with 4.70 q/ha yield. Data indicates that emamectin benzoate 5 SG @ 10 gm *a.i.* produced highest yield which was 9.35 q/ha and the 4.65 q/ha yield was higher than the untreated control followed by the Azadirachtin 5% EC @ 1% (8.36q/ha). The next treatment was *Bacillus thuringiensis* @ 2 × 10^{11} spores/ml (8.22 q/ha) which produced 3.52 q/ha yield more than untreated control. Remaining treatment such as Pongamia oil, *Beauveria bassiana* and *Verticellium lecanii* yielded 7.45, 6.88 and 6.50 q/ha grain of green gram and increased were calculated in these treatments were 2.75, 2.18 and 1.80 q/ha, respectively.

The plot treated with emamectin benzoate 5 SG had the highest incremental cost-benefit ratio (5.89) during the Summer of 2021 and 2022, followed *Bacillus thuringiensis* was get the second position with ICBR (4.79). Pongamia oil also performed better and was ranked third in the table for the ICBR, which were 3.23. *Verticillium lecanii,* with an ICBR of 2.25, took fifth place in the table, trailing *Beauveria bassianai*, which came in fourth place with 2.50. Due to its 1.65 ICBR, the plot treated with azadirachtin had the lowest ICBR and was ranked last in the table.

The our findings were supported by the Sreekanth *et al.* (2015), who reported that the cost benefit ration for emamectin benzoate was 1:3.13 and Yadav and Singh (2014) also revealed that azadirachtin gives the lesser yield than the synthetic pesticides. These results also found similar with the findings of Singh and Singh (2017), who revealed that spinosad 60g a.i./ha and emamectin benzoate 8 g *a.i.*/ha were the most effective treatments and significantly superior than the other treatments *Verticillium lecanii* (1×10^{8} Spores/g) 5g/L was the least effective treatment.

Interest of conflict : None

Acknowledgement

On the behalf of all author, I sincerely thankful to Department of Entomology, S.V.P. University of Agriculture and Technology, Meerut and I.C.A.R. (New Delhi) to provide all the necessary facilities, Guidance and instructions to complete this research well on time.

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