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Economics of various treatments against Legume pod borer, *Maruca vitrata* (Fab.) in green gram

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Abstract
Field experiment was carried out to assess the economics of plant protection treatments against legume pod borer (*Maruca vitrata*) on greengram during two consecutive years of 2021 and 2022. Emamectin benzoate gave the highest yield which was 9.35 q/ha followed by the Azadirachtin 5% EC with 8.23 q/ha and *Bacillus thuringiensis* @ 2×10^{11} spores/ml (8.23 q/ha). However, the lower yield of 6.50 q/ha was recorded in the *Verticellium lacani* @ 1×10^{8} Spores/ml treated plot as compared to 4.70 q/ha untreated control. The ICBR calculated for Emamectin benzoate 5 SG, *Bacillus thuringiensis* @ 2×10^{11} spores/ml, Pungam oil (Karanj), *Verticellium lacani* @ 1×10^{8} Spores/ml, *Beauveria bassiana* @ 1×10^{8} spores/ml and Azadirachtin 5% EC was 1:5.89, 1:4.79, 1:3.23, 1:2.25, 1:2.51 and 1:1.51, respectively.

Keywords: ICBR, *Maruca vitrata*, pesticides and yield

Introduction

In India's semi-arid regions, pulses are cultivated in a variety of agro-climatic conditions. Mungbean, often known as green gram, is one of the primary pulse crops grown in India. Due to its short growing season and adaptability for crop rotation and crop mixes, greengram is grown all year long during all cropping seasons. The low productivity in greengram may be attributed to a number of issues, the most significant of which is the ravaging of insect pests. These factors include limited varietal improvement, low tolerance to soil moisture stress, and pest infestation (Sandhya *et al.*, 2014) [4]. Legume pod borer is a significant factor in the loss of yield. It has been documented to be a pest on 39 host plants in Asia, where it becomes particularly dangerous during the flowering and pod production stages. The larvae directly harm flowers and pods, which accounts for a significant yield loss in all of the host crops. In different crops, the grain yield losses from legume pod borer are reported to range from 10% to 80%. (Sambath Kumar *et al.*, 2014) [3].

Although the harm this pest does is typically difficult to see, wind activity can break down plants. Its field observation can be carried out by looking at the pods or by making longitudinal cuts in the attacked plant stems. Additionally, your stool does not obstruct the opening on the petioles and pods of soybean plants. Chemical insecticides must be applied promptly and be readily available to control M. vitrata damage to crops, but their efficiency is limited by the tight larval webbing that minimizes pesticide contact. In addition, most subsistence farmers in developing countries cannot afford insecticides (Chen and Ravallion, 2004) [1]. This species has emerged as a significant danger to economic and humanitarian interests due to the losses it has caused and the following management issues it has created. In green gram, it turned into a persistent pest. It is estimated to cost US$ 30 million and result in an economic loss of 20–25%, yield loss of 2–84%, and pod damage of 20–60% in green gram (Zahid *et al.*, 2008) [6]. The estimated 20–60% reduction in grain yield pulses as a result of *Maruca* damage. As a result, this study was conducted to assess various insecticides and bio-pesticides for the control of this significant insect pest of mungbean.

Methods and Materials

The field experiments were carried out during the *summer* seasons of 2021 and 2022 at C.R.C. of S.V.P. university of agriculture and technology, Meerut, Uttar Pradesh, to assess the economics of different biopesticides and a synthetic insecticides such as *Bacillus thuringiensis* @ 2×10^{11} spores/ml, Pungam oil, *Verticellium lacani* @ 1×10^{8} Spores/ml, Azadirachtin 5% EC, *Beauveria bassiana* @ 1×10^{8} spores/ml and Emamectin benzoate.

The crop was cultivated in a randomized block design with three replications at a spacing of 30 10 cm (RBD). To determine the insect pest's economic threshold values, the incidence of spotted pod borer was tracked weekly in the experimental field. Using a knapsack sprayer with a cone-shaped nozzle, two spraying was conducted. According to the active ingredient, the necessary amount of each pesticide was measured using an electronic balance and micro pipette before being combined with water to create the required insecticide concentration (600 L ha^{-1}). When the wind speed was appropriate, insecticides were applied during the appropriate times of the day. This assisted in preventing spray solution drift to nearby plots. By selecting 50 pods at random from each plot in each replication, the percentage of pod and seed damage was calculated. Quintal/ha units were used to measure the grain yield from each plot. Additionally, calculations were made for avoided grain production loss and percent gain in yield over control. The net profit was calculated based on the current market prices of the crop, the cost of insecticides, the cost of labor, and the cost of other inputs. The calculation were done with the help of given formulas-

$$\%\ \text{Pod and Grain damage} = \frac{Total\ number\ of\ damaged\ pod\ and\ grain}{Total\ number\ of\ pod\ and\ grain\ taken} \text{ x } 100$$

$$\%\ \text{increased yield over control} = \frac{Yield\ in\ treatment - yield\ in\ control}{Yield\ in\ control} \text{ x } 100$$

$$\%\ \text{Avoidable loss} = \frac{Yield\ in\ treatment - Yield\ in\ control}{Yield\ in\ treatment} \text{ x } 100$$

Result and Discussion

The pooled data are presented in table 1 and table 2. The data on per cent pod damage indicated that lowest damage was recorded from the Emamectin benzoate 5 SG which was 8.13 per cent followed by the *Bacillus thuringiensis* @ 2×10^{11} spores/ml (9.03 per cent) which was significantly most effective among rest of all treatments. The next effective treatment was Azadirachtin 5% EC with 12.95 per cent pod damage, Pungam oil (13.16), *Beauveria bassiana* @ 1×108 spores/ml (14.66) and *Verticellium lacani* @ 1×10^8 Spores/ml (18.23).

The same pattern was followed for the seed damage where the least seed damage was observed in the Emamectin benzoate 5 SG (5.80 per cent) followed by the *Bacillus thuringiensis* @ 2×10^{11} spores/ml (6.43 per cent) which was significantly most effective among rest of all treatments. The next effective treatment was Azadirachtin 5% EC with 9.95 per cent pod damage, Pungam oil (10.36), *Beauveria bassiana* @ 1×10^8 spores/ml (11.16) and *Verticellium lacani* @ 1×10^8 Spores/ml (13.90).

Yield

On the basis of all expenses in the experiment like insecticides, cost of insecticides, labour and sprayer charges etc. and the increased income over control due to the treatments rice yields; we obtained the cost benefit ratio which is presented in the Table-2. All the treated plot resulted significantly higher production ranging from 6.50 to 9.35 q/ha than untreated control with 4.70 q/ha. yield.

Data indicates that Emamectin benzoate involving cost of Rs. 4,880.00 has contributed to an increased net income of Rs. 28,767.40 over control. The total production of this treatment was 9.35 q/ha which was 98.95 per cent more than the untreated control. The cost benefit ratio of this treatment was 1:5.89 which was highest and ranks first among the all treatments followed by Azadirachtin @ 5% EC with 8.36 q/ha with 88.87 per extra yield over control but it ranks second in production and ranks last in case of cost benefit ratio with the involving cost of 10,000 Rs. and increased net income Rs. 16,483.76 over untreated control among the all treatments. After this, *Bacillus thuringiensis* @ 2×10^{11} spores/ml was third most effective treatments in cost benefit ration with the yield of 8.22 q/ha (74.89 per cent increased yield) involving the cost of Rs. 4,400 and Rs.21,070.72 net increased income over untreated control. 1:4.79 was the cost benefit ratio for this treatment. The use of Pungam oil @ 2% involving an expenditure of Rs. 4,700 has provided an increased net income of Rs. 15,162.82 ranks fourth with 58.51 increased per cent yield over untreated control, just after *Bt* with the cost benefit ratio of 1:3.23.The spray of *Beauveria bassiana* @ 1 x 10^8 spores/ml was found next in order of effectiveness with46.38 per cent increased yield over control and better than *Verticellium lacani*. The yield of *Bb* treatment was 6.88 q/ha and the expenditure of treatment was Rs. 4,500 has influenced an increased net income of Rs. 11,274.48 and cost benefit ratio of this treatment was 1:2.51. *Beauveria bassiana* @ 1 x 10^8 spores/ml @ 2.5 kg/ha, ranks fourth in the cost benefit ratio in all treatments. Data evident that *Verticellium lacani* @ 1 x 10^8 spores/ml, involving the cost of Rs. 4,000 for the production of 6.50 q/ha and recorded 38.30 per increased yield over untreated control, has contributed to an increased net income of Rs. 8,988.62 q/ha over control. The cost benefit ratio for this treatment was 1:2.25 and it ranks at the fifth in ICBR and last in case of production over control. Singh and Singh (2019) [5] that other insecticides and NSKE, biopesticides among the treatments were likewise effective against the borer, but to a lower level. According to Kaushik *et al.* (2016) **[2]**, *V. lecanii* treated plot throughout both seasons produced the lowest yield.

Emamectin benzoate is an efficient insecticide in the control of *M. vitrata* in greengram while *V. lacani* was found to be least effective against the pod borer.

Table 1: Effect of treatment on the yield of greengram (Pooled)

Tr. No.	Treatment	Dose/ha	Pod damage (%)	Seed Damage (%)	Yield (q/ha)	Yield Increased (%)	Avoidable yield loss (%)
T_1	*Bacillus thuringiensis* @ 2×10^{11} spores/ml	1 L	9.03 (3.12)	6.43 (2.73)	8.22	74.89	42.82
T_2	Pungam oil (Karanj)	2%	13.16 (3.76)	10.36 (3.37)	7.45	58.51	36.91
T_3	*Verticellium lacani* @ 1×10^8 Spores/ml	2.5 L	18.23 (4.38)	13.90 (3.84)	6.50	38.30	27.69
T_4	Azadirachtin 5% EC	1%	12.95 (3.73)	9.95(3.31)	8.36	77.87	42.89
T_5	*Beauveria bassiana* @ 1×10^8 spores/ml	2.5 L	14.66 (3.96)	11.16 (3.49)	6.88	46.38	31.69
T_6	Emamectin benzoate 5 SG	10 gm *a.i.*	8.13 (3.02)	5.80 (2.60)	9.35	98.94	49.73
T_7	Control	-	20.06 (4.59)	18.56 (4.42)	4.70	0.00	0.00
SE(m) CD at 5%			0.06 0.19	0.13 0.40	-	-	-

Figures in the parenthesis are arcsine transformed value

Table 2: Pooled economics of treatments during *summer* 2021-2022

Treatments	Dose/ha	Cost of one spray (Rs./ha)	No. of spray	Total cost of spraying (Rs./ha)	Yield (q/ha)	Increased yield over control (q/ha)	Value of increased yield (Rs./ha)	Additional Net profit (Rs./ha)	ICBR
Bacillus thuringiensis @ 2×10^{11} spores/ml	1 L	2200	2	4400	8.22	3.52	25470.72	21070.72	4.79
Pongamia oil	2%	2350	2	4700	7.45	2.75	19862.82	15162.82	3.23
Verticellium lacani @ 1×10^8 Spores/ml	2.5 L	2000	2	4000	6.50	1.80	12988.62	8988.62	2.25
Azadirachtin 5% EC	1%	5000	2	10000	8.36	3.66	26483.76	16483.76	1.65
Beauveria bassiana @ 1×10^8 spores/ml	2.5 L	2250	2	4500	6.88	2.18	15774.48	11274.48	2.51
Emamectin benzoate 5 SG	10 gm *a.i.*	2440	2	4880	9.35	4.65	33647.40	28767.40	5.89
Control	-	-	-	-	4.70	-	-	-	-

Cost of one spray (Rs./ha) = Insecticide + labour + sprayer charge
ICBR= Incremental cost benefit ratio
Average MSP of Greengram during 2021-2022 = 72.36 INR/kg
Labour Charge = 400/day/labour
Sprayer Charge = 100 INR/Day

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