



Evaluation of Some Biopesticides against Pod Borer in Garden Pea (*Pisum sativum* L.) under Natural Conditions of Prayagraj (U.P.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted at the research plot of the Department of Agricultural Entomology at the Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the *Rabi* season of 2021-22. The treatments Selected for this experiment were evaluated against Pod borer, *Helicoverpa armigera* i.e., Neem oil 2% @ 2ml/lit, Spinosad 45% SC @ 0.2ml/lit, NSKE 5% @ 5ml/lit, *Bacillus thuringiensis* 4% WSP @ ml/lit, NSKE+HaNPV+Bt @ 1ml/lit, Emamectin Benzoate 5% SG @ 2ml/lit, *Beauveria bassiana* @ 2ml/lit and Untreated control in RBD with three replications. Results revealed that among the different treatments Emamectin benzoate 5% SG (10.57%) was found to be the most effective treatment in the reduction of *H. armigera* followed by Spinosad 45% SC (15.21%), NSKE+HaNPV+Bt (9.03%), *Beauveria bassiana* 1.5% SG (13.98%), NSKE 5% (16.41%), *Bacillus thuringiensis* 4% WSP (12.00%) and Neem oil 2% (17.32%) was found to be least effective against this pest. Among all the treatments, the cost-benefit ratio has been analyzed, in which the highest was Emamectin benzoate 5% SG (1:4.25) and marketable yield (19.20 q/ha) followed by Spinosad 45% SC (1:3.43 and 16.40 q/ha), and NSKE+HaNPV+Bt (1:3.00 and 14.60 q/ha), *Beauveria bassiana* 1.5% SG (1:2.80 and 13.25 q/ha), NSKE 5%(1:2.69 and 12.45 q/ha), *Bacillus thuringiensis* 4% WSP (1:2.55 and 11.80 q/ha) and the lowest was Neem oil 2% (1:2.48 and 11.20 q/ha) have been recorded.

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1. INTRODUCTION

Garden pea (*Pisum sativum* L. var. Hortense) Garden originated in the region comprising Central Asia, Mediterranean countries and Ethiopia. It is native to Syria, Iraq, Iran, Turkey, Israel, Jordan, Ethiopia, Lebanon and has been cultivated in Europe for several thousand years [1].

In terms of productivity, India stands as the second largest producer of green peas next to China and ranks ten among the vegetable crops. The annual global production of green pea and dry pea seeds are approximately 14.5 million tons and 22 million tons, respectively [2].

In India, it is grown in an area of 0.42 million ha with the production of 4.01 million metric tonnes and productivity is 9.5 t/ha. Garden pea is a cool season crop mainly grown during winter season in plains and during summer season in hills [1]. The major Pea producing states are Uttar Pradesh, Punjab, Himachal Pradesh, Orissa, Karnataka and Haryana, etc. [3].

Uttar Pradesh is the leading state in the area (1.8 lakh ha) and production (18.8 lakh tonnes) followed by Madhya Pradesh (22.8 thousand ha; 5.34 lakh tonnes). Jammu and Kashmir is the leading state in productivity (20.8 t/ha) followed by Jharkhand [1]. The nutritional value of dry pea seed is similar to other grain legumes and contains 18-30 % protein, 35-50% starch and 4-7 % fiber [4].

The crop is known to suffer from a number of insect pests like pod borers (*Etiella zinckenella* Tr. and *Helicoverpa armigera* Hub.), pea stem fly (*Melanagromyza phaseoli* Tyron), pea leaf miner (*Chromatomyia horticola* Goureau), aphid (*Acyrtosiphon pisum*) and thrips (*Caliothrips indicus* Bagnall). These are serious insect pest and often cause substantial loss to the crop. Insect pest in western Uttar Pradesh, in addition to other insect pests, the pod borers *Etiella zinckenella* (Treitschke) and *Helicoverpa armigera* (Hübner) are most serious insect pest of vegetable pea appearing during the flowering and pod stage which seriously damages the crop and is considered to be a major limiting factor for the production of vegetable pea [5].

Helicoverpa armigera completes its life cycle (from egg to adult) in 4-5 weeks at an average

temperature of 28°C. Adult insects having stout bodies with broad thorax are named as Moth. A female moth can lay up to 3000 eggs. Eggs are generally laid on leaves, pods and flowers. 1st to 3rd instar larvae generally feed on leaves, twigs and flowers. In later stages larger larvae (4th to 6th instar caterpillars) shift to developing pods by making holes/bores and consume entire developing seeds. Pod borers can cause yield losses up to 90 percent depending upon the insect density and susceptibility of cultivars [6].

Various abiotic and biotic factors cause losses in the crops. Among the biotic constraints, the losses caused by insect-pests are a major limiting factor in realization of optimum yield of various crops. Every year world widely more than 20% of damage was occurring by insect pests, however individual fields may sustain losses up to 50–100% from one or more pests.

1.1 Objectives

1. To evaluate the effect of some microbial and botanical biopesticides against the damage of pod borer in garden pea
2. To calculate the cost and benefit ratio.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi* 2021 at Central Research Farm, the Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P, to evaluate the efficacy of Some Biopesticides viz., Neem oil 2%(T₁), Spinosad 45% SC (T₂), NSKE 5% (T₃), *Bacillus thuringiensis* (T₄), NSKE+HaNPV+Bt (T₅), Emamectin benzoate5%SG (T₆), *Beauveria bassiana*(T₇) and untreated Control (T₀) in RBD with three replications at a spacing of 45cm x 30cm. Anonymous the experimental field was monitored for incidence of garden pea pod borer at the weekly interval to observe ETL levels of insects. Spraying was done by using a Hand compression sprayer. Pod damage analysis was recorded by randomly picking 5 plants per plot from each treatment a day prior to insecticide application and seven, fourteen days after each treatment At each picking the average numbers of larvae (pod borer) of each species were counted in five randomly selected plants from each treatment and replication wise. The number of pods per plant and number of damaged pods; number of healthy and infested seeds were

Table 1. Comparative effect and economics of some biopesticides against the damage of pod borer in garden pea *rabi* season 2021-2

Sl. No.	Treatments	Pod damage percentage									Yield (q/ha)	C:B Ratio
		First spray				Second spray				Overall Mean		
		1DBS	7DAS	14DAS	Mean	1DBS	7DAS	14DAS	Mean			
T ₁	Neem oil 2%	24.04	13.31	17.18	18.18	17.18	15.02	19.76	17.32	17.18	11.20	1:2.48
T ₂	Spinosad 45% SC	24.17	7.14	11.54	14.16	11.54	8.27	12.27	10.57	11.54	16.40	1:3.43
T ₃	NSKE 5%	24.19	11.41	15.76	17.06	15.75	13.03	17.04	15.21	15.75	12.45	1:2.69
T ₄	<i>Bacillus thuringiensis</i>	24.21	12.40	16.33	17.79	16.33	14.22	18.25	16.41	16.33	11.80	1:2.55
T ₅	NSKE+HaNPV+Bt	24.07	8.54	12.32	14.98	12.32	9.57	14.09	12.00	12.32	14.60	1:3.00
T ₆	Emamectin benzoate 5% SG	24.33	6.21	9.21	13.27	9.21	7.38	10.45	9.03	9.21	19.20	1:4.25
T ₇	<i>Beauveria bassiana</i> 1.5% SG	24.88	10.63	15.75	16.72	15.76	11.01	16.25	13.98	15.76	13.25	1:2.80
T ₀	Control	24.26	27.95	29.25	27.07	29.25	27.95	28.99	28.64	29.25	8.2	1:1.90
	F-Test	NS	S	S	S	S	S	S	S	S		
	S. Ed. (±)		1.65	1.55	2.37	1.55	1.54	1.52	0.49	1.55		
	C.D. (P = 0.05)		3.5	3.3	5.09	3.3	3.31	3.27	1.05	3.3		

Table 2. Economics of cultivation

Sl. No.	Treatments	Yield of q/ha	Cost of yield / ₹/q	Total cost of yield (₹)	Common cost (₹)	Treatment cost(₹)	Net return(₹)	Total cost (₹)	C:B ratio
1	Neem oil 2%	11.20	5620	62944	24205	1160	37579	25365	1:2.48
2	Spinosad 45% SC	16.40	5620	92168	24205	2640	65323	26845	1:3.43
3	NSKE 5%	12.45	5620	69969	24205	1800	43964	26005	1:2.69
4	<i>Bacillus thuringiensis</i> 4% WSP	11.80	5620	66316	24205	1700	40411	25905	1:2.55
5	NSKE-HaNPV-Bt 5%-250LE-1L	14.60	5620	82052	24205	3100	54747	27305	1:3.00
6	Emamectin benzoate5%SG	19.20	5620	107904	24205	1130	82569	25335	1:4.25
7	<i>Beauveria bassiana</i> 1.5% SG	13.25	5620	74465	24205	2100	48160	26305	1:2.80
8	Control	8.2	5620	46084	24205	0	22279	24205	1:1.90

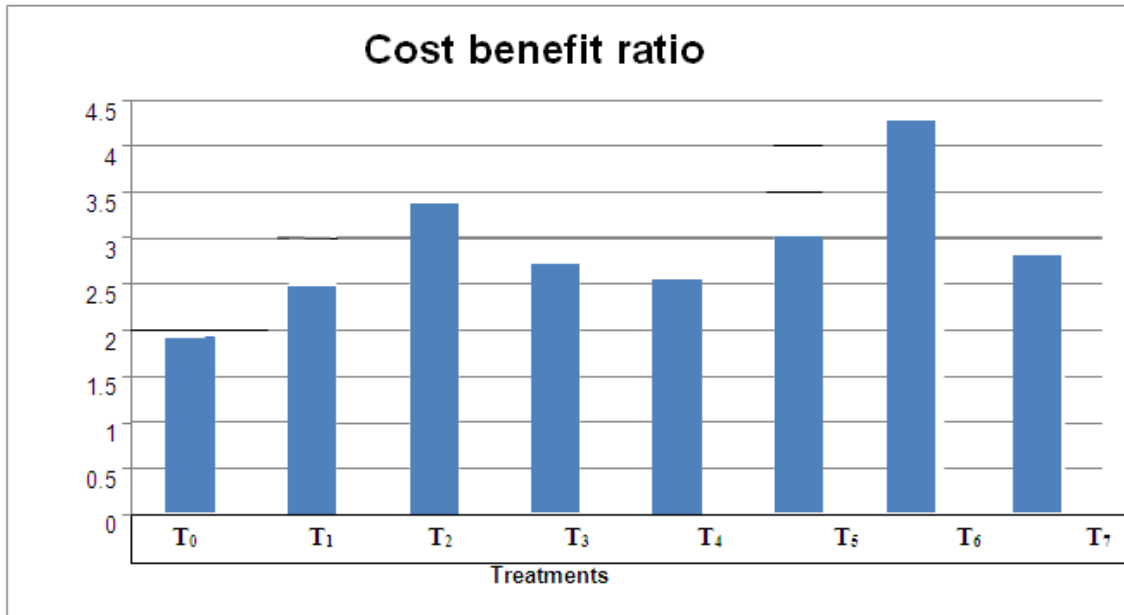


Fig. 1. Cost-benefit ratio of different treatments

recorded and expressed as per cent pod damage, seed damage, percent reduction in pod damage over control and % increasing The pod yield was recorded on the net plot area basis which was later converted to q/ha [7].

$$\text{Percentage Pod damage} = \frac{\text{No. of affected pods}}{\text{Total no. of pods}} \times 100$$

Cost-benefit ratio of treatments: Gross returns was calculated by multiplying the total yield with the market price of the produce. The cost of cultivation and cost of treatments will be deducted from the gross returns, to find out the returns and cost benefit of ratio by following formula,

$$\text{B. C. R} = (\text{Gross Returns} / \text{Total cost of Production})$$

3. RESULTS AND DISCUSSION

In the experiments, Seven treatments and Control of different treatments, consisting application of were tested to compare the efficacy against *Helicoverpa armigera* and their influences on the yield of a garden pea. The results obtained are discussed in the light of available relevant literature in this chapter as before.

Overall mean analysis of 7th and 14th days after 1st insecticidal application indicated that all the

insecticidal treatments were significantly effective in highly reduced pod damage percentage of *H. armigera* as compared to untreated plots (Table 1) Emamectin benzoate 5% SG (14.16%) was found significantly superior among all the treatments. Spinosad 45% SC (17.06%) is the next best treatment for reducing the population of pod borers. It is followed by *NSKE+HaNPV+Bt* (13.27%), *Beauveria bassiana* 1.5% SG (16.72%) and NSKE 5% (17.79%), *Bacillus thuringiensis* 4% WSP (14.98%) followed by Neem oil 2% (18.18%) which is less effective against pod borer.

The data on percent pod damage of *Helicoverpa armigera* on the second spray revealed that all the treatments were significantly superior to control. Among all treatments, Emamectin benzoate 5% SG (9.03%) was found significantly superior among all the treatments which are in line with the similar findings of Akhtar et al. [8] with (10.4% and 11.9%) and Upadhyay et al. [9] with (7.33%) and Dadas et al. (2019) with (8.33%). Spinosad 45% SC (10.57%) is the next best treatment for reducing the population of pod borer which is in line with the similar findings of Dadas et al. (2019) with (7.33%), Agale et al. [10] with pooled mean percent (6.82%), Mihretie et al. [11] with (11.39%), Akhtar et al. [8] with (7.8%). It is followed by *NSKE+HaNPV+Bt* (12.00%) which is in line with the similar finding of Byrappa et al. [12] with (15.96%), *Beauveria bassiana* 1.5% SG (13.98%) which is in line with the similar finding

of Singh et al. [13] and Khorasiya et al. [7] with (9.8%), and NSKE 5% (16.41%), *Bacillus thuringiensis* 4% WSP (12.00%) which is in line with the similar finding of Khorasiya et al. [7] and Meena et al. [14] with (13.17% and 10.50%) followed by Neem oil 2% (17.32%) which is in line with the similar finding of Abhilasha and Shekarappa [15] and Mishra et al. [16] with (25.68%) which is less effective against pod borer.

The yields among the treatments were found to be significant. The highest yield was recorded in Emamectin benzoate 5% SG (19.20 q/ha) which is in line with the similar findings of Kumar and Kumar [17] with (1966 kg/ha), Santhosh and Kumar [18] with (19.72q/ha) and Chaukikar et al. [19] with (1810kg/ha) followed by Spinosad 45% SC (16.40q/ha) which is in line with the similar findings of Mihretie et al. [11] with (16.68q/ha), Mishra et al. [16] with (17.53q/ha) and Upadhyay et al. [9] with (15.55q/ha), *NSKE+HaNPV+Bt* (14.60q/ha) which is in line with the similar finding of Byrappa et al. [12] with (10.01q/ha), *Beauveria bassiana* 1.5% SG (13.25 q/ha) which is in line with the similar finding of Khorasiya et al. [7] with (12.33q/ha), NSKE 5% (12.45 q/ha) which is in line with the similar finding of Meena et al. [14] with (12.22q/ha) and Hossain et al. [20] with (11.46q/ha), *Bacillus thuringiensis* 4% WSP (11.80 q/ha) with similar findings of Khorasiya et al. [7] with (11.17q/ha), Meena et al. (2018) with (11.23q/ha) and Singh et al. (2016) with (11.4q/ha) and Neem oil 2% (11.20 q/ha) with similar findings of Santhosh and Kumar [18] with (13.61q/ha) as compared to control plot (8.2q/ha).

When cost benefit ratio was worked out, interesting result was achieved (Fig. 1.) and (Table 2). Among the treatments studied, the best and most economical treatment was Emamectin benzoate 5% SG (1:4.25) with the similar finding of Kumar and Kumar [17] with (1:4.5) followed by Spinosad 45% SC (1:3.43) with the similar findings of Kumar and Kumar [17] with (1:1.40) and Abhilasha and Shekarappa [15] with (1:3.91), *NSKE+HaNPV+Bt* (1:3.00) with the similar finding of Byrappa et al. [12] with (1:2.27), *Beauveria bassiana* 1.5 % SG (1:2.80) with the similar finding of Singh et al. [13], NSKE 5% (1:2.69) with the similar findings of Abhilasha and Shekarappa [15] with (1:2.89) an Hossain et al. [20], *Bacillus thuringiensis* 4% WSP (1:2.55) with similar findings of Khorasiya et al. [7] with (1:2.83) and Meena et al. [14] with (1:2.29) and Neem oil 2% (1:2.48) with the similar findings of

Abhilasha and Shekarappa [15] with (2.73) and Santhosh and Kumar [18] with (1:2.41) as compared to Control (1:1.90) (Table 2) [31-35].

4. CONCLUSION

The present study was conducted on the evaluation of insecticides during *rabi* season 2021-22 on garden pea pod borer, *H. armiger*. Percent pod damage revealed that, Emamectin benzoate 5% SG (10.57%) was found to be the most effective treatment in the reduction of *H. armigera* followed by Spinosad 45% SC (15.21%), *NSKE+HaNPV+Bt* (9.03%), *Beauveria bassiana* 1.5% SG (13.98%), NSKE 5% (16.41%), *Bacillus thuringiensis* 4% WSP (12.00%) and Neem oil 2% (17.32%). Among all the treatments, the cost-benefit ratio has been analyzed, in which the highest was Emamectin benzoate 5% SG (1:4.25) and marketable yield (19.20 q/ha) followed by Spinosad 45% SC (1:3.43 and 16.40 q/ha), and *NSKE+HaNPV+Bt* (1:3.00 and 14.60 q/ha), *Beauveria bassiana* 1.5 % SG (1:2.80 and 13.25q/ha), NSKE 5% (1:2.69 and 12.45 q/ha), *Bacillus thuringiensis* 4% WSP (1:2.55 and 11.80 q/ha) and the lowest was Neem oil 2% (1:2.48 and 11.20 q/ha) have been recorded.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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