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Efficacy of selected insecticides against pod borer [*Helicoverpa armigera* (Hubner)] on green gram

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Abstract
A field trail was conducted at Central research farm, SHUATS *kharif* season of 2021. Eight treatments including control were evaluated against *H. armigera.* The result of the efficacy of treatments on first spray showed that, among all the treatments lowest per cent reduction of green gram pod borer was recorded in Chlorantraniliprole 18.5 SC (74.211) followed by Spinosad 45 SC (69.47), Indoxacarb 14.5 SC (66.257), Neem oil 2% (64.266), *Ha* NPV 250 LE (59.031), *Bacillus thuringiensis* 4% WSP (54.755) and *Beauveria bassiana* 1.15% WP (52.081) is found to be least effective but comparatively superior over the control. According to the data of second spray, it showed that Chlorantraniliprole 18.5 SC (74.422%) is found to be most effective. Followed by Spinosad 45 SC (70.523%) and Indoxacarb 14.5 SC (67.017%). Treatments Neem oil 2% (64.220%) and *Ha* NPV 250 LE (60.938%) was found to be average. *Bacillus thuringiensis* 4% WSP (55.893%), *Beauveria bassiana* 1.15% WP (52.382%) was found to be less effective in reducing the larval population of *Helicoverpa armigera* but comparatively superior over the control. While, the highest yield 16.9 q/ha was obtained from the treatment when cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Chlorantraniliprole 18.5 SC (1:4.13) followed by Spinosad 45 SC (1:3.99), Indoxacarb 14.5 SC (1:3.94), Neem oil 2% (1:3.52), *Ha* NPV 250 LE (1:3.59), *Bacillus thuringiensis* 4% WSP (1:3.39), *Beauveria bassiana* 1.15% WP (1:3.18), as compared to control plot (1:1.19).

Keywords: Efficacy, insecticides, *Helicoverpa armigera,* pod borer, green gram

Introduction

Pulses, also known as legumes, are the edible seeds of leguminous plants cultivated for food. Dried beans, lentils and peas are the most commonly known and consumed types of pulses. Pulses constitute an excellent supplement of protein in the vegetarian diet of human being and plays a significant role in correcting the wide spread malnutrition all over the world. Pulses are known as the "poor man's meat" because they are rich in nutrition and low in cost (Umbarkar *et al*., 2010) [20].

Mung beans are recognized for their high nutritive value. Mung beans contain about 55%-65% carbohydrate and are rich in protein, fat, vitamins and minerals. It is composed of about 20% to 50% protein of total dry weight, among which globulin (60%) and albumin (25%) are the primary storage proteins. Mung bean is considered to be a substantive source of dietary proteins. The proteolytic cleavage of these proteins are even higher during sprouting. Mung bean carbohydrates are easily digestible, which causes less flatulence in human compared to other forms of legumes. Both seeds and sprouts of mung bean produce lower calories compared to other cereals, which makes it more attractive to obese and diabetic individuals.

The total area under green gram cultivation was about 30.48 lakh hectares with an annual production of 13.45 lakh tonnes. It is the largest producer of grain legumes (pulses) in the world. India ranks first in green gram production (70% of the total world production). It produces about 1.5 to 2.0 million tonnes of Mung annually from about 3 to 4 million hectares of area, with an average productivity of 798 kg per hectare.

The gram pod borer, *Helicoverpa armigera* is a potential and polyphagous pest, with various characteristic features like high fecundity, migratory behavior, high adaptations to various agro climatic conditions and development of resistance to various insecticides, extensively damaging many crops including Greengram and chickpea (Kambrekar *et al.*, 2009) [9]. The caterpillar not only defoliates the tender leaves but also makes holes in the pods and feed upon the developing seeds the anterior body portion of the caterpillar remains inside the pod and rest half or so hanging outside.

When seeds of one pod are finished, it moves to the next. Unless the pest is controlled in the initial stages of infestation it takes the heavy toll of the crop. Worldwide losses due to *Helicoverpa armigera* have been estimated over US $300 million annually (Kaur *et al*., 2007) [10].

Materials and Methods

During the *kharif* season of 2021, a field trial was conducted in Central Research Field (CRF), SHUATS, Uttar Pradesh, India. The experiment was set up using the cultivar Anand in a Randomized Block Design (RBD) with 8 treatments duplicated three times using a suggested package of practises excluding plant protection in a plot size of (2m x 2m) at a spacing of (30x10cm). With eight treatments, including control, consisting application of Indoxacarb 14.5 SC (T1), Spinosad 45 SC (T2), *Beauveria bassiana* 1.15% WP (T3), *Ha* NPV 250 LE (T4), Neem oil 2% (T5), Chlorantraniliprole 18.5 SC (T6), *Bacillus thuringiensis* 4% WSP (T7) and untreated Control (T8) were tested to compare the efficacy against *Helicoverpa armigera* and their influences on yield of greengram.

Data was collected on many parameters in accordance with the study's requirements. After careful examination for the presence of pod borer, the number of infested pods with larva from 5 randomly selected plants per plot were counted and recorded at weekly intervals. One day before spraying, three days after spraying, seven days after spraying, and fourteen days after spraying were recorded. Pods infested by larva from randomly selected five plants in three replications of each treatment were recorded at each picking. On a number basis, the mean larval population of greengram pods by greengram pod borer was determined. Based on healthy pods, yield data was recorded at each picking. The data was then transformed appropriately, and the critical difference CD (p=0.05) level of significance was calculated using one-way ANOVA. For evaluating the yield performance, the increase in yield above the untreated control was also calculated. Finally, the benefit cost ratio (BCR) was estimated using market prices for greengram, pesticides, and spraying costs.

$$\text{B: C Ratio} = \frac{\text{Net returns}}{\text{Total cost incurred}}$$

Where,
B:C Ratio = Benefit Cost Ratio

Results and Discussion

In the experiments, eight different treatments, consisting application of Indoxacarb 14.5 SC (T1), Spinosad 45 SC (T2), *Beauveria bassiana* 1.15% WP (T3), *Ha* NPV 250 LE (T4), Neem oil 2% (T5), Chlorantraniliprole 18.5 SC (T6), *Bacillus thuringiensis* 4% WSP (T7) and untreated Control (T8) were tested to compare the efficacy against *Helicoverpa armigera* and their influences on yield of greengram. The results obtained are discussed in the light of available relevant literature in this chapter as before.

The data on percent reduction of Greengram Pod borer, *Helicoverpa armigera* over control at three days after first spray revealed that all the treatments were significantly superior over control. Among all the treatments, the plot treated with Chlorantraniliprole 18.5 SC (78.697%) recorded maximum percent population reduction as compared to the remaining treatments. It was followed by Spinosad 45 SC (73.03%) which was found at par with Indoxacarb 14.5 SC (70.583%), and Neem oil 2% (66.633%). It was followed by *Ha* NPV 250 LE (62.627%), which was found at par with *Bacillus thuringiensis* 4% WSP (56.007%) and *Beauveria bassiana* 1.15% WP (50.617%). The treatments (T2, T1), (T5, T4), were statistically at par with each other.

The data on percent reduction of Greengram Pod borer, *Helicoverpa armigera* over control at Seven days after first spray revealed that all the treatments were significantly superior over control. Among all the treatments, the plot treated with Chlorantraniliprole 18.5 SC (74.83%) recorded maximum percent population reduction as compared to the remaining treatments and it was found at par with Spinosad 45 SC (67.28%) and Indoxacarb 14.5 SC (63.98%) and Neem oil 2% (63.19%). It was followed by *Ha* NPV 250 LE (56.44%), which was at par with *Bacillus thuringiensis* 4% WSP (55.22%) and *Beauveria bassiana* 1.15% WP (53.77%). The treatments which are at par with each other are (T1, T5) (T4 T7 T3) (T7 T3).

The data on percent population reduction of greengram podborer over control on second spray revealed that all the treatments were significantly superior over control. Among all treatments, Chlorantraniliprole 18.5 SC (74.422%) and Spinosad 45 SC (70.523%) recorded highest reduction of Podborer population which was significantly superior over control followed by Indoxacarb 14.5 SC (67.017%), Neem oil 2% (64.220%) and *Ha* NPV 250 LE (60.938%), *Bacillus thuringiensis* 4% WSP (55.893%), *Beauveria bassiana* 1.15% WP (52.382%) was the least effective among all treatments.

The data on the mean per cent population reduction of first spray and second spray, overall mean revealed that all the treatments except untreated control are effective and at par. Among all the treatments highest per cent reduction of Greengram podborer was recorded in Chlorantraniliprole 18.5 SC (74.316%). Similar findings made by Gadhiya *et al*. (2014) [7], Sonune and Bhamare with (55.0%) and Mahajan *et al.* (2020) [12] (45.0%). Spinosad 45 SC (69.996%) is found to be the next best treatment which is in line with the findings of Muhammad *et al.* (2005) [15] (50.0%), Singh *et al*. (2012) [18] (52.3%) and Meena *et al*. (2014) [13] (45.0%) they reported that Spinosad 45 SC was found most effective in reducing percent population reduction of Greengram podborer as well as increasing the yield.

Indoxacarb 14.5 SC (66.637%) is found to be the next best treatment which is in line with the findings of Rashid *et al*. (2003) [17] (42.5%), Singh *et al*. (2007) [19] (42.8%) and Babariya *et al*. (2010) [1] (57.0%) Neem oil 2% (64.243%) is found to be the next effective treatment which is in line with the findings of Moraly *et al.* (2000) [14] and Chandra *et al.* (2018) [3] (51.78%) and *Ha* NPV 250 LE (59.984%) is found to be next best treatments is found to be the next effective treatment which is in line with the findings of Kale (2008) [8] (59.37%), Byrappa *et al*. (2012) [2] (45.7%) and Rahman *et al.* (2014) [16] (62.5%) The result of *Bacillus thuringiensis* 4% WSP (55.324%) which is in support with Kumar *et al.* (2019) [11] and Fite (2020) [6]. *Beauveria bassiana* 1.15% WP (52.231%) is found to be least effective but comparatively superior over the control, these findings are supported by Choudhary *et al*. (2017) [5] (51.78%) and Mahajan *et al.* (2020) [12].

Table 1: Effect of biopesticides and chemicals on the larval population of pod borer *H. Armigera on green gram*

S. NO	Treatments	Per cent reduction in larval population (First spray)					Per cent reduction in larval population (Second spray)					Over
		Before spray	3 DAS	7 DAS	14 DAS	Mean	DBS	3 DAS	7 DAS	14 DAS	Mean	All Mean
T0	Indoxacarb 14.5 SC	5.200	70.583	63.983	64.207	66.257	4.333	70.580	66.310	64.160	67.017	66.637
T1	Spinosad 45 SC	5.000	73.303	67.280	67.827	69.470	4.267	75.350	68.527	67.693	70.523	69.9965
T2	*Beauveria bassiana* 1.15% WP (1X108 CFU/gm)	4.800	50.617	53.770	51.857	52.081	5.067	52.913	52.323	51.910	52.382	52.2315
T3	*Ha* NPV 250 LE	4.867	62.627	56.437	58.030	59.031	4.600	65.983	57.310	59.520	60.938	59.9845
T4	Neem oil 2%	5.067	66.633	63.193	62.973	64.266	4.533	69.430	62.560	60.670	64.220	64.243
T5	Chlorantraniliprole 18.5 SC	4.533	78.697	74.827	69.110	74.211	4.333	78.883	75.820	68.563	74.422	74.3165
T6	*Bacillus thuringiensis* 4% WSP	4.800	56.007	55.220	53.040	54.755	5.000	57.683	56.027	53.970	55.893	55.324
T7	Control	4.933	0.000	0.000	0.000	0.000	5.533	0.000	0.000	0.000	0.000	0.000
	F-test	NS	S	S	S	S	NS	S	S	S	S	S
	S. Ed. (±)	0.25	2.07	3.16	1.91	1.81	0.23	2.23	2.85	2.98	1.86	1.10
	C.D. (P = 0.05)		4.44	0.351	4.09	3.88		4.79	0.57	0.52	3.99	1.13

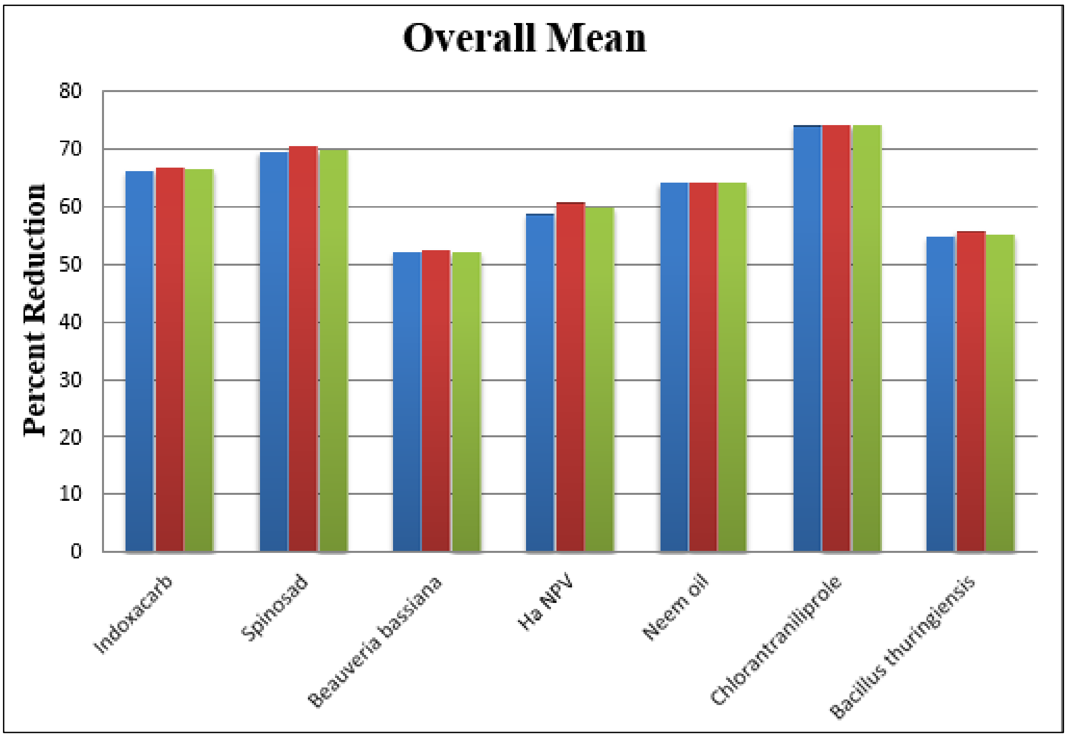

Fig 1: Effect of biopesticides and chemicals on the larval population of pod borer

Table 2: Economics of the Cultivation

S. No	Treatments	Yield of q/ha	Cost of yield /₹/ qtl	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	C:B ratio
1	Indoxacarb 14.5 SC	15.7	6000	94200	20120	3800	23920	1:3.94
2	Spinosad 45 SC	16.3	6000	97800	20120	4400	24520	1:3.99
3	*Beauveria bassiana* 1.15% WP (1X108 CFU/gm)	12.2	6000	73200	20120	2900	23020	1:3.18
4	*Ha* NPV 250 LE	13.4	6000	80400	20120	2240	22360	1:3.59
5	Neem oil 2%	13.7	6000	82200	20120	3200	2332 0	1:3.52
6	Chlorantraniliprole 18.5 SC	16.9	6000	101400	20120	4400	24520	1:4.13
7	*Bacillus thuringiensis* 4% WSP	12.5	6000	75000	20120	2000	22120	1:3.39
8	Control	4	6000	24000	20120	0	20120	1:1.19

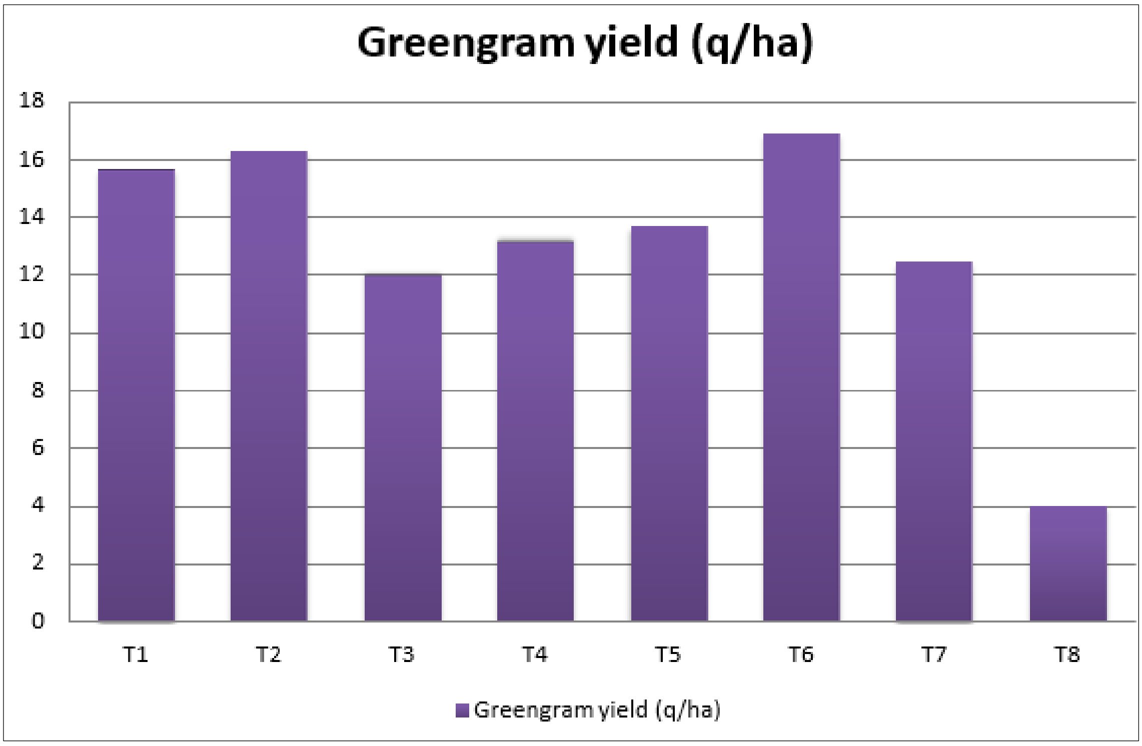

Fig 2: Yield of Greengram

The yields among the different treatments were significant. All the treatments were superior over control. The highest yield was recorded in Chlorantraniliprole 18.5 SC (16.9 q/ha) followed by Spinosad 45 SC (16.3 q/ha), Indoxacarb 14.5 SC (15.7 q/ha), Neem oil 2% (13.7 q/ha), *Ha* NPV 250 LE (13.4 q/ha), *Bacillus thuringiensis* 4% WSP (12.5 q/ha), *Beauveria bassiana* 1.15% WP (12.2 q/ha), as compared to control plot (4 q/ha).

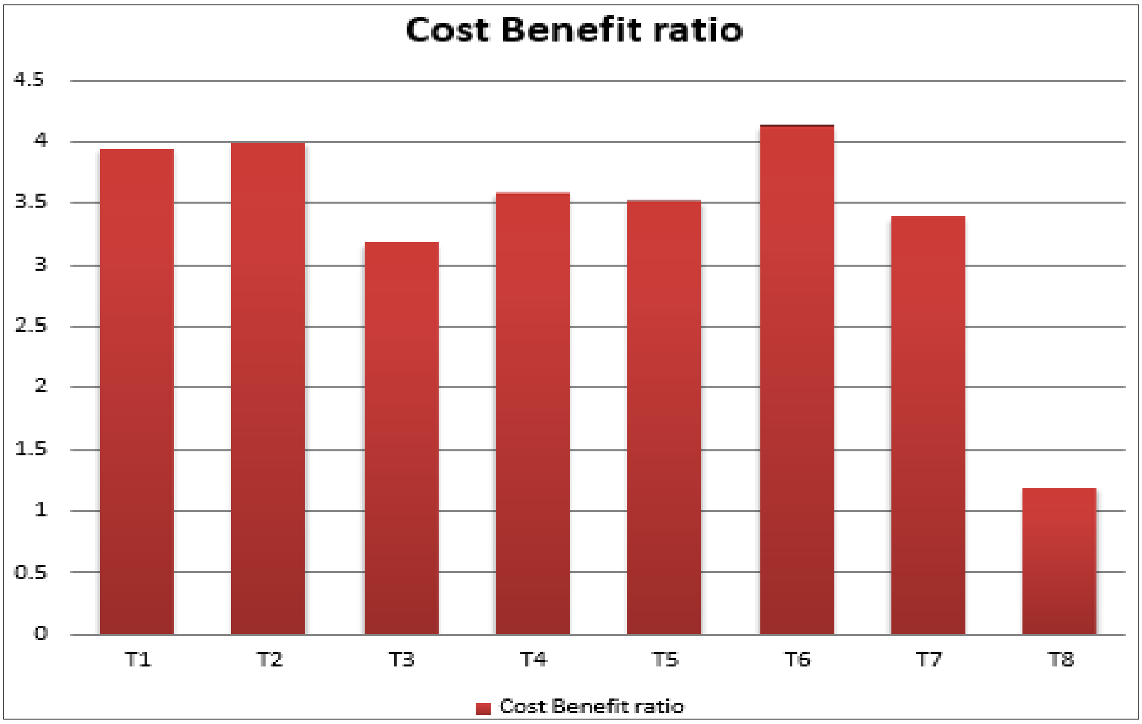

Fig 3: Cost benefit ratio of treatments

When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Chlorantraniliprole 18.5 SC (74.316%), (1:4.13) followed by Spinosad 45 SC (69.996%), (1:3.99), Indoxacarb 14.5 SC (66.637%), (1:3.94), Neem oil 2% (64.243%), (1:3.52), *Ha* NPV 250 LE (59.984%), (1:3.59), *Bacillus thuringiensis* 4% WSP (55.324%),(1:3.39), *Beauveria bassiana* 1.15% WP (52.231%), (1:3.18), as compared to control plot (1:1.19).These findings are supported by Cherry (2000) [4], Singh *et al*. (2007) [19], Babariya *et al*. (2010) [1], Gadhiya *et al*. (2014) [7], Rahman *et al*. (2014) [16] and Vikrant *et al*. (2018) [21].

Conclusion

From the critical analysis of the present findings, it can be concluded that Chlorantraniliprole 18.5 SC is more effective in controlling per cent population reduction of Greengram podborer followed by Spinosad 45 SC, Indoxacarb 14.5 SC, Neem oil 2%, Ha NPV 250 LE in managing Greengram podborer. Among the treatments studied, the best and most economical treatment was Chlorantraniliprole 18.5 SC (1:3.96) followed by Spinosad 45 SC (1:3.72), Indoxacarb 14.5 SC (1:3.39), Neem oil 2% (1:3.31), Ha NPV 250 LE (1:2.98), *Bacillus thuringiensis* 4% WSP (1:2.53), *Beauveria bassiana* 1.15% WP (1:2.27), as compared to control plot (1:1.79). Respectively. Hence this can be a part of integrated pest management in order to avoid indiscriminate use of pesticides for ecofriendly management and to balance flora and fauna from eco system which causes pollution in the environment and also it will be less harmful to beneficial insects and Human beings.

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