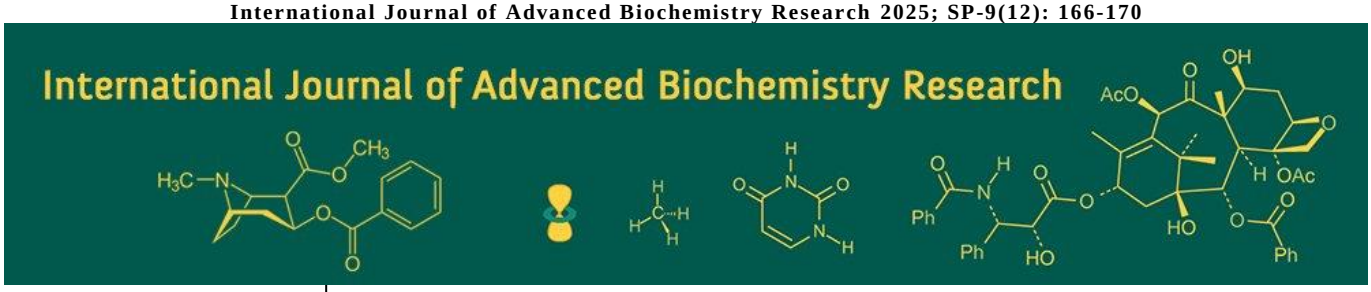

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Bio-efficacy of certain insecticide against *Helicoverpa armigera* (Hubner) on green gram (*Vigna radiata* L.)

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Abstract
Studies on the "Bio-efficacy of certain insecticide against *Helicoverpa armigera* (Hubner) on green gram (*Vigna radiata* L.)" at field condition was carried out during kharif season 2022 at Koirengei, Imphal,Manipur, India, in a randomized block design with eight treatments replicated three times using Raiyur seeds in a plot size of 2m x 2m at a spacing of 30cm x 10cm with a recommended package of practices excluding plant protection. The soil of the experimental site was well drained and medium high. The experiment was conducted in randomized block design with three replications. A good tilth area will be divided into three main blocks. Each main block was sub-divide into 9 sub- plots each of which was be of 2m x 2m with maintaining 30cm orders as bunds and the treatments was assigned randomly. It could be concluded that for the management of green gram pod borer and yield Chlorantraniliprole 0.3ml/lit on green gram crop, recommended insecticide schedule of Chlorantraniliprole 0.3ml/lit proved to be most effective and economical followed by Spinosad 0.6ml/lit, Flubendamide 150gm/ha, Emamectin benzoate 0.4gm/lit and Imidacloprid 0.50ml/lit. The highest yield was recorded in Chlorantraniliprole 0.3ml/lit (15.36 q ha-1) followed Spinosad 0.6ml/lit, Flubendamide 150gm/ha, Emamectin benzoate 0.4gm/lit and Imidacloprid 0.50ml/lit.

Keywords: Bio-efficacy, *Helicoverpa armigera*, green gram, insecticides, chlorantraniliprole

Introduction
Green gram [*Vigna radiata* L. Wilczek. 2n=22], and belongs to family leguminaceae, it is an economically important legume food grown worldwide in tropical and sub-tropical regions and it is one of the leading pulse crops in India. The importance of this legume is related to desirable characteristics such as high protein content (25-28%) and less flatulent than other pulses, broad adaptation, low need for agricultural inputs and its ability to increase soil fertility. Sprouts and green pods of green gram are also rich in vitamins and minerals thus are good and in expensive source of dietary protein for poor people Mehandi *et al.,* (2019) [4]. Among these only few are economically important as pests *viz*., Tur plume moth, *Exelastis atomosa* (Walsh), Tur pod borer, *Helicoverpa armigera* (Hubner) and Tur Pod fly, *Melanagromyza obtusa* (Mall). Which are collectively referred as "Pod borer complex" Lal (1998) [3]. This pod borer complex recorded economic damage at various places ranging 30 to 100 percent, as a result we had to import pulses from other countries by investing a huge amount, in addition direct loss to cultivators in the past years Patil *et al.,* (1990) [5]. 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) [1]. 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 Gayathri and Kumar (2021) [6]. 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 agroclimatic conditions and development of resistance to various insecticides, extensively damaging many crops including greengram (Kambrekar *et al*., 2009) [1].

Materials and Methods

Studies on the "Bio-efficacy of certain insecticide against *Helicoverpa armigera* (Hubner) on green gram (*Vigna radiata* L.)" at field condition was carried out during kharif season 2022 at Koirengei,Imphal, India, in a randomized block design with eight treatments replicated three times using Raiyur seeds in a plot size of 2m x 2m at a spacing of 30cm x 10cm with a recommended package of practices excluding plant protection. The soil of the experimental site was well drained and medium high. The experiment was conducted in randomized block design with three replications. A good tilth area will be divided into three main blocks. Each main block was sub-divide into 9 sub-plots each of which was be of 2m x 2m with maintaining 30cm orders as bunds and the treatments was assigned randomly.

Table 3.1: Details of insecticides treatment used for field assessment against *Helicoverpa armigera* (Hubner) in green gram

Treatment no	Treatment details	Dosage
T_1	Flubendamide	150gm/ha
T_2	Chlorantraniliprole	0.3ml/lit
T_3	Spinosad	0.6ml/lit
T_4	Fipronil	0.1ml/lit
T_5	Emamectin benzoate	0.4gm/lit
T_6	Lamda cyhalothrin	1ml/lit
T_7	Imidacloprid	0.50ml/lit
T_0	Control	-

Field evaluation of insecticides for the management of green gram pod borer, *Helicoverpa armigera* (Hubner)

A field trial was conducted during kharif season 2022 at Koirengei,Imphal,Manipur,India. The experiment was laid out in randomized block design with 9 treatment replicated thrice in 2×2 m plot size. The green gram "Raiyur" was raised as per the recommended package of practices. The details of treatment are given in table 3.1. Three new insecticides and five conventional insecticides were evaluated against the green gram pod borer, *Helicoverpa armigera* (table 3.1). The treatments were imposed by using hand compressor sprayer @ 400-500 liters of spray solution/hectare depending on stage of the crop. The crop received two sprays, the first being given at 50 per cent flowering stage (*i.e.*40 days after sowing) when the population crossed economic threshold level (one larvae/plant) while, the second spray was imposed 15days after spray.

The economics of management of green gram pod borer was determined considering the cost of inputs, cost of application and additional return.

Larval count was taken 24 hours before spraying on 5 tagged plants per treatment, which was further converted into per plant population subsequent observations were recorded at 3, 7 and 14 days after spraying on same plants.

3.9 Method of Recording Observations

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

Thilagam *et al.*, (2020)

Results and Discussion

The present study entitled "Bio-efficacy of certain insecticide against gram pod borer *Helicoverpa armigera* L. in green gram" was under taken at Koirengei, Imphal, Manipur.

4.1 Efficacy of various treatment against pod borer on pod damage (%) of *Helicoverpa armigera* L. in green gram first spray

3rd Days after spraying

The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (6.31) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (6.41), Flubendamide 150gm/ha (6.52), Emamectin benzoate 0.4gm/lit (6.83) and Imidacloprid 0.50ml/lit (6.84). The least effective treatments were control with (11.53) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_6, T_4, T_5, T_1, T_3, T_2) and (T_6, T_4, T_5, T_1, T_3, T_2) are significantly par with each other.

7th Days after spraying

The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (3.90) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (4.52), Flubendamide 150gm/ha (5.00), Emamectin benzoate 0.4gm/lit (5.43) and Imidacloprid 0.50ml/lit (6.00). The least effective treatments were control with (12.91) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_7, T_5, T_1, T_3) and (T_3 and T_2) are significantly par with each other.

14th Days after spraying

The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (4.48) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (4.90), Flubendamide 150gm/ha (5.37), Emamectin benzoate 0.4gm/lit (5.71) and Imidacloprid 0.50ml/lit (6.38). The least effective treatments were control with (12.91) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_6, T_4) and (T_4, T_7, T_5), (T_5, T_1, T_3) and (T_3, T_2) are significantly par with each other.

Table 4.1: Efficacy of chemical insecticides against green gram pod borer *H.armigera* during *Kharif* season, (1st Spray)

Treatment no	Treatment details	Dosage	1st Spray (Pod damage)				
			1 DBS	3 Days	7 Days	14 Days	Overall Mean
T_1	Flubendamide	150gm/ha	8.35 16.79	6.52 14.79	5.00 12.90	5.37 13.38	5.63 13.71
T_2	Chlorantraniliprole	0.3ml/lit	8.16 16.58	6.31 14.54	3.90 11.35	4.48 12.21	4.90 12.77
T_3	Spinosad	0.6ml/lit	8.28 16.97	6.41 14.66	4.52 12.27	4.90 12.78	5.28 13.28
T_4	Fipronil	0.1ml/lit	9.54 17.99	7.31 15.66	6.22 14.43	6.51 14.77	6.68 14.96
T_5	Emamectin benzoate	0.4gm/lit	8.81 17.24	6.83 15.12	5.43 13.47	5.71 13.82	5.99 14.16
T_6	Lamda cyhalothrin	1ml/lit	9.78 18.22	7.60 15.98	6.32 14.55	6.66 14.94	6.86 15.18
T_7	Imidacloprid	0.50ml/lit	9.04 17.49	6.84 15.15	6.00 14.17	6.38 14.62	6.41 14.65
T_8	Control	-	9.09 17.54	11.53 19.83	12.91 21.05	13.54 21.58	12.66 20.83
	F-Test		NS	S	S	S	-
	S.Ed. (±)		0.625	0.555	0.439	0.399	-
	C.D. at 0.5%		1.341	1.191	0.941	0.856	-

4.2 Efficacy of various treatment against pod borer on pod damage (%) of *Helicoverpa armigera* L. in green gram second spray

3rd Days after spraying

The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (4.31) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (4.69), Flubendamide 150gm/ha (5.12), Emamectin benzoate 0.4gm/lit (5.52) and Imidacloprid 0.50ml/lit (6.13). The least effective treatments were control with (14.29) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_6, T_4, T_7) and (T_7, T_5), (T_5, T_1, T_3) and (T_1, T_3) are significantly par with each other.

7th Days after spraying

The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (3.16) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (3.51), Flubendamide 150gm/ha (3.94), Emamectin benzoate 0.4gm/lit (4.60) and Imidacloprid 0.50ml/lit (6.13). The least effective treatments were control with (15.24) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_6, T_4, T_7) and (T_7, T_5), (T_5, T_1, T_3) and (T_1, T_3) are significantly par with each other.

14th Days after spraying

The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (4.14) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (4.50), Flubendamide 150gm/ha (4.91), Emamectin benzoate 0.4gm/lit (5.31) and Imidacloprid 0.50ml/lit (5.90). The least effective treatments were control with (15.24) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_6, T_4, T_7) and (T_4, T_7, T_5), (T_5, T_1) and (T_1, T_3) are significantly par with each other.

Table 4.2: Efficacy of chemical insecticides against green gram pod borer *H. armigera* during *Kharif* season, (2nd Spray)

Treatment no	Treatment details	2nd Spray (Pod damage)					
		Dosage	1 DBS	3 Days	7 Days	14 Days	Overall Mean
T_1	Flubendamide	150gm/ha	5.37	5.12 13.06	3.94 11.45	4.91 12.78	4.66 12.45
T_2	Chlorantraniliprole	0.3ml/lit	4.48	4.31 11.96	3.16 10.22	4.14 11.73	3.87 11.33
T_3	Spinosad	0.6ml/lit	4.90	4.69 12.50	3.51 10.77	4.50 12.24	4.23 11.87
T_4	Fipronil	0.1ml/lit	6.51	6.27 14.49	5.25 13.23	6.02 14.20	5.85 13.96
T_5	Emamectin benzoate	0.4gm/lit	5.71	5.52 13.59	4.60 12.37	5.31 13.31	5.14 13.10
T_6	Lamda cyhalothrin	1ml/lit	6.66	6.37 14.63	5.30 13.29	6.13 14.32	5.93 14.05
T_7	Imidacloprid	0.50ml/lit	6.38	6.13 14.32	5.17 13.12	5.90 14.04	5.73 13.84
T_8	Control	-	13.54	14.29 22.20	15.24 22.97	16.29 23.80	15.27 23.07
	F-Test		S	S	S	S	-
	S.Ed. (±)		0.399	0.437	0.518	0.796	-
	C.D. at 0.5%		0.856	0.937	0.111	0.371	-

4.3 Overall performance of chemical insecticidal treatment, on the mean pod damage of gram pod borer *H. armigera* (Observations on the mean of fir and second spray).

Overall mean (3rd Days, 7th Days and 14 Days) first spray The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (4.90) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (5.28), Flubendamide 150gm/ha (5.63), Emamectin benzoate 0.4gm/lit (5.99) and Imidacloprid 0.50ml/lit (6.41). The least effective treatments were control with (12.66) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_6, T_4, T_7) and (T_4, T_7), (T_7, T_5, T_1) and (T_5, T_1, T_3) and (T_3, T_2) are significantly par with each other.

Overall mean (3rd Days, 7th Days and 14 Days) second spray: The data reveals that all the treatments were significantly superior over untreated control. Among the treatments, Chlorantraniliprole (0.3ml/lit) was found to be superior to the rest of treatment by recording (3.87) pod damage percentage of *Helicoverpa armigera* L. in green gram followed by Spinosad 0.6ml/lit (4.23), Flubendamide 150gm/ha (4.66), Emamectin benzoate 0.4gm/lit (5.14) and Imidacloprid 0.50ml/lit (5.73). The least effective treatments were control with (15.27) pod damage of *Helicoverpa armigera* L. over control and at par with each other. The treatment (T_6, T_4, T_7, T_5) and (T_5, T_1) and (T_1, T_2) are significantly par with each other.

Table 4.3: Overall performance of chemical insecticidal treatment, on the mean pod damage of gram pod borer *H. armigera* (Observations on the mean of 2 rounds of spray)

Treatment no	Treatment details	Dosage	Overall mean (Pod damage)		
			1st Spray	2nd spray	Pooled Mean
T_1	Flubendamide	150gm/ha	5.63 13.71	4.66 12.45	5.15
T_2	Chlorantraniliprole	0.3ml/lit	4.90 12.77	3.87 11.33	4.39
T_3	Spinosad	0.6ml/lit	5.28 13.28	4.23 11.87	4.76
T_4	Fipronil	0.1ml/lit	6.68 14.96	5.85 13.96	6.27
T_5	Emamectin benzoate	0.4gm/lit	5.99 14.16	5.14 13.10	5.57
T_6	Lamda cyhalothrin	1ml/lit	6.86 15.18	5.93 14.05	6.40
T_7	Imidacloprid	0.50ml/lit	6.41 14.65	5.73 13.84	6.07
T_8	Control	-	12.66 20.83	15.27 23.07	13.97
	F-Test		S	S	-
	S.Ed. (±)		0.388	0.414	-
	C.D. at 0.5%		0.833	0.888	-

4.4 Efficacy of chemical insecticides against *H. armigera (Hubner)* on pod yield (q ha-1) of green gram

The data revealed that all the insecticide treatment gave significantly higher yield compare to control. The highest yield was recorded with the spray application of Chlorantraniliprole (0.3ml/lit) (15.36 q ha-1) followed by Spinosad 0.6ml/lit (14.15 q ha-1), Flubendamide 150gm/ha (13.44 q ha-1) and Emamectin benzoate 0.4gm/lit (12.21 q ha-1). The low yield was recorded from the plots sprayed with T_0 Control (Water) (4.97q ha^{-1}).

Table 4.4: Efficacy of chemical insecticides against *H. armigera (Hubner)* on pod yield (q ha-1) of green gram

Treatment No.	Treatment combination	Dose	Pod yield (q ha-1)	increase in yield over control
T_1	Flubendamide	150gm/ha	13.44	8.47
T_2	Chlorantraniliprole	0.3ml/lit	15.36	10.39
T_3	Spinosad	0.6ml/lit	14.15	9.18
T_4	Fipronil	0.1ml/lit	10.85	5.88
T_5	Emamectin benzoate	0.4gm/lit	12.21	7.24
T_6	Lamda cyhalothrin	1ml/lit	9.24	4.27
T_7	Imidacloprid	0.50ml/lit	11.31	6.34
T_0	Control	--	4.97	-
		F-Test	S	
		C.D. at 0.5	0.837	
		S.Ed.	0.390	

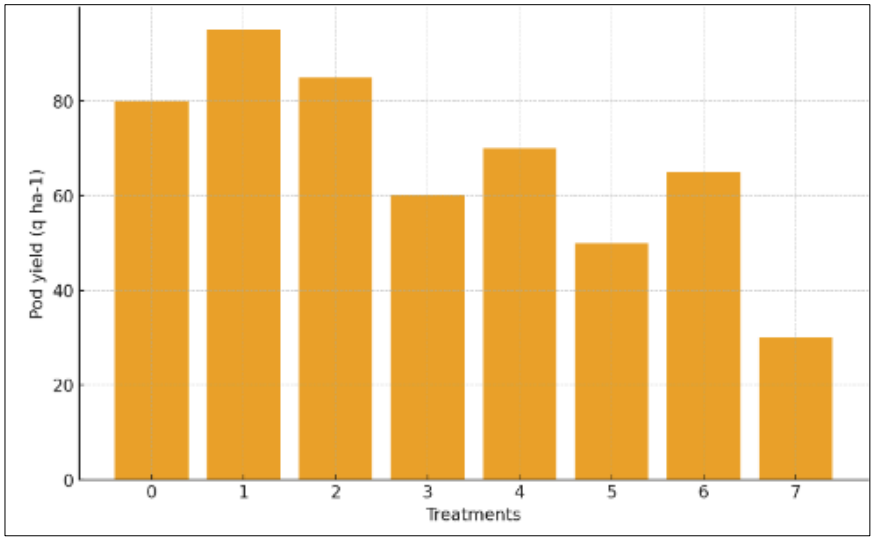

Fig 4.4: Efficacy of chemical insecticides against *H. armigera (Hubner)* on pod yield (q ha-1) of green gram

Conclusion

It could be concluded that for the management of green gram pod borer and yield Chlorantraniliprole 0.3ml/lit on green gram crop, recommended insecticide schedule of Chlorantraniliprole 0.3ml/lit proved to be most effective and economical followed by Spinosad 0.6ml/lit, Flubendamide 150gm/ha, Emamectin benzoate 0.4gm/lit and Imidacloprid 0.50ml/lit. The highest yield was recorded in Chlorantraniliprole 0.3ml/lit (15.36 q ha-1) followed Spinosad 0.6ml/lit, Flubendamide 150gm/ha, Emamectin benzoate 0.4gm/lit and Imidacloprid 0.50ml/lit.

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