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Field efficacy of selected insecticides with combination of neem oil against gram pod borer [*Helicoverpa armigera* (Hubner)]

T Jayanth and Ashwani Kumar

Abstract
The field experiment was conducted to determine Field efficacy of selected insecticides with combination of neem oil against gram pod borer [*Helicoverpa armigera* (Hubner)], infesting chickpea at Central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India during *Rabi* season of 2021-2022. Efficacy of seven treatments *viz.*, Chlorantraniliprole 18.5% SC, Cypermethrin 4% EC, Profenophos 40% EC + Cypermethrin 4% EC , Chlorantraniliprole 18.5% SC + Neem oil, Profenophos 40% EC, Cypermethrin 35% EC+ Neem oil, Neem oil were evaluated against gram pod borer [*Helicoverpa armigera* (Hubner)]. Among all the treatments Chlorantraniliprole 18.5% SC was most effective treatment against gram pod borer with lowest mean larval population is 0.81 per treatment followed by Cypermethrin 4% EC (1.02), Profenophos 40% EC+ Cypermethrin 4% EC (1.2), Chlorantraniliprole 18.5% SC + Neem oil (1.25), Profenophos 40% EC (1.28), Cypermethrin 35% EC+ Neem oil (1.51) were next effective treatments. Among all the treatments Neem oil was least effective treatment against gram pod borer with highest mean larval population with 1.66 but comparatively superior over control (3.19) (Water spray) . The highest yield was recorded and when cost benefit ratio worked out, interesting result was achieved, among the treatment studied, *i e.*, Chlorantraniliprole 18.5% SC (19.32 q/ha) with C:B ratio 1:3.42 followed by Cypermethrin 4% EC (18.80 q/ha) with C:B ratio 1:3.34, Profenophos 40%+ Cypermethrin 4% (15.84 q/ha) with C:B ratio 1:2.71, Chlorantraniliprole 18.5% SC + Neem oil (14.35 q/ha) with C:B ratio 1:2.46, Profenophos 40% EC (13.32 q/ha) with C:B ratio 1:2.34, Cypermethrin 35% EC+ Neem oil (12.24 q/ha) with C:B ratio 1:2.04, Neem oil 4ml/lit (10.50 q/ha) with C:B ratio 1:1.87 and control (water spray) (9.56 q/ha) with C:B ratio 1:1.88 respectively.

Keywords: Chick pea, cost benefit ratio, efficacy, *Helicoverpa armigera*, insecticides

Introduction
Chickpea (*Cicer arietinum* L.) which is essential legume crop throughout Asian region. It is cultivated as staple and cash crop on little to huge areas and its immature seeds, shoots and pods also be in utilized as a vegetable. Due to its nutritional values especially its seed which is highly enriched with protein (25.3-28.9%); considered as a most important human consumed food. Chemical control is still an important and the most effective tool of pest management. However, intelligent use of insecticides is dire need of the day. The discriminate use of insecticides results in increased resistance of insecticides against insects with the passage of time and creates the problem of environmental pollution. Proper hoeing and weeding results in checking the multiplication of *Helicoverpa armigera* in initial stages of crop growth. Such practices will ultimately decrease the number of sprays.

Pulses historically have been one of the most important constituent of the Indian cropping and consumption patterns and long considered “the poor man's meat” as it is one of the less expensive sources of protein (Mohanty and Satyasai 2015) [7]. During 2017-18, globally it was grown on 149.66 lakh ha area, with the total production of 162.25 lakh tonnes (FAOSTAT, 2019) [4] and average productivity of 1252 kg/ha. Out of which, 71 per cent of global area with 70 per cent of global production of *chick pea* is contributed by India as it ranks 1st in area and production but lags behind several countries in terms of productivity because of poor adoption. Two types of chickpea cultivars are recognized globally-kabuli types which are generally grown in the Mediterranean region including southern Europe, Western Asia and Northern Africa, and the desi types are grown mainly in Ethiopia and Indian subcontinent.

The major insect pests attacking chickpea are pod borer, leaf feeding caterpillar, black cutworm, aphid and semilooper.

Helicoverpa armigera is the major damaging pest in areas where chickpea is grown. 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 chickpea. *Helicoverpa armigera* belongs to insect order Lepidoptera, family Noctuidae. Its life cycle involves four major developmental stages (eggs, larvae, pupae and adult). *Helicoverpa armigera* completes its life cycle from egg to adult in about 30-34 days at an average temperature of 28 ºC (Fichetti *et al*., 2009) [3]. 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. 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.

Materials and Methods

The experimental trial was conducted at central research farm, SHUATS, Prayagraj, U.P. during *rabi* season of 2021-22. The experimental trial was laid out in a randomized block design consisting of seven different treatments *viz.*, Chlorantraniliprole, Cypermethrin, Profenophos 40% EC+ Cypermethrin 4%EC , Chlorantraniliprole 18.5% SC + Neem oil, Profenophos 40% EC, Cypermethrin 35% EC+ Neem oil, Neem oil and one control plot in three replications, with each net plot size 2x2m with spacing 30x10cm.

All the recommended agronomic practices were followed and two sprayings of insecticides ad neem oil were done.

The first spray was at appearance of the larvae and the subsequent spray was given at an interval of 15 days after first, with knapsack sprayer. The number of larvae from 5 randomly selected plants in each plot was counted at weekly intervals, starting from the initiation of flowering up to the application of the last treatment.

The pre and post treatment larval population counts from each plot was made from a 1meter row length (MRL). The pretreatment population was taken just before the spray of insecticide and post-treatment the population was taken after 3, 7 and 14 days of spray by visually counting the larvae of *Helicoverpa armigera* in Chickpea crop.

In the experiment Randomized Block Design (RBD) was adopted. The analysis of variance (ANOVA) technique was applied for drawing conclusion from data. The calculated values were compared the tabulated values at 5% level of probability for the appropriate degree of freedom.

Cost benefit ratio of treatments

Cost effectiveness of each treatment was assessed based on the net returns. Net returns of each treatment was worked out by deducting total cost of the treatment from gross returns.

Total cost of production included both cultivation as well as plant protection charges.

Gross return = Marketable yield × Market price

Net return = Gross return – Total cost

The B:C ratio can be calculated by formula…

$$\text{Benefit Cost Ratio} = \frac{\text{Gross return}}{\text{Total cost}}$$

Where,

BCR = Benefit Cost Ratio.

Results and Discussion

The data on the mean (3rd, 7th & 14th) Overall mean larval population of first spray revealed that few treatments are effective against control. Overall mean larval population of pod borer was recorded in Among the treatments lowest Mean larval population of gram pod borer was recorded in T3-Chlorantraniliprole 18.5% SC (1.03) followed by T7 Cypermethrin 4% EC (1.28), T4 Profenophos 40%+ Cypermethrin 4% (1.43), T6 Profenophos 40% EC (1.5), T1 Chlorantraniliprole 18.5% SC + Neem oil (1.5), T5 Cypermethrin 35% EC+ Neem oil (1.73). Highest mean larval population of gram pod borer was recorded in T2 Neem oil 4ml/lit (1.86) and control T0 (2.61).Here follows the tables to represent data of treatment Overall mean larval population and gram pod borer of first spray, second spray and two spray means of all 1 DBS, 3DAS, 7DAS and 14DAS.

Table 1: To evaluate the Field efficacy of selected insecticides with combination of neem oil against [*Helicoverpa armigera* (Hubner)] overall mean larval population of First spray

	Overall mean larval population of gram pod borer at first spray/ Plot				
Trt. Sl. No	**DBS**	**3DAS**	**7DAS**	**14DAS**	**Mean**
T1	2.6	1.2	1	1.2	1.5
T2	2.53	1.8	1.6	1.53	1.86
T3	2.26	0.8	0.53	0.73	1.08
T4	2.4	1.2	1	1.13	1.43
T5	2.53	1.6	1.4	1.4	1.73
T6	2.33	1.33	1.13	1.2	1.5
T7	2.4	1	0.8	0.93	1.28
T0	2.53	2.33	2.46	3.13	2.61
SE+_M	0.12	0.07	0.06	0.09	0.10
CD	0.18	0.22	0.20	0.28	0.30
Test of Significant	NS	S	S	S	S
CV	8.82	9.10	9.05	11.39	14.38

DBS* =Day before spray

DAS* = Days after spray

Overall mean larval population count (3rd, 7th and 14th DAS) of second spray

The data on the mean (3rd, 7th & 14th) Overall mean larval population of second spray revealed that few treatments are effective against control. Among the treatments lowest Mean larval population of gram pod borer was recorded in T3-

Chlorantraniliprole 18.5% SC (0.55) followed by T7 Cypermethrin 4% EC (0.76), T4 Profenophos 40%+ Cypermethrin 4% (0.96), T6 Profenophos 40% EC (1.06), T1 Chlorantraniliprole 18.5% SC + Neem oil (1.01), T5 Cypermethrin 35% EC+ Neem oil (1.3), T2 Neem oil 4ml/lit (1.46) and control T0 (3.76). In this T5 Cypermethrin 35% EC+ Neem oil (1.30) is found to be least effective than all the treatments and is significantly superior over the control T0 (3.76).

Table 2: To evaluate the Field efficacy of selected insecticides with combination of neem oil against [*Helicoverpa armigera* (Hubner)] Overall mean larval population of second spray

Overall mean larval population of gram pod borer at Second spray / Plot					
DBS		**3DAS**	**7DAS**	**14DAS**	**Mean**
T1	1.2	1	0.86	1	1.01
T2	1.53	1.6	1.4	1.33	1.46
T3	0.73	0.6	0.33	0.53	0.55
T4	1.13	1	0.8	0.93	0.96
T5	1.4	1.4	1.2	1.2	1.3
T6	1.2	1.13	0.93	1	1.06
T7	0.93	0.8	0.6	0.73	0.76
T0	3.13	3.66	3.86	4.4	3.76
SE+_M	0.04	0.07	0.10	0.07	0.11
CD	0.28	0.22	0.29	0.21	0.33
Test of significant	S	S	S	S	S
CV	11.39	9.02	13.47	8.66	16.57

Overall mean larval population count (3rd, 7th and 14th DAS) of two sprays

The data on the mean (3rd, 7th & 14th) Overall mean larval population of two spray revealed that few treatments Chlorantraniliprole 18.5% SC was most effective treatment against gram pod borer with lowest Mean larval population 0.81, followed by Cypermethrin 4% (1.02), Profenophos 40%+ Cypermethrin 4% (1.2), Chlorantraniliprole 18.5% SC + Neem oil (1.25), Profenophos 40% EC (1.28), T5 Cypermethrin 35% EC+ Neemoil (1.51), Neem oil. Among all the treatments Neem oil was least effective treatment against gram pod borer with highest mean larval population 1.66 but comparatively superior over control (Water spray).

Table 3: To evaluate the Field efficacy of selected insecticides with combination of neem oil against *Helicoverpa armigera* Overall mean larval population (first and second spray/plot)

Treatments	1 SPRAY	2 SPRAY	Mean
T1	1.5	1.01	1.25
T2	1.86	1.46	1.66
T3	1.083	0.55	0.81
T4	1.43	0.96	1.2
T5	1.73	1.3	1.51
T6	1.5	1.06	1.28
T7	1.28	0.76	1.02
T0	2.61	3.76	3.19
SEm±			0.22
CD or LSD			0.73
Test of significance (p=0.05)			S
CV			18.93

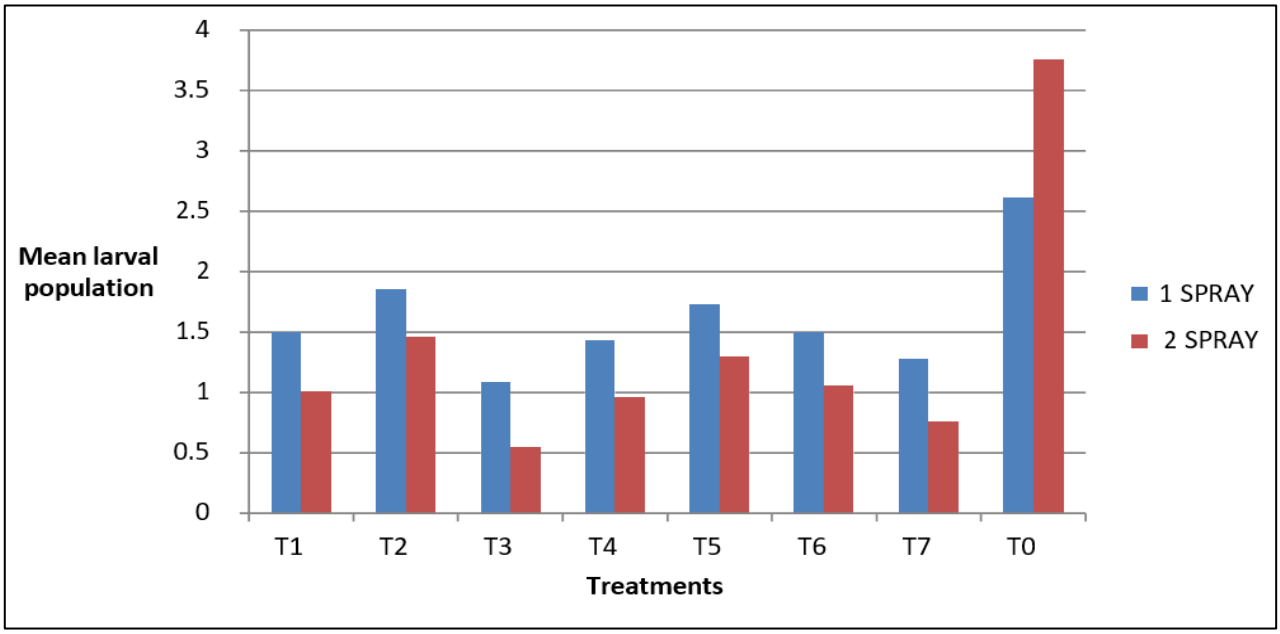

Fig 1: Field efficacy of selected insecticides with combination of neem oil against [*Helicoverpa armigera* (Hubner)] Overall mean larval population (First and Second spray/Plot)

Sudharani *et al*, (2018) [8] proved that plots treated with chlorantraniliprole 20% SC and flubendiamide 20% WG was most effective in reducing the incidence of *Helicoverpa armigera*. Gayathri and Kumar *et al.*, (2021) [5] findings concluded that the new generation insecticides like flubendiamide, chlorantraniliprole, and spinosad were found effective against *Helicoverpa armigera*. Sreekanth *et al.* (2014) [9] findings clearly indicated that new generation insecticides like chlorantraniliprole, flubendiamide and spinosad were found effective against gram pod borer, *Helicoverpa armigera*. significantly highest grain yield (1486 kg/ha) in comparison to control (778 kg/ ha).

Benefit Cost Ratio (BCR)

The data on cost benefit ratio of the treatments are presented in tables

Table 4: Economics of cultivation

Sr. No:	Treatment	Yield of q/ha	Cost of yield q/(Rs)	Total cost of yield (Rs)	Common cost (Rs)	Treatment cost (Rs)	Total cost	B:C ratio
T1	Chlorantraniliprole 18.5% SC + Neem oil	14.35	5500	78925	27865	4205	32070	1:2.46
T2	Neem oil	10.50	5500	57750	27865	2925	30790	1:1.87
T3	Chlorantraniliprole 18.5% SC	19.32	5500	106260	27865	3180	31045	1:3.42
T4	Profenophos 40%+ Cypermethrin 4%	15.84	5500	87120	27865	4326	32101	1:2.71
T5	Cypermethrin 35% EC + Neem oil	12.24	5500	67320	27865	5019	32884	1:2.04
T6	Profenophos 40% EC	13.32	5500	73260	27865	3390	31255	1:2.34
T7	Cypermethrin 4% EC	18.80	5500	103400	27865	3069	30934	1:3.34
T0	Control	9.56	5500	52580	27865	-	27865	1:1.88

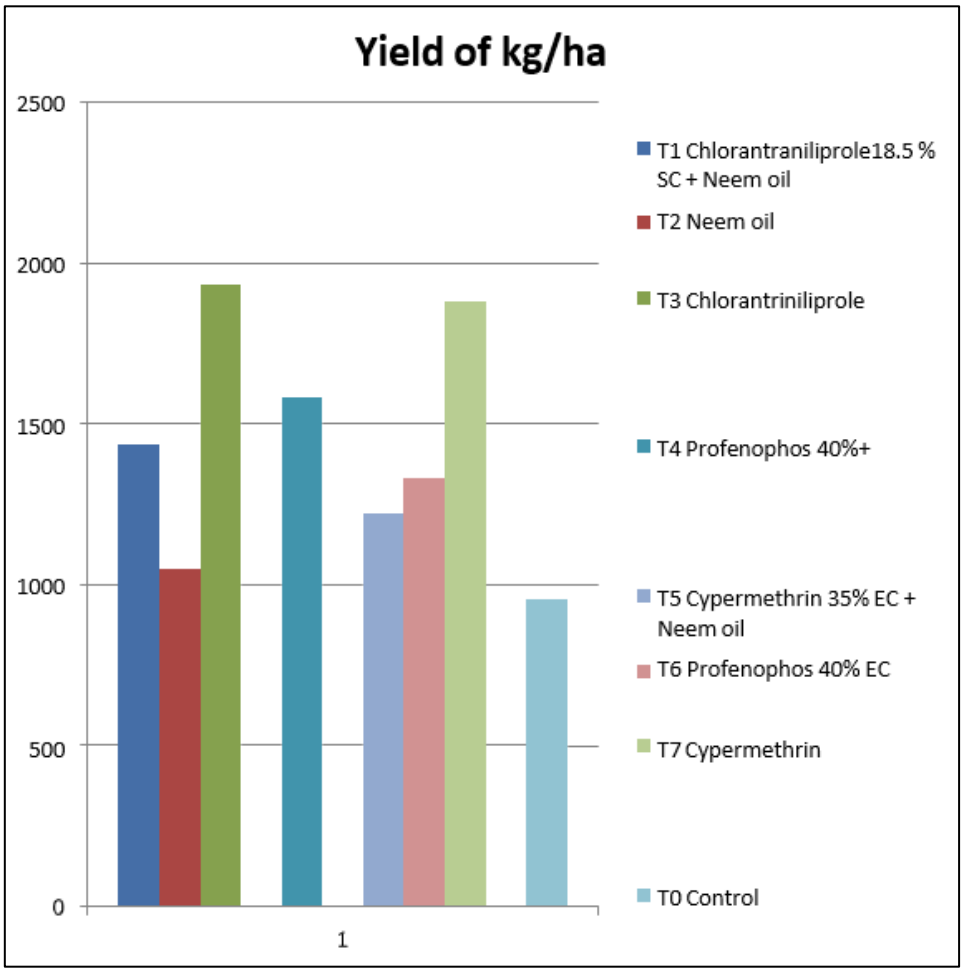

Fig 2: Field efficacy of selected insecticides with combination of neem oil against [*Helicoverpa armigera* (Hubner)] of Yield (kg/Ha)

Economics of various Treatments

The yields among the treatment were significant. The highest yield was recorded in T3- Chlorantraniliprole 18.5% SC (19.32 q/ha) followed by T7 Cypermethrin 4% EC (18.80 q/ha), T4 Profenophos 40% EC + Cypermethrin 4% EC (15.84 q/ha), T1 Chlorantraniliprole 18.5% SC + Neem oil q/ha), T6 Profenophos 40% EC (13.32 q/ha), T5 Cypermethrin 35% EC+ Neemoil (12.24 q/ha), T2 Neem oil 4ml/lit (10.50 q/ha) and T0 control (9.56 q/ha). When cost benefit ratio worked out, interesting result was achieved, among the treatment studied, the best and most economical treatment T3- Chlorantraniliprole 18.5% SC (1:3.42) followed by T7 Cypermethrin 4% EC (1:3.34), T4 Profenophos 40% EC + Cypermethrin 4% EC (1:2.71), T1 Chlorantraniliprole 18.5% SC + Neem oil (1:2.46), T5 Cypermethrin 35% EC+ Neem oil (1:2.04), T2 Neem oil 4ml/lit (1:1.87), and T6 Profenophos 40% EC (1:2.34).

The results are in close agreement with the inferred yield data by Chitralekha *et al.*, (2018) [2] who indicated that, chlorantraniliprole 18.5% SC was more effective against gram pod borers and with lowest mean larval population of *Helicoverpa armigera* with its novel properties that ultimately leads to increase in yield (7.60 q/ha) as against control (3.97 q/ha) and highest cost benefit ratio (1:1.72). The findings of Khorasiya SG *et al.*, (2014) [6] also support the results that highest grain yield was recorded in chlorantraniliprole treated plots (686.1 kg/ha) with 127.5 percent increase over control, followed by flubendiamide (595.8 kg/ha) and spinosad (589.0 kg/ha) with 97.6 and 95.3 percent increase over control respectively as against the minimum yield of 301.6 kg/ha in the untreated check. Similar studies by Babariya *et al.*, (2010) [1] indicated that Indoxacarb0.0075% recorded

Conclusion

Results showed that among all the treatments T3 Chlorantraniliprole 18.5% SC recorded lowest mean larval

population of gram pod borer *i.e.,* 0.81 which was significantly superior over control followed by T7 Cypermethrin 4% EC (1.02) and Neem oil was least effective treatment against gram pod borer with highest mean larval population 1.66 of *Helicoverpa armigera* due to theirmode of action compare to other selected Insecticides and Neem oil.

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