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Comparative efficacy of selected insecticides and neem products against chickpea pod borer [*Helicoverpa armigera* (Hubner)]

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Abstract
The current study was carried out at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, U.P. during the *Rabi* season of 2021-2022. Two applications of seven insecticides were used against *Helicoverpa armigera* (Hubner) and the results revealed that treatments T4-Chlorantraniliprole 18.5% SC is most effective treatment with lowest Mean larval population of gram pod borer with (1.42) followed by T6-Emamectin Benzoate 5% SG (1.64), T7-Flubendiamide 20WG (1.74), T3- Spinosad 45% SC (2.01), T1 NSKE 10% (2.1), T2 Neem oil (2.15), T5 Indoxacarb 0.05% (2.25) as compare to T0-control (Water spray) (3.45). Cost benefit ratio were found highest in T4 Chlorantraniliprole 48% SC (1:3.42) followed by T6 Emamectin Benzoate 5% SG (1:3.31), T7 Flubendiamide 20WG (1:2.90), T3 Spinosad 45% SC (1:2.56), T1 NSKE 10% (1:2.51), T2 Neem oil 4ml/lit (1:2.41), T5 Indoxacarb 0.05% SC (1:2.26) and control T0 (1:1.80).

Keywords: Benefit cost ratio, chick pea**,** efficacy, *Helicoverpa armigera*, pod borer

Introduction
Chickpea is a diploid (2n = 16). Highly autogenous crop, with natural cross pollination ranging between zero and one percent. Chickpeas are often divided into two major groupings via. Desi types (smaller angular seeds with sharp edges with variously pigmented flowers), are traditionally grown in warmer climates in South Asia and East Africa and Kabuli types (large round seeds, ram's head shape, white or pale cream or beige colored and flowers are non-pigmented) suited to the more temperate climates of West Asia. A third type, designated as intermediate, is characterized by small to medium size, pea-shaped and cream-colored seeds. This type is found more often in germplasm collections than in farmer's fields. Desi type accounts for 90% of world production, the remainder being Kabuli (Sarnaik and Chiranjeevi 2017) [15].

Pulses historically have been one of the most important constituents 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) [13]. During 2017-18, globally it was grown on 149.66 lakh ha area, with the total production of 162.25 lakh tonnes (FAOSTAT, 2019) [7] 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. *H. armigera* is the major damaging pest in areas where chickpea is grown. The present study is aimed at evaluating the efficacy of certain new insecticides against the pod borer in chickpea ecosystem. [*Helicoverpa armigera* (Hubner)] (Lepidoptera: Noctuidae) is a cosmopolitan, polyphagous and notorious pest which attacks numerous crops of agricultural importance and widely distributed in the tropics and sub-tropics. Its life cycle involves four major developmental stages (eggs, larvae, pupae and adult). The low yield of chickpea is attributed to the regular outbreaks of pod borer, *H. armigera* which is considered as one of the major pests of chickpea. It alone is responsible for losses over Rs 35, 000 million annually in India despite heavy pesticide inputs. The pod borers inflicted great crop losses from seedling to maturity.

But the losses reached at its peak when the pods appeared (Hossain *et al*., 2010) [9] reported that the seed yield losses due to *H. armigera* were 75-90% and in some places the losses were up to 100%.

Materials and Methods

The experimental trial was conducted at central research farm, SHUATS, Prayagraj, U.P. during *rabi* season of 2021-22. The experiment was laid down in randomized block design (RBD) with 3 replications and 8 treatments including control (water spray) are T_1- NSKE 10%, T_2- Neem Oil, T_3- Spinosad 45% SC, T_4-Chlorantraniprole E 48.5 SC, T_5- Indoxacarb 0.05% SC, T_6-Emamectin Benzoate 5% SG, T_7- Flubendiamide 20WG, T_0- Control using variety Pusa-362 in a plot size of (2m x 2m) at a spacing of (30x10 cm).

The pre-and post-treatment larval population counts from each plot was made from five randomly selected plants. The pre-treatment population will be 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.*

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.

Pod damage analysis

At 80 per cent maturity of the crop, both healthy and damaged pods was plucked from 5 randomly selected plants in each plot, and data is going to be recorded on per cent pod damage by green gram spotted pod borer.

Pod damage percentage was calculated using the following formula:

$$\text{Percent of Pod damage} = \frac{\text{Number of infected pods}}{\text{Total number of pods}} \times 100$$

(Kumar *et al*., 2014) [11]

Cost benefit ratio of treatments

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

Gross return = Marketable Yield x Market price

Net return = Gross return – Total cost

$$\text{BCR} = \frac{\text{Gross returns}}{\text{Total cost}}$$

(Verma *et al.*, 2020) [3]

Results and Discussion

The results of the experiment entitled "Efficacy of selected chemicals and neem products against Chickpea pod borer [*Helicoverpa armigera* (Hubner)]" to study cost benefit ratio during *Rabi* season of 2021.The data so obtained through observation on various aspects were subjected to statistical analysis wherever necessary and the complied mean data was tabulated in the following pages.

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 T4 Chlorantraniliprole 48% SC (1.63) followed by T6 Emamectin Benzoate 5%SG (1.86), T7 Flubendiamide 20WG (1.88), T3 Spinosad 45% SC (2.21), T2 Neem oil 4ml/lit (2.23), T1 NSKE 10% (2.25), T5 Indoxacarb 0.05%SC (2.35) was found to be least effective than all the treatments and is significantly superior over the control T_0 (3.01).

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 T4 Chlorantraniliprole 48% SC (1.21) followed by T6 Emamectin Benzoate 5% SG (1.41), T7 Flubendiamide 20WG (1.6), T3 Spinosad 45% SC (1.83), T1 NSKE 10% (1.93), T2 Neem oil 4ml/lit (2.03), T5 Indoxacarb 0.05% SC (2.13) was found to be least effective than all the treatments and is significantly superior over the control T0 (3.88).

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 (1.42), followed by Emamectin Benzoate 5% SG (1.64), Flubendiamide 20WG (1.74), Spinosad 45% SC (2.01), NSKE 10% (2.1), Neem oil (2.15). Among all the treatments Indoxcarb 0.05% SC was least effective treatment against gram pod borer with highest mean larval population 2.25 but comparatively superior over control (3.45).

All the insecticides were found very effective and significantly superior over control. The minimum larval population was recorded in T4 Chlorantraniliprole 48% SC with minimum percent of infestation of pod borer (1.42). These findings were similar to Chitralekha *et al*., 2018 [3] (1.37), followed by T6 Emamectin benzoate 5% SG with minimum percent of infestation of pod borer (1.64) as it was supported by Chaukikar *et al*., 2017 [2] (1.33), Sarnaik *et al*., 2017[15] (1.23), followed by T7 Flubendiamide 20WG with minimum percent of infestation of pod borer (1.74) as it was supported by Sreekanth *et al*., 2014 [16] (1.16), followed by T3 Spinosad 45% SC with minimum percent of infestation of pod borer (2.01) as it was supported by Jakhar *et al*., 2017 [10] (2.75), followed by T1 NSKE 10% with minimum percent of infestation of pod borer (2.1) as it was supported by Jakhar *et al.*, 2017 [10] (3.16), followed by T2 Neem oil 4ml/lit with minimum percent of infestation of pod borer (2.15) as it was supported by Chandra *et al.*, 2018 [8] (2.30), followed by T5 Indoxacarb 0.05% SC with minimum percent of infestation of pod borer (2.25) as it was supported by Yogeeswarudu *et al.*, 2014 [18] (1.53).

The highest grain yield was recorded in T4 Chlorantraniliprole 48% SC (21.38q/ha). These findings were similar to Chitralekha *et al*., 2018 [3] (1494.72 kg/ha), followed by T6 Emamectin Benzoate 5% SG (19.72q/ha) were similar with Chaukikar *et al*., 2017 [2] (22.60q/ha), followed by T7 Flubendiamide 20WG (18.33q/ha) as it was supported by Upadhyay *et al.*, 2020 [17] (16.44q/ha) followed by T3 Spinosad 45% SC (17.50q/ha) as it was supported by Deshmukh *et al*., 2010 [5] (17.60 q/ha), followed by T1 NSKE 10% (14.16q/ha) were similar with Bhushan *et al*., 2011 [1] (15.9q/ha), followed by T2 Neem oil 4ml/lit (13.61q/ha) as it was supported by Reza *et al*., 2016[14] (12.00q/ha), followed by T5 Indoxacarb 0.05% SC (12.77/ha) as it was similar with Dabhi *et al*., 2015 [4] (15.98q/ha) and minimum grain yield was recorded in control T_0 (9.72q/ha).

The higher benefit cost ratio was recorded in T4

Chlorantraniliprole 48% SC with (1:3.42) were similar to Sreekanth *et al*., 2014 [16] (1:4.64) followed by T6 Emamectin Benzoate 5% SG with BC ratio (1:3.31) were similar to Upadhyay *et al.,* 2020 [17] (1:2.63), followed by T7 Flubendiamide 20WG with BC ratio (1:2.90) as it was supported by Sreekanth *et al*., 2014 [16] (1:4.50) followed by T3 Spinosad 45% SC with BC ratio (1:2.56) as it was supported by Dodia *et al*., 2009 [6] (1:3.61) followed by T1 NSKE 10% with BC ratio (1:2.51) as it was supported by Bhushan *et al*., 2011 [1] (1:2.47) followed by T5 Indoxacarb 0.05% SC with BC ratio (1:2.26) as it was similar with Lavanya *et al*., 2022 [12] (1:3.07).

Table 1: Efficacy of combined insecticide on the incidence of *Helicoverpa armigera* Overall mean larval population of gram pod borer (first spray)

Mean population of *Helicoverpa armigera* / five plants						
S.no		**Before spraying**	**3DAS**	**7DAS**	**14DAS**	**Mean**
T1	NSKE 10%	2.86	2.4	1.66	2.13	2.26
T2	Neem Oil	2.53	2.53	1.8	2.2	2.26
T3	Spinosad 45% SC	2.93	2.26	1.53	2.06	2.2
T4	Chlorantraniprole E 48.5 SC	2.53	1.73	0.93	1.33	1.63
T5	Indoxacarb 0.05% SC	2.66	2.66	1.93	2.26	2.38
T6	Emamectin Benzoate 5% SG	2.8	1.93	1.13	1.6	1.86
T7	Flubendiamide 20WG	2.4	2.06	1.33	1.73	1.88
T0	Control	2.6	3	3.06	3.4	3.01
	SEm±	0.13	0.06	0.06	0.17	0.16
	CD or LSD	0.41	0.19	0.17	0.51	0.48
	Test of significance (p=0.05)	NS	S	S	S	S
	CV%	8.74	4.74	5.9	13.94	14.82

***DAS:** Day After Spray

Table 2: Efficacy of combined insecticide on the incidence of *Helicoverpa armigera* overall mean larval population of gram pod borer (second spray)

	Mean population of *Helicoverpa armigera*/ five plants					
S.no	**Treatments**	**Before spraying**	**3DAS**	**7DAS**	**14DAS**	**Mean**
T1	NSKE 10%	2.13	2.2	1.46	1.93	1.93
T2	Neem Oil	2.2	2.33	1.6	2	2.03
T3	Spinosad 45% SC	2.06	2.06	1.33	1.86	1.83
T4	Chlorantraniprole E 48.5 SC	1.33	1.53	0.73	1.26	1.21
T5	Indoxacarb 0.05% SC	2.26	2.46	1.73	2.06	2.13
T6	Emamectin Benzoate 5% SG	1.6	1.73	0.93	1.4	1.41
T7	Flubendiamide 20WG	1.73	1.93	1.13	1.6	1.6
T0	Control	3.4	3.8	4.13	4.2	3.88
	SEm±	0.17	0.06	0.11	0.18	0.11
	CD or LSD	0.51	0.20	0.33	0.56	0.33
	Test of significance (p=0.05)	S	S	S	S	S
	CV%	13.94	4.97	11.38	15.56	11.24

***DAS:** Day After Spray

Table 3: Efficacy of combined insecticide on the incidence of *Helicoverpa armigera* Overall mean larval population of gram pod borer (First and second spray).

	Treatments	**Over all mean population**		**mean**
		1st Spray	**2nd Spray**	
T1	NSKE 10%	2.26	1.93	2.1
T2	Neem Oil	2.26	2.03	2.15
T3	Spinosad 45% SC	2.2	1.83	2.01
T4	Chlorantraniprole E 48.5 SC	1.63	1.21	1.42
T5	Indoxacarb 0.05% SC	2.38	2.13	2.25
T6	Emamectin Benzoate 5% SG	1.86	1.41	1.64
T7	Flubendiamide 20WG	1.88	1.6	1.74
T0	Control	3.01	3.88	3.45
	SEm±	0.22		
	CD or LSD	0.72		
	Test of significance (p=0.05)	S		
	CV%	14.53		

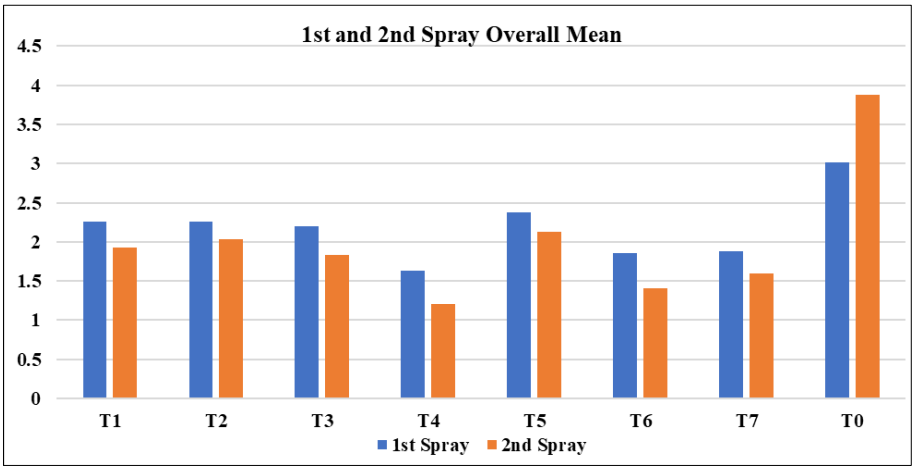

Fig 1: Efficacy of combined insecticide on the incidence of *Helicoverpa armigera* of Mean larval population (First and Second spray)

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/ (₹)	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total treatment cost	B:C ratio
T1	NSKE 10%	14.16	5500	77880	29550	1400	30950	1:2.51
T2	Neem Oil	13.61	5500	74855	29550	1400	30950	1:2.41
T3	Spinosad 45% SC	17.50	5500	96250	29550	7920	37470	1:2.56
T4	Chlorantraniliprole E 48.5 SC	21.38	5500	117590	29550	4802	34352	1:3.42
T5	Indoxacarb 0.05% SC	12.77	5500	70235	29550	1400	30950	1:2.26
T6	Emamectin Benzoate 5% SG	19.72	5500	108460	29550	3200	32750	1:3.31
T7	Flubendiamide 20WG	18.33	5500	100815	29550	5100	34650	1:2.90
T0	Control	9.72	5500	53460	29550	-	29550	1:1.80

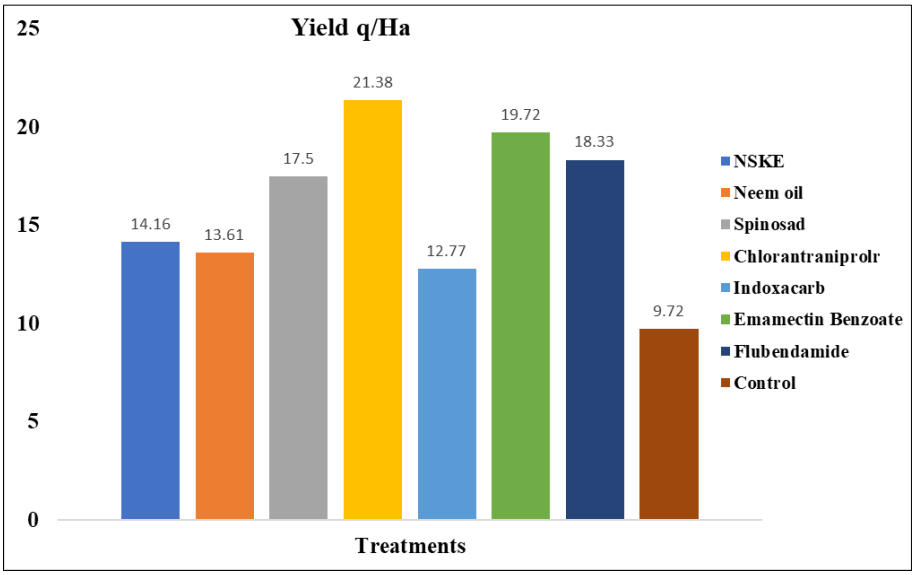

Fig 2: Efficacy of combined insecticide on the incidence of *Helicoverpa armigera* of Yield (q/Ha)

Conclusion

Results showed that among all the treatments T_4 Chlorantraniliprole 48% SC recorded lowest mean larval population of gram pod borer *i.e.,* 1.42 which was significantly superior over control followed by T6 Emamectin Benzoate 5% SG (1.64) and T5 Indoxacarb 0.05% SC was least effective treatment against gram pod borer with highest mean larval population 2.25 of *Helicoverpa armigera* due to their mode of action compare to other selected Insecticides and Neem products.

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