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Field evaluation of some novel insecticides against pod borer, *helicoverpa armigera* (hubner) in chickpea

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Abstract

A field experiment was conducted to determine the comparative efficacy of insecticides i.e. *Lambda Cyhalothrin 5 EC @ 500 ml/ha, Carbosulfan 25 EC @ 1000 ml/ha, Indoxacarb 14.5 SC @ 500 ml/ha, Bifenthrin 20 EC @ 500 ml/ha, Novaluron 10 EC @ 750 ml/ha, Flubendiamide 39.35 EC @ 75 ml/ha, Spinosad 45 SC @ 500 ml/ha and Cypermethrin 25 EC @ 1250 ml/ha Biopesticide* viz., B t *@ 1.5 kg/ha and Botanical* viz., *Neemarin 1500 ppm @ 3000 ml/ha, which were sprayed on chickpea variety Surya against pod borer,* Helicoverpa armigera *(Hubner) during* Rabi *2020-21 and 2021-22. The effect of these applications was also recorded on the yield attributes. All the treatments had the comparable lower number of larvae as well as pod infestation than un-treated control. Flubendiamide was best with lowest pod infestation of 10.73 and 12.59 per cent, respectively and 16.84 q/ha yield followed by Indoxacarb, Spinosad, Novaluron, Carbosulfan, Bifenthrin, Lambda Cyhalothrin, Cypermethrin, Neemarin and* Bt, *which gave 15.96, 15.11, 14.89, 14.16, 13.88, 13.23, 13.02, 12.21 and 11.49 q/ha yield respectively.*

Keywords: Efficacy, Novel insecticides, *Helicoverpa armigera*, Flubendiamide, Chickpea

Introduction

Chickpea (*Cicer arietinum)* is very important pulse crops of India. India is the largest producer with 75% of world acreage and production of gram. India produces 5.3 mt of chickpea from 6.67 mha with an average production of 844 kg/ha (www.iipr.res.in). Chickpea is cultivated for the seeds to be consumed as pulses. Pulses are important sources of protein for India's large and growing population. Among the biotic constraints, the losses caused by insect pests are a major limiting factor in realization of optimum yield of the chickpea crop. It is known to be ravaged by several insect pests during its various crop stages. Among the insect pests particularly pod borer, *Helicoverpa armigera* (Hubner) is one of the main constraints which limit the production of chickpea. The pod borer *H. armigera* appear during the flowering and pod stage which seriously damage the crop and is considered major limiting factor for the production of chickpea. The yield loss in chickpea due to pod borer was 10 – 60 per cent in normal weather conditions (Bhatt and Patel, 2001). Pesticides continue to be one of the most powerful tools available for the control of insect- pests and increasing crop yields. Presently, chemical control is the only practical method for a farmer to respond to an increasing pod borers' infestation. The use of conventional insecticides causes sudden decrease in the number of natural enemies also. Keeping in view the importance of chickpea crop, the present study was undertaken to test the relative efficacy of some novel insecticides, biopesticide and botanical with conventional insecticide against pod borer, *H. armigera* in chickpea crop.

Materials and Methods

The experiment was conducted at Research Block, Krishi Vigyan Kendra, Pilibhit of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110 (U.P.) for two consecutive years during *Rabi* 2020-21 and 2021-22. The experiment was laid in randomized block design (RBD), having 11 treatments (Lambda Cyhalothrin 5 EC @ 500 ml/ha, Carbosulfan 25 EC @ 1000 ml/ha, Indoxacarb 14.5 SC @ 500 ml/ha, Bifenthrin 20 EC @ 500 ml/ha, Novaluron 10 EC @ 750 ml/ha, Flubendiamide 39.35 EC @ 75 ml/ha, Spinosad 45 SC @ 500 ml/ha, *B t* @ 1.5 kg/ha, Neemarin 1500 ppm @

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2500 ml/ha, Cypermethrin 25 EC @ 1250 ml/ha and untreated (control) which were replicated thrice. The plot size was 4 × 2.5 m with a spacing of 30 × 10 cm. Normal fertilizers doses and recommended agronomical practices were adopted. All these insecticides and bio-pesticides were sprayed with knapsack sprayer twice. First spray was done at pod forming stage when 50 % of pods were formed and second spray at 15 days after the first spray. The count of pod borers' larvae and infested pods was taken one day before spraying and three and nine days after first and second spray, from ten randomly selected plants in each plot. The percentage of pod damage was worked out by the following formula:

$$\text{Pod/seed damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number pods}} \times 100$$

The pods were counted one day before and three and nine days after the application of treatments. The seed yield was recorded at harvest and converted into q/ha. The data were statistically analyzed as suggested by Panse and Sukhatme (1985).

Results and Discussions

All the treatments were significantly effective in reducing the number of pod borer's larvae as compared to the control (Table 1). In treated plots, the pod borers' larval population ranged from 0.83 to 14.17 as against 16.67 per ten plants in control, nine days after second spray. Indoxacarb 14.5 SC @ 0.5 lit. / ha was found most effective against pod borer in minimizing the number and was followed by Carbosulfan 25 EC @ 1000 ml /ha. > Lambda-Cyhalothrin 5 EC @ 500 ml/ha > Novaluron 10 EC @ 750 ml/ha > Bifenthrin 20 EC @ 500 ml/ha > Spinosad 45 SC @ 500 ml/ha > Flubendiamide 39.35 SC @ 75 ml/ha > Cypermethrin 25 EC @ 1250 ml/ha in the decreasing order, nine days after second spray. The bio-pesticidal treatments of Neemarin recorded 8.00 while *B. thuringiensis* 14.17 larvae per ten plants. The highest larval population of 16.67 larvae per ten plants was recorded with untreated control. It was evident that chemical insecticides including bio-pesticides suppressed the population of pod borer. The insecticide Indoxacarb has been observed to be very effective against pod borers, *H. armigera* and *E. zinckenella* (Gehan and Abdalla, 2006) which corroborates present finding. Further, Murray *et al*. (2005) reported that this chemical provided very good control of *H.armigera* in cereal crops, while Singh *et al*. (2010) obtained the similar result against *H. armigera* in black gram. Hakim Ali Sahito *et al*. (2012) reported Spinosad and Bifenthrin to be effective in reducing the number of larvae in chickpea crop and this is also corroborative with the present study.

As far as the per cent infested pods are concerned, it was found to be minimal with Flubendiamide closely followed by Indoxacarb during both the years as clearly shown by pooled data of two years (Table 2). The most effective treatment was Flubendiamide in which minimum per cent infestation of pods was recorded 11.09 and 10.73 three and nine days after second spray, respectively. The next best

Table 1: Pooled effect of different treatments on larval population of *H. armigera* on chickpea

Treatments	Dose/ha	Number of larvae/10 plants					
		First Spray			Second Spray		
		Before Spray	3 DAS	9 DAS	Before Spray	3 DAS	9 DAS
T_1 Lambda cyhalothrin 5 EC	500 ml	13.33 (3.78)	2.83 (1.90)	2.33 (1.80)	11.33 (3.51)	2.17 (1.77)	1.50 (1.58)
T_2 Carbosulfan 25 EC	1000 ml	13.67 (3.83)	2.67 (1.87)	2.00 (1.68)	11.67 (3.55)	2.17 (1.73)	1.00 (1.41)
T_3 Indoxacarb 14.5 SC	500 ml	14.00 (3.87)	2.50 (1.86)	1.83 (1.67)	10.67 (3.41)	1.83 (1.65)	0.83 (1.32)
T_4 Bifenthrin 20 EC	500 ml	13.67 (3.83)	3.17 (2.00)	1.83 (1.62)	10.33 (3.36)	2.67 (1.87)	1.83 (1.68)
T_5 Novaluron 10 EC	750 ml	13.83 (3.85)	4.17 (2.27)	3.33 (2.07)	10.00 (3.31)	2.67 (1.91)	1.67 (1.61)
T_6 Flubendiamide 39.35 EC	75 ml	14.00 (3.87)	6.00 (2.64)	4.67 (2.38)	9.67 (3.26)	4.17 (2.27)	2.17 (1.74)
T_7 Spinosad 45 SC	500 ml	13.33 (3.78)	5.17 (2.47)	3.67 (2.16)	10.33 (3.25)	3.17 (2.04)	1.83 (1.68)
T_8 *Bacillus thuringiensis*	1500 g	14.00 (3.87)	12.67 (3.69)	13.50 (3.79)	11.33 (3.50)	13.83 (3.85)	14.17 (3.88)
T_9 Neemarin 1500 ppm	3000 ml	13.67 (3.83)	10.83 (3.43)	11.00 (3.45)	12.00 (3.60)	10.50 (3.38)	8.00 (2.99)
T_{10} Cypermethrin 25 EC	1250 ml	12.67 (3.69)	6.33 (2.71)	5.00 (2.44)	13.00 (3.74)	4.33 (2.27)	4.83 (2.39)
T_{11} Untreated Control	-	12.83 (3.72)	14.83 (3.98)	16.00 (4.11)	16.33 (4.16)	17.50 (4.30)	16.67 (4.20)
SEm±		-	0.18	0.18	-	0.21	0.18
CD (0.05)		-	0.54	0.54	-	0.61	0.54

Data in parentheses are square root transformed values DAS = Day after spraying

Table 2: Pooled effect of different treatments on pod damage by *H. armigera* on chickpea

Treatments	Dose/ha	% damage of pods					
		First Spray			Second Spray		
		Before Spray	3 DAS	9 DAS	Before Spray	3 DAS	9 DAS
T_1 Lambda cyhalothrin 5 EC	500 ml	11.38	11.83	12.15	12.36	12.10	11.36
T_2 Carbosulfan 25 EC	1000 ml	10.64	11.37	11.73	12.12	11.48	11.09
T_3 Indoxacarb 14.5 SC	500 ml	10.70	11.17	11.28	11.89	11.18	10.77
T_4 Bifenthrin 20 EC	500 ml	10.95	11.40	11.78	12.34	11.97	11.12
T_5 Novaluron 10 EC	750 ml	10.81	11.78	12.04	12.46	11.48	10.92
T_6 Flubendiamide 39.35 EC	75 ml	11.63	10.95	11.84	12.14	11.09	10.73
T_7 Spinosad 45 SC	500 ml	11.03	11.08	11.69	12.67	11.18	10.86
T_8 *Bacillus thuringiensis*	1500 g	10.54	13.10	16.57	17.89	19.31	21.28
T_9 Neemarin 1500 ppm	3000 ml	10.89	12.39	15.65	16.78	18.16	18.57
T_{10} Cypermethrin 25 EC	1250 ml	11.42	12.29	14.39	15.78	15.57	16.02
T_{11} Untreated Control	-	10.85	14.19	19.30	21.23	22.37	26.60
SEm±		-	0.44	0.63	-	0.60	0.85
CD (0.05)		-	1.31	1.88	-	1.77	2.53

Data in parentheses are angular transformed values DAS = Day after spraying

treatment in order were Indoxacarb, Spinosad, Novaluron, Carbosulfan, Bifenthrin, Lambda Cyhalothrin and Cypermethrin with pod infestation per cent of 11.18, 11.18, 11.48, 11.48, 11.97, 12.10 and 15.97 after three days and 10.77, 10.86, 10.92, 11.09, 11.12, 11.36 and 16.02 after nine days of second spray, respectively. All treatments were statistically at par with each other as well as with the best treatment. The less effective treatments were Neemarin and *B. thuringiensis* with 18.16 and 19.31 after three days while 18.57 and 21.28 per cent pod infestation nine days after second spray, respectively. The maximum per cent pod infestation of 22.37 and 26.07 three and nine days after second spray, respectively, were found with the untreated control.

These findings are in confirmation with Ebbinghaus *et al.* (2007) who also found that Flubendiamide shows excellent performance for the control of a broad range of Lepidopterous pests. Chitralekha *et al*. (2018) also reported the effectivity of Novaluron 10 EC in managing pod borer in chickpea. Ashok Kumar and Shivaraju (2009) reported that Flubendiamide was highly effective against pod borers of black gram, *H. armigera* and *E. zinckenella*. Nauen *et al*. (2007), Hirooka *et al*. (2007) and Latif *et al*. (2009) also reported the supremacy of Flubendiamide against Lepidopterous pests in their experiments.

All the treatments resulted higher seed yield and were proved significantly superior over untreated control during both the years (Table 3). The highest seed yield of 16.84 q/ha was harvested with Flubendiamide. The yield with Indoxacarb, Spinosad, Novaluron, Carbosulfan, Bifenthrin, Lambda Cyhalothrin, Cypermethrin, Neemarin and *Bt*, ranged from 15.96 to 11.49 q/ha. Untreated control recorded lowest pod yield of 10.54 q/ha. By working out the cost benefit ratio (Table 3), it was revealed that Flubendiamide ranked 1st with highest cost benefit ratio (1:13.73) and was followed by Indoxacarb, Carbosulfan, Bifenthrin, Lambda Cyhalothrin, Cypermethrin, Novaluron, Neemarin and Spinosad with 12.54, 11.62, 11.12, 10.60, 8.06, 7.17, 3.85 and 1.69 C: B ratio, respectively. The lowest C:B ratio (1:1.50) was observed under the treatment of *B. thuringiensis*. Ashok Kumar and Shivaraju (2009) reported that Indoxacarb is highly effective in control of *H. armigera* and gave high returns. Latif *et al*. (2009) reported that Flubendiamide treatment plots gave higher yield and controlled the damage against *L. orbonalis* on brinjal and Memon and Memon (2005) also reported that the application of Spinosad in lentil field gave high yield and returns as compared with other treatments. Rao *et al*. (2007) found Spinosad and Indoxacrb as effective and economical treatments in the term of C:B ratio. The results revealed that since the plots treated with Flubendiamide 39.35 EC had the lowest pod damage percentage and produced maximum seed yield than other treatments and it was followed by Indoxacarb 14.5 SC and Novaluron 10 EC, so all these can be recommended for the management of the pod borer in chickpea.

Table 3. Economics of different treatments against pod borer, *H. armigera* in chickpea on pooled yield

Treatments	Dose/ha	Yield (q/ha)	Increase in yield over control q/ha	Value of increase yield (Rs./ha)	Cost of treatment/ha	Net profit (Rs./ha)	Cost benefit ratio
T_1 Lambda cyhalothrin 5EC	500 ml	13.23	2.69	14795.00	3733.00	14010.00	10.60
T_2 Carbosulfan 25 EC	1000 ml	14.16	3.62	19910.00	4038.00	17890.00	11.62
T_3 Indoxacarb 14.5 SC	500 ml	15.96	5.42	29810.00	4808.00	25220.00	12.54
T_4 Bifenthrin 20 EC	500 ml	13.88	3.34	18370.00	3879.00	16789.00	11.12
T_5 Novaluron 10 EC	750 ml	14.89	4.35	23925.00	5987.00	19226.00	7.17
T_6 Flubendiamide 39.35 EC	75 ml	16.84	6.30	34650.00	4783.00	29205.00	13.73
T_7 Spinosad 45 SC	500 ml	15.11	4.57	25135.00	14758.00	11445.00	1.69
T_8 *Bacillus thuringiensis*	1500 g	11.49	0.95	5225.00	5878.00	4035.00	1.50
T_9 Neemarin 1500 ppm	3000 ml	12.21	1.67	9185.00	4258.00	8895.00	3.85
T_{10} Cypermethrin 25 EC	1250 ml	13.02	2.48	13640.00	3708.00	13090.00	8.06
T_{11} Untreated Control	-	10.54	-	-	-	-	-

* Labour charges - @ Rs. 250.00/day/labour
* Rental value of sprayer - @ Rs. 45.00/day.
* Market price of chickpea seeds - @ Rs. 5500.00/qt.

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