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Bio-efficacy of newer insecticides for the management of *Helicoverpa armigera* Hubner on pigeonpea

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Abstract
Bio-efficacy of newer insecticides were assessed against pod borer, *Helicoverpa armigera* Hubner on pigeonpea during *Kharif*, 2020. The results revealed that all the treatments were significantly superior in reducing the pest infestation. However, Chlorantraniliprole 18.5SC at 150 ml/ha caused significantly minimum larval population recorded the lowest flower, pod, and grain damage, and significantly found maximum grain yield. Indoxacarb 14.5 SC at 500 ml/ha and Flubendiamide 480 SC at 100 ml/ha were found to be the next best effective treatment. Whereas, Novaluran 10 EC at 500 ml/ha and Monocrotophos 36 SL 500 ml/ha (Farmer's practices) were observed least effective treatments against the pest. The yield increased varied from 22.85 to 90.81 percent. The highest (1:7:51) ICBR was also recorded Chlorantraniliprole 18.5 SC at 150 ml/ha followed by Indoxacarb 14.5 SC at 500 ml/ha (1:5.98), Spinosad 45 SC at 125 ml/ha (1:4.94) and Emamectin benzoate 5 SG at 125 gm/ha (1:4.55).

Keywords: *Cajanus cajan*, *Helicoverpa armigna*, newer insecticides, management

Introduction
Piegonpea, *Cajanus cajan* L. is the second most important grain legume crop of India after chickpea and providing high quality pulse protein. Regrettably, pigeonpea is attacked by several insect pest species and among which gram pod borer, *Helicoverpa armigera* Hubner is the serious and major constraints (Dialoke *et al.*, 2010) [5]. The larva feed on flowers and young pods (Chi *et al.*, 2003, Rekha and Mallapur, 2007) [4, 8] The young larvae found mainly on flowers, while the mature ones attack pods (Liao and Lin 2000) [7]. The third and fifth instars are capable of boring into pods and can consume the developing grains (Gopali *et al.*, 2010) [6]. They also cause more economic damage leading to very low yield levels of 5.0 to 8.0 q/ha as against the potential yield of 18 to 20 q/ha (Soni *et al.*, 2018) [10].
At present different pest control methods are adopted, insecticidal approaches is one of the most effective and quick methods in managing pod borers. However, none of them have shown promising results, may be due to development of resistance especially *H. armigera* to organophosphates and synthetic pyrethroids (Armas *et al.*, 2006) [12]. Hence, implementation of alternative options, such as new groups of insecticides which changes insect-plant-environment interaction with specific and novel mode of action is essential which will be an important factor in Integrated Pest Management Programme. Keeping this view, efficacy of newer insecticides was tested against *H. armigera* on pigeonpea.

Materials and Methods
Field experiments on the efficacy of newer insecticides against pod borer on pigeonpea were conducted at the farmer's field during *Kharif*, 2020. Pigeonpea variety Narendra Aarhar-1 was shown in plots, each measuring of 5.4 x 5.4 sqm 60 cm x 45 cm plant spacing on 08th July during year, 2020. The experiment was conducted in Randomized Block Design with four replications. There were eight treatments *viz.* Flubendiamide 480 SC @ 100 ml/ha, Emamectin benzoate 5 SG @ 125 gm/ha, Spinosad 45 SC @ 125 ml/ha, Indoxacarb 14.5 SC @ 500 ml/ha, Chlorantraniliprole 18.5 SC @ 150 ml/ha, Novaluron 10 EC @ 500 ml/ha, Monocrotophas 36 SL @ 500 ml/ha (Farmer's practice) and apart from untreated check for comparison. Each treatment was applied three times at an interval of 10 days by initiating first spray at peak flowering stage.
Evaluation was made by counting larval population of *H. armigera* at 5 and 10 day after each spray on five randomly selected plants. The observation on pod damage was recorded at the time of picking of green and mature pods by counting the total number of pods and number of damaged pods on 5 plants selected randomly. Percent pod damage was calculated. Similarly,

the observation on flowers damage was recorded by counting the total number of flower and number of damaged flower in each replication at 10 days after the spray. The percent infestation of grains by the pod borers was determined by weighing the healthy and damaged grains at the time of harvesting from five plants.

Symptoms of phyto-toxicity *viz* red spots on the leaves and leaf margin damage was recorded 24 hrs before spraying. The intensity of phyto-toxicity was recorded 5 and 10 days after the application of each spray using 1 to 10 score.

The mature pods were picked, threshed and weighed separately replication wise. The yield per hectare was computed for each treatment. The economic efficacy of different insecticides was analysed based on the net return and Cost: benefit ratio. Due to fluctuation of market prices throughout the season, the average price of pulse grain yield was fixed at Rs. 6,000/quintal.

Results and Discussion

Efficacy of newer insecticides for the management of *H. armigera* revealed that all the treatments were significantly superior to untreated check. The larval population ranged from 0.43 to 3.84 per five plant. The mean larval population count for five plant after 10 days interval of two spray revealed that minimum larval population (0.43 larvae per five plant) was observed in the plot treated with Chlorantraniliprole 18.5 SC @100 ml/ha.which was significantly superior overall other treatment (Table-1). The treatment with Indoxacarb 14.5 SC @ 500 ml/ha gave the second lowest mean larval count (0.88) which was at par with that of 0.95 in treatment schedule of Flubendiamide 480 SC @ 100 ml/ha. Above findings are in accordance to Amita *et al.* (2011) [13]. Who reported that Flubendiamide 480 SC at 50, 75 and 100 ml/ha along with Indoxacarb 14.5 SC at 500 ml/ha and Spinosad 45 SC at 187.5 ml/ha against *H. aremigera* in pigeonpea was most effective in reducing the larval population. These treatments were next in order of effective spraying of Emamectin benzoate 5 SG @125 gm/ha. Novaluron 10 EC @ 500 ml/ha (1.71) and Monocrotophos 36 SL @ 500 ml/ha (2.06) were also found effective against pod borer over untreated check of 3.84 (Table-1).

The lowest flower damage with a mean of 12.76 percent was recorded in case of two sprays of Chlorantraniliprole 18.5 SC @ 100 ml/ha. It was followed by Indoxacarb 14.5 SC @ 500 ml/ha and Flubendamide 480 SC @ l00 ml/ha and which recorded mean flower damage of 13.88 and 14.45 percent, respectively. Monocrotophos 36 SL @ 500 ml/ha was found maximum flower damage (23.25%) but significantly superior over untreated check (Table-1)

The lowest pod damage with mean of 15.16 and 13.27 percent was recorded in case of Chlorantraniliprole 18.5 SC @ 150 ml/ha during green pod and harvest stage, respectively. It was followed by Indoxacarb 14.5 SC @ 500 ml/ha (16.62 and 14.48%), Flubendiamide 480 SC @ 100 ml/ha (17.21 and 16.37%) and Spinosed 45 SC @ 125 ml/ha (18.55 and 17.84%), during green pod and harvest stage, respectively (Table-1).

The highest grain damage (13.92%) due to *H. armigera* were recorded from the treatment with Monocrotophos 36 SL @ 500 ml/ha followed by Novaluran 10 EC @ 500 ml/ha (12.16%) and Emamectin benzoate 5 SG@ 125gm/ha (11.24%) but significantly superior over untreated check (17.61%) However, Chlorantraniliprole 18.5 SC @ 100 ml/ha gave significantly lowest percent grain damage (6.35%) as compare to other three treatments *viz,* Indoxacarb 14.5 SC @ 500 ml/ha (8.96%), Flubendiamide 480 SC @ 100 ml/ha (9.49%) and Spinosed 45 SC @ 125 ml/ha (10.32%). However, other insecticidal schedules and recommended synthetic insecticide as Monocrotophos 36 SL @ 500 ml/ha (13.92%) were found less effective in checking pod and grain damage due to pod borer in comparison with new molecule of insecticides. These results are in conformity with the report of Ameta *et al.* (2011) [1].

The highest yield of 15.78 q/ha was recorded from Chlorantraniliprole 18.5 SC @ 100 ml/ha and which was significantly superior over other treatments (Table-1). The second highest yield was recorded from Indoxacarb 14.5 SC @ 500 ml/ha (14.25 q/ha) followed by Flubendiamide 480 SC @ 100 ml/ha, Spinosad 45 SC @ 125 ml/ha and Emamectin benzoate 5 SG @ 125 gm/ha with producing the yield of 14.16, 13.21 and 12.82 q/ha, respectively (Table.-1). These findings are in accordance with those of Sahoo and Senapathi (2000) [9], Suganthi *et al.* (2006) [11]. The percent increased yield was varies from 21.42 to 86.75 over untreated check (Table-2).

While judging the utility of any insecticides in pest management programme, it is not only evaluated by its relative potency against the target pest and the period for which its application provides protection to the crop, but the economics of treatments also remained a major consideration. Hence, the benefit cost ratio was also worked out in the present investigation. The data recoded that the Chlorantraniliprole 18.5 SC 150 ml/ha gave maximum cost benefit ratio of 12.13:1 (Table-2). Followed by Indoxacarb 14.5 SC @ 500 ml/ha, Flubendiamide 480 SC @ 100 ml/ha, Spinosed 45 SC @ 125 ml/ha and Emamectin Benzoate 5 SG @ 125 gm/ha, which resulted benefit cost ratio of 10.31:1, 10.16:1, 9.85:1 and 9.37:1, respectively. The minimum cost benefit ratio of 7.86:1 was found in Novaluron 10 EC @ 5 ml/ha followed by Monorotophos 36 SL @ 500 ml./ha (6.22:1).

Table 1: Bio-efficacy of newer insecticides against *Helicoverpa armigera* on pigeonpea.

Treatments	Dose ml/g/ha	*Mean larval population/ 5 plants	**Mean flower damage (%)	**Mean pod damage (%)		Grain damage (%)	Yield (q/ha)
				Green pod stage	Harvest stage		
Flubendiamide 480 SC	100 ml.	0.95 (1.20)	14.45 (22.38)	17.21 (24.50)	16.37 (23.89)	9.49 (17.95)	14.16
Emamectin benzoate 5 SG	125 ml.	1.69 (1.48)	17.82 (24.95)	20.16 (26.71)	18.73 (25.62)	11.24 (19.55)	12.82
Spinosad 45 SC	125 ml.	1.62 (1.46)	16.50 (23.97)	18.55 (25.48)	17.84 (24.95)	10.32 (18.78)	13.21
Indoxacarb 14.5 SC	500 ml.	0.88 (1.17)	13.87 (21.89)	16.62 (24.04)	14.48 (22.38)	8.96 (17.38)	14.25

Chlorantraniliprole 18.5 SC	150 ml.	0.43 (0.96)	12.76 (20.96)	15.16 (22.87)	13.27 (21.39)	6.35 (14.65)	15.78
Novluron 10 EC	500 ml.	1.71 (1.49)	18.47 (25.48)	21.46 (27.63)	20.25 (26.78)	12.16 (20.44)	11.52
Monocrotophos 36 SL (Farmer's practices)	500 ml.	2.06 (1.60)	23.25 (28.86)	27.18 (31.44)	25.39 (30.92)	13.92 (21.89)	10.26
Untreated Check (Control)	-	3.84 (2.08)	28.92 (32.52)	33.41 (35.30)	31.04 (33.83)	17.61 (24.83)	8.45
SEm (+)	-	0.508	0.914	0.773	1.271	1.062	1.084
CD (P = 0.05)	-	1.524	2.742	2.316	3.814	3.185	3.257

*Figures in parentheses are $\sqrt{X + 0.5}$ transformed values.
**Figures in parentheses are arc sin transformed values

Table 2: Field performance of newer insecticides against *Helicoverpa armigera* on pigeonpea

Treatments	Dost ml/g/ha	Yield (q/ha)	Percent increased yield over control	Cost of treatments (Rs/ha)	Gross ritun (Rs/ha)	Net return (Rs/ha)	BC ratio
Flubendiamide 480 SC	100 ml.	14.16	67.57	8365.00	84960.00	76595.00	10.16 : 1
Emamectin benzoate 5 SG	125 ml.	12.82	51.72	8206.00	76920.00	68714.00	9.37 : 1
Spinosad 45 SC	125 ml.	13.21	56.33	8044.00	79260.00	71216.00	9.85 : 1
Indoxacarb 14.5 SC	500 ml.	14.25	68.64	8292.00	85500.00	7708.00	10.31 : 1
Chlorantraniliprole 18.5 SC	150 ml.	15.78	86.75	7807.00	94680.00	86873.00	12.13 : 1
Novluron 10 EC	500 ml.	11.52	36.34	8790.00	69120.00	60330.00	7.86 : 1
Monocrotophos 36 SL (Farmer's practices)	500 ml.	10.26	21.42	9896.00	61560.00	51664.00	6.22 : 1
Untreated Check (Control)	-	8.45	-	-	-	-	-
SEm (+)	-	1.084	-	-	-	-	-
CD (P = 0.05)	-	3.257	-	-	-	-	-

*Calculation made on the basis of market price of pigeonpea yield @ Rs. 6000/quintal

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