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Efficacy of certain chemicals against gram pod borer [*Helicoverpa armigera* (Hubner)] on chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during *Rabi* season of 2015-2016 at the central research farm of Sam Higginbottom Institute of Agriculture, Technology and Sciences, Deemed-to-be-University, Allahabad to evaluate the efficacy of certain chemicals against Gram pod borer, *Helicoverpa armigera* (Hubner) on chickpea (*Cicer arietinum* L.) The occurrence of pod borer commenced from 6th standard week (February first week) with an average population of 0.42 larvae/plant. The pod borer population increased and gradually reached its peak level of 6.48 larvae/plant at 12th standard week (March last week) there after declined trend was observed as temperature increased. It was observed that the temperature between 30-37^{0}C favored the multiplication of gram pod borer. The per cent population reduction of gram pod borer *H. armigera* on third, seventh and fourteenth days after spraying revealed that all treatments are superior over control. Among the treatments rynaxypyr found superior over all the treatments followed by spinosad and indoxacarb after first and second sprays, respectively. Highest reduction in larval population (74.02%) was observed with rynaxypyr 20 SC @ 0.3 ml/lit. Minimum pod damage of 11.98% and highest yield of 2390 Kg/ha was registered in rynaxypyr. Highest cost benefit ratio (C:B) was recorded in indoxacarb (1:3.07) followed by spinosad (1:3.01), rynaxypyr (1:2.92), flubendamide (1:1.96), cypermethrin (1:2.85), lambda cyhalothrin(1:2.68) and chlorpyriphos (1:2.67).

Keywords: Chemicals, chickpea, *Helicoverpa armigera*, cost benefit ratio, pod damage, per cent population reduction

Introduction

Chickpea, *Cicer arietinum* (L.) family Leguminaceae (Fabaceae) is originated in South-eastern Turkey and spread to other parts of world. According to De Candolle, the fact that gram has a Sanskrit name "Chanaka" which indicates that the crop was under cultivation in India longer than in any other country in the world. It is adapted to relatively cooler climates. The largest area of adaptation is in the Indian sub-continent. In recent years its cultivation has spread to Australia. Gram commonly as chickpea or Bengal gram is the most important pulse crop of India. In India it is also known as 'King of pulses' 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 per ha. (www.iipr.res.in)

Chickpea is used for human consumption as well as for feeding to animals. Its seeds eaten as green vegetable, fried, roasted, as snack food and ground to obtain flour and dhal. (Pachundkar *et al.*, 2013) [7] On an average in 2013, it covers 10.91 million ha area with annual production is 8.28 million tones (FAOSTAT, 2013) and production of gram in India 2014-15 is 7.17 million tonnes Based on Agricultural statistics division, Directorate of Economics and Statistics (DES)

The gram pod borer, *Helicoverpa armigera* (Hubner) is a key pest of chickpea and causes serious yield loss in most places where ever chickpea is grown (Gowda *et al.*, 2007) [4] is reported to have developed resistance to many commonly used insecticides. (Hossain *et al.*, 2010) [5] The gram pod borer attacks over 200 crop species belonging to 45 families globally leading a yield loss tune to US $ 2 billion annually. In India the loss tune to 200 million US $ on pigeon pea and chickpea. (Rummana *et al*., 2010) [10].

Materials and Methods

The field trial was laid out at the university farm in randomized block design with eight treatments including an untreated control, each with three replications.

The “K-850” variety of chickpea was used and a healthy crop was raised by following all the recommended agronomical practices. The plot size was 2m x 2m and the spacing between rows and plants was maintained at 30 and 15 cm, respectively. Sprays were initiated on reaching 4-5 larvae per plant and pod damage by the borer and repeated three times during the crop season as and when the pod damage exceeded 10-20 percent. Spraying was done with the help of a knapsack sprayer.

Observations on larvae and pod damage by the borer were recorded daily on 5 randomly selected plants per plot during the vegetative stage of crop and later on number of damaged and total pods, from these data the percentage of pod damage was worked out and the data before subjecting to statistical analysis. The economics of the insecticidal treatments was also determined through cost benefit ratio analysis.

Seasonal incidence also observed in separate three plots of size 2m x 2m at different places within university farm. Observations were taken daily, to observe incidence of key pest of chickpea.

Preparation of insecticidal solution

The insecticidal spray solution of desired concentration as per treatment will be freshly prepared every time at the time of expermientation just before the start of spraying operations. The spray solution of desired concentration will be prepared by adopting the following formula-

$$V = \frac{C \times A}{a.\text{i}.\,\%}$$

Where

V = volume/ weight of commercial insecticide ml. or gm.
C = Concentration required.
A = Volume of solution to be prepared.
% a.i. = Percentage active ingredient

Pod damage analysis and percentage reduction in pod damage

Pod damage percentage will be calculated using the following formulae (Hussain, 2007):

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

$$\%\ \text{reduction in pod damage over control} = \frac{\text{Pod damage in control - pod damage in treatment}}{\text{Pod damage in control}} \times 100$$

Increase in yield over control

$$\%\ \text{increase in yield over control} = \frac{\text{Grain yield in treatment} - \text{Grain yield in control}}{\text{Grain yield in control}} \times 100$$

Cost benefit ratio

The value of C: B of different treatments will be calculated by following formula.

$$C : B = \frac{\text{Net returns}}{\text{Cost of treatment}}$$

Where,

C: B - Cost Benefit Ratio

Results and Discussion

The results presented in (Table.1) revealed that 3 days after first spray, rynaxypyr (0.3ml/lit.) was most effective showing maximum per cent larval population reduction 60.55, followed by spinosad (0.3ml/lit.) 56.67 and indoxacarb (0.5ml/lit.) 54.97, Plots treated with lambda cyhalothrin (2ml/lit) 52.98, cypermethrin (1ml/lit.) 32.03, chlorpyriphos (2ml/lit.) 31.80 and flubendiamide (0.5ml/lit.) 28.33 percent larval population reduction. Seven days after first spray, rynaxypyr (0.3ml/lit.) was the best treatment with 64.49% population reduction, followed by spinosad (0.3ml/lit.) 61.06 and indoxacarb (0.5ml/lit.) 51.21 cypermethrin (1ml/lit.) 48.14, chlorpyriphos (2ml/lit.) 40.21, lambda cyhalothrin (2ml/lit). 38.51 and flubendiamide (0.5ml/lit.) 33.33 percent larval population reduction.. Fourteen days after first spray also revealed, rynaxypyr was the best treatment with 69.82% larval population reduction, followed by spinosad 67.81, indoxacarb 53.09, cypermethrin 46.85, lambda cyhalothrin 42.13, chlorpyriphos 37.84 and flubendiamide 24.62 percent larval population reduction.

The results revealed 3 days after second spray, rynaxypyr (0.3 ml/lit.) was most effective showing maximum per cent larval population reduction 74.63, followed by spinosad (70.83%), indoxacarb (62.60%), cypermethrin (47.26%), chlorpyriphos (38.46%), lambda cyhalothrin (38.04%) and flubendiamide (33.01%). Seven days after second spray still rynaxypyr (0.3 ml/lit.) was best treatment with 83.08% population reduction, followed by spinosad (76.45%), indoxacarb (72.00%), cypermethrin (63.48%), chlorpyriphos (62.88%), lambda cyhalothrin (50.00%), and flubendiamide (44.40%). Fourteen days after second spray also revealed, rynaxypyr (0.3 ml/lit.) was best treatment with 91.54% population reduction, followed by spinosad (88.95%), cypermethrin (73.02%), indoxacarb (72.00%), chlorpyriphos (66.73%), flubendiamide (58.25%) and lambda cyhalothrin (50.00%).

The results revealed the mean of first spray, rynaxypyr was recorded highest reduction of pod borer population (64.95%) followed by spinosad (61.84%), indoxacarb (53.09%), lambda cyhalothrin (44.54%), cypermethrin (42.34%), chlorpyriphos (36.62%) and flubendiamide (28.76%). flubendiamide (28.76%) was least effective among all the treatments, mean of second spray, rynaxypyr was recorded highest reduction of pod borer population (83.08%) followed by spinosad (61.84%), indoxacarb (53.09%), lambda cyhalothrin (44.54%), cypermethrin (42.34%), chlorpyriphos (36.62%) and flubendiamide (28.76%). flubendiamide (28.76%) was least effective among all the treatments.

Two sprays revealed that rynaxypyr 20 SC@ 0.3ml/l was found to be more effective than other chemical insecticides. Rynaxypyr recorded the per cent larval population reduction by 74.02% followed by spinosad 45 SC@ 0.3ml/l, indoxacarb 15SC @ 0.5 ml/l, cypermethrin 25 EC@ 1ml/l, chlorpyriphos 20 EC@ 2ml/l, lambda cyhalothrin 5EC @ 2ml/l and flubendiamide 39.35 SC@ 0.5ml/l recorded the per cent pod damage reduction by, 70.29, 60.98, 51.80, 46.32, 45.27 and 36.99 per cent respectively. Flubendiamide recorded least effective among the treatments but significant and superior over control.

All the treatments were found to be significantly superior over control. Rynaxypyr was more effective in percentage reduction of larval population with 74.02% reduction over control. Adsure S, P and Mohite P, B (2014) [1] reported that rynaxypyr gave the highest percentage of reduction of larval population and its results are supported by Iqbal *et al*. (2014) [6] and spinosad was found to be next effective treatment

(69.97%) its results are supported by Venkateshalu *et al.* (2009) [14], and Tariq *et al.* (2005) [13].

The results pertaining to seasonal incidence of key pest of chickpea was as follows (Table. 2), The occurrence of chickpea pod borer, *H. armigera* commenced from 6th standard week (February first week) with an average 0.42 larvae/plant. The pod borer population increased and gradually reached peak level of 6.28 larvae/plant at 12th standard week (March last week). Thereafter, declined trend was observed. Reddy *et al.* (2009) [9] conducted to study the incidence of the pod borer in chickpea commenced from second week of February *i.e.* in the early part of 1st fortnight of February. The larval population started increasing and reached its maximum during 4th week of March. These findings are in close association with Pandey *et al.* (2012) [8] as well.

Finally the results pertaining to pod damage percentage, yield data and subsequent economic analysis (Table 3 & 4.) revealed that minimum pod damage of 11.98% and higher grain yield of 2390 kg/ha was obtained from rynaxypyr treated plots. Shivaleela *et al.* (2014) [11] reported maximum grain yield was recorded in rynaxypyr with minimum pod damage. Higher cost benefit ratio of 1:3.07 was obtained from indoxacarb treated plots. Singh S, S and Yadav S, K (2006) [12] reported that highest grain yield and cost benefit ratio was obtained in the treatment of indoxacarb and these results were supported by Deshmukh *et al.* (2010) [3] and Babariya *et al.* (2010) [2].

Table 1: Efficacy of certain chemicals against chickpea pod borer, *Helicoverpa armigera* (Hub.) during *Rabi* season 2015-16

Treatment	% reduction of larval population					% reduction of larval population							
	Pre- treat. (1st Spray)	DAS*				Pre- treat. (2nd Spray)	DAS*				DAS*		
		3	7	14	Mean		3	7	14	Mean	1st Spray Mean	2nd Spray Mean	Overall Mean
Chlorpyriphos 20EC	5.47	31.81	40.21	37.84	36.62	5.20	38.46	62.88	66.73	56.02	36.62	56.02	46.32
Cypermethrin 25EC	5.40	32.03	48.14	46.85	42.34	4.93	47.26	63.48	73.02	61.25	42.34	61.25	51.80
Lambda cyhalothrin 5% EC	5.53	52.98	38.51	42.13	44.54	4.80	38.04	50.00	50.00	46.01	44.54	46.01	45.27
Flubendiamide 39.35 SC	5.40	28.33	33.33	24.62	28.76	5.27	33.01	44.40	58.25	45.22	28.76	45.22	36.99
Indoxacarb15 SC	5.33	54.97	51.21	53.09	53.09	5.00	62.60	72.00	72.00	68.86	53.09	68.86	60.98
Spinosad 45 SC	5.47	56.67	61.06	67.81	61.84	4.80	70.83	76.45	88.95	78.75	61.84	78.75	70.29
Rynaxypyr 20SC	5.07	60.55	64.49	69.82	64.95	4.73	74.63	83.08	91.54	83.08	64.95	83.08	74.02
Control	5.53	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F-test	NS*	*S	S	S	S	NS	S	S	S	S	S	S	S
S.Ed (+)	0.28	0.18	0.92	0.96	0.98	0.28	0.23	0.41	0.53	0.70	0.98	0.70	0.64
C.D.(P= 0.05)	0.60	0.38	1.97	2.10	2.25	0.60	0.50	0.87	1.13	1.50	2.25	1.50	1.45

*DAS- days after spray, *NS- Non significant, *S – Significant

Table 2: Seasonal incidence of chickpea pod borer, *Helicoverpa armigera* (Hub.) and weather parameters during *Rabi* season, 2015-2016.

Standard Week	Date	No. of larvae/plant	Temperature		Humidity %		Rainfall	Wind Velocity	Sunshine hr/day
			Max.	Min.	Morning	Evening	(mm)		
45th	02-08 Nov.	0.00	33.94	20.08	90.71	55.42	0.00	0.56	8.28
46th	09-15 Nov.	0.00	32.40	19.34	90.85	60.42	0.00	0.50	8.40
47th	16-22 Nov.	0.00	33.77	17.51	90.85	52.71	0.00	0.60	8.17
48th	23-29 Nov.	0.00	31.51	10.94	91.14	53.14	0.00	0.56	8.31
49th	30-06 Dec.	0.00	30.34	17.28	90.85	58.57	0.48	0.87	7.77
50th	07-13 Dec.	0.00	26.20	15.20	94.00	62.42	0.00	0.78	5.00
51st	14-20 Dec.	0.00	24.80	08.78	92.00	62.57	0.00	0.95	7.45
52nd	21-27 Dec.	0.00	25.41	08.91	91.71	60.85	0.00	0.65	5.94
53rd	28-03 Jan.	0.00	24.62	09.28	92.85	58.00	0.00	1.08	5.88
1st	04-10 Jan.	0.00	27.05	09.88	90.57	58.85	0.00	0.92	7.40
2nd	11-17 Jan.	0.00	27.91	10.05	90.28	52.85	0.00	1.04	8.28
3th	18-24 Jan.	0.00	21.02	09.82	93.14	67.85	1.40	2.06	4.17
4th	25-31 Jan.	0.00	26.71	09.51	90.71	50.14	0.00	0.60	7.57
5th	01-07 Feb.	0.42	30.28	11.65	89.85	47.42	0.00	1.41	8.34
6th	08-14 Feb.	0.87	30.25	11.20	88.85	45.28	0.00	1.67	8.17
7th	15-21 Feb.	1.35	30.94	13.11	90.14	48.57	0.34	1.24	7.20
8th	22-28 Feb.	2.04	33.25	12.34	87.71	44.28	0.00	2.01	8.28
9th	29-06 Mar.	3.10	33.82	13.94	87.42	41.85	0.00	1.19	8.34
10th	07-13 Mar.	4.65	35.77	17.94	87.85	42.42	2.68	2.17	7.61
11th	14-20 Mar.	5.37	35.82	17.00	88.00	40.57	0.77	1.82	6.42
12th	21-27 Mar.	6.48	37.51	23.28	84.85	36.42	0.00	1.46	8.48
13th	28-03 Apr.	4.59	39.77	24.51	82.28	35.28	0.00	2.18	8.47
14th	04-10 Apr.	3.20	42.85	22.31	79.14	30.71	0.00	1.63	8.42
15th	11-17 Apr.	2.50	43.08	22.94	72.28	31.28	0.00	1.72	8.77
16th	18-24 Apr.	2.25	44.47	25.85	68.14	26.57	0.00	1.59	8.82
17th	25-30 Apr.	1.08	44.17	25.05	54.28	28.71	0.00	1.43	8.95
		r=	0.609	0.560	-0.313	-0.693	0.299	0.664	0.254
		t=	0.001	0.000	0.000	0.000	0.073	0.000	0.000
		F- test	S*	S	NS**	NS	S	S	S

*S - Significant
*NS- Non significant

Table 3: Efficacy certain chemicals on Pod damage and Yield of chickpea (*Cicer arietinum* L.)

Treatment No.	Treatments	Pod damage (%)	% Decrease in pod damage over UTC*	% Increase in yield over UTC*	Yield (Kg/ ha)
T_1	Chlorpyriphos 20EC	23.97	43.05	1745	51.28
T_2	Cypermethrin 25EC	21.14	49.77	1845	53.92
T_3	Lambda cyhalothrin 5% EC	24.48	41.83	1680	49.40
T_4	Flubendiamide 39.35 SC	30.86	26.68	1430	40.55
T_5	Indoxacarb15 SC	14.04	66.64	2035	58.23
T_6	Spinosad 45 SC	13.40	68.16	2150	60.46
T_7	Rynaxypyr 20SC	11.98	71.53	2390	64.43
T_0	Control	42.09		850	
	F-Test	S			
	S.Ed(+)	0.97			
	C.D.	2.07			

*UTC – untreated check

Table 4: Economics of chickpea pod borer management using certain chemicals.

Tr. No.	Treatment	Yield q/ha	Cost of yield Rs/q	Total cost of yield Rs.	Cost of cultivation Rs.	Treatment cost Rs.	Total cost Rs.	Net returns Rs.	C:B ratio*
T_1	Chlorpyriphos 20EC	17.45	4400	76780	20720	1600	22320	59,672	1:2.67
T_2	Cypermethrin 25EC	18.45	4400	81180	20720	1360	22080	63,020	1:2.85
T_3	Lambda cyhalothrin 5% EC	16.80	4400	73920	20720	1400	22120	59,326	1:2.68
T_4	Flubendiamide 39.35 SC	14.30	4400	62920	20720	4000	24720	48,670	1:1.96
T_5	Indoxacarb15 SC	20.35	4400	89540	20720	2050	22770	69,983	1:3.07
T_6	Spinosad 45 SC	21.50	4400	94600	20720	2400	23120	69,722	1:3.01
T_7	Rynaxypyr 20SC	23.90	4400	105160	20720	3000	23720	69,493	1:2.92
T_0	Control	8.50	4400	37400	20720	------	20720	16680	1:0.80

*C:B- cost benefit ratio

Conclusion

From the critical analysis of the present findings it can be concluded that chickpea pod borer population increased with increasing maximum temperature, minimum temperature, morning and evening relative humidity and decreased with increasing maximum temperature above 35°C, wind velocity and sunshine hours. Insecticides like rynaxypyr and spinosad can be suitably incorporated in pest management schedule against *Helicoverpa armigera* as an effective tool as their recommended field doses are very low, newer insecticide molecules, highly specific and effective.

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