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Evaluation of insecticides against *Helicoverpa armigera* Hubner in chickpea

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Abstract
The experiment was conducted at College Farm, College of Agriculture, Navsari Agricultural University, Bharuch-392 012 during *rabi*, 2021-22. Among all the insecticides significantly lowest population of *H. armigera* larvae was found in treatment of chlorantraniliprole 18.5 SC (0.31 larvae/plant) and it was at par with spinosad 45 SC (0.44 larvae/plant). Flubendiamide 39.35 SC (0.56 larvae/plant) was significantly at par with emamectin benzoate 5 WSG (0.63 larvae/plant) and indoxacarb 14.5 SC (0.67 larvae/plant). The significant minimum pod damage (8.49%), maximum chickpea seed yield (2202 kg ha^{-1}), maximum increased yield over control (78.29%) was recorded in the treatment of chlorantraniliprole 18.5 SC at 0.006%.

Keywords: Chickpea, *Helicoverpa armigera*, pod damage, yield

Introduction
Chickpea (*Cicer arietinum* Linnaeus) is one of the important crops grown in *rabi* season. Chickpea faces the attack of more than 60 insect-pests right from germination to maturity and also in storage [9]. The pest feeds voraciously from seedling stage to maturity and causes about 50 to 60 percent damage to the chickpea pods [7]. Out of them, gram pod borer, *Helicoverpa armigera* (Hubner) Hardwick (Lepidoptera: Noctuidae) is a cosmopolitan, polyphagous and notorious pest which attacks more than 182 plant species. It infests the crop during early stage and continues up to flowering, podding and till the crop maturity [1]. *H. armigera* is the major biotic constraint and is known to cause 10- 35 percent reduction in pod yield [10]. The low yield of chickpea is attributed to the regular outbreaks of *H. armigera* which is considered as one of the major pests of chickpea crop. The problem of this pest is magnified due to its direct attack on fruiting structures, voracious feeding habits, high mobility and fecundity, multivoltine nature, overlapping generations, nocturnal behaviour *etc*. [8].

Materials and Methods
The experiment was conducted at College Farm, College of Agriculture, Navsari Agricultural University, Bharuch-392 012 during *rabi*, 2021-22. The chickpea variety GJG 5 was sown during fourth week of October and raised by adopting all recommended agronomical practices. First spray of insecticides *viz*., emamectin benzoate 5 WSG at 0.002%, spinosad 45 SC at 0.009%, indoxacarb 14.5 SC at 0.01%, flubendiamide 39.35 SC at 0.0096%, chlorantraniliprole 18.5 SC at 0.006%, lamda cyhalothrin 5 EC at 0.005%, novaluron 10 EC at 0.01% was given at that time of appearance of pest. For recording observations, five plants were selected randomly from each net plot. Observations of *H. armigera* larvae were recorded from five selected plants. The observations were recorded prior to first spray as well as 3, 7, 10 and 14 days of each spray. Total and damaged pods were counted from five plants. The yield of chickpea was recorded plot wise. The plot wise yield obtained was converted to hectare basis. The percent increase in yield over control was calculated by using the following formula.

$$\text{Increase in yield over control (\%)} = \frac{\text{Yield in treatment - Yield in control}}{\text{Yield in control}} \text{X } 100$$

Results and Discussion

The periodical spray-wise data on *H. armigera* larval population before and after 3, 7, 10 and 14 days of application are presented in Table 1 and Table 2. The data on larval population were found non-significant before the first spray indicating homogenous distribution of all the treatments in field plot. The data on pooled over periods (Table 1) after first spray revealed that the significant lower population of *H. armigera* larvae was recorded in plots treated with chlorantraniliprole 18.5 SC (0.41 larvae/plant) and it was at par with spinosad 45 SC (0.58 larvae/plant). Flubendiamide 39.35 SC (0.69 larvae/plant) was at par with emamectin benzoate 5 WSG (0.75 larvae/plant) and indoxacarb 14.5 SC (0.80 larvae/plant). Novaluron 10 EC (1.00 larvae/plant) was at par with lamda cyhalothrin 5 EC (1.04 larvae/plant) which found less effective among all other treatments. The highest larval population was observed in control (2.04 larvae/plant).

Pooled over periods results (Table 2) of second spray revealed that the insecticide treatments found significantly superior over control. Significant lower population of *H. armigera* larvae was recorded in plots treated with chlorantraniliprole 18.5 SC (0.22 larvae/plant) and it was at par with spinosad 45 SC (0.31 larvae/plant). Flubendiamide 39.35 SC (0.44 larvae/plant) was at par with emamectin benzoate 5 WSG (0.51 larvae/plant), indoxacarb 14.5 SC (0.55 larvae/plant) and lamda cyhalothrin 5 EC (0.61 larvae/plant). Novaluron 10 EC (0.74 larvae/plant) was found least effective among all the treatments.

Pooled over two sprays result (Table 2) revealed that the significant lower population of *H. armigera* was recorded in plots treated with chlorantraniliprole 18.5 SC (0.31 larvae/plant) and it was at par with spinosad 45 SC (0.44 larvae/plant). The flubendiamide 39.35 SC (0.56 larvae/plant) was significantly at par with emamectin benzoate 5 WSG (0.63 larvae/plant) and indoxacarb 14.5 SC (0.67 larvae/plant). The lamda cyhalothrin 5 EC (0.81 larvae/plant) was significantly at par with novaluron 10 EC (0.87 larvae/plant) which was the least effective among all other treatments. The order of insecticides in their effectiveness based on *H. armigera* larval population per plant (given in bract after each insecticide) after first and second spray were Chlorantraniliprole 18.5 SC (0.31) < Spinosad 45 SC (0.44) < Flubendiamide 39.35 SC (0.56) < Emamectin Benzoate 5 WSG (0.63) < Indoxacarb 14.5 SC (0.67) < Lamda cyhalothrin 5 EC (0.81) < Novaluron 10 EC (0.87) < Control (1.97).

The significant minimum pod damage (8.49) was found in plot treated with chlorantraniliprole 18.5 SC at 0.006%. Significant maximum seed yield (2202 kg ha^{-1}) was recorded in plot treated with chlorantraniliprole 18.5 SC and it was remained at par with spinosad 45 SC (2113 kg ha^{-1}), flubendiamide 39.35 SC (1987 kg ha^{-1}), emamectin benzoate 5 WSG (1764 kg ha^{-1}) and indoxacarb 14.5 SC (1759 kg ha^{-1}). Maximum (78.29%) increased in yield over control was found in plot treated with chlorantraniliprole 18.5 SC which followed by spinosad 45 SC (71.09%), flubendiamide 39.35 SC (60.89%), emamectin benzoate 5 WSG (42.83%), indoxacarb 14.5 SC (42.42%), novaluron 10 EC (34.66%) and lamda cyhalothrin 5 SC (22.42%). The present finding was in more or less confirmation with various scientists at different time and places. [4] evaluated the efficacy of insecticides and biopesticides against *H. armigera* on chickpea variety GNG 1581 in which flubendiamide 480 SC @ 200 ml ha^{-1} was found most effective. [2] revealed that the application of emamectin benzoate 5 SG was found more effective against *H. armigera* in chickpea followed by lamda cyhalothrin 5 EC. [3] recorded the minimum larval population of *H. armigera* in chlorantraniliprole 18.5 SC. [6] recorded highest 76.17 percent reduction in the larval population of *H. armigera* on chickpea with minimum pod damage (18.64%) and produced 15.23 q ha^{-1} yield in treatment of spinosad 45 SC @ 0.01%. [11] revealed that chlorantraniliprole 18.5 SC 92 g a.i. ha^{-1} followed by flubendiamide 39.35 EC 49 g a.i. ha^{-1} and spinosad 45 SC 74 g a.i. ha^{-1} were found most effective in reducing *H. armigera* population and pod damage in chickpea and highest yield was recorded in the treatment chlorantraniliprole 18.5 SC 92 g a.i. ha^{-1} (17.33 q ha^{-1}). [5] revealed that among all the treatments, spinosad 45 SC was found best with the maximum percent reduction (78.23%) followed by chlorantraniliprole 18.5 SC (73.08%).

Table 1: Efficacy of insecticides against *H. armigera* on chickpea after first spray

Sr. No.	Treatments	Mean no. of *H. armigera* larvae per plant					
		Before spray	Days After Spray (DAS)				Pooled Over Periods
			3	7	10	14	
T_1	Emamectin benzoate 5 WSG at 0.002%	1.49(1.73)	1.16(0.86)	1.07(0.65)	1.05(0.59)	1.19(0.93)	1.12(0.75)
T_2	Spinosad 45 SC at 0.009%	1.51(1.78)	1.14(0.79)	0.98(0.45)	0.94(0.39)	1.10(0.72)	1.04(0.58)
T_3	Indoxacarb 14.5 SC at 0.01%	1.49(1.71)	1.22(1.00)	1.14(0.79)	1.07(0.65)	1.13(0.78)	1.14(0.80)
T_4	Flubendiamide 39.35 SC at 0.0096%	1.54(1.86)	1.17(0.87)	1.11(0.73)	1.01(0.53)	1.07(0.65)	1.09(0.69)
T_5	Chlorantraniliprole 18.5 SC at 0.006%	1.52(1.80)	1.05(0.59)	0.91(0.33)	0.86(0.25)	0.98(0.46)	0.95(0.41)
T_6	Lamda cyhalothrin 5 EC at 0.005%	1.53(1.85)	1.24(1.05)	1.22(1.00)	1.19(0.93)	1.30(1.19)	1.24(1.04)
T_7	Novaluron 10 EC at 0.01%	1.48(1.69)	1.27(1.12)	1.20(0.93)	1.17(0.87)	1.27(1.12)	1.23(1.00)
T_8	Control (Water spray)	1.53(1.85)	1.56(1.92)	1.60(2.05)	1.62(2.13)	1.60(2.06)	1.59(2.04)
S. Em. ±		0.08	0.07	0.06	0.06	0.07	0.03
S. Em. ± (P×T)		-	-	-	-	-	0.07
CD at 5%		NS	0.22	0.18	0.19	0.20	0.08
CD at 5% (P×T)		-	-	-	-	-	0.24
CV%		9.09	10.30	9.16	9.79	9.34	9.70

Note: Figure in parentheses are retransform value whereas, those outside are $\sqrt{X + 0.5}$ transformed values.

Table 2: Efficacy of insecticides against *H. armigera* on chickpea after second spray

Sr. No	Treatments	*Mean no. of *H. armigera* larvae per plant						**Percent pod damage	Yield (kg ha^{-1})	Increase in yield over control (%)
		Days After Spray				Pooled Over Periods	Pooled Over two sprays			
		3	7	10	14					
T_1	Emamectin benzoate 5 WSG at 0.002%	1.08(0.66)	1.01(0.53)	0.94(0.39)	0.98(0.46)	1.00(0.51)	1.06(0.63)	19.06(10.66)	1764	42.83
T_2	Spinosad 45 SC at 0.009%	0.94(0.39)	0.87(0.26)	0.83(0.19)	0.94(0.39)	0.90(0.31)	0.97(0.44)	17.94(9.49)	2113	71.09
T_3	Indoxacarb 14.5 SC at 0.01%	0.98(0.46)	0.94(0.39)	1.01(0.53)	1.17(0.87)	1.03(0.55)	1.08(0.67)	20.12(11.83)	1759	42.42
T_4	Flubendiamide 39.35 SC at 0.0096%	1.02(0.53)	0.98(0.45)	0.91(0.32)	0.98(0.46)	0.97(0.44)	1.03(0.56)	18.75(10.33)	1987	60.89
T_5	Chlorantraniliprole 18.5 SC at 0.006%	0.87(0.26)	0.83(0.19)	0.79(0.13)	0.87(0.26)	0.85(0.22)	0.90(0.31)	16.94(8.49)	2202	78.29
T_6	Lamda cyhalothrin 5 EC at 0.005%	1.13(0.79)	1.05(0.59)	0.98(0.46)	1.05(0.59)	1.05(0.61)	1.15(0.81)	21.27(13.16)	1512	22.42
T_7	Novaluron 10 EC at 0.01%	1.16(0.86)	1.11(0.73)	1.08(0.66)	1.10(0.72)	1.11(0.74)	1.17(0.87)	22.91(15.16)	1663	34.66
T_8	Control (Water spray)	1.58(2.00)	1.53(1.85)	1.54(1.86)	1.51(1.79)	1.54(1.87)	1.57(1.97)	25.10(18.00)	1235	-
S. Em. ±		0.05	0.06	0.06	0.05	0.03	0.02	1.13	148.91	-
S. Em. ± (P×T)		-	-	-	-	0.05	0.06	-	-	-
CD at 5%		0.19	0.19	0.17	0.17	0.08	0.06	3.30	451.67	-
CD at 5% (P×T)		-	-	-	-	0.21	0.23	-	-	-
CV%		9.80	10.23	9.80	9.13	8.98	9.40	9.49	14.49	-

Note: *Figure in parentheses are retransform value whereas, those outside are $\sqrt{X + 0.5}$ transformed values.

** Figures, those outside are arc shine transformed values.

Conclusion

Among different insecticides evaluated, more effective insecticide is chlorantraniliprole 18.5 SC at 0.006% and the next effective insecticide is spinosad 45 SC at 0.009% and flubendiamide 39.35 SC at 0.0096% against *H. armigera* in chickpea.

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