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# Efficacy of insecticides against *Helicoverpa armigera* on chickpea

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**Abstract**

Studies on the efficacy of insecticides against *H. armigera* were conducted under field conditions of Haryana. Eight different treatments including control *viz*, novaluron 10EC @ 375 ml/ha, chlorantraniliprole 18.5SC @ 135 ml/ha, quinalphos 25EC @ 1000 ml/ha, lambda-cyhalothrin 5EC @ 500 ml/ha, nimbecidine 300ppm, *Bacillus thuringiensis* var. *kurstaki* @ 750 g/ha and emamectin benzoate 5 SG @ 220 g/ha were applied at economic threshold of *H. armigera*, i.e. 1 l/mrl on chickpea. After first and second spray minimum mean larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (0.68 and 0.90 l/mrl) and it was statistically on par with novaluron 10 EC (0.97 and 0.90 l/mrl), whereas maximum mean larval population was in nimbecidine (1.57 and 1.83 l/mrl) and it was statistically on par with emamectin benzoate 5 SG (1.51 and 1.65 l/mrl). All the treatments were significantly better than control. Percent larval reduction over control was highest in chlorantraniliprole 18.5 SC (85.68 and 82.59), whereas it was lowest in nimbecidine (66.94 and 59.68) after first and second spray of insecticides. On the basis of pooled mean of both the years (2015-16 and 2016-17), minimum pod damage (20.23%) and highest yield (1494.72 kg/ha) was recorded in chlorantraniliprole 18.5 SC.

**Keywords:** Chickpea, efficacy, *H. armigera*, insecticides

## Introduction

Chickpea is an important pulse crop of India, known as king of pulses. It is the third most important pulse crop after dry bean and peas, produced in the world which is mostly grown under dry land condition with heavy and sandy soil. India is the major producing country for chickpea, contributing for over 75% of total production in the world. The majority of the world's chickpea is grown in South Asia, where India has the largest share in world's chickpea area (8.39 m ha) and production (7.06 mt), respectively (Anonymous, 2016). In Haryana, total area under chickpea cultivation was 42 thousand ha with total production of 26 thousand tonnes (Anonymous, 2016) and productivity 619 Kg /ha. The poor crop management, low doses of fertilizers, diseases and serious damage by insect pests are the main constrains for successful cultivation of the crop. The major insect pests attacking chickpea are pod borer *Helicoverpa armigera*, leaf feeding caterpillar *Spodoptera exigua* (Hubner), black cutworm *Agrotis ipsilon*, aphid *Aphis craccivora* and semilooper *Autographa nigrisigna*. *H. armigera* is the major damaging pest in areas where chickpea is grown. The attack of this pest begins right from vegetative stage and continue upto maturity. Young larvae of *H. armigera* feeds on leaflets, buds, flowers and pods of chickpea (Mandal and Roy, 2012) [6]. While the later instars make a more or less circular hole in the pods and insert its head and former portion of body into it and feed upon the developing grains. A single caterpillar of this insect can damage 25-40 pods (Sanap and Deshmukh, 1987) [8]. It causes on average 30-40% damage to pods that can increase upto 80-90% under favorable environmental conditions.

## Materials and Methods

A field experiment was conducted at Research Farm of the Pulses Section, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar. The trial was laid out during *rabi* 2015-16 and 2016-17 in randomized block design with seven treatments replicated thrice having a plot size of 12 sqm. The chickpea variety HC-1 was sown on 20$^{th}$ November 2015 & 2016 and all the normal agronomical practices were followed for the cultivation of the crop. Spraying was initiated at the ETL of *H. armigera* i.e. 1 larva/mrl. The larval population of *H. armigera* was recorded before spraying and 1, 3, 7, 10 and 14 days after spraying.

Spray was repeated after 15 days of first spray. At the time of maturity all the pods of 3 randomly selected plants were plucked and number of healthy & damaged pods were counted and percent pod damage were calculated.

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

**Yield:** Grain yield of each plot was recorded at harvest. The plants plucked for recording percent pod damage were also added to record the total yield/plot. It was converted as kg/ha and analyzed statistically. Data was analysed by using the software OPSTAT developed by CCS HAU Hisar.

## Results and Discussion

Larval population of *H. armigera*: Before spray, the larval population of *H. armigera* varied from 1.66 to 3.33 larvae/ mrl in different treatments. The variation in larval population in different treatments were found to be non-significant indicating uniform distribution of the pest population.

All the treatments had significant effect in minimizing population ranging from 0.11 to 2.33 larvae per meter row length after one day of the spray as compared to 3.44 in control (Table-1). Among all the treatments, chlorantraniliprole 18.5 SC was found most effective, resulted in minimum population (0.11 l/mrl) and it was statistically on par with novaluron 10 EC and (0.33 l/mrl) and quinalphos 25 EC (0.55 l/mrl). Maximum larval population was recorded in nimbecidine (2.33 l/mrl). At 3 DAS, all the treatments were significantly better in minimizing population, ranging from 0.22 to 1.33 larvae per meter row length as compared to control. Minimum larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (0.22 l/mrl) which was statistically on par with novaluron 10 EC (0.44 l/mrl) and quinalphos 25 EC (0.53 l/mrl). Maximum larval population was recorded in emamectin benzoate 5 SG (1.33 l/mrl) which statistically on par with nimbecidine (0.99 l/mrl), *Bt* var. *kurstaki* (0.77 l/mrl) and lambda-cyhalothrin 5 EC (0.65 l/mrl). Minimum larval population was recorded in chlorantraniliprole 18.5 SC (0.55 l/mrl) where it was significantly better over novaluron 10 EC (0.99 l/mrl) and quinalphos 25 EC (1.10 l/mrl) and these were significantly better over remaining treatments in 7 DAS. At 10 DAS, minimum larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (1.22 l/mrl) which was statistically on par with novaluron 10 EC (1.44 l/mrl) whereas maximum was on quinalphos than control. At 14 DAS, minimum larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (1.32 l/mrl) which was statistically on par with lambda-cyhalothrin 5 EC (1.44 l/mrl) and *Bt* var. *kurstaki*. Maximum larval population was recorded in emamectin benzoate 5 SG (2.10 l/mrl) which was statistically on par with quinalphos 25 EC (1.99 l/mrl). Minimum mean larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (0.68 l/mrl) which was statistically on par with novaluron 10 EC (0.97 l/mrl), whereas maximum mean larval population was in nimbecidine (1.57 l/mrl) which was statistically on par with emamectin benzoate 5 SG (1.51 l/mrl. Percent larval reduction over control was highest in chlorantraniliprole 18.5 SC (85.68), and lowest in nimbecidine (66.94). The second application of insecticides consisting of different treatments was done at 15 days interval. On the basis of the mean larval population of *H. armigera* 1, 3, 7, 10 and 14 days after spray of insecticides, minimum mean larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (0.79 l/mrl) and it was statistically on par with novaluron 10 EC (0.90 l/mrl), whereas maximum mean larval population was in nimbecidine (1.83 l/mrl) and it was statistically on par with emamectin benzoate 5 SG (1.65 l/mrl). All the treatments were better than control. Percent reduction over control was highest in chlorantraniliprole 18.5 SC (82.59) followed by novaluron 10 EC (80.17), whereas it was lowest in nimbecidine (59.69). Maximum larval population was observed in lambda-cyhalothrin 5 EC (2.66 l/mrl) Table 1.

**Table 1:** Efficacy of insecticides against *Helicoverpa armigera* on chickpea during the year 2015-16

| Treatments | | No. of larvae per meter row length | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st Spray | | | | | | | | 2nd Spray | | | | | | |
| | | BS | 1 DAS | 3 DAS | 7 DAS | 10 DAS | 14 DAS | Mean larval popn | Percent reduction over control | 1 DAS | 3 DAS | 7 DAS | 10 DAS | 14 DAS | Mean larval popn | Percent reduction over control |
| $T_1$ | Novaluron 10EC | 2.22 (1.79) | 0.33 (1.14) | 0.44 (1.19) | 0.99 (1.40) | 1.44 (1.56) | 1.66 (1.62) | 0.97 (1.39) | 79.57 | 0.33 (1.15) | 0.55 (1.24) | 0.88 (1.36) | 1.21 (1.48) | 1.55 (1.57) | 0.90 (1.37) | 80.17 |
| $T_2$ | Chlorantraniliprole 18.5SC | 2.11 (1.75) | 0.11 (1.05) | 0.22 (1.09) | 0.55 (1.21) | 1.22 (1.48) | 1.32 (1.50) | 0.68 (1.28) | 85.68 | 0.22 (1.10) | 0.44 (1.19) | 0.77 (1.32) | 1.10 (1.44) | 1.44 (1.54) | 0.79 (1.32) | 82.59 |
| $T_3$ | Quinalphos 25EC | 2.00 (1.71) | 0.55 (1.24) | 0.53 (1.24) | 1.10 (1.44) | 1.99 (1.72) | 1.99 (1.72) | 1.23 (1.47) | 74.10 | 0.77 (1.31) | 0.88 (1.35) | 1.21 (1.47) | 1.55 (1.59) | 1.88 (1.69) | 1.25 (1.49) | 72.46 |
| $T_4$ | Lambda cyhalothrin 5EC | 2.55 (1.88) | 0.77 (1.33) | 0.65 (1.28) | 0.97 (1.41) | 1.77 (1.66) | 1.44 (1.56) | 1.12 (1.44) | 76.42 | 0.44 (1.19) | 1.10 (1.43) | 1.44 (1.56) | 1.88 (1.69) | 2.19 (1.78) | 1.41 (1.53) | 68.94 |
| $T_5$ | *Bt* var. *kurstaki* | 1.66 (1.62) | 1.22 (1.48) | 0.77 (1.32) | 1.44 (1.56) | 1.88 (1.69) | 1.55 (1.59) | 1.37 (1.53) | 71.15 | 1.77 (1.66) | 0.77 (1.32) | 1.10 (1.43) | 1.44 (1.56) | 1.77 (1.65) | 1.37 (1.53) | 69.82 |
| $T_6$ | Nimbecidine 300ppm | 2.89 (1.96) | 2.33 (1.81) | 0.99 (1.40) | 1.21 (1.48) | 1.55 (1.58) | 1.77 (1.63) | 1.57 (1.59) | 66.94 | 1.21 (1.48) | 1.55 (1.59) | 1.88 (1.69) | 2.21 (1.79) | 2.33 (1.82) | 1.83 (1.67) | 59.69 |
| $T_7$ | Emamectin benzoate 5SG | 1.88 (1.69) | 1.00 (1.41) | 1.33 (1.51) | 1.44 (1.56) | 1.66 (1.63) | 2.10 (1.75) | 1.51 (1.57) | 68.21 | 1.10 (1.42) | 1.10 (1.43) | 1.55 (1.59) | 1.99 (1.72) | 2.55 (1.87) | 1.65 (1.62) | 63.65 |
| $T_8$ | Control | 3.33 (2.07) | 3.44 (2.10) | 3.70 (2.16) | 4.36 (2.31) | 5.14 (2.47) | 7.10 (2.84) | 4.75 (2.38) | | 5.44 (2.53) | 3.99 (2.23) | 4.32 (2.30) | 4.99 (2.44) | 3.99 (2.23) | 4.54 (2.35) | |
| CD(P=0.05) | | (N.S) | (0.20) | (0.24) | (0.26) | (0.25) | (0.36) | (0.15) | | (0.36) | (0.29) | (0.30) | (0.19) | (0.26) | (0.13) | |
| SEm± | | (0.10) | (0.06) | (0.08) | (0.08) | (0.08) | (0.12) | (0.05) | | (0.11) | (0.09) | (0.09) | (0.06) | (0.08) | (0.04) | |

*DAS: Days after spray, **BS: Before spray

Figures in parentheses are $\sqrt{(n+1)}$ transformed values

mrl- meter row lengh

On the basis of pooled mean of both years (2015-16 & 2016-17), non-significant difference in the larval population of *H. armigera* was observed before application of insecticides (Table-2). After taking the mean larval population of 1, 3, 7, 10 and 14 days after spray, minimum mean larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (0.92 l/mrl) which was statistically on par with novaluron 10 EC (1.24 l/mrl), whereas maximum mean larval population was in nimbecidine (1.68 l/mrl) which was statistically on par with remaining treatments. All the treatments were significantly better than control. Percent reduction over control was highest in chlorantraniliprole 18.5 SC (80.54) followed by novaluron 10 EC (74.25) and lowest in nimbecidine (64.48). During second application, after taking the mean larval population of 1, 3, 7, 10 and 14 days after spray, minimum mean larval population of *H. armigera* was recorded in chlorantraniliprole 18.5 SC (0.91 l/mrl) which was statistically on par with novaluron 10 EC (1.17 l/mrl), whereas maximum mean larval population was in nimbecidine (1.87 l/mrl)

**Table 2:** Efficacy of insecticides against *Helicoverpa armigera* on chickpea during the year 2015-16 and 2016-17 (Pooled Mean)

| Treatments | | No. of larvae per meter row length | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st Spray | | | | | | | | 2nd Spray | | | | | | |
| | | **BS** | **1 DAS** | **3 DAS** | **7 DAS** | **10 DAS** | **14 DAS** | **Mean larval pop$^n$** | **Percent reduction over control** | **1 DAS** | **3 DAS** | **7 DAS** | **10 DAS** | **14 DAS** | **Mean Larval pop$^n$** | **Percent reduction over control** |
| $T_1$ | Novaluron 10EC | 2.21 (1.79) | 0.66 (1.28) | 0.83 (1.34) | 1.16 (1.47) | 1.66 (1.63) | 1.88 (1.69) | 1.24 (1.48) | 74.25 | 0.55 (1.24) | 0.82 (1.34) | 1.16 (1.46) | 1.49 (1.57) | 1.82 (1.67) | 1.17 (1.46) | 75.87 |
| $T_2$ | Chlorantraniliprole 18.5SC | 2.10 (1.76) | 0.44 (1.19) | 0.55 (1.24) | 0.78 (1.33) | 1.41 (1.55) | 1.44 (1.56) | 0.92 (1.37) | 80.54 | 0.38 (1.17) | 0.55 (1.24) | 0.82 (1.34) | 1.16 (1.47) | 1.66 (1.62) | 0.91 (1.37) | 81.23 |
| $T_3$ | Quinalphos 25EC | 1.83 (1.66) | 0.88 (1.37) | 1.16 (1.47) | 1.55 (1.59) | 1.91 (1.70) | 1.88 (1.69) | 1.48 (1.56) | 68.71 | 1.10 (1.43) | 1.32 (1.52) | 1.55 (1.59) | 1.77 (1. 66) | 2.21 (1.79) | 1.59 (1.60) | 67.21 |
| $T_4$ | Lambda cyhalothrin 5EC | 2.55 (1.88) | 0.83 (1.35) | 0.83 (1.35) | 1.22 (1.48) | 2.00 (1.72) | 1.83 (1.68) | 1.34 (1.52) | 71.67 | 0.77 (1.32) | 1.27 (1.50) | 1.55 (1.59) | 2.05 (1.74) | 2.43 (1.85) | 1.61 (1.61) | 66.80 |
| $T_5$ | *Bt* var. *kurstaki* | 1.83 (1.67) | 1.16 (1.46) | 0.94 (1.39) | 1.61 (1.61) | 2.08 (1.75) | 1.94 (1.71) | 1.55 (1.59) | 67.23 | 1.32 (1.51) | 1.16 (1.47) | 1.60 (1.61) | 1.71 (1.64) | 2.05 (1.74) | 1.57 (1.60) | 67.62 |
| $T_6$ | Nimbecidine 300ppm | 2.61 (1.89) | 2.22 (1.79) | 1.22 (1.48) | 1.44 (1.56) | 1.83 (1.68) | 1.72 (1.63) | 1.68 (1.63) | 64.48 | 1.32 (1.52) | 1.66 (1.63) | 1.88 (1.69) | 2.10 (1.76) | 2.44 (1.85) | 1.87 (1.69) | 61.44 |
| $T_7$ | Emamectin benzoate 5 SG | 1.88 (1.69) | 1.11 (1.45) | 1.33 (1.52) | 1.77 (1.66) | 1.85 (1.68) | 2.27 (1.80) | 1.66 (1.62) | 64.90 | 1.15 (1.46) | 1.15 (1.46) | 1.77 (1.66) | 1.78 (1.67) | 2.32 (1.82) | 1.63 (1.62) | 66.39 |
| $T_8$ | Control | 2.99 (1.99) | 3.22 (2.05) | 3.57 (2.13) | 4.46 (2.33) | 5.10 (2.46) | 7.33 (2.88) | 4.73 (2.37) | | 4.99 (2.44) | 4.49 (2.34) | 4.82 (2.41) | 4.99 (2.44) | 4.98 (2.44) | 4.85 (2.42) | |
| CD(P=0.05) | | (N.S) | (0.15) | (0.15) | (0.18) | (0.12) | (0.21) | (0.14) | | (0.21) | (0.21) | (0.21) | (0.16) | (0.09) | (0.09) | |
| SEm± | | (0.10) | (0.05) | (0.05) | (0.06) | (0.04) | (0.07) | (0.04) | | (0.07) | (0.07) | (0.07) | (0.05) | (0.03) | (0.03) | |

Figures in parentheses are √(n+1) transformed values

*DAS: Days after spray, **BS: Before spray

Percent reduction over control was highest in chlorantraniliprole 18.5 SC (81.23) followed by novaluron 10 EC (75.87) whereas, it was lowest in nimbecidine (61.44). Looking into the efficacy pattern of the insecticides during both the years, it is observed that the treatments consisting of chlorantraniliprole 18.5 SC proved most effective in minimizing the larval population of *H. armigera* in chickpea variety HC-1.

However the results of this treatment were on par with novaluron 10 EC whereas nimbecidine was least effective in controlling the pest population. These results are in close proximity with Iqbal *et al*. (2014) [4] who reported that maximum mortality of gram pod borer was observed in profenofos (94%, 90% & 85%) and chlorantraniliprole (92%, 90% & 85%) at 7, 5 and 3 days after treatment (DAT), respectively. Sreekanth *et al*. (2014) [10] who reported that the number of larvae per plant were lowest in plots treated with chlorantraniliprole 20 SC (0.43), flubendiamide 480 SC (0.59) and spinosad 45 SC (0.85) as against untreated control plot (4.17). Patel *et al*. (2016) [7] who reported that chlorantraniliprole 35 WG @ 30 g a.i./ha reduced larval population of *H. armigera* as well as lowest percent of fruit damage compared to standard check.

**Percent pod damage and grain yield**

On the basis of pooled mean of both the years (2015-16 and 2016-17) pod damage ranged from 20.23 to 32.44% among the treatments and 58.69% in the control. Minimum pod damage was recorded in chlorantraniliprole 18.5 SC (20.23%).

**Table 3:** Effect of insecticides on pod damage by *Helicoverpa armigera* on chickpea during the year 2015-16 and 2016-17

| Treatments | | 2015-16 | | 2016-17 | | Pooled Mean | |
|---|---|---|---|---|---|---|---|
| | | **Pod damage (%)** | **Yield (kg/ha)** | **Pod damage (%)** | **Yield (kg/ha)** | **Pod damage (%)** | **Yield (kg/ha)** |
| $T_1$ | Novaluron 10EC | 24.30(29.50*) | 1558.16 | 28.35(32.15) | 1226.57 | 26.32(30.84) | 1392.37 |
| $T_2$ | Chlorantraniliprole 18.5SC | 19.25 (26.00) | 1627.66 | 21.22(27.41) | 1361.77 | 20.23(26.71) | 1494.72 |
| $T_3$ | Quinalphos 25EC | 26.29(30.83) | 1423.16 | 28.41(32.16) | 1205.44 | 27.35(31.51) | 1314.30 |
| $T_4$ | Lambda cyhalothrin 5EC | 30.55(33.53) | 1346.36 | 27.92(31.88) | 1142.24 | 29.23(32.71) | 1244.30 |
| $T_5$ | Nimbecidine 300ppm | 32.82(34.92) | 1326.33 | 32.06(34.47) | 1080.75 | 32.44(34.70) | 1203.50 |
| $T_6$ | *Bt* var. *kurstaki* | 32.40(34.67) | 1367.51 | 30.01(33.20) | 1055.40 | 31.20(33.94) | 1211.46 |
| $T_7$ | Emamectin benzoate 5 SG | 31.95(34.40) | 1384.33 | 29.30(32.76) | 1194.16 | 30.62(33.58) | 1289.25 |
| $T_8$ | Untreated | 55.67(48.23) | 890.16 | 61.72(51.78) | 852.22 | 58.69(49.99) | 871.19 |
| CD(P=0.05) | | (1.39) | 3.360 | (2.38) | 6.106 | (3.48) | 0.987 |
| SEm± | | (0.45) | 1.097 | (0.77) | 1.994 | (1.02) | 0.322 |

Maximum pod damage was in nimbecidine (32.44%) which was statistically on par with *Bt* var. *kurstaki* (31.20%) and emamectin benzoate 5 SG (30.62%). On the basis of pooled analysis of both the years 2015-16 and 2016-17, yield ranged from 871.19 to 1494.72 kg/ha. Maximum yield was recorded in the chlorantraniliprole 18.5 SC (1494.72 kg/ha) followed by novaluron 10 EC (1392.37). Minimum yield was recorded in nimbecidine (1203.50 kg/ha) followed by *Bt* var. *kurstaki* (1211.46 kg/ha) and lambda-cyhalothrin 5 EC (1244.30 kg/ha). The results are more or less similar with Singh and Verma (2006) [9] who reported that lower pod damage was recorded in novaluron (16.6%), emamectin benzoate (13.4%) and spinosad (10.3%) treatments in comparison to control (33.2%) respectively. Hosamani *et al.* (2013) [5] who reported that larval population, percent pod damage and grain yield was on par with all the three doses of chlorantraniliprole 20 SC (20, 25, 30g a.i./ha). Sreekanth *et al*. (2014) [10] who concluded that pod damage was maximum in untreated plot 10.22% and highest grain yield was recorded in plot treated with chlorantraniliprole (686.1 kg/ha), followed by flubendiamide (595.8 kg/ha) and spinosad (589.0 kg/ha).

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