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# Bio-efficacy of fruit extracts against gram pod borer *Helicoverpa armigera* (Hubner) in chickpea

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**Abstract**

Studies were conducted to evaluate the aqueous extracts of different plant fruits @5% *viz.* chinaberry, Karanj, Jatropha, Datura, golden shower, Babool and algaroba and indoxacarb 14.5 SC during *rabi* crop seasons 2016-17 and 2017-18 for their efficacy against *H. armigera* in chickpea. All the fruit extracts were found effective in reducing the larval population of target pest (3.17 to 5.06 larvae/plants). However, the least (1.95) and highest (11.78) larval population were recorded in insecticide and untreated control plots, respectively. Apart from reducing the *H. armigera* larval population plant leaf extracts were also proved safer to its natural enemy, *Campoletis chlorideae* (1.51 to 1.92 cocoons/10 plants) than insecticide, indoxacarb (0.42 cocoons/10 plants). Reduced larval populations of *H. armigera* in plots treated with leaf extracts were reflected in their resultant parallel action of significantly lower pod damage (14.75 to 22.34 %) than untreated control (38.70 %). Subsequently, the impact of reduced pod damage by *H. armigera* larvae was observed in a proportionate increase in grain yield of chickpea (9.21 to 12.29 q/ha), significantly higher than untreated control (5.51 q/ha).

**Keywords:** chickpea, *Helicoverpa armigera*, *Campoletis chlorideae*, fruit extracts and indoxacarb

## 1. Introduction

Chickpea (*Cicer arietinum* Linn. Leguminosae) is generally known as gram or Bengal gram is the most important pulse crop in India and also considered as 'King of pulses' [1]. The crop has multiple uses in rural as well as urban India. It is mostly consumed in the form of processed whole seed or dal or dal flour. Its fresh green seeds consumed as green vegetables and their green foliage with pods for feeding to animals also. Being a source of high quality protein, chickpea enriches the cereal-based diet of the people and improves their nutritional balance [2]. Globally, chickpea is grown over an area of 13.54 million hectares with a production of 13.10 million tonnes and productivity of 968 kg per hectare. India is the largest producer of gram with 75 per cent of world acreage and production. Even though, India occupies first position with respect to area and production, the productivity remained low due to biotic stresses of which the major limiting factor is *H. armigera* [3].

The gram pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is a polyphagous, prolific and wide spread pest known to feed on several economically important crops such as chickpea, pigeon pea, cotton, sorghum, groundnut, tomato and most of the vegetables [4]. The *H. armigera* is a key pest of chickpea and causes serious yield loss in most places where ever chickpea is grown and reported to have developed resistance to many commonly used insecticides [5]. The attack of this pest starts from vegetative stage and continue up to crop maturity. The yield loss in chickpea due to pod borer was 10 to 60 per cent in normal weather conditions [6] and during severe conditions up to the extent of 85 per cent [7] and 90 per cent [8].

Pest management in the developing countries like India is mainly depends on the use of chemical pesticides as they are the most reliable and economical but indiscriminate use of them resulted in a series of problems in the agro-ecosystem *viz.* resistance, resurgence and residue [9]. The *H. armigera* was reported to have developed resistance against organophosphates and carbamates in many countries of Asia [10]. Insecticide application for pod borer is also uneconomical under subsistence farming and largely beyond the means of resource poor farmers. The failure of modern tactics has compelled the scientific community to go back to the traditional and indigenous products for tackling the pest problem. Babu [11] and Wongphalung *et al.* [12] recorded the antifeedant activity of NSKE and chinaberry seed kernel against *Spodoptera litura* and that of *Jatropha curcus* seed extracts against second instar *H.*

*armigera* larvae, respectively. The fruit and seed extracts of *Cassia fistula* recorded the highest antifeedant activity of 94.30 per cent, moderate repellency of 6.30 per cent and least insecticidal property of 1.22 per cent against 4th instar larva of *H. armigera* [13]. Rajguru *et al*. [14] reported that *Datura stramonium* seed extract fortified with *Bacillus thuringiensis* recorded as high as 74.70 per cent mean larval mortality of second instar *S. litura*. Reena *et al.* [15] reported that the *Pongamia pinnata* mature seed extract @ 5.0% exhibited more than 50 per cent first instar larval mortality and more than 65 per cent third instar larval feeding deterrence in extract treated chickpea pods.

According to the literature searched so far, most of the studies related to bioassay studies under laboratory conditions. Keeping these points in mind, the present study was designed to evaluate the field efficacy of some plant's fruit extracts @5% against *H. armigera* in chickpea. The objectives of the study were to evaluate the bio-efficacy of fruit extracts against *H. armigera* and their effect on natural enemy *C. chlorideae*. To assess their impact on pod damage and grain yield of chickpea.

## 2. Material and Methods

The field experiments were conducted during *rabi* crop seasons in 2016-17 and 2017-18 at experimental farm NEBCRC, GBPUA&T Pantnagar. The chickpea variety PG-186 was sown with a spacing of 30x10 cm in 3x3= 9m$^2$ plots. Studies on efficacy of fruit extracts were consisted of total 9 treatments including one chemical insecticide indoxacarb 14.5 SC @ 75 ml a.i/ha and one untreated control allocated randomly to different plots each of three blocks. Treatments were consists of known botanical plants namely chinaberry (*Melia azadirachta*), Karanj (*Pongamia pinnata*), Jatropha (*Jatropha curcas*), datura (*Datura stramonium*), golden shower (*Cassia fistula*) and unexplored plants *viz.* babool (*Acacia nilotica*) and algaroba (*Acacia nilotica*).

### 2.1 Methodology for preparation aqueous fruit extracts

Fruits of selected plants were collected from the University campus of GBPUA&T, Pantnagar. The fruits of babool and algaroba were collected from Kattigehalli village, Davanagere, Karnataka. The collected fruits were brought to the laboratory and washed thoroughly in tap water to remove any surface contamination and allowed to dry in shade for few hours. The 100 g of shade dried fruits were soaked in 2 liter of water for 24 hours in plastic containers. When the soaked fruits imbibed enough water, they were removed from the container and crushed under stone to obtain the coarse pieces. Again these coarse pieces of fruit were grounded in an electric domestic grinder with the addition of water to make the paste. To prepare 5 per cent of fruit extracts 100 g of the ground paste was immersed in 2 liter of water**.** The solution was allowed for overnight and in the next day filtered and squeezed through muslin cloth to obtain a filtrate. The obtained filtrate was added with two pinches of detergent powder to serve as a sticker and a wetting agent. The resultant solutions were used as 5 per cent formulations for spraying on chickpea crop against *H. armigera* [16, 17].

### 2.2 Observations on the efficacy of plant extracts against *H. armigera* on chickpea

The prepared ready to spray formulations were sprayed twice on chickpea crop starting from the incidence (ETL) of the pest at fort nightly intervals during evening hours. Observations on the effect of fruit extracts on population of *H. armigera* were recorded at one day before, three, seven and fifteen days after treatment (DAT) imposition. Ten plants from each plot were randomly selected for recording larval counts. Similarly, to determine the effect of spraying these botanical formulations on natural enemy *C. chlorideae* the observations were recorded on its cocoon population after fifteen days of each spray by selecting ten plants randomly from each plot.

Pod damage at maturity of the crop was recorded from pods of 10 plants per plot at random in each plot. The pods without any external damage symptom and with big circular holes were considered as healthy and damaged pods, respectively. Per cent pod damage was calculated by using following formula.

$$\textbf{Per cent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

After harvesting chickpea plants were threshed and obtained grains were dried in open sunlight to stabilize the moisture content. The total yield per plot was then computed on quintal per hectare basis.

### 2.3 Statistical analysis

Data was analyzed for RBD analysis of variance after suitable transformations by using software STPR 3.00 version. The mean values were transformed to a square root with adding factor 0.5. The per cent values were analyzed by angular transformation.

## 3. Results and Discussion

The data pertaining to efficacy of plant fruit extracts on the larval population of *H. armigera,* cocoon population of natural enemy of target pest *i.e. C. chlorideae*, pod damage caused by larval feeding and grain yield of chickpea during the both *rabi* crop seasons 2016-17 and 2017-18 are presented in table-1 and table-2, respectively. The data on overall mean population of larvae after two sprays of both years showed that indoxacarb 14.5 SC (1.95 larvae/10 plants) registered with least larvae followed by fruit extracts chinaberry (3.17 larvae/10 plants), Jatropha (3.64 larvae/10 plants), Karanj (3.83 larvae/10 plants), golden shower (4.26 larvae/10 plants) and datura (4.31 larvae/10 plants). The observations revealed that after first spray, fruit extracts produced a significant effect on *H. armigera* by reducing its incidence to 2.06 to 2.84 after first spray, whereas the indoxacarb (1.50 larvae/10 plants) and untreated control (7.50 larvae/10 plants) plots recorded with lowest and highest overall mean larval population, respectively. After second spray, though the similar treatments proved their efficacy in reducing pest incidence as before, there was a significant increase in larval population (2.39 to 16.06 larvae/10 plants) observed irrespective of treatments including indoxacarb in comparison to only 1.50 to 7.50 larvae per ten plants recorded after first spray (Figure-1). This significant increase in pest incidence even after the second spray may be due to the slow mode of action by fruit extracts, availability of suitable pod maturation stage and favorable climate factors to pod borer larva *viz.* temperature, relative humidity and rainfall prevailed in the experimental region.

After first spray there was no significant differences observed between fruit extracts with respect to overall mean *C. chlorideae* with a range of 1.67 to 2.17 cocoons per ten plants, whereas indoxacarb (0.50 cocoons/10 plants) and untreated control (3.34 cocoons/10 plants) observed with lowest and higher natural enemy population, respectively. The natural enemy population varied accordingly to the availability of host larvae to parasitize and thus followed the trend of *H. armigera* larval population after spray (Figure-1). However, the variations observed between different treatments may be attributed to the varied availability of early instar host larvae to parasitize by *C. chlorideae* and also by possible direct effects of treatments on natural enemy. Similar trend was observed after second spray also with respect to natural enemy population in different treatments. However, there was an decrease in natural enemy population observed after second spray (0.34 to 1.67 cocoons/10 plants) except to untreated control in comparison to first spray (0.50 to 2.00 cocoons/10 plants) (Figure-1). These variations may be attributed to the possible direct and indirect effects of different treatments and prevailed climatic factors on *C. chlorideae*.

The data on pooled mean of both years revealed that indoxacarb registered with lowest of 11.38 per cent pod damage whereas untreated control found inferior with highest pod damage of 38.70 per cent (Table-3). However, the fruit extracts treatments such as, chinaberry (14.75%), Jatropha (16.19%), datura (18.77%), Karanj (18.80%), golden shower (19.19%), babool (19.27%) and algaroba (22.34%) though significantly inferior to indoxacarb but still found far superior from untreated control plots. Similarly, the indoxacarb recorded with maximum grain yield of 15.15 quintals per hectare and untreated control with minimum of 5.51 quintals per hectare. However, among the fruit extracts chinaberry (12.29 q/ha), Jatropha (11.77 q/ha), Karanj (10.95/ha), datura (10.85 q/ha), golden shower (10.68), babool (9.83 q/ha) and algaroba (9.21 q/ha) treatments were on par with each other and found significantly far superior to untreated control (Table-4).

Apart from reducing the *H. armigera* larval population, the fruit extract formulations were also proved safer to natural enemy, *C. chlorideae* (1.51 to 1.92 cocoons/10 plants) than insecticide, indoxacarb (0.42 cocoons/10 plants). Reduced larval populations of *H. armigera* in plots treated with fruit extracts were reflected in their resultant parallel action of significantly lower pod damage (14.75 to 22.34%) than untreated control (38.70%). Subsequently, the impact of reduced pod damage by *H. armigera* larvae was observed in proportionate increase in grain yield of chickpea (9.21 to 12.29 q/ha), significantly higher than untreated control (5.51 q/ha) (Figure-2). Therefore, it was found that fruit extracts recorded lower larval population, lower pod damage and higher grain yields of chickpea under field conditions.

The present results are supported by the following findings of different scientists. Sharma and Gupta [18] reported that aqueous extract of *Melia azedarach* (19.60%) showed higher mortality of *H. armigera* larvae than *Azadirachta indica* (18.5%). Similarly, ethanol seed extract of *M. azedarach* @ 5% (88.3%) provided maximum protection to the cabbage foliage from *H. armigera* than *A. indica* (82.5%). Nicolas *et al.* [19] recorded that a methanol extract of jatropha resulted in the significantly largest reduction of *H. armigera* under field conditions, with corresponding to 47.8 per cent, 61.38 per cent and 82.8 per cent for all three concentrations tested 125 ppm, 250 ppm and 500 ppm, respectively. Shah *et al.* [20] documented the minimum number of *H. armigera* larvae per tomato plant (0.40 and 0.46) in neem seed extract and emamectin benzoate followed by pongamia extract (1.25%) and maximum number of 1.00 larvae per plant was recorded in control. In field experiments by Chauhan *et al.* [21] significant results was obtained with the spray of neem leaf extract (2.5 to 10%) and *Acacia* extract (5.0%) concentration in comparison to control experiments. *Acacia* seed extract @5% resulted in a lower number of 0.34 larvae per ten plants and 1.00 per cent fruit damage against significantly higher 8.00 larvae per ten plants and 9.00 per cent fruit damage in the tomato crop.

## 4. Conclusion

The present field studies clearly revealed that the fruit extracts @5% such as chinaberry, jatropha, karanj, datura and golden shower were found to be effective against the larval population of *H. armigera* with less pod damage, higher grain yields, and with no any adverse effect on natural enemy population. However, the chemical insecticide indoxacarb 14.5 SC was proved significantly superior to best fruit extract treatments meanwhile it was also observed with negative effect on natural enemy of target pest *i.e. C. chlorideae*. Thus, it can be concluded that the aqueous fruit extracts @5% can easily be incorporated in an Integrated Pest management programme against *H. armigera* in chickpea crop as it is eco-friendly, cost effective easily available at farmers level.

## 5. Acknowledgment

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**Table 1:** Field efficacies of fruit extracts on larval population of *H. armigera* in chickpea during *Rabi* crop season 2016-17

| Treatments | Mean number of larvae/10 plants | | | | | | | | | Overall Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | After first spray | | | Mean | After second spray | | | Mean | |
| | 1 DBS | 3 DAS | 7 DAS | 14 DAS | | 3 DAS | 7 DAS | 14 DAS | | |
| Chinaberry @5% | 2.67 (1.78)* | 2.33 (1.35) | 1.33 (1.35) | 3.00 (1.87) | 2.22 | 2.67 (1.78) | 5.33 (2.41) | 4.33 (2.19) | 4.11 | 3.16 |
| Karanj @5% | 3.67 (2.04) | 2.33 (1.68) | 1.67 (1.47) | 3.00 (1.87) | 2.33 | 4.00 (2.50) | 6.00 (2.55) | 5.33 (2.41) | 5.11 | 3.72 |
| Jatropha @5% | 3.33 (1.96) | 2.33 (1.29) | 1.00 (1.23) | 3.33 (1.96) | 2.22 | 3.33 (1.96) | 6.33 (2.61) | 4.67 (2.27) | 4.78 | 3.50 |
| Datura @5% | 4.33 (2.19) | 1.67 (1.47) | 2.67 (1.78) | 3.67 (2.05) | 2.67 | 4.67 (2.27) | 6.67 (2.67) | 5.67 (2.48) | 5.67 | 4.17 |
| Golden shower @5% | 4.00 (2.50) | 1.67 (1.47) | 2.00 (1.58) | 4.00 (2.50) | 2.55 | 5.00 (2.35) | 4.67 (2.27) | 6.67 (2.68) | 5.45 | 4.00 |
| Babool @5% | 3.67 (2.04) | 1.67 (1.47) | 2.67 (1.78) | 4.33 (2.19) | 2.89 | 5.67 (2.48) | 5.00 (2.35) | 7.00 (2.74) | 5.89 | 4.39 |
| Algaroba @5% | 3.00 (1.87) | 2.67 (1.68) | 1.67 (1.47) | 5.00 (2.35) | 3.11 | 6.33 (2.61) | 7.67 (2.86) | 6.00 (2.48) | 6.67 | 4.89 |
| Indoxacarb 14.5 @ 75 ml a.i/ha | 3.67 (2.05) | 0.00 (0.05) | 1.00 (1.23) | 2.67 (1.78) | 1.22 | 0.67 (1.08) | 2.33 (1.68) | 3.00 (1.87) | 2.00 | 1.61 |
| Untreated control | 4.00 (2.12) | 6.33 (2.61) | 7.67 (2.85) | 9.00 (3.05) | 7.67 | 11.33 (3.43) | 14.33 (3.85) | 18.00 (4.30) | 14.55 | 11.11 |
| SEM± | 0.06 | 0.06 | 0.05 | 0.06 | | 0.06 | 0.06 | 0.108 | | |
| CD @5% | 0.018 | 0.018 | 0.016 | 0.019 | | 0.181 | 0.006 | 0.108 | | |
| CV | 0.307 | 0.417 | 0.276 | 0.182 | | 0.191 | 0.172 | 2.738 | | |

*Figures in the parentheses are square root transformation values with adding factor 0.5

DBS: Day Before Spraying, DAS: Days After Spraying

**Table 2:** Field efficacies of fruit extracts on larval population of *H. armigera* in chickpea during *Rabi* crop season 2017-18

| Treatments | Mean number of larvae/10 plants | | | | | | | | | Overall Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 DBS | After first spray 3 DAS | 7 DAS | 14 DAS | Mean | After second spray 3 DAS | 7 DAS | 14 DAS | Mean | |
| Chinaberry @5% | 3.00 (1.87)* | 2.67 (1.78) | 1.67 (1.47) | 4.33 (2.20) | 1.89 | 3.33 (1.95) | 4.67 (1.47) | 5.33 (2.41) | 4.44 | 3.33 |
| Karanj @5% | 4.33 (2.20) | 3.00 (1.87) | 2.00 (1.58) | 4.33 (2.20) | 2.11 | 4.33 (2.20) | 5.33 (2.41) | 7.67 (2.86) | 5.77 | 3.88 |
| Jatropha @5% | 4.00 (2.50) | 3.33 (1.95) | 2.33 (1.68) | 5.67 (2.48) | 2.44 | 4.67 (1.47) | 4.33 (2.20) | 6.33 (2.61) | 5.11 | 3.94 |
| Datura @5% | 4.00 (2.50) | 3.00 (1.87) | 2.67 (1.78) | 6.67 (2.67) | 2.45 | 5.67 (2.41) | 6.33 (2.61) | 7.33 (2.79) | 6.44 | 4.50 |
| Golden shower @5% | 3.67 (2.04) | 3.00 (1.87) | 2.33 (1.68) | 6.33 (2.61) | 2.22 | 5.00 (2.35) | 6.67 (2.67) | 8.67 (2.79) | 6.78 | 4.00 |
| Babool @5% | 4.33 (2.20) | 3.33 (1.95) | 2.33 (1.68) | 7.00 (2.74) | 2.55 | 6.00 (2.55) | 5.67 (2.48) | 9.67 (3.03) | 7.44 | 4.44 |
| Algaroba @5% | 5.33 (2.41) | 3.67 (2.04) | 2.33 (1.68) | 7.67 (2.86) | 2.56 | 7.33 (2.80) | 6.00 (2.55) | 10.33 (3.24) | 7.88 | 4.78 |
| Indoxacarb 14.5 @ 75 ml a.i/ha | 4.67 (2.27) | 0.67 (1.08) | 1.67 (1.47) | 3.00 (1.87) | 1.78 | 1.67 (1.47) | 2.67 (1.78) | 4.00 (2.50) | 2.78 | 2.28 |
| Untreated control | 3.00 (1.78) | 5.33 (2.41) | 8.00 (2.92) | 8.67 (3.03) | 7.33 | 14.67 (3.89) | 17.34. (4.23) | 20.67 (4.60) | 17.56 | 12.45 |
| SEM± | 0.006 | 0.006 | 0.006 | 0.005 | | 0.112 | 0.006 | 0.004 | | |
| CD @5% | 0.019 | 0.018 | 0.017 | 0.015 | | 0.336 | 0.017 | 0.011 | | |
| CV | 0.275 | 0.341 | 0.359 | 0.154 | | 3.185 | 0.146 | 0.089 | | |

**Table 3:** Effect of fruit extracts on mean population of *Campoletis chlorideae* in chickpea during *Rabi* crop seasons 2016-17 and 2017-18

| Treatments | Mean number of cocoons of *C. chlorideae*/10plants | | | | | | |
|---|---|---|---|---|---|---|---|
| | After 1st spray | | | After 2nd Spray | | | Overall Mean |
| | 2016-17 | 2017-18 | Mean | 2016-17 | 2017-18 | Mean | |
| Chinaberry @5% | 1.67 (1.47)* | 2.33 (1.68) | 2.00 | 1.00 (1.23) | 1.33 (1.35) | 1.17 | 1.59 |
| Karanj @5% | 1.33 (1.35) | 2.33 (1.68) | 1.83 | 1.00 (1.23) | 2.00 (1.58) | 1.50 | 1.67 |
| Jatropha @5% | 1.33 (1.35) | 2.00 (1.58) | 1.67 | 1.00 (1.23) | 1.67 (1.47) | 1.34 | 1.51 |
| Datura @5% | 1.67 (1.47) | 2.00 (1.58) | 1.84 | 1.33 (1.35) | 1.33 (1.35) | 1.33 | 1.59 |
| Golden shower @5% | 1.33 (1.35) | 2.33 (1.68) | 1.83 | 1.00 (1.23) | 1.67 (1.47) | 1.34 | 1.59 |
| Babool @5% | 1.67 (1.47) | 2.33 (1.68) | 2.00 | 1.00 (1.23) | 1.67 (1.47) | 1.34 | 1.67 |
| Algaroba @5% | 2.00 (1.58) | 2.33 (1.68) | 2.17 | 1.33 (1.35) | 2.00 (1.58) | 1.67 | 1.92 |
| Indoxacarb 14.5 SC @ 75 ml a.i/ha | 0.33 (0.09) | 0.67 (1.07) | 0.50 | 0.67 (1.07) | 0.00 (0.50) | 0.34 | 0.42 |
| Untreated control | 3.00 (1.87) | 3.67 (2.04) | 3.34 | 3.33 (1.95) | 4.67 (2.27) | 4.00 | 3.67 |
| SEM± | 0.006 | 0.007 | | 0.006 | 0.006 | | |
| CD @5% | 0.017 | 0.021 | | 0.017 | 0.018 | | |
| CV | 0..611 | 0.553 | | 0.783 | 0.558 | | |

**Table 4:** Efficacy of fruit extracts on pod damage and grain yield of chickpea during *Rabi* crop seasons 2016-17 and 2017-18

| Treatments | Per cent pod damage during crop seasons | | | Grain yield during crop seasons | | |
|---|---|---|---|---|---|---|
| | 2016-17 | 2017-18 | Overall mean | 2016-17 | 2017-18 | Overall mean |
| Chinaberry @5% | 14.16 (22.09)* | 15.33 (23.04) | 14.75 | 12.50 (3.61)** | 12.07 (3.54) | 12.29 |
| Karanj @5% | 17.78 (25.29) | 19.83 (26.43) | 18.80 | 11.00 (3.39) | 10.90 (3.38) | 10.95 |
| Jatropha @5% | 15.52 (24.78) | 16.86 (24.23) | 16.19 | 11.80 (3.51) | 11.74 (3.49) | 11.77 |
| Datura @5% | 17.26 (24.93) | 20.28 (26.76) | 18.77 | 11.37 (3.44) | 10.34 (3.29) | 10.85 |
| Golden shower @5% | 17.58 (24.54) | 20.79 (27.12) | 19.19 | 11.23 (3.42) | 10.13 (3.26) | 10.68 |
| Babool @5% | 18.26 (27.12) | 20.28 (26.76) | 19.27 | 10.13 (3.26) | 9.83 (3.21) | 9.83 |
| Algaroba @5% | 20.79 (12.76) | 23.89 (29.53) | 22.34 | 9.87 (3.22) | 8.54 (2.74) | 9.21 |
| Indoxacarb 14.5 SC @ 75 ml a.i/ha | 09.74 (18.19) | 13.02 (21.15) | 11.38 | 15.60 (4.01) | 14.70 (3.90) | 15.15 |
| Untreated control | 38.34 (38.25) | 39.05 (38.67) | 38.70 | 05.66 (2.48) | 05.35 (2.42) | 5.51 |
| SEM± | 1.037 | 1.123 | | 0.006 | 0.224 | |
| CD @5% | 3.109 | 2.992 | | 0.024 | 0.674 | |
| CV | 9.201 | 8.452 | | 0.091 | 3.626 | |

*Figures in parenthesis are angular transformed values

** Figures in parentheses are square root transformed values with adding factor 0.5

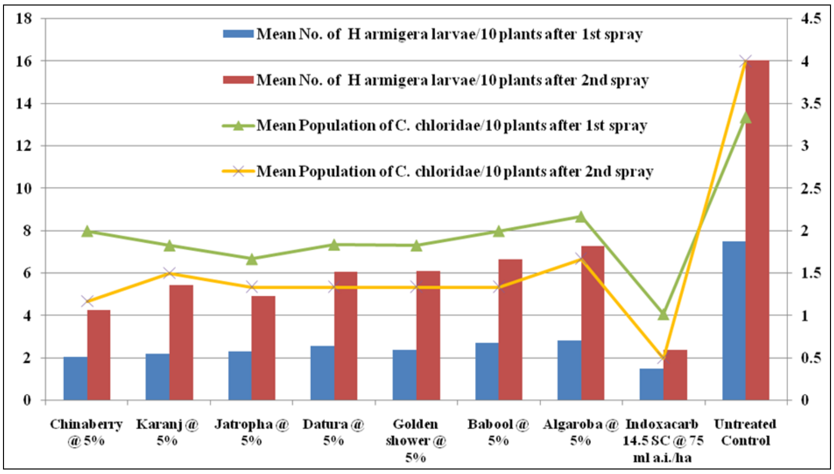


**Fig 1:** Effect of plant fruit extracts on the dynamics of *H. armigera* larval population and its natural enemy, *C. chlorideae* after first and second sprays in chickpea crop during *rabi* seasons, 2016-17 and 2017-18

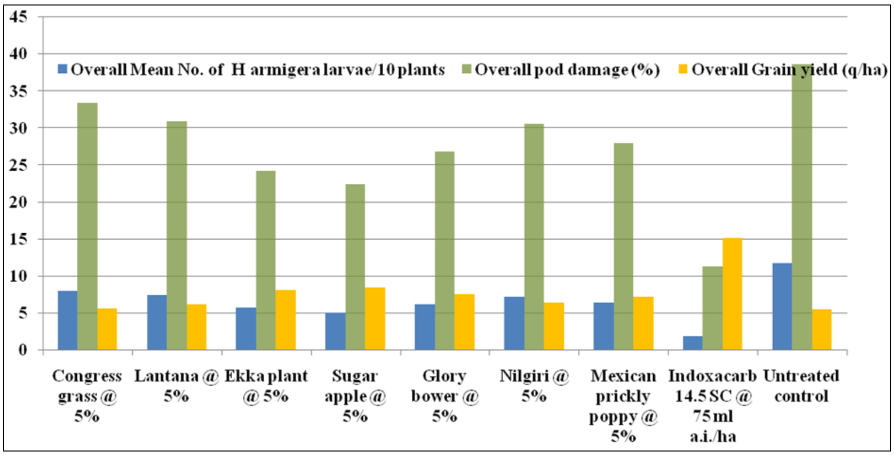


**Fig 2:** Relating the laboratory efficacy of plant fruit extracts (antifeedant activity and larval survival) to pooled field data on larval population *H. armigera*, pod damage and grain yield of chickpea (2016-18)

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