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Field Efficacy of Plant Leaf Extracts against *Helicoverpa armigera* (Hubner) on Chickpea at Pantnagar, Uttarakhand

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ABSTRACT

Field studies were conducted on the eco-friendly management of H. armigera by incorporating 5% aqueous extracts of some weeds and plants viz. congress grass, lantana, ekka plant, sugar apple, glory bower, nilgiri, mexican prickly poppy and a chemical insecticide indoxacarb 14.5 SC @ 75 ml a.i/ha during rabi crop seasons i.e. 2016-17 and 2017-18 in chickpea at NBCRC, Pantnagar, Uttarakhand. The plant extracts were found effective in reducing the larval population of target pest (5.11 to 8.03 larvae/10 plants) with the least (1.95) and highest (11.78) larval population was 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, C. chlorideae (1.58 to 2.33 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 (22.29 to 33.39 %) 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 (5.69 to 8.48q/ha), significantly higher than untreated control (5.51 q/ha).

Key words: *Chickpea, Helicoverpa armigera, Campoletis chlorideae, Plant extracts, Indoxacarb*

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 vegetable and their green foliage with pods for feeding to animals also. Fresh green seeds are also consumed as green vegetable. Being a source of high quality protein, chickpea enriches the cereal-based diet of the people and improves their nutritional balance[17]. 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.

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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*[12].

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[18]. 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[2] and during severe conditions up to the extent of 85 per cent[14] and 90 per cent[16].

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[19]. 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. Prabhu *et al.*[11] evaluated the ovicidal activity of *Calotropis gigantia*. Its leaf extracts caused 100 per cent inhibition of egg hatchability followed by flower extract (90%). Lall *et al.*[8] studied the bioefficacy of *Argemone maxicana* and *Calotropis procera* extracts against 4th instar larvae of *H. armigera* with special reference to the effect on peritrophic membrane. Growth and development inhibition effects included mainly of occurrence of larval-pupal and pupal-adult intermediate stages incapable of becoming adult and adverse effects on larvae. Maity and Mondal[9] evaluated the four indigenous plants *viz. Azadirachta indica*, *Annona squamosa, Jatropha curcas* and *Lantana camara* for their insecticidal activity against *H. armigera* under laboratory. The order of efficacy of different botanicals against *H. armigera* was *J. curcas, A. indica, A. squamosa* and *L. camara,* respectively. Bijewar[3] studied the different plant leaf extracts, cow urine and their combinations against pigeon pea pod borer complex under field conditions. Among the different leaf extracts, ekka plant followed by datura and lantana @ 5% (w/v) proved to be the most effective. 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 aqueous plant leaf extracts @ 5% against *H. armigera* in chickpea, their effect on natural enemy, *C. chloride,* pod damage caused by the target pest and grain yield of chickpea.

MATERIAL AND METHODS

The field experiments were conducted during *rabi* crop seasons in 2016-17 and 2017-18 at experimental farm NEBCRC, GBPUAT, Pantnagar, Uttarakhand. The chickpea variety PG-186 was sown with a spacing of 30x10 cm in 3x3= 9m^2 plots. Studies on efficacy of leaf extracts were consist of total 9 treatments including one chemical insecticide indoxacarb 14.5 SC @75ml a.i/ha (T_8) and one untreated control (T_9) allocated randomly to different plots each of three blocks. Different weeds and tree leaves used for 5% aqueous extracts preparation namely, T_1-Congress grass (*Parthenium hysterophorus*), T_2-Lantana (*Lantana camara*), T_3-Ekka plant (*Calotropis gigantea*), T_4-Sugar apple (*Annona squamosa*), T_5-Glory bower (*Clerodendrum inerme*), T_6-Nilgiri (*Eucalyptus globules*) and T_7-Mexican prickly poppy (*Argemone mexicana*).

Methodology for preparation aqueous plant leaf extracts

Required weeds and plant leaves were collected from the university campus of GBPUA&T, Pantnagar during the morning hours. Collected plants and leaves were washed thoroughly in tap water to remove dust

and surface contamination. Washed leaves allowed for drying in shade until the surface moisture dry off. The 100 g of cleaned leaves were ground with little water by using domestic electric grinder to form the chunky paste. To prepare 5 per cent of plant extracts 100 g of the ground paste was immersed in 2 l of water for overnight. In the next day, that solution was filtered and squeezed through the muslin cloth. Around two pinch of detergent powder added to the filtrate to serve as a sticker and wetting agent. The obtained 5 per cent formulations were used for spraying on chickpea crop against *H. armigera*[7, 13].

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 biorationals 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 different 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.

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

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.

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 square root with adding factor 0.5. The per cent values were analyzed by angular transformation.

RESULTS AND DISCUSSION

The pooled data pertaining to efficacy of plant leaf extracts on larval population of *H. armigera*, cocoon population of *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. The data revealed that leaf extracts exhibited a significant effect on *H. armigera* by reducing its incidence to 2.61 to 4.22 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) irrespective of treatments including indoxacarb in comparison to only1.50 to 7.50 larvae per ten plants recorded after first spray. This significant increase in pest incidence even after second spray may be due to plant leaf extracts slow mode of action, availability of suitable pod maturation stage and favorable climate factors to pod bored larva *viz.* temperature, relative humidity and rainfall prevailed in the area.

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 leaf extracts formulations such as sugar apple (5.11 larvae/10 plants), ekka plant (5.81 larvae/10 plants) glory bower (6.28

larvae/10 plants) and Mexican prickly poppy (6.47 larvae/10 plants). However, the treatments *viz.* nilgiri (7.31 larvae/10 plants), lantana (7.45 larvae/10 plants) and congress grass (8.03 larvae/10 plants) were also found significantly superior over untreated control (11.78 larvae/10 plants). These findings are supported by the findings of Kapadia and Butani[6] who reported that leaf extracts of neem, lantana, custard apple, karanj and jatropha found to be very effective against *H. armigera*. However, the findings related to lantana and *Clerodendrum* are contradictory with the results of Yankanchi and Patil[20] they reported that *L. camara* (1%) tended to result in a lower percentage of intensity of cabbage damage (4 %) than caused by *H. armigera* than control and *Clerodendrum*. Mishra *et al.*[10] reported a significant decrease in the percentage of pod damage after spraying vermiwash with neem oil and custard apple leaf extract. Gorakh nath and Singh[4] reported the efficacy of leaf extracts of neem, custard apple leaves and garlic singly and in combination with vermiwash collected from animal dung against *H. armigera*.

After first spray there were no significant differences observed between plant leaf extracts with respect to overall mean *C. chlorideae* with a range of 1.83 to 2.66 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 variations of natural enemy population in different treatments. However, there was an decrease in natural enemy population observed after second spray (0.34 to 2.00 cocoons/10 plants) in all treatments except to untreated control in comparison to first spray (0.50 to 2.66 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*. These observations on *C.chlorideae* are in line with the findings of Shivaleela[15] who reported that spray sequences consisting of botanicals (HaNPV 250 LE–neem oil 2%–*Clerodendron* 5%) recorded the higher number of *C. chlorideae* cocoons than chemical insecticides (Rynaxypyr 20 SC–Flubendiamide 480 SC–Emamectin benzoate 05 SG) in chickpea crop ecosystem and thus concluded that botanicals are safer to natural enemy. The activity of the *C. chlorideae* fluctuated as the host population varied over a season. The latter cause may be a reason for natural enemy fluctuations in the present studies.

The data pertaining to pooled mean pod damage by *H. armigera* 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. However, among the leaf extracts sugar apple (22.49 %) and ekka plant (24.22 %) found superior to other leaf extracts (Table 1 and Figure 2). These were closely followed by glory bower (26.82 %) and Mexican prickly poppy (27.98 %). Whereas, the treatments nilgiri (30.57 %), lantana (30.96 %) and congress grass (33.39 %) was recorded significantly higher per cent pod damage among plant leaf extracts.

The data on pooled mean grain yield of both years revealed that indoxacarb registered with maximum grain yield of 15.15 quintals per hectare and untreated control with minimum of 5.51 quintals per hectare. However, among the leaf extracts sugar apple (8.48 q/ha), ekka plant (8.12 q/ha), glory bower (7.59 q/ha) and Mexican prickly poppy (7.27 q/ha) treated plots were recorded with significantly superior grain yield over other and found on par with each other. Whereas, the treatments nilgiri (6.48 q/ha), lantana (6.26 q/ha) and congress grass (5.69 q/ha) were recorded significantly lower mean grain yield

among plant leaf extracts (Table 1 and Figure 2).

A significant reduction in the number of infected chickpea pods were observed after spraying these combinations. Bijewar[3] studied the efficacy of different plant leaf extracts, cow urine and their combinations against pigeon pea pod borer complex under and conditions and found that the leaf extracts of ekka plant followed by datura and lantana @ 5% the most effective against *H. armigera* larval population with (3.96, 4.30 and 4.96 larvae/5 plants), pod damage (23.5 %, 25.21 % and 28.12 %) and grain yield (731.46, 723.16 and 579.00 kg/ha), respectively.

CONCLUSION

The present field studies clearly revealed that the plant leaf extracts @5% such as sugar apple, ekka plant, glory bower and Mexican prickly poppy were found to be effective against 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 leaf extract treatments meanwhile it also observed with negative effect on natural enemy of target pest *i.e. C. chlorideae*. Thus, it can be concluded that the aqueous plant leaf extracts @5% can easily be incorporated in Integrated Pest management programme against *H. armigera* in chickpea crop as it is eco-friendly, cost effective easily available at farmers' level.

Table 1. Pooled data on the efficacy of leaf extracts on larval population of *H. armigera, C. chlorideae*, pod damage and grain yield of chickpea during *rabi* crop seasons 2016-17 and 2017-18

Treatments	During *rabi* crop seasons 2016-17 and 2017-18											
	Mean number of *H armigera* larvae/10 plants							Mean Population of *C. chlorideae*/10 plants			Overall pod damage (%)	Overall Grain yield (q/ha)
	After first spray			After second spray			Overal l mean	After First spray	After second spray	Mean		
Congress grass @ 5%	3.55	4.89	**4.22**	11.56	12.11	**11.84**	**8.03**	2.34	1.84	**2.09**	**33.39**	**5.69**
Lantana @ 5%	3.45	4.89	**4.17**	10.00	11.44	**10.72**	**7.45**	2.66	2.00	**2.33**	**30.96**	**6.26**
Ekka plant @ 5%	2.56	3.44	**3.00**	8.11	9.11	**8.61**	**5.81**	1.83	1.34	**1.58**	**24.22**	**8.12**
Sugar apple @ 5%	2.11	3.11	**2.61**	7.44	7.78	**7.61**	**5.11**	2.50	1.83	**2.17**	**22.49**	**8.48**
Glory bower @ 5%	3.22	4.11	**3.67**	8.56	9.22	**8.89**	**6.28**	2.33	1.83	**2.08**	**26.82**	**7.59**
Nilgiri @ 5%	3.67	4.33	**4.00**	10.33	10.89	**10.61**	**7.31**	2.50	1.50	**2.00**	**30.57**	**6.48**
Mexican prickly poppy @ 5%	3.33	3.89	**3.61**	9.33	9.89	**9.33**	**6.47**	2.00	1.16	**1.58**	**27.98**	**7.27**
Indoxacarb 14.5 SC @ 75 ml a.i./ha	1.22	1.78	**1.50**	2.00	2.78	**2.39**	**1.95**	0.50	0.34	**0.42**	**11.38**	**15.15**
Untreated control	7.67	7.33	**7.50**	14.55	17.56	**16.06**	**11.78**	3.34	4.00	**3.67**	**38.70**	**5.51**
SEM±	**0.59**	**0.50**	**1.03**	**1.13**	**1.30**	**1.221**		**0.25**	**0.32**	**0.006**	**0.006**	**0.008**
CD@5%	**1.56**	**2.33**	**1.95**	**7.44**	**7.78**	**7.61**		**2.17**	**1.34**	**1.76**	**0.019**	**0.0173**
CV	**2.56**	**2.67**	**2.62**	**8.11**	**9.11**	**8.61**		**2.00**	**1.34**	**1.67**	**0.03**	**1.30**

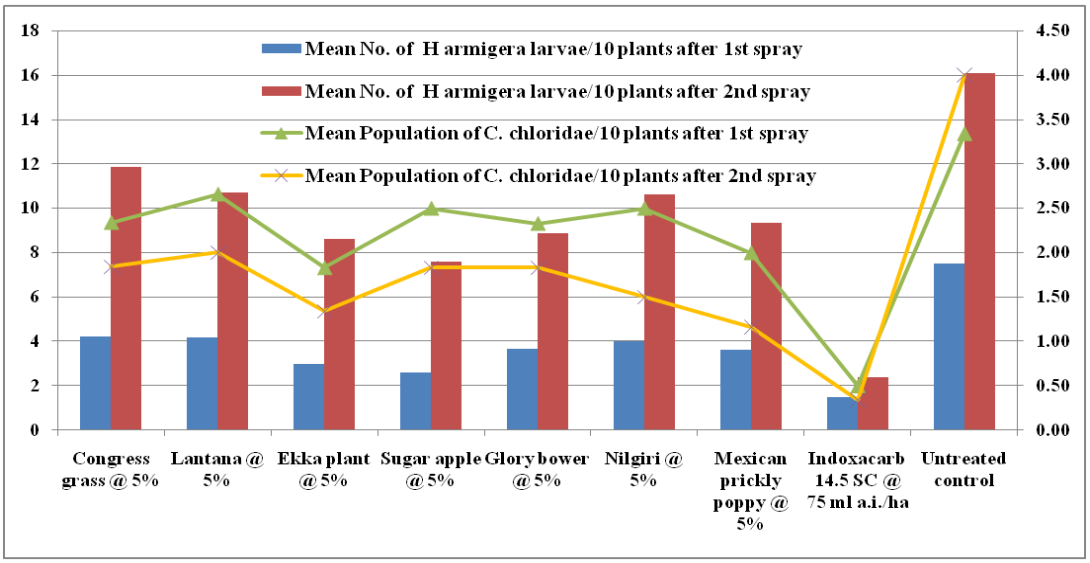

Fig. 1: Effect of plant leaf extracts on the dynamics of *H. armigera* larval population and its natural enemy, *C. chlorideae* after first and second sprays in chickpea crop during *rabi* seasons, 2016-17 and 2017-18

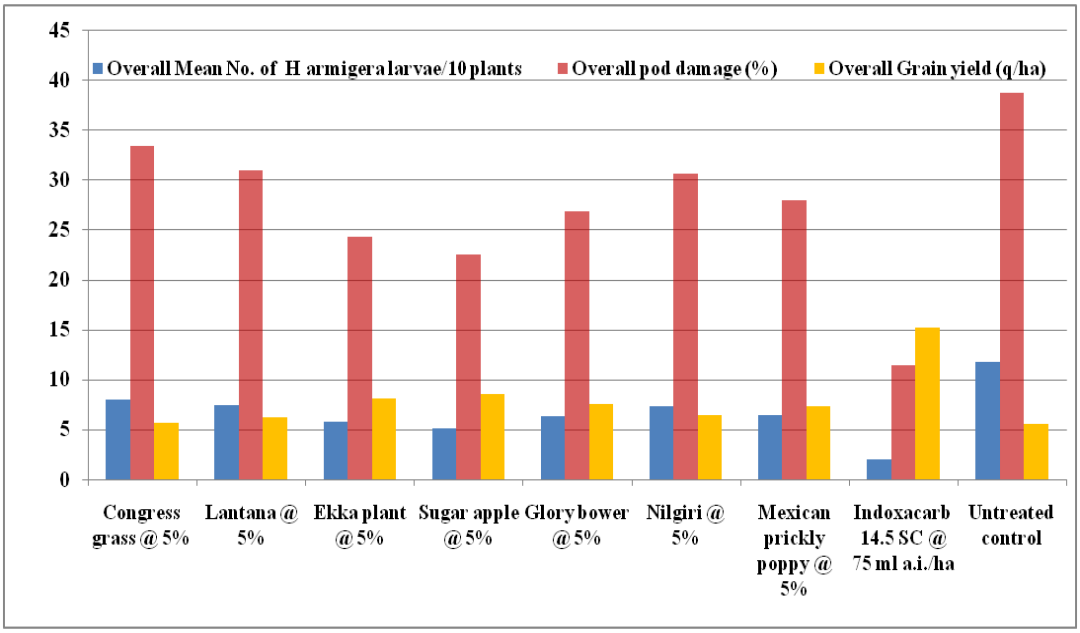

Fig. 2: Field efficacy of plant leaf on larval population *H. armigera*, pod damage and grain yield of chickpea (2016-18)

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