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RELATIVE TOXICITY OF DIFFERENT INSECTICIDES AGAINST *HELICOVERPA ARMIGERA* (HUBNER) IN PUNJAB

Anureet Kaur Chandi

Department of Entomology, Punjab Agricultural University, Ludhiana - 141 004, India.
e-mail: anureetchandi@pau.edu

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ABSTRACT : *Helicoverpa armigera* (Hubner) populations were collected from different regions of Punjab i.e. Amritsar, Kapurthala, and Ludhiana. Toxicity of some commonly used insecticides i.e. Spinosad 48 SC, Indoxacarb 15 EC, Chlorpyriphos 20 EC, Chlorantraniliprole 18.5 SL, Deltamethrin 2.8 EC against third instar larvae of *H. armigera* was determined by using the standard 'Leaf-disc dip' method of bioassay. LC_{50} values for these test-insecticides for Amritsar population were 0.00504, 0.35956, 3.77906, 0.00037 and 4.69631 per cent, respectively. For Kapurthala population LC_{50} values were 0.00486, 0.33866, 3.66899, 0.000321 and 4.58624 per cent, respectively. The LC_{50} values for Ludhiana populations against third instar larvae of *H. armigera* were 0.00468, 0.30183, 3.48554, 0.000275 and 4.40279 per cent, respectively. Based on these LC_{50} values, the order of toxicity of the insecticides against *H. armigera* populations was found to be Chlorantraniliprole > Spinosad > Indoxacarb > Chlorpyriphos > Deltamethrin, for all the three populations. Perusal of data revealed that chlorantraniliprole was found to be the most toxic to *H. armigera* with LC_{50} values ranging from 0.000275 per cent for Ludhiana, 0.000321 per cent for Kapurthala and 0.00037 per cent for Amritsar. The maximum level of resistance in *H. armigera* was observed for Deltamethrin, followed by Chlorpyriphos, Indoxacarb and Spinosad. This assessment of changing insecticide resistance is essential for its management.

Key words : Insecticide-resistance, *Helicoverpa armigera,* toxicity.

INTRODUCTION

Helicoverpa armigera (Lepidoptera: Noctuidae), is a cosmopolitan insect and a serious threat to many crops of economic importance. It has gained importance as a major destructive pest owing to its capacity to feed on many a variety of plant species, some of which are important agricultural crops such as cotton, chickpea, tomato, sunflower, okra, pea, tobacco, potato etc. (Dinsdale *et al*, 2010; Wakil *et al*, 2012). It causes damage to more than 60 species of cultivated and non-cultivated plants and 47 families (Fathipour and Sedaratian, 2013). It causes heavy loss up to 60 per cent with an annual loss estimated to be US $ 400 million (Anonymous, 2004*).* It is a major problem across the World due to its great mobility, fecundity, voracious larval feeding, and its well documented ability to develop resistance to insecticides deployed against it, Hence the control up to desired level has become difficult (McCaffery *et al*, 1998; Wakil *et al*, 2010).). However, the indiscriminate use of insecticides has resulted in the development of resistance in many *H. armigera* populations (Ferre and van, 2002). Moderate to high level of resistance to conventional insecticides such as chlorinated hydrocarbons, organophosphates, carbamates and pyrethroids as well as to neonicotinoids pesticides and Insect Growth Regulator (IGR) has been reported in field populations of *H. armigera* (Ahmad *et al*, 2010; Nauen and Bretschneider, 2002). *H. armigera* has posed a serious threat to the cultivation of cauliflower and cabbage, especially early and late season crops in Punjab. Consequently farmers intensively spray cabbage and cauliflower with insecticides either singly or in mixtures throughout the growing season of the crop (Chandi and Singh, 2011). This practice may lead to worsening the problems of insecticide resistance by increased selection pressure on the pest. This study aimed to assess the current status of insecticide resistance to five insecticides including new chemistry in *H. armigera* populations.

MATERIALS AND METHODS

The larvae of *H. armigera* were collected from different locations i.e. Amritsar, Kapurthala and Ludhiana districts of Punjab State. Each larva was reared separately in a plastic tube (10 × 2.5 cm) kept individually and fed on artificial diet at a constant temperature of 27±2°C and 65±5 per cent relative humidity (RH) in an incubator in Insect Physiology Laboratory of Department of Entomology, Punjab Agricultural University, Ludhiana. After pupation these were transferred into the separate jars. The grown up larvae pupated in the tube. The newly emerged moths from these tubes were released in pairs in the glass jars for egg laying. The upper ends of the jars were kept closed with a piece of muslin cloth fastened

Table 1. Toxicity of insecticides against third instar larvae of *Helicoverpa armigera* in Amritsar.

Insecticide	LC_{50}(%)	Fiducial limit		Slope
		Lower limit	Upper limit	
Spinosad	0.00504	0.00320	0.00789	2.392±0.583
Indoxacarb	0.35956	0.22998	0.56634	2.392±0.583
Chlorpyriphos	3.77906	2.39882	5.90713	2.392±0.583
Chlorantraniliprole	0.00037	0.04010	0.09874	2.392±0.583
Deltamethrin	4.69631	2.98105	7.34090	2.392±0.583

Table 2 : Toxicity of insecticides against third instar larvae of *Helicoverpa armigera* in Kapurthala.

Insecticide	LC_{50}(%)	Fiducial limit		Slope
		Lower limit	Upper limit	
Spinosad	0.00486	0.00309	0.00768	2.392±0.583
Indoxacarb	0.33866	0.19442	0.55410	2.033±0.529
Chlorpyriphos	3.66899	2.32895	5.73508	2.392±0.583
Chlorantraniliprole	0.000321	0.00030	0.00090	1.944±0.529
Deltamethrin	4.58624	2.91114	7.16885	2.392±0.583

Table 3. Toxicity of insecticides against third instar larvae of *Helicoverpa armigera* in Ludhiana.

Insecticide	LC_{50}(%)	Fiducial limit		Slope
		Lower limit	Upper limit	
Spinosad	0.00468	0.00297	0.00731	2.392±0.583
Indoxacarb	0.30183	0.16519	0.50174	1.944±0.529
Chlorpyriphos	3.48554	2.21250	5.44833	2.392±0.583
Chlorantraniliprole	0.000275	0.00028	0.00084	1.944±0.529
Deltamethrin	4.40279	2.79471	6.88209	2.392±0.583

with rubber band. Cotton leaves were used as substrate for egg laying. The adults were fed on 10 per cent honey solution. The female moths laid eggs on the leaves, walls of glass jars and on muslin cloth. These eggs were removed gently with the help of a moist camel hair brush.

Third instar *H. armigera* larvae were subjected to standard 'Leaf-disc dip' method of bioassay for determining the LC_{50} values of test insecticides i.e. Spinosad 48 SC, Indoxacarb 15 EC, Chlorpyriphos 20 EC, Chlorantraniliprole 18.5 SL, Deltamethrin 2.8 EC. Serial dilutions of these insecticides were prepared in distilled water. Fresh leaf discs (5 cm diameter) of cotton leaves were dipped in the test concentrations for 20 seconds with gentle agitation and then air dried at room temperature. Cotton leaf discs dipped in water were used as control. Experiment was conducted with three replications and ten larvae per replication. The larvae exposed to treated leaf discs were kept at room temperature. The observations for mortality were recorded after 24 and 48 hours of exposure of larvae to the treated leaf discs. The log concentration-mortality regression was worked out by log probit technique (Finney, 1971) employing the computer programme POLO (Robertson *et al,* 1980).

RESULTS AND DISCUSSION

The LC_{50} values for test-insecticides (Spinosad 48 SC, Indoxacarb 15 EC, Chlorpyriphos 20 EC, Chlorantraniliprole 18.5 SL, Deltamethrin 2.8 EC) against third instar larvae of *H. armigera* have been worked out and the values for these insecticides for Amritsar population were 0.00504, 0.35956, 3.77906, 0.00037 and 4.69631 per cent, respectively. For Kapurthala population LC_{50} values were 0.00486, 0.33866, 3.66899, 0.000321 and 4.58624 per cent, respectively. The LC_{50} values for Ludhiana populations against third instar larvae of *H. armigera* were 0.00468, 0.30183, 3.48554, 0.000275 and 4.40279 per cent, respectively. Based on these LC_{50} values, the order of toxicity of the insecticides against *H. armigera* populations was found to be Chlorantraniliprole > Spinosad > Indoxacarb > Chlorpyriphos > Deltamethrin, for all the three populations. Perusal of data revealed that chlorantraniliprole was found to be the most toxic to all the three populations of *H. armigera* with LC_{50} values ranging from 0.000275 per cent for Ludhiana, 0.000321 per cent for Kapurthala and 0.00037 per cent for Amritsar. The maximum level of resistance in *H. armigera* was observed for Deltamethrin, followed by Chlorpyriphos, Indoxacarb and Spinosad.

The inferences of the present study, showing resistance by *H. armigera* to the test-insecticides are endorsed by the earlier findings where varying levels of resistance to these insecticides were reported. Dilbar *et al* (2014) reported resistance ratio in *H. armigera* ranging between 3.48-9.62 folds for chlorpyriphos for the field populations. Similarly, relative toxicity of quinalphos to *P. xylostella* also varied as reported by different workers. In a study conducted to monitor the insecticide resistance status in *H. armigera*, Rashid and Farhat (2007) conducted two different bioassay methods; larval dip bioassay and surface diet bioassay were tested for the contact/ingestion toxicity using spinosad against second instar larvae of *H. armigera* recorded as LC_{50} values which were 170 and 130ppm, respectively. The LC_{50} values for spinosad in leaf disc method were 0.13 mg ai/ L against first instar of *H. armigera* (Rafiee *et al* 2008). The LC_{50} values of chlorpyrifos and spinosad against third instar larvae of *H. armigera* were 4.6 and 62.26 ppm, respectively (Samad *et al*, 2011). Kanwar *et al* determined the lowest LC_{50} values of 0.00610 and 0.006163% for flubendiamide 480 SC during 2008-09 and 2009-10 respectively on 3 to 4 day-old larvae of *H.armigera*. Based on the LC_{50} and relative toxicity, the tested insecticides could be arranged in a decreasing order of toxicity as flubendiamide 480 SC > indoxacarb 14.5 SC > beta-cyfluthrin 2.5 SC > lambda-cyhalothrin 5 EC > endosulfan 35 EC.

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