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PATTERN OF RESISTANCE AND TOXICITY OF SOME INSECTICIDES TO TWO POPULATIONS OF *HELICOVERPA ARMIGERA* (HUB.) FROM HARYANA

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ABSTRACT

Two meta- populations of *Helicoverpa armigera* (Hub.) collected from Sirsa (more pesticide use) and Bhiwani (less pesticide use) areas of Haryana were evaluated for their susceptibility to four commercial formulations of insecticides *i.e.*, profenofos (Carina) 50 EC, fenvalerate (Fennock) 20 EC, endosulfan (Thiodan) 35 EC and monocrotophos (Kadett) 36 SL in the laboratory at 27±2°C. The insecticide dissolved in acetone were applied to the larvae weighing 30-50 mg @ 1 ìl/larva by topical application method. Observations on toxicity were recorded at 24, 48 and 72h of application. The Sirsa population showed resistance to all the four insecticides when compared with Bhiwani population at all the three observation intervals. The resistance ratios in Sirsa population over Bhiwani population to profenofos, fenvalerate, endosulfan and monocrotophos were 3.88, 1.44, 4.70 and 2.60 at 24h exposure; 3.46, 2.35, 4.65 and 1.13 at 48h exposure and 2.50, 2.89, 3.65 and 1.13 at 72h exposure, respectively. This indicated that the insecticides were more toxic to Bhiwani populations as compared to Sirsa population and the differences in relative toxicity were more pronounced at 72h after application. Monocrotophos was found to be the least toxic and profenofos the most toxic to both the populations. As compared to the Bhiwani population, the Sirsa population of *H. armigera* was 2.5, 2.89, 3.66, and 1.13 times more tolerant to profenofos, fenvalerate, endosulfan and monocrotophos, respectively when observed after 72h of exposure.

Key words: Resistance, *Helicoverpa armigera*, Populations

To boost up production, the farmers rely heavily on the use of agro-chemicals and fertilizers. The indiscriminates use of pesticides has upset the ecological balance of pests populations leading to their resurgence, secondary pest out-break, development of resistance and toxic residues in food and environment. A survey of insecticide use pattern of the farmers of Haryana revealed that the pesticides were being repeatedly used, often with much higher doses, to control insect pests (Saini and Jaglan, 1998). Under high selection pressure of insecticides, field populations of *H. armigera* have the tendency to develop resistance to different molecules of the insecticides (Armes *et al.*, 1996). The present studies were, therefore, planned to know the response of *H. armigera* from two different pesticide use pattern areas *i.e.* Sirsa (high use) and Bhiwani (low use) to the commercial grades of four insecticides *i.e.* profenofos, fenvalerate, endosulfan and monocrotophos.

MATERIALS AND METHODS

The grown-up larvae of *Helicoverpa armigera* were collected from the cotton fields of the farmers around 30 km radius of Sirsa and Bhiwani. The larvae were collected individually in the plastic vials (10x3.75 cm) and brought to the laboratory and reared in the separate vials on artificial diet at 27±2°C in a BOD incubator till pupation. The pupae were sorted into males and females as per Paul. The newly emerged adults were paired and kept in battery jars (20x15 cm) covered with muslin. The adults were provided with cotton swab soaked in 10 per cent sucrose solution to serve as food. The freshly laid eggs were removed daily and kept for hatching. The freshly hatched larvae were transferred to artificial diet in petriplates (10 cm diameter) @ 50 larvae per petriplate. After three days, the larvae were transferred individually to specimen-vial containing artificial diet and kept at 27±2°C. The individual larva weighing 30-50 mg was employed for bioassay investigations (Armes *et al*., 1992).

Various concentrations of profenofos (Carina) 50 EC, fenvalerate (Fennock) 20 EC, endosulfan (Thiodan) 35 EC and monocrotophos (Kadett) 36 SL were prepared in acetone. One ìl of the insecticides solution was topically applied with Eppendorb Digital Micro Applicator on the dorsal surface in the mesothoracic region of the larva. The micro-applicator had an accuracy of 98.5 per cent to deliver 1 ìl of solution at each stroke. Side by side a control using acetone alone was run as above. There were three replications each consisting of 10 larvae. The treated larvae

Table 1: Toxicity of different insecticides to *Helicoverpa armigera* of Sirsa and Bhiwani populations after 24h exposure period

Insecticide	Population	Heterogeneity factor	Regression equation	LD_{50} (µg/larvae)	Fiducial lmits		Resistance ratio
					Lower	Upper	
Profenofos	Sirsa	$X^2_{(4)}$ =0.843	Y=6.49595+0.76370X*	0.1099	0.0382	0.9428	3.883
	Bhiwani	$X^2_{(4)}$ =1.914	Y=6.40355+0.55083X**	0.0283	0.0067	3.0868	
Fenvalerate	Sirsa	$X^2_{(4)}$ =0.875	Y=6.14028+0.45355X*	0.0305	0.0018	1.6015	1.438
	Bhiwani	$X^2_{(4)}$ =0.619	Y=7.07718+0.77718X**	0.0212	0.0076	0.2582	
Endosulfan	Sirsa	$X^2_{(4)}$ =1.665	Y=6.78046+0.90526X*	0.1082	0.0731	0.6935	4.700
	Bhiwani	$X^2_{(4)}$ =1.296	Y=7.49792+0.95333X**	0.0230	0.0099	0.0961	
Monocrotophos	Sirsa	$X^2_{(4)}$ =0.887	Y=6.12672+0.83445X*	0.4461	0.1635	4.3237	2.600
	Bhiwani	$X^2_{(4)}$ =0.966	Y=6.61099+0.91181X*	0.1711	0.0706	1.1014	

*X= log dose x 10^4 **X= log dose x 10^5

Table 2: Toxicity of different insecticides to *Helicoverpa armigera* of Sirsa and Bhiwani populations after 48h exposure period

Insecticide	Population	Heterogeneity factor	Regression equation	LD_{50} (µg/larvae)	Fiducial limits		Resistance ratio
					Lower	Upper	
Profenofos	Sirsa	$X^2_{(4)}$ =0.443	Y=6.92474+0.75725X*	0.0287	0.0043	0.0859	3.457
	Bhiwani	$X^2_{(4)}$ =1.354	Y=6.73393+0.56302X**	0.0083	0.0010	0.0562	
Fenvalerate	Sirsa	$X^2_{(4)}$ =0.168	Y=7.15852+0.79191X*	0.0188	0.0050	0.0567	2.350
	Bhiwani	$X^2_{(4)}$ =0.117	Y=7.29178+0.73974X**	0.0080	0.0023	0.0375	
Endosulfan	Sirsa	$X^2_{(4)}$ =0.786	Y=6.65743+0.75100X*	0.0600	0.0158	0.2016	4.650
	Bhiwani	$X^2_{(4)}$ =0.738	Y=7.59601+0.89174X**	0.0129	0.0047	0.0408	
Monocrotophos	Sirsa	$X^2_{(4)}$ =0.910	Y=6.17071+0.67104X*	0.1800	0.0533	1.4410	1.130
	Bhiwani	$X^2_{(4)}$ =0.556	Y=6.22875+0.68330X*	0.1591	0.0471	1.0552	

*X= log dose x 10^4 **X= log dose x 10^5

Table 3: Toxicity of different insecticides to *Helicoverpa armigera* of Sirsa and Bhiwani populations after 72h exposure period

Insecticide	Population	Heterogeneity factor	Regression equation	LD_{50} (µg/larvae)	Fiducial lmits		Resistance ratio
					Lower	Upper	
Profenofos	Sirsa	$X^2_{(4)}$ =0.582	Y=8.18361+0.97220X*	0.0055	0.0032	0.0374	2.500
	Bhiwani	$X^2_{(4)}$ =3.304	Y=7.41911+0.65972X**	0.0022	0.0001	0.0071	
Fenvalerate	Sirsa	$X^2_{(4)}$ =0.026	Y=7.37108+0.79850X*	0.0107	0.0022	0.0299	2.892
	Bhiwani	$X^2_{(4)}$ =0.101	Y=7.78343+0.81115X**	0.0037	0.0009	0.0105	
Endosulfan	Sirsa	$X^2_{(4)}$ =0.812	Y=6.98900+0.77819X*	0.0278	0.0019	0.0781	3.650
	Bhiwani	$X^2_{(4)}$ =0.101	Y=8.06391+0.98298X**	0.0076	0.0030	0.0199	
Monocrotophos	Sirsa	$X^2_{(4)}$ =0.884	Y=6.30113+0.64776X*	0.0980	0.0231	0.5217	1.125
	Bhiwani	$X^2_{(4)}$ =0.458	Y=6.30939+0.63558X*	0.0871	0.0186	0.4502	

*X= log dose x 10^4 **X= log dose x 10^5

Table 4: Relative toxicity of different insecticides to *Helicoverpa armigera* larva of Sirsa and Bhiwani populations

Insecticide	Population	Exposure period	LD_{50} (µg/larva)	Relative toxicity
Profenofos	Sirsa	24h	0.1099	4.06
Fenvalerate	-do-	-do-	0.0305	14.63
Endosulfan	-do-	-do-	0.1082	4.12
Monocrotophos	-do-	-do-	0.4461	1.00
Profenofos	Bhiwani	24h	0.0283	6.05
Fenvalerate	-do-	-do-	0.0212	8.07
Endosulfan	-do-	-do-	0.0230	7.44
Monocrotophos	-do-	-do-	0.1711	1.00
Profenofos	Sirsa	48h	0.0287	6.27
Fenvalerate	-do-	-do-	0.0188	9.57
Endosulfan	-do-	-do-	0.0600	3.00
Monocrotophos	-do-	-do-	0.1800	1.00
Profenofos	Bhiwani	48h	0.0083	19.17
Fenvalerate	-do-	-do-	0.0080	19.89
Endosulfan	-do-	-do-	0.0129	12.33
Monocrotophos	-do-	-do-	0.1591	1.00
Profenofos	Sirsa	72h	0.0055	17.82
Fenvalerate	-do-	-do-	0.0107	9.16
Endosulfan	-do-	-do-	0.0278	3.53
Monocrotophos	-do-	-do-	0.0980	1.00
Profenofos	Bhiwani	72h	0.0022	39.59
Fenvalerate	-do-	-do-	0.0037	23.54
Endosulfan	-do-	-do-	0.0076	11.46
Monocrotophos	-do-	-do-	0.0871	1.00

were shifted to the specimen vials containing artificial diet and transferred to BOD incubator running at 27±2°C .The corrected kill was obtained using Abott's Formula (Abott, 1925) and the data were subjected to Probit Analysis to work out LD_{50} values (Finney, 1971).

RESULTS AND DISCUSSION

The results of Probit Analysis of the two meta-populations of *Helicoverpa armigera* are presented in Tables 1- 3. After 24 h of application, the LD_{50} values for profenofos, fenvalerate, endosulfan and monocrotophos were 0.1099, 0.0305, 0.1082, and 0.4461 ìg/larva for Sirsa population; and 0.0283, 0.0212, 0.0230 and 0.1711 ìg/larva for Bhiwani population, respectively. The resistance ratios for Sirsa population over Bhiwani population were 3.88, 1.44, 4.70 and 2.60 for profenofos, fenvalerate, endosulfan and monocrotophos, respectively (Table-1).

The LD_{50} values after 48h of exposure for profenofos, fenvalerate, endosulfan and monocrotophos were 0.0287, 0.0188, 0.0600 and 0.1800 ìg/larva for Sirsa population and 0.0083, 0.0080, 0.0129 and 0.1591ìg/larva for Bhiwani population, respectively. The Sirsa population was 3.46, 2.35, 4.65 and 1.13 times resistant over Bhiwani population (Table-2).

After 72 h of exposure, the LD_{50} values for profenofos, fenvalerate, endosulfan and monocrotophos for Sirsa population were 0.0055, 0.0107, 0.0278 and 0.0980 ìg/larva, and that for Bhiwani population as 0.0022, 0.0037, 0.0076 and 0.0871 ìg/larva, respectively. The Sirsa population showed 2.50, 2.89, 3.65 and 1.13 times resistance to profenofos, fenvalerate, endosulfan and monocrotophos, respectively, when compared with Bhiwani population.

It was clear from the above observations that the Sirsa population was resistant to various insecticides when compared with the Bhiwani population.

Ernst and Dittrich (1991) also observed profenofos resistance in *H. armigera* populations collected from various countries. Ahmad *et al.* (1999) reported low level of resistance in *H. armigera* to profenofos in 1994 owing to its low use, but an upward trend during 1996-97 due to its regular use after 1994. Kathuria (1999) observed 1.64-fold resistance to fenvalerate in Sirsa population as compared to Bhiwani population. Several workers have observed mild to high degree of resistance in this pest, owing to the pattern of use of fenvalerate from different countries (Phokela *et al.*, 1990; McCaffery and Walker, 1991, Reddy *et al.*, 1991; Lande and Sarode, 1995; Deepak and Armes, 1996 and Lal, 1998).

The relative toxicity showed wider variation with increase in the exposure period. The relative toxicities of profenofos, fenvalerate, endosulfan and monocrotophos to Sirsa population of *H. armigera* at 72h exposure period were 17.82, 9.16, 3.53 and 1.00 ìg/larva, respectively and that to Bhiwani population 39.59, 23.54, 11.46 and 1.0 ìg/larvae, respectively (Table 4). This indicated monocrotophos to be least toxic and profenofos to be most toxic insecticide. This was in conformity with their use in the area, *i.e.* monocrotophos was more frequently used while profenofos less frequently used. As compared to the Bhiwani population, the Sirsa population of *H. armigera* was 2.5, 2.89, 3.66, and 1.13 times more tolerant to profenofos, fenvalerate, endosulfan and monocrotophos, respectively when observed after 72h of exposure.

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