SYNERGISM OF PYRETHROIDS WITH PIPERONYL BUTOXIDE (PBO) IN JASSID, *AMRASCA DEVASTANS* (DIST.) (HOMOPTERA: CICADELLIDAE) FROM PAKISTAN

Muhammad Razaq, Muhammad Aslam and *Anjum Suhail
University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan
* Department of Agri. Entomology, University of Agriculture, Faisalabad, Pakistan

ABSTRACT

Adults of cotton jassid, *Amrasca devastans* (Dist.), collected from okra, *Abelmoscus esculentus*, fields from different locations were treated in the laboratory by leaf dip method with fenpropathrin and esfenvalerate alone and in combination with different ratios of piperonyl butoxide (PBO). LC_{50} values were higher for esfenvlerate (139.8 to 22.54 ppm) as compared to fenpropathrin (87.32 to 26.98 ppm) for various locations. Results of PBO synergism were not consistent for all the locations. Lower toxicities, even with the addition of PBO were observed for esfenvalerate and fenpropathrin, indicating different mechanisms of resistance possessed by jassids. We also discuss reasons for incomplete PBO synergism and possibilities for managing resistance.
Keywords: Jassid; insecticide resistance; PBO; resistance mechanism; synergism

INTRODUCTION

Cotton has been world wide challenging for pest management problems. About 1326 species of insects and mites attack cotton crop around the world. It is attacked by 145 species of insects and mites in Pakistan (Huque, 1994). Cotton jassid, *Amrasca devastans* (Dist.), cotton whitefly, *Bemisia tabaci* (Genn.), and thrips, *Thrips tabaci* (Lind.) are regular sucking insect pests in Pakistan whereas spotted bollworms *Earias spp.,* pink bollworm *Pectinophora gossypiella* (Saund.) and American bollworm *Helicoverpa amigera* (Hüb.) are regular insect pests on bolls. These pests require regular application of insecticides. Several species of insect pests have developed varying levels of resistance to different classes of insecticides. *H. armigera* has developed resistance against organocholrienes, organophosphates (OPs), carbamates (Ahmad *et al.*, 1995; 1998) and to pyrethroids (Ahmad *et al.*, 1997; 1999a). Cahill *et al.* (1994; 1995) and Ahmad *et al.* (2000) reported resistance against whitefly to different pyrethroids and organophosphates. Field populations of jassid, *Amrasca devastans* were also reported to be resistant against pyrethroids (Ahmad *et al.,* 1999b).

Knowledge and clarification of mechanism of insecticide resistance is a pre-requisite to understanding resistance problem and in some cases is vital to its reversal (Castle *et al*., 1999). Synergists are used to diagnose resistance mechanism by inhibition of detoxifying enzymes. These chemicals give preliminary information about possible mechanism of resistance in the easiest and fastest ways (Raffa and Priester, 1985; Scott, 1990). Piperonly butoxide (PBO) synergism has been reported in several insect pests like *B. tabaci* (Dittrich *et al.,* 1990), *H .armigera* (Forrester *et al*., 1993) and pear psylla, *Cacopsylla pyrs* L. (Bues *et al*., 2003). Insect pests of cotton receive insecticides wiÿÿ different modes of action in ÿÿ sstan. No studies have been reported on determination of mechanism of insecticide resistance from Pakistan. Present studies were therefore, planned to find out synergism of PBO with fenpropathrin and esfenvalerate in *Amrasca devastans* and we report complete and partial synergism.

MATERIALS AND METHODS

Collection

Jassid, *Amrasca devastans* feed upon cotton and okra during summer season. Higher densities of jassid are found on okra than cotton. So, adult jassids were collected from okra fields during June-September, 2003. Three sites (Table 1) were selected to collect the jassids. Sites were at about 25 km away from each other. Each collection was made from an area of about a hectare. Jassids were not collected from far off areas due to high mortality during transportation. Method developed by Ahmad *et al.* (1999b) was adopted for the transportation of adults from the field to the laboratory. This method includes, collecting the jassids by sweeping the plants with hand net and placing the catch in a wooden box (35.5 × 35.5 × 45.0 cm), having one clear glass on the back, plastic sides and a black cloth sleeve on the front. During transportation jassids were provided with fresh leaves. Very little mortality was observed by this method of collection and transportation.

Insecticides and synergist

The two commonly used insecticides against insect pest complex of cotton were choosen for toxicological studies. Formulated insecticides were used for preparation of test solutions. These were fenpropathrin (Danitol, 30EC, Sumitomo Chemical Company, Japan) and esfenvalerate (Sumialpha, 110EC, Sumitomo Chemical Company, Japan).

Piperonyl butoxide (PBO, Fluka 90% GC) was used for synergism studies. Concentration of PBO was similar as that of insecticide for synergistic effect but concentration was adjusted accordingly, i.e. half of insecticide quantity for 1: 0.5 ratio and so on to determine the effect on toxicity of each insecticide.

Bioassay

After bringing the insects into the laboratory they were treated as soon as possible. Bioassay methods were similar to those of Ahmad *et al.* (1999b). More than five serial concentrations for each formulated insecticide were prepared in distilled water as parts per million (ppm) of active ingredient. Concentrations were increased till the conclusion of experiment. Each concentration was repeated for five times. PBO was put into beaker containing mixture of insecticide and water. Cotton leaf disks were cut by punch (5 cm disc size) and dipped into the test solutions with gentle agitation. These were allowed to dry on paper towel and then put into the petri dishes containing moistened filter paper to avoid desiccation of leaves. Insects were briefly immobilized only for few experiments in the beginning by placing plastic jars into refrigerator (2-3^0 C temperature) for about 10 minutes (Horowitz *et al.*, 1988). But later on carbon dioxide was used for immobilization, as later method proved better. Jassids were transferred into petri dishes by tapping or by fine camel hair brush. Ten to twenty insects were put into one petri dish. There were five petri dishes for each concentration. The same number of petri dishes was kept as control on leaves dipped into distilled water. Petri dishes containing insects were held at constant temperature of 25±2^o C and photoperiod of 14:10 (L: D) h.

Data recording and analysis

Mortality was assessed after 48 hours. Jassids were considered dead if unable to move in a coordinated way when prodded with blunt prod. Results were expressed as percent mortalities corrected for untreated control by using Abbott's formula (Abbott, 1925). Data were analyzed on computer to determine LC_{50} values by Probit Analysis (Finney, 1971).

Comparisons of insecticide toxicity were made on the LC_{50} values of different locations, as no susceptible strain was available to determine the base line susceptibility for comparison.

RESULTS

Fenpropathrin

LC_{50} values of fenpropathrin varied greatly for all the locations (Table 1). Highest LC_{50} (87.32 ppm) was observed in university strain, whereas lowest LC_{50} (26.98 ppm) was observed in jassids collected from old Shujaabad road. Slope of regression line was near 2 in second location but slopes in all other locations were <2, which is typical of the field populations. Confidence limits of LC_{50} did not overlap for three locations.

Esfenvalerate

LC_{50} value of esfenvalerate was the highest (139.8 ppm) in insects collected from 1st location (Table 1). But other two locations exhibited almost similar toxicity (LC_{50}, 22.54 & 23.61 ppm respectively). LC_{50} values of esfenvalerate were lower than that of fenpropathrin.

PBO synergism

PBO synergized the toxicity of fenpropathrin at all the locations. Highest synergism was observed in jassids collected from university. The LC_{50} of fenpropathrin alone was lower than that of toxicant and synergist (1:1) in jassids collected from old Shujaabad road. Like fenpropathrin, PBO synergized the toxicity of esfenvalerate at all the locations. Highest synergism was observed in jassid populations collected from the university.

Table 1. Synergistic effect of PBO with fenpropathrin and esfenvalerate on jassid adults collected from okra during July-September, 2003

Insecticide	Location	Ratio of PBO	n	LC_{50} (95% CL)	SLOPE ± SEM
Fenpropathrin	Zakariya University	1:0	559	87.32 (65.61-116.21)	1.55±0.20
		1:1	850	34.40 (22.72-52.10)	2.60±. 36
		1:1.5	526	7.97 (3.66-17.35)	1.45±0.27
		1:0.5	488	8.26 (6.02-11.34)	1.26±0.17
	Old Shujaabad Road	1:0	590	26.98 (21.97-33.13)	1.99±0.20
		1:1	854	37.69 (33.19-42.81)	2.16±0.15
		1:1.5	563	8.69 (7.0510.71)	1.69±0.16
		1:0.5	540	10.52 (8.58-12.89)	1.65±0.17
	Khanewal Road	1:0	998	46.92 (40.24-54.70)	1.57±0.12
		1:1	954	21.01 (16.55-26.68)	1.20±0.13
		1:1.5	512	7.54 (5.80-9.80)	1.54±0.18
		1:0.5	484	17.80 (13.93-22.76)	1.64±0.18
Esfenvelerate	Zakariya University	1:0	512	139.8 (111.5-175.4)	1.03±0.12
		1:1	454	5.73 (2.68-12.27)	1.40±0.27
		1:1.5	522	7.74 (6.13-9.78)	1.36±0.16
		1:0.5	494	9.04 (7.13-11.46)	1.38±0.16
	Old Shujaabad Road	1:0	640	22.54 (13.37-33.74)	1.07±0.33
		1:1	525	23.00 (16.83-31.41)	1.63±0.20
		1:1.5	389	13.90 (5.76-33.54)	1.55±0.35
		1:0.5	499	12.64 (10.2015.66)	1.49±0.18
	Khanewal Road	1:0	596	23.61 (19.48-28.61)	2.16±0.24
		1:1	1055	23.81 (16.98-33.39)	1.79±0.22
		1:1.5	595	11.08 (8.60-15.59)	1.01±0.14
		1:0.5	580	34.14 (26.12-40.21)	1.53±0.20

n= Total number of adult jassids exposed

DISSCUSSION

Results of PBO synergism were not consistent for all the locations like pyrethroids. Lower toxicities, even with the addition of PBO or its ratios, were observed for esfenvalerate and fenpropathrin for the jassids collected from old Shujaabad road. Incomplete synergism with PBO indicates that other than PBO suppressible mechanism(s) also exist. It has been also noted from the results that addition of or increase in the ratio of PBO did not decrease $LC_{50.}$ It clearly indicates that jassids have been selected for more than one mechanism of resistance. PBO synergism and antagonism with cypermethrin has also been reported in whitefly, *B. tabaci* populations from various parts of world (Dittrich *et al*., 1990). PBO also synergized insecticides from different groups including cypermethrin to varying degrees in the resistant strain of obliquebanded leafroller, *Choristoneura rosaceana* (Ahmad and Hollingworth, 2004). Insecticide resistance mechanism in cotton jassid has yet not been reported from Pakistan However, Ahmad *et al*. (1999a) reported involvement of oxidative and hydrolytic detoxifications to pyrethroids in synergism studies on whiteflies from cotton. PBO mediated resistance in heliothine Lepidoptera has been reported due to overproduction of esterases or monooxygenases (McCaffery, 1998). Therefore, it shall remain provisional in present study that PBO suppressible resistance is due to esterases or monooxygenases unless confirmed biochemically.

Cotton jassid also attacks crops like okra, tobacco and other solanaceaous vegetables like brinjal. These crops also receive insecticides. Tobacco is sown in spring season followed by brinjal and okra. Cotton crop is sown in summer and jassid shift to cotton from these hosts. Jassids are the 1st insect pest receives insecticide application on cotton. Methamidophos, monocrotophos were common insecticides, which were used to control this insect pest (Ahmad *et al.,* 1995). These insecticides developed resistance to other insect pests like *Bemisia tabaci*. Now neonicotinoids like imidacloprid are sprayed in the beginning. Lower population of jassid remains throughout the crop season so these receive every insecticide used. Pyrethroids are used alone or in combination with other insecticides to control bollworms during mid to late season of cotton. So jassids receive pyrethroids in lower quantity. Thus field use of insecticides exerts disruptive selection pressure from insecticides which almost always results in more than one mechanism (Roush and McKenzie, 1987). Many insect pests possessed more than one mechanism including whiteflies. Resistance in *B. tabaci* from different regions of the world has been identified as due to acetylcholinesterse insensitive to OPs and metabolic detoxification of OPs and pyrethroids by esterases and monooxygenases (Denholm *et al.,* 1998). Whitefly populations collected from same locations have been reported to resistant to pyrethroids and organophosphates therefore possessing more than one mechanism from Pakistan (Ahmad *et al*., 2003). Therefore, it is quite possible that Pakistani jassids possess more than one mechanism.

Life cycle of jassid is completed in less than 30 days on cotton (Huque, 1994). But no literature reports duration of various life stages on other hosts and either similar or different generation(s) of this pest attacks cotton. It is therefore needed that biology of this pest should be studied on regional basis on its different hosts. It should also be determined that either the same or next generation of jassids attacks cotton crop from the early spring from hosts like okra, brinjal and tobacco. On the basis of biology, windows should be fixed for application of insecticides with different modes of action for different generations. The success has been achieved by this way on cotton pests in Australia, China, Israel and USA (Castle *et al*., 1999). In USA strategy has also been developed for controlling whiteflies on cross commodities basis (Palumbo *et al.*, 2001).

Hairy varieties that are resistant to jassids may not prove better as these are favoured by whiteflies. Applying judicious amount of nitrogenous fertilizer and delaying first irrigation are options other than chemical control measures (Huque, 1994).

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