

Toxicity of Different Insecticide Mixtures Against Cotton Bollworm, *Helicoverpa armigera* (Hub.) (Lepidoptera: Noctuidae)

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Abstract.- Toxicity of different insecticide mixtures belonging to different groups viz., decis™ 2.5EC + thiodan™ 35EC, decis™ 2.5EC + curacron™ 500EC, decis™ 2.5EC + somialfa™ 110EC, decis™ 2.5EC + advantage™ 20EC, thiodan™ 35EC+ curacron™ 500EC and thiodan™ 35EC + somialfa™ 110EC was recorded using their field recommended doses against *Helicoverpa armigera* (Hubner) by leaf-dip method. Percent mortality was determined to compare efficacy of mixtures and their probability of synergism. The results concluded that organophosphates in combination with pyrethroids exhibited an enhanced toxicity showing the high probability of synergistic effects. Significantly high toxicity was shown by decis™ 2.5EC + curacron™ 500EC which caused 100 per cent mortality to the insect followed by thiodan™ 35EC + somialfa™ 110EC causing 83.3 per cent mortality after 72hrs of exposure. These findings on insecticide mixtures could serve as useful tool in the management of insecticide resistance.

Key words: Insecticide resistance, pyrethroids, organophosphates, carbamates, cotton bollworm, synergism.

INTRODUCTION

The average yield of seed cotton in Pakistan is 511kg/hectare but it is still lower than the countries like Australia, USA, Egypt and Turkey (Ahmed, 1999a). The reason is that its yield declines mainly due to the attack of insect pests, diseases and weeds. Insect pests alone cause 20 to 40 per cent losses in potential yield (Ahmed, 1999b). Insecticides, being one of the most effective methods of control are very popular among the farming community throughout the world. In United States, pesticides have been the only way to avoid economic damage to this high value crop (Knippling, 1979). In Pakistan, annual import of insecticides is worth Rs. 14 billions, of which 80 per cent are used on cotton (Naveed *et al.*, 2002). The indiscriminate, and non-judicious use of individual insecticides of different groups has led to resistance in various insect pests of cotton especially in *Helicoverpa armigera*. This pest has been recorded from at least 160 cultivated and 67 wild host plants (Reed and Pawar, 1982). There are several species of *Helicoverpa* that infest cotton in different parts of

the world. *H. armigera* is the most important species in the old world, from Africa to the Pacific islands.

To counter the increasing resistance against insecticides in *H. armigera*, different mixtures comprising of pyrethroid, organophosphate and carbamate insecticides were tested for their synergistic effects against third instar larvae of *H. armigera* under laboratory conditions.

MATERIALS AND METHODS

Test insect

Cotton bollworm, *H. armigera* was collected from cotton field at NIAB and reared on artificial diet containing chick pea powder as main ingredient under laboratory conditions set at $27\pm 2^{\circ}\text{C}$, $65\pm 5\%$ R.H and 14:10hrs Light: Dark (Ahmed and McCaffery, 1991). A homogeneous stock of third instar larvae was obtained from F-1 generation for insecticidal treatments.

Insecticides

Six mixtures of insecticides having agricultural grade viz., decis™ 2.5EC + thiodan™ 35EC, decis™ 2.5EC + curacron™ 500EC, decis™ 2.5EC + somialfa™ 110EC, decis™ 2.5EC + advantage™ 20EC, thiodan™ 35EC + curacron™ 500EC and thiodan™ 35EC + somialfa™ 110EC

were tested in field recommended doses (Table 1). These mixtures were placed in beakers and used soon after preparation.

Test method

Leaf dip method was used to determine toxicity of six insecticide mixtures (Busvine, 1971). Cotton leaves were dipped in the test concentrations prepared in water, for 10 seconds and then allowed to dry on blotting paper. These leaves were placed in Petri dishes having wet blotting paper underneath to avoid their desiccation. Twelve larvae of third instar were released on leaves in Petri dishes per treatment with four larvae per replicate. Each treatment was replicated thrice. Larvae in control were released on leaves treated with distilled water.

Statistical analysis

Observations for larval mortality were taken after 24, 48 and 72hrs of application. Data on percent mortality were subjected to statistical analysis through software MSTAT-C using IBM PC. Relative toxicity of mixtures to larvae were calculated as the ratio of mortality of decisTM 2.5EC + advantageTM 20EC to the mortalities of the insecticides in question.

RESULTS AND DISCUSSION

The results in Table II showed significant variations in toxicity amongst test insecticide mixtures against third instar larvae of *H. armigera* after 24, 48 and 72hrs of application. No mortality was observed for decis 2.5EC + thiodan 35EC after 24hrs of application, whereas it was significantly high (58.3 per cent) for thiodan35EC + somialfa 110EC followed by 41.6 percent for thiodan 35EC + curacron 500EC. The lowest mortality of 25 per cent was caused by decis 2.5EC + curacron 500EC followed by 33.3 per cent by decis 2.5EC + somialfa 110EC. Larval mortality increased after 48hrs. However, the lowest mortality of 25 per cent was caused by mixtures both of decis 2.5EC + thiodan 35EC and decis 2.5EC + advantage 20EC, whereas the highest mortality of 100 per cent was caused by decis 2.5EC + curacron 500EC. Mortality after 72 hrs increased significantly in three mixtures as 58.3 per cent for decis 2.5EC + thiodan 35EC, 75 percent

for thiodan 35EC + curacron 500EC and 83.3 percent for thiodan 35EC+ somialfa 110EC. However, it was constant in the remaining mixtures. It was 25 per cent for decis 2.5EC + advantage 20EC, 33.3 per cent for decis 2.5EC + somialfa 110EC and 100 per cent for decis 2.5EC + curacron 500EC. The toxicity ratio of the mixtures, considering decis 2.5EC + advantage 20EC as standard, indicated that decis 2.5EC + curacron 500EC, thiodan 35EC + somialfa 110EC, thiodan 35EC + curacron 500EC, decis 2.5EC + thiodan 35EC and decis 2.5EC + somialfa 110EC were 4.0, 3.33, 3.0, 2.33 and 1.33 times more toxic than decis 2.5EC + advantage 20EC after 72 hrs of application. Larval mortality with decis 2.5EC + curacron 500EC being 4 fold of the decis 2.5 + advantage 20EC indicate the probability of synergism.

In previous studies, organophosphates synergized pyrethroids positively against *H. armigera* (Asher *et al.*, 1986; Vaissayre and Lucas-Chauvelon, 1989; Goebel and Jacquemard, 1990). Synergism between organophosphates and pyrethroids has also been reported in other pyrethroids-susceptible heliothine species, *Helicoverpa zea* (Boddie) and *H. virescens* (F.) (All *et al.*, 1977). After acquisition of resistance against pyrethroids, the increased synergistic effect of pyrethroid and organophosphate insecticides has been reported in *Helicoverpa* larvae in United States (Campanhola and Plapp, 1989) where metabolic resistance of tobacco budworm was mostly due to the enhanced activity of mono-oxygenases (Zhao *et al.*, 1996) and in Australia (Forrester *et al.*, 1993) where resistance was explained by an increase of esterases activity (Gunning *et al.*, 1999).

The pyrethroid insecticide mixture *i.e.*, decis 2.5EC + somialfa 110EC (pyrethroid + pyrethroid) remained least toxic, showing *no* probability of synergism. These findings agree with the work of previous scientists, as the resistance to pyrethroids in *H. armigera* was reported in Australia (Gunning *et al.*, 1984), Thailand (Ahmed and McCaffery, 1988), India (McCaffery *et al.*, 1989), Turkey (Ernst and Dittrich, 1992), Indonesia (McCaffery *et al.*, 1991), and China (Shen *et al.*, 1992). The reason of this resistance has been due to nerve insensitivity, metabolic detoxification involving oxidases or esterases, and penetration

Table I.- Different insecticides showing formulations, active ingredients, groups, recommended field doses and calculated doses.

Treatments	Active ingredients	Group	Ratio for recommended field dose/acre (ml/100 L)	Calculated doses/100 ml
Decis TM 12.5EC + thiodan TM 35EC	(deltamethrin) + (endosulfan)	PY ^a + OC	250:1000	0.25+1.0
Decis TM 2.5EC + curacron TM 500EC	(deltamethrin) + profenophos)	PY + OP ^b	250:1000	0.25+1.0
Decis TM 2.5EC + somialfa TM 110EC	(deltamethrin) + (esfenvalerate)	PY + PY	250:175	0.25+0.17
Decis TM 2.5EC + advantage TM 20EC	(deltamethrin) + (carbosulfan)	PY + CA ^c	250:1000	0.25+1.0
Thiodan TM 35EC+ curacron TM 500EC	(endosulfan) + (profenophos)	OC ^d + OP	1000:1000	1.0+1.0
Thiodan TM 35EC + somialfa TM 110EC	(endosulfan) + (esfenvalerate)	OC + OP	1000:175	1.0+0.17

Groups: a, Pyrethroid; b, Organophosphorus; c, Carbamate; d, Organochlorine.

Table II.- Toxicity of different insecticide mixtures on third instar larvae of *H. armigera* at various intervals.

Treatments	Mean percent mortalities after			Relative toxicity
	24 hrs	48 hrs	72 hrs	
Decis TM 12.5EC + thiodan TM 35EC	00.0 c	25.0 cd	58.3 bc	2.33
Decis TM 2.5EC + curacron TM 500EC	25.0 b	100.0 a	100.0 a	4.0
Decis TM 2.5EC + somialfa TM 110EC	33.3 b	33.3 c	33.3 cd	1.33
Decis TM 2.5EC + advantage TM 20EC	00.0 c	25.0 cd	25.0 de	-
Thiodan TM 35EC+ curacron TM 500EC	41.6 ab	66.6 b	75.0 ab	3.0
Thiodan TM 35EC + somialfa TM 110EC	58.3 a	75.0 ab	83.3 ab	3.33
Control	00.0 c	0.0 d	00.0 e	0.0

Means sharing the same letter(s) in column are not significantly different at P=0.05

resistance (Gunning *et al.*, 1995; McCaffery, 1998). The resistance mechanism in the deltamethrin-selected strain is the result of an increased metabolic detoxification by the cytochrome P₄₅₀-dependent mono-oxygenases (Martin *et al.*, 2002). In the present studies the mixture of pyrethroid (decisTM 2.5EC) with organophosphate (curacronTM 500EC) gave 100 per cent mortality of test insect showing high probability of synergism. These findings could play important role in devising IRM strategies.

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(Received 28 June 2005, revised 9 September 2005)