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Toxicity of Certain Novel Insecticides Against Chilli Thrips, *Scirtothrips dorsalis* (Hood) in Andhra Pradesh

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ABSTRACT

Novel insecticides with different modes of action was evaluated for their efficacy against chilli thrips, *S.dorsalis*. Based on LC_{50} values the order of efficacy was spinosad > pymetrozine > diafenthiuron > imidacloprid > fipronil > clothianidin > vertimec > indoxacarb > chlorfenapyr > flubendiamide > emamectin benzoate. Spinosad, pymetrozine, diafenthiuron, imidacloprid and fipronil were highly effective and proved very successful in suppression of resistance.

Key words : Novel insecticides, Resistance management, Toxicity.

India has emerged today as the foremost producer and exporter of chillies contributing to almost 1/4th of the world's production. In India, chilli is grown in an area of 8.06 lakh ha, with a production of 12.98 lakh tonnes (Agricultural Statistics at a glance, 2009). The important chilli growing states in India are Andhra Pradesh, Orissa, Maharashtra, Karnataka and also in a number of other states as a round the year crop. In Andhra Pradesh, chilli is cultivated in an area of 1.89 lakh hectares with a production of 2.08 lakh tonnes. Guntur district in Andhra Pradesh alone contributes to over 35 per cent in area under chilli crop in the state.

The important pests in chilli are thrips, *Scirtothrips dorsalis* (Hood), white mite, *Polyphagotarsonemus latus* (Banks), aphids, *Aphis gossypii* Glover and *Myzus persicae* Sulzer as sucking complex and tobacco caterpillar, *Spodoptera litura* (Fabricius) and pod borer, *Helicoverpa armigera* (Hubner) as pod borers (Rao and Ahmed, 1985). Chilli thrips, *S. dorsalis* (Hood) (Thysanoptera : Thripidae) is a serious pest of *Capsicum annuum* L. in India, responsible for leaf curling (Ananthakrishnan, 1971). It multiplies appreciably at a faster rate during dry weather periods and the yield loss caused by the thrips is reported to range from 30-90 per cent (Borah, 1987 and Varadharajan, 1994).

Guntur district in Andhra Pradesh is traditionally a chilli growing district with an area of 63,573 ha with high input usage under monocropping conditions. Further, intensive cultivation of input responsive high yielding varieties and hybrids and sole reliance on insecticides are the common features of chilli cultivation in Guntur district. The excessive dependence on insecticides, their over use and abuse has accelerated insect control problems through development of insecticide resistance (Reddy *et al*., 1992), pest resurgence, pesticide residues (Joia *et al*., 2001), reduction in natural enemy population and environmental contamination. Moreover, several of the chilli consignments meant for export were rejected stating higher insecticide residues being the culprit, thus lots of foreign exchange lost by way of rejections. Further there were several reports from farmers experiencing difficulties in pest control. Many conventional insecticides are being used to manage these pests with which many folds of resistance was reported in pests like *S. litura* (Prasad *et al*., 2008), *Spodoptera exigua* (Hubner) (Wang *et al.,* 2002), *H. armigera* (Kranthi *et al*., 2002) *etc*. The development of insecticide resistance strains can be delayed by reducing the selection pressure and by adopting insecticide resistance management strategies and alternate insecticides with novel mode of action. In view of the above constraints in chilli cultivation, it is felt high time to estimate the current status of insecticide resistance so as to corrologate with field control problems besides evaluating newer insecticides with novel mode of action both under laboratory and field conditions so as to have better option on hand that could mitigate the present control failures and residue problems plausing the farming community.

MATERIAL AND METHODS

Among the available new synthetic organic insecticides, *viz*., fipronil, imidacloprid, spinosad, diafenthiuron, indoxacarb, pymetrozine, abamectin,

Table 1. Toxicity of new insecticides against resistant population of *S. dorsalis* of Guntur district.

S. No.	Insecticides	LC_{50} (%) (95%FL)	LC_{90} (%) (95%FL)	Slope ± S.E (b)	Heterogeneity (χ^2)	Regression equation
1	Fipronil 5% SC	0.0120 (0.0080-0.0160)	0.0390 (0.0260-0.1280)	2.492 ± 0.68	1.777	Y = 9.785+ 2.492 X
2	Imidacloprid 17.8% SC	0.0090 (0.0030-0.0260)	0.6120 (0.1330-29.7870)	0.703 ± 0.17	0.709	Y = 6.432 + 0.703 X
3	Spinosad 45% SC	0.0050 (0.0020-0.0090)	0.0920 (0.0340-1.1410)	1.002 ± 0.24	3.802	Y = 7.319 + 1.002 X
4	Diafenthiuron 50% WP	0.0080 (0.0020-0.0220)	0.7760 (0.1450-71.0480)	0.637 ± 0.16	1.103	Y = 6.352 + 0.637 X
5	Indoxacarb 14.5% SC	0.0200 (0.0110-0.0300)	0.1170 (0.0630-0.6150)	1.676 ± 0.43	3.316	Y = 7.846 + 1.676 X
6	Emamectin Benzoate 5% SG	0.0220 (0.0080-0.0510)	0.7260 (0.2320-8.1690)	0.845 ± 0.18	1.822	Y = 6.399 + 0.845 X
7	Abamaction 1.8% EC	0.0160 (0.0090-0.0210)	0.0470 (0.0310-0.1960)	2.652 ± 0.81	2.804	Y = 9.795 + 2.652 X
8	Flubendiamide 39.35% SC	0.0210 (0.0110-0.0320)	0.1140 (0.0620-0.6210)	1.745 ± 0.47	3.221	Y = 7.929 + 1.745 X
9	Chlorfenapyr 10% SC	0.0200 (0.0110-0.0300)	0.1360 (0.0690-0.9290)	1.528 ± 0.40	2.540	Y = 7.604 + 1.528 X
10	Pymetrozine 50% WDS	0.0060 (0.0030-0.0130)	0.1120 (0.0380-2.1520)	1.015 ± 0.26	3.072	Y = 7.247 + 1.015 X
11	Clothianidin 50% WDG	0.0130 (0.0060-0.0230)	0.1400 (0.0560-3.5610)	1.233 ± 0.37	4.259	Y = 7.332 + 1.233 X

Table 2. Relative toxicity of new insecticides to *S. dorsalis* on chillies in comparison with conventional insecticides

Insecticides	Number of folds toxic at LC_{50} compared to					
	Mono crotophos	Dime thoate	Ace phate	Pho salone	Car-baryl	Tri azophos
Fipronil	11.17	14.92	12.17	14.17	10.50	9.33
Imidacloprid	14.89	19.89	16.22	18.89	14.00	12.44
Spinosad	26.80	35.80	29.20	34.00	25.20	22.40
Diafenthiuron	16.75	22.38	18.25	21.25	15.75	14.00
Indoxacarb	6.70	8.95	7.30	8.50	6.30	5.60
Emamectin Benzoate	6.09	8.14	6.64	7.73	5.73	5.09
Vertimec	8.38	11.19	9.13	10.63	7.88	7.00
Flubendiamide	6.38	8.52	6.95	8.10	6.00	5.33
Chlorfenapyr	6.70	8.95	7.30	8.50	6.30	5.60
Pymetrozine	22.33	29.83	24.33	28.33	21.00	18.67
Clothianidin	10.31	13.77	11.23	13.08	9.69	8.62

chlorfenapyr, clothianidin, flubendiamide and emamectin benzoate were selected to test the relative toxicity against *S. dorsalis*. The *S. dorsalis* population of Guntur district which was found relatively resistant than Vizianagaram population was selected for this study. The toxicity of these eleven insecticides to the resistant population of Guntur district was determined by conducting leaf dip method of bioassay (FAO, 1979) as detailed in 3.3.5.1 and LC_{50} and LC_{90} values were determined.

The relative toxicity of the insecticides was calculated by dividing the LC_{50} and LC_{90} values of each of the conventional insecticides *viz,* monocrotophos, acephate, dimethoate, triazophos, phosalone and carbaryl with the corresponding LC_{50} and LC_{90} values of each of the new insecticides tested and thus the toxicity of new insecticides compared to the conventional ones were determined for the management of the resistant population of *S. dorsalis*.

RESULTS AND DISCUSSION

The LC_{50} and LC_{90} values of fipronil were 0.0120 and 0.0390 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). When the toxicity of fipronil was compared with monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos, it was found to be 11.17, 14.92, 12.17, 14.17, 10.50 and 9.33 times more toxic at LC_{50} and 9.15, 9.03, 11.18, 9.10, 11.90 and 7.13 times more toxic at LC_{90} than the respective insecticides (Table 2 & 2a). The LC_{50} and LC_{90} values of imidacloprid were 0.0090 and 0.6120 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). Imidacloprid was found to be 14.89, 19.89, 16.22, 18.89, 14.00 and 12.44 times more toxic at LC_{50} and 0.58, 0.58, 0.71, 0.58, 0.76 and 0.45 times more toxic at LC_{90} than monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos at LC_{50} and $LC_{90,}$ respectively (Table 2 & 2a). The LC_{50} and LC_{90} values of indoxacarb were 0.0200 and 0.1170 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). Indoxacarb was found to be 6.70, 8.95, 7.30, 8.50, 6.30 and 5.60 times more toxic at LC_{50} and 3.05, 3.01, 3.73, 3.03, 3.97 and 2.38 times more toxic at LC_{90} than monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos at LC_{50} and $LC_{90,}$ respectively (Table 2 & 2a). The LC_{50} and LC_{90} values of spinosad were 0.0050 and 0.0920 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). When the toxicity of spinosad was compared with monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos, it was found to be 26.80, 35.80, 29.20, 34.00, 25.20 and 22.40 times more toxic at LC_{50} and 3.88, 3.83, 4.74, 3.86, 5.04 and 3.02 times more toxic at LC_{90} than the respective insecticides (Table 2 & 2a). The LC_{50} and LC_{90} values of emamectin benzoate were 0.0220 and 0.7260 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). Emamectin benzoate was found to be 6.09, 8.14, 6.64, 7.73, 5.73 and 5.09 times more toxic at LC_{50} and 0.49, 0.48, 0.60, 0.49, 0.64 and 0.38 times more toxic at LC_{90} than monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos at LC_{50} and $LC_{90,}$ respectively (Table 2 & 2a). The LC_{50} and LC_{90} values of diafenthiuron were 0.0080 and 0.7760 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). When the toxicity of diafenthiuron was compared with monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos, it was found to be 16.75, 22.38, 18.25, 21.25, 15.75 and 14.00 times more toxic at LC_{50} and 0.46, 0.45, 0.56, 0.46, 0.60 and 0.36 times more toxic at LC_{90} than the respective insecticides (Table 2 & 2a). The LC_{50} and LC_{90} values of pymetrozine were 0.0060 and 0.1120 per cent, respectively (Table 1). Comparison of the toxicity of pymetrozine with monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos revealed that it was 22.33, 29.83, 24.33, 28.33, 21.00 and 18.67 times more toxic at LC_{50} and 3.19, 3.14, 3.89, 3.17, 4.14 and 2.48 times more toxic at $LC_{90,}$ respectively (Table 2 & 2a). The LC_{50} and LC_{90} values of abamectin were 0.0160 and 0.0470 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). Abamectin was found to be 8.38, 11.19, 9.13, 10.63, 7.88 and 7.00 times more toxic at LC_{50} and 7.60, 7.49, 9.28, 7.55, 9.87 and 5.91 times more toxic at LC_{90} than monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos at LC_{50} and $LC_{90,}$ respectively (Table 2 & 2a). The LC_{50} and LC_{90} values of clothianidin were 0.0130 and 0.1400 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). When the toxicity of clothianidin was compared with monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos, it was found to be 10.31, 13.77, 11.23, 13.08, 9.69 and 8.62 times more toxic at LC_{50} and 2.55, 2.51, 3.11, 2.54, 3.31 and 1.99 times more toxic at LC_{90} than the respective insecticides (Table 2 & 2a). The LC_{50} and LC_{90} values of chlorfenapyr were 0.0200 and 0.1360 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). Comparison of the toxicity of

Table 2a. Relative toxicity of new insecticides to *S. dorsalis* on chillies in comparison with conventional insecticides

Insecticides	Number of folds toxic at LC_{90} compared to					
	Mono crotophos	Dime thoate	Ace phate	Pho salone	Car- baryl	Tri azophos
Fipronil	9.15	9.03	11.18	9.10	11.90	7.13
Imidacloprid	0.58	0.58	0.71	0.58	0.76	0.45
Spinosad	3.88	3.83	4.74	3.86	5.04	3.02
Diafenthiuron	0.46	0.45	0.56	0.46	0.60	0.36
Indoxacarb	3.05	3.01	3.73	3.03	3.97	2.38
Emamectin Benzoate	0.49	0.48	0.60	0.49	0.64	0.38
Vertimec	7.60	7.49	9.28	7.55	9.87	5.91
Flubendiamide	3.13	3.09	3.82	3.11	4.07	2.44
Chlorfenapyr	2.63	2.59	3.21	2.61	3.41	2.04
Pymetrozine	3.19	3.14	3.89	3.17	4.14	2.48
Clothianidin	2.55	2.51	3.11	2.54	3.31	1.99

chlorfenapyr with monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos revealed that it was 6.70, 8.95, 7.30, 8.50, 6.30 and 5.60 times more toxic at LC_{50} and 2.63, 2.59, 3.21, 2.61, 3.41 and 2.04 times more toxic at $LC_{90,}$ respectively (Table 2 & 2a). The LC_{50} and LC_{90} values of flubendiamide were 0.0210 and 0.1140 per cent respectively to the resistant population of *S. dorsalis* of Guntur district (Table 1). Flubendiamide was found to be 6.38, 8.52, 6.95, 8.10, 6.00 and 5.33 times more toxic at LC_{50} and 3.13, 3.09, 3.82, 3.11, 4.07 and 2.44 times more toxic at LC_{90} than monocrotophos, dimethoate, acephate, phosalone, carbaryl and triazophos at LC_{50} and $LC_{90,}$ respectively (Table 2 & 2a).

Spinosad was superior to all other novel insecticides tested and also to the commonly used insecticides *viz*., monocrotophos, acephate, dimethoate, phosalone, triazophos and carbaryl at LC_{50}. The superior toxicity of spinosad was also reported against several lepidopteran caterpillars. Since spinosad belongs to a new class of natural insecticide which has spinosyn as an active principle with novel mode of action. It acts on the central nervous system by activation of nicotinic acetylcholine receptors and also effects on GABA gated chloride channels. pymetrozine can be used as an effective tool for the management of resistant population of *S. dorsalis* on chilli as it belongs to a new group of insecticides with different mode of action which blocks the stylet penetration. Imidacloprid can also be used as an effective tool for the management of resistant population of *S. dorsalis* on chilli as it belongs to a new group of insecticides *i.e*., neonicotinyl compounds with different mode of action which act by binding with nicotine acetyl choline receptors.

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