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Relative toxicity of some insecticides and azadirachtin against four crop infesting aphid species

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Abtract: Indirect application was used to assay the toxicity of five insecticides; viz. malathion, carbosulfan, cymbush, imidacloprid and azadirachtin against four important crop infesting aphid species, *Aphis craccivora* Koch, *Aphis gossypii* Glover, *Myzus persicae* (Sulzer) and *Lipaphis erysimi* (Kaltenbach), reared on bean, brinjal, potato and cauliflower plants respectively. Residual film technique was applied by bringing leaves with tested aphids of the vegetable plants in the laboratory. Malathion was the least toxic to all aphids having LC_{50} as 327.97, 333.92, 305.26 and 313.77 µg cm^{-2} for *A. craccivora, A. gossypii, M. persicae* and *M. persicae* respectively. Cypermethrin was the most toxic showing LC_{50} as 12.55, 12.29, 12.55 and 12.10 µg cm^{-2} in the above mentioned species of aphid respectively. Carbosulfan and imidacloprid showed moderate toxicity. Azadirachtin as a natural plant origin insecticide proved to be the most toxic having LC_{50} as 0.41 µg cm^{-2} for *A. craccivora*, 0.34 µg cm^{-2} for *A. gossypii* and 0.44 µg cm^{-2} for both *M. persicae* and *L. erysimi.*

Key words: Insecticide, toxicity, azadirachtin, *Aphis craccivora, Aphis gossypii, Myzus persicae, Lipaphis erysimi*

Introduction

Aphids are small and soft-bodied insects with considerable morphological polymorphism, such as intraspecies colour variation, apterous (wingless) females and alate (winged) adults, etc. Of all aphid subfamilies, Aphididae is the most diverse and exceptionally host specific, except for a number of species that are polyphagous agricultural pests (von Dohlen *et al*., 2006; Farag & Gesraha, 2007; Lu *et al*., 2008). Aphid feeding causes an alteration of plant source-sink relationships (Girousse *et al*., 2005), the induction of premature leaf senescence (Pegadaraju *et al*., 2005), secondary pathogen infection through fungal growth on aphid honeydew, and the transmission of plant viruses (Liu & Yue, 2001; Bridges *et al*., 2001; Gray & Gildow, 2003; Rana, 2005). In addition to damages caused directly through feeding behaviour, the sooty mold induced by the great amount of aphid honeydew, will hamper photosynthesis, leaving plants wither rapidly. Furthermore, the short generation time and impressive fecundity of aphids accelerate the vicious circle causing considerable economical loss (Lane & Walters, 1991; Blackman & Eastop, 2000). Economic importance of aphids may be summarized as; (1) Removal of plant sap causes wilting and curling of the leaves (2) by the toxic action of their salivary secretions, causing galls on leaves, stems or roots (3) honeydew excretion favours the secondary growth of fungus and moulds which further damage the growth of leaves and young shoots (4) as plant virus vectors, causing many diseases of plants (Toper Kaygın *et al*., 2008).

Chemical control would continue to be the first line of defense against mustard aphid particularly under out break situation. More than 90% mortality of aphids is possible by use of systemic insecticides but the population attains similarity under treated and untreated field within a period of 2 to 3 weeks due to high rate of multiplication (Singh *et al.*, 1984). The ultimate bioassay of any pesticide must be its evaluation under field conditions. However, such trails are not practical for all purposes, since they are expensive of time and labour, and are subjects to the vagaries of weather and severity of pest infestation. It is therefore necessary to assess the toxicity of a chemical under a carefully controlled laboratory conditions as a prerequisite to extensive field trails.

The efficacy of residual assays for measuring toxicity has been demonstrated numerous times (Busvine, 1971, 1980). In direct application, aphids take up insecticide either by contact with a treated surface, by ingestion or as vapour. Some methods can examine these routes in isolation, but in the most widely used technique of placing aphids on treated leaves, all three routes may be involved (Devonshire & Rice, 1988). In this experiment indirect application (residual film method) was used to assay with five insecticides; viz. malathion, carbosulfan, cymbush, imidacloprid and azadirachtin on four important aphid species, *Aphis craccivora* Koch, *Aphis gossypii* Glover, *Myzus persicae* (Sulzer) *and Lipaphis erysimi* (Kaltenbach), which permit uniform coverage on the leaf surface.

Materials and Methods

A. craccivora, A. gossypii, M. persicae and L. erysimi populations were reared on bean, brinjal, potato and cauliflower plants respectively. Residual film technique (Busvine, 1971) was applied by bringing leaves with test aphids of the vegetable plant in the laboratory. Insecticides were serially diluted in acetone and a fixed volume (0.1 ml) of insecticide solution was dropped on 2.4 cm circular leaf, placed previously on a petridish (9 cm diameter). Each insecticide was tested with four doses having three replications. The doses were 462.66,

370.13, 277.60, 185.06 µg cm^{-2} for malathion (97% technical); 64.93, 48.70, 32.46, 16.23 µg cm^{-2} for carbosulfan (94% technical); 24.35, 16.23, 12.17, 8.11 µg cm^{-2} for cypermethrin (96% technical); 48.70, 32.46, 16.23, 8.11 µg cm^{-2} for imidacloprid (96% technical) and 0.77, 0.58, 0.38, 0.19 µg cm^{-2} for azadirachtin (nimbicidin 0.2%). A separate control batch was maintained in which only acetone was dropped on the surface of leaf. Petiole of the leaf was wrapped with wet cotton bud.

The mortality of the aphid was recorded after 24 hours of treatment. Corrected mortality (%) was calculated using Abbott's formula (Abbott, 1925). Probit regressions were estimated from mortality data according to the probit analysis of Busvine (1971) using a computer software developed in the Department of Agriculture and Environmental Science, University of Newcastle Upon Tyne, UK.

Results and Discussion

The $LC_{50,}$ 95% confidence limits, regression equations and chi-square values are presented in Table 1. Malathion was the least toxic to all aphids having LC_{50} as 327.97, 333.92, 305.26 and 313.77 µg cm^{-2} for *A. craccivora, A. gossypii, M. persicae* and *M. persicae* respectively. Among insecticides used cypermethrin was the most toxic showing LC_{50} as 12.55, 12.29, 12.55 and 12.10 µg cm^{-2} in the above mentioned species of aphid respectively. Carbosulfan and imidacloprid showed moderate toxicity. Azadirachtin as a natural plant origin insecticide proved to the most toxic having the LC_{50} as 0.41 µg cm^{-2} for *A. craccivora*, 0.34 µg cm^{-2} for *A. gossypii* and 0.44 µg cm^{-2} for both *M. persicae* and *L. erysimi.* In all cases no significant heterogeneity was found.

Pareek & Kavadia (1988) observed the effect of toxicity of nine insecticides on *A. gossypii* reared on musk melon. Furk & Vedjhi (1990) used glasshouse populations of *A. gossypii* on chrysanthemum to test primicarb (900 mg a.i./l), which kills 100% susceptible and 0% to 20% resistant aphids. Kerns and Gaylor (1992ab) used cypermethrin (3 ppm), dicrotophos (17 ppm) and sulprofos (840 ppm) on *A. gossypii* on cotton leaf disc in laboratory.

Table 1. LC_{50}, 95% confidence limits and regression equations of different insecticides on different adult aphid species after 24 hours.

Insecticide	Aphid species	LC_{50} µg cm^{-2}	95% confidence limits		Regression equation	(χ^2 at 2df)
			Lower	Upper		
Malathion	*A. craccivora*	327.97	284.75	377.75	Y= – 4.808203 + 3.898582X	0.07
	A. gossypii	333.92	295.29	377.59	Y= – 6.606956 + 4.599293X	0.82
	M. persicae	305.26	268.16	347.49	Y= – 5.657588 + 4.289325X	0.19
	L. erysimi	313.77	276.45	356.12	Y= – 6.035272 + 4.420096X	1.38
Carbosulfan	*A. craccivora*	33.52	28.00	40.11	Y= 0.03564119 + 3.254754X	2.20
	A. gossypii	34.36	28.22	41.82	Y= 0.6037893 + 2.86207X	4.70
	M. persicae	33.87	28.47	40.29	Y= – 0.1129513 + 3.34211X	1.22
	L. erysimi	38.46	31.62	46.75	Y= 0.5007954 + 2.838644X	1.23
Cypermethrin	*A. craccivora*	12.55	10.84	14.52	Y= 0.6553388 + 3.954181X	2.04
	A. gossypii	12.29	10.82	13.95	Y= – 0.1328015 + 4.71093X	0.59
	M. persicae	12.55	10.91	14.44	Y= 0.4131098 + 4.174335X	1.05
	L. erysimi	12.10	10.22	14.32	Y= 1.251157 + 3.461651X	0.11
Imidacloprid	*A. craccivora*	21.14	16.96	26.33	Y=1.555902 + 2.599273X	1.07
	A. gossypii	22.34	17.05	29.26	Y=2.225848 + 2.056378X	0.43
	M. persicae	21.25	16.43	27.48	Y=2.09961 + 2.184966X	1.17
	L. erysimi	21.52	16.49	28.06	Y=2.2328 + 2.07619 X	0.37
Azadirachtin	*A. craccivora*	0.41	0.33	0.49	Y=3.24277 + 2.889528X	0.95
	A. gossypii	0.34	0.27	0.41	Y=3.38501 + 3.072167X	1.06
	M. persicae	0.44	0.36	0.53	Y=3.130178 + 2.916688X	0.45
	L. erysimi	0.44	0.36	0.53	Y=3.119209 + 2.909572X	4.67

Some authors made detailed studies on the toxic effect of imidacloprid to *M. persicae* (Jarande & Dethe, 1994; Natwick *et al*., 1996; Sweeden & McLeod, 1997; Vantornhout, *et al*. 1999; Boiteau & Singh, 1999). Aslam *et al.* (2001) observed that one day after insecticide application mortality of *Brevicoryne brassicae* (Linn.) in Imidacloprid 25WP, Carbosulfan 20EC and Triazophos 40EC treated plots was non-significantly different from each other, but was significantly higher than that in Imidacloprid 200SL and control. Mohammad *et al.* (2008) recorded LD_{50} of pirimicarb from 2.52 to 3.37 ng per insect for *M. persicae*. Rana *et al.* (2007) tested imidacloprid 200 SL, carbosulfan 20EC and bifenthrin10 EC and found all

tested insecticides performed better against mustard aphid as compared to untreated plots, yet carbosulfan proved to be the most effective insecticide. The obtained results were matched with those results obtained by Nucifora (1998) when applied imidacloprid to control *Aphis gossypii* associated with small colonies of *M. persicae* and *Toxoptera aurantii* infestation, who mentioned that imidacloprid activity was very satisfactory. Imidacloprid acts on the nicotinic acetycholine receptor, causing the insect to reduce or stop feeding, and reduces mobility (Gourment *et al.*, 1994; Boiteau & Osborn, 1997).

A number of insecticides, i.e. phosphamidan (0.02%), dimethoate (0.02%), methyl-demeton (metasystox) (0.10%), fenthion (0.75%), and disulfan (0.10%), formothion, carbaryl and thiometon as foliar spray against aphids on mustard gave 59.0 to 93.4 percent mortality after 72 hours of treatment when compared with check (12.4%) (Sharma & Joshi, 1972). Application of cartap hydrochloride (Padan 10 G) and monocrotophos, reduced 91.59 and 90.80 percent aphid population in mustard (Hussain & Begum, 2000).

A comparison of the LC_{50} values of different insecticides against *L. erysimi* indicate that endosulfan was least effective while deltamethrin, methyl-O-demeton and monocrotophos were more toxic (Geol & Sachan, 2002). Tang *et al.* (2001) observed that the lethal concentration of azadirachtin resulting in 50% mortality (LC_{50}) of adult aphids (3782 ppm at 2 d and 30.37 ppm at 4 d post-treatment) was much higher than that of aphid nymphs (41.91 ppm at 2 d and 3.99 ppm at 4 d post-treatment). Neem-based insecticides have been found to have little impact on many beneficial organisms such as honey bees, predators and parasitoids (Lowery & Isman, 1995). In the present experiment azadirachtin offered better result because the LC_{50} values were lower than the values of the insecticides used.

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