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Toxicity of Some Commonly Used Insecticides Against *Coccinella undecimpunctata* (Coleoptera: Coccinellidae)

Munir Ahmad,[1,*] Muhammad Rafiq,[2] Muhammad Iqbal Arif[2] and Ali H. Sayyed[3]
[1]*Department of Entomology, Arid Agriculture University, Murree Road, Rawalpindi, Pakistan*
[2]*Central Cotton Research Institute, Old Shujabad Road, Multan, Pakistan*
[3]*Institute of Biotechnology, Bahauddin Zakariya University, Multan, Pakistan*

Abstract.- *Coccinella undecimpunctata* is one of the most common indigenous predators of sucking insect pests such as aphids, mealybugs, whiteflies on different crops like cotton, sunflower, fruit plants and vegetables. Effect of some commonly used insecticides like imidacloprid, acetamiprid, cypermethrin, deltamethrin and profenofos were tested for their residual effects using glass vial method and treated leaves for the residual effects of insecticides. Mortality of adult *C. undecimpunctata* at 24, 48 and 72 hours ranging from 50-91% and 10-78 % was observed in glass vial and treated leaves methods, respectively. Profenofos was the most toxic insecticide in both methods whereas imidacloprid caused the lowest mortality. Field sprayed leaves exposure proved imidacloprid the least toxic insecticide. In residual film method, acetamiprid was the least toxic but most toxic in glass vial method.

Key words: Ladybird beetle; neonicotiniods, pyrethroids, organophosphate.

INTRODUCTION

The use of insecticides is considered as a rapid and effective control method of different insect pests with more interest when accompanied with indigenous or exotic biocontrol agents (Stauffer and Rose, 1997; Miller and Utez, 1998). The overuse of insecticides however has resulted in problems such as insecticides resistance, pest resurgence and residues on crops (Khaliq *et al*., 2007). This led to adopt alternative strategies of pest management, such as biological control. Biocontrol agents, such as predators and parasitoids, are considered as important tools in integrated management of economic insect pests. Recent resurgence of sucking insect pests such as mealybugs and whiteflies, made indispensable to use and develop indigenous parasitoids and predators (Anonymous, 2007). Eleven-spot ladybirdbeetle, *Coccinella undecimpunctata* (Coleoptera: Coccinellidae) plays vital role in management of sucking insect pests on cotton, sunflower, citrus, vegetables and weeds (Smith and Krischik, 2000; Naveed *et al*., 2007; Saeed *et al*., 2007; Ahmad *et al*., 2008).

Diversification of habitat and food sources with refraining from the usage of broad-spectrum pesticides can help the biocontrol agents to improve their effectiveness. Coccinellid susceptibility to insecticides varies with the species and the type of insecticide (Candolfi *et al*., 1999) as well as with the nature of exposure (Grafton-Cardwell and Gu, 2003). Previous studies have examined harmful effects of old-generation insecticides on coccinellids (Banken and Stark, 1997) but only limited studies on neonictinoids have been done. For example, imidacloprid and acetamiprid have been continuously used against sucking insect pests of cotton for several years (Razaq *et al*., 2003; Naveed *et al*., 2007) but there is little information about their impacts on predators. In addition, these pesticides are considered selective to some beneficial insects, including families Cybocephalidae, Coccinellidae, Syrphidae and Chrysopidae (Erkilic and Uygun, 1997; Jansen, 2000; James, 2002) and are recommended for integrated pest management (IPM). We evaluated the lethal effects of different insecticides, two neonicotinoids *viz.* imidacloprid and acetamiprid, two pyrethroids *viz.* cypermethrin and deltamethrin, and one organophosphate *viz.* profenofos, which are used at early and middle stage of cotton cycle, on survival of *C. undecimpunctata.*

* Corresponding author: munirahmad@uaar.edu.pk
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MATERIALS AND METHODS

Insects

Adults of *C. undecimpunctata* were used for residual/indirect exposure to insecticides as this stage has shown a particular response of leaving a sprayed field after insecticide application (personal observations). To establish populations of whiteflies and mealybugs on cotton, cotton crop was grown in a field without the application of any pesticide at Central Cotton Research Institute (Multan, Pakistan) in 2008. This field was also used as the stock of *C. undecimpunctata* for the experiments.

Laboratory bioassays

Imidacloprid (Confidor® 20SL, 100 ml/acre, Bayer Crop Science), acetamiprid (Mospilon® 125SP, 330 ml/acre, UDL), cypermethrin (Arrivo® 10EC, 330 ml/acre, FMC), deltamethrin (Decis Super® 10.5EC, 125 ml/acre, UDL) and profenofos (Curacron® 50EC, 800 ml/acre, Syngenta) were used in the experiments.

Scintillation glass vials (30 ml) were used for insecticide residual exposure testing. Three different methods were adapted including: (1) treatment of insects directly with field doses of insecticides in glass vials, (2) treatment of insects with insecticide-treated leaf discs in leaf dip method placed in glass vials (3) treatment of insects with insecticide-treated leaves of field sprayed plots placed in glass vials and (4) treatments of insects with serial concentrations of insecticides in glass vials in order to determine their LC_{50} values (Ahmad *et al*., 2008). To determine the residual activity of insecticides, the beetles were exposed in these bioassays and placed in glass vials. Ten adult beetles were exposed in each vial with three vials as replicates per insecticide tested. Three to six serial concentrations for each insecticide were used. After releasing *C. undecimpunctata* in the treated glass vials, their opening were closed with cotton plugs. Mealybugs were provided as food of *C. undecimpunctata* adults. The experiments were kept under a standard constant environment (25±2°C, 65±5% RH and L:D 16:8 h). Mortality was assessed after 24, 48 and 72 h exposure to insecticides for field-dose experiments and after 48 and 72 h for serial concentrations.

Field experiments

Cotton field were sprayed with above-mentioned insecticides, and cotton leaves were then collected after 2 and 24 h. . In laboratory, leaves were exposure to *C. undecimpunctata* adults in 30 ml scintillation glass vials for residual testing. Mealybug nymphs were also provided in these vials as food of *C. undecimpunctata* adults. Mortality was measured after 24, 48 and 72 h.

Data analysis

Mortality data was corrected using Abbott (1925) formula, which was then used to determine LC_{50} values and their confidence interval using probit analysis (Finney, 1971) in POLO-PC (LeOra Software, 2003). Mean comparisons were performed using the least significant difference (LSD).

RESULTS AND DISCUSSION

In film residual test (Table I), profenofos resulted in about 87% mortality followed by acetamiprid and Cypermethrin with 63% kill. Minimum mortality observed was due to imidacloprid and deltamethrin with 53% mortality after 24 hours exposure. After 48 hr exposure, highest mortality was observed in profenofos and Cypermethrin with minimum in imidacloprid. Imidacloprid did not showed increase in mortality after 72 hours as compared to other insecticides with more than 80% kill, however, differ statistically. In contrast, Delbeke *et al.* (1997) reported high residual activity of imidacloprid against *Orius laevigatus.*

Table I.- Percent mortality of *C. undecimpunctata* adult beetles when exposed to residual film method in glass vials in the laboratory.

Treatments	*n	Rate (ml/ 100 L)	% mortality		
			24 h	48 h	72 h
Imidacloprid	30	100	53.3 c	53.3 c	53.3 c
Acetamiprid	30	125	63.3 b	83.3 b	83.3 b
Cypermethrin	30	330	63.3 b	93.3 a	93.3 a
Deltamethrin	30	125	53.3 c	83.3 b	83.3 b
Profenofos	30	800	86.7 a	93.3 a	93.3 a
Control	30	0.0	0.0 d	0.0 d	0.0 d

Means sharing a letter do not differ statistically at 0.05% probability level (LSD test).
*n = three replicates with 10 beetles per glass vial.

Exposure of adults of lady bird beetles on insecticide treated cotton leaves at field dose rates showed profenofos highly toxic as compared to other tested insecticides follwed by deltamethrina dn acetamiprid (Table II). Imidacloprid and cypermethrin were responsible for low level of *C. undecimpunctata* mortality with about 20% after 72 hours exposure period.

Table II.- Percent mortality of *C. undecimpunctata* adult beetles when exposed to cotton leaves treated with leaf dip method in the laboratory.

Treatments	*n	Rate (ml/ 100 L)	% mortality		
			24 h	48 h	72 h
Imidacloprid	30	100	0.0 c	13.3 d	20.0 d
Acetamiprid	30	125	20.0 b	43.3 c	53.3 c
Cypermethrin	30	330	0.0 c	0.0 e	23.3 d
Deltamethrin	30	125	23.3 b	53.3 b	63.3 b
Profenofos	30	800	73.3 a	83.3 a	83.3 a
Control	30	0.0	0.0 c	0.0 e	0.0 e

Means sharing a letter do not differ statistically at 0.05% probability level (LSD test)
*n = three replicates with 10 beetles per glass vial

Table-III.- Percent mortality of *Coccinella undecimpunctata* adult beetles when exposed to field sprayed cotton leaves in the laboratory.

Treatments	*n	Rate (ml/ 100 L)	% mortality		
			24 h	48 h	72 h
Leaves exposed 2 hr after spray					
Imidacloprid	30	100	6.7 b	26.7 b	23.3 b
Acetamiprid	30	125	43.3 a	63.3 a	73.3 a
Leaves exposed 24 hr after spray					
Imidacloprid	20	100	10.0 b	10.0 b	13.3 b
Acetamiprid	20	125	16.7 a	16.7 a	63.3 a

Means sharing a letter do not differ statistically at 0.05% probability level (LSD test).
n = 30 (with 10 adults per vial as one replicate)

Two nicotinoids *i.e.*, imidacloprid and acetamiprid were compared for toxicity of field sprayed leaves against *C. undecimpunctata* (Table III). Mortality percentage of *C. undecimpunctata* decreased from 23 to 13% with delay of 24 hour exposure for imidacloprid and 73 to 63% for acetamiprid. High mortality occured with acetamiprid which was also toxic in laboratory treated leaf discs (Table II). Decline in mortality to 13% due to imidacloprid treated leaf exposure to *C. undecimpunctata* could be helpful in early crop stage role of *C. undecimpunctata* for management of insect pests in cotton crop. These results suggest that imidacloprid was the safest tested insecticides to *C. undecimpunctata*.

In bioassays for LC_{50} values and their comparison, profenofos was the most toxic insecticide against *C. undecimpunctata* with the least LC_{50} value of 3.02 and 2.35 ppm after 48 and 72 hr exposure (Table IV). High slope values of profenofos also confirmed the homogenous toxic response against *C. undecimpunctata*. Based on lowest LC_{50} values, other insecticides values were compared by dividing their values to that of profenofos. Data after 48 hr exposure showed, however, acetamiprid as the least toxic insecticide compared with imidacloprid and pyrethroids tested. Acetamiprid was also least toxic after 72 hr exposure followed by imidacloprid, cypermethrin and deltamethrin. Both pyrethroids

Different ways of exposure to imidacloprid caused insignificant mortality to *C. undecimpunctata*. Our results indicated that *C. undecimpunctata* survived from residual and contacts applications of imidacloprid at field dose rate (100 mg a.i./1). Imidacloprid proved harmless to *Perillus bioculatus* after 24 h of contact with recently sprayed potato foliage (Hough-Goldstein and Whalen, 1993). Imidacloprid has also been observed as harmless to the predatory insects like *Deraeocoris nebulosus*, *Olla v-nigrum*, *Chrysoperla rufilabris* and predatory mites like *Neoseiulus couegae*, *Phytoseiulus macropilis* and *Proprioseiopsis mexacanus* (Mizell and Sconyers, 1992). However, it has been observed harmful to *P. maculiventris* through ingestion (De Cock *et al.*, 1996). Use of imidacloprid in IPM, therefore, could be recommended against sucking pests such as whitefly and aphids particularly in horticultural crops (*e.g.*, cabbage and potato).

Acetamiprid, a long term residual insecticide, is an agonist of the nicotinic acetylcholine receptor and affects the synapses in the insect central nervous system (Tomlin, 2001). Previously, it was found harmless to spiders in the field (Beltramin da Fonseca *et al.*, 2008) and *Neoseiulus* mites (Poletti *et al.*, 2007) but it was harmful for *C. undecimpunctata* in our studies. The topical

Table IV.- Response of *Coccinella undecimpunctata* adult beetles for laboratory bioassay for LC_{50} values.

Insecticides	Time (hr)	LC_{50} ul/ml	FL at 95%	Slope±SE	χ^2	df	P	CV	n
Imidacloprid	48	34.2	21.7-46.9	2.75±0.61	0.29	3	0.96	11.3	120
	72	28.7	12.9-40.9	3.18±1.06	0.14	2	0.93	12.2	100
Acetamiprid	48	93.5	51.2-305	1.46±0.48	0.24	3	0.97	30.9	120
	72	50.0	24.8-100	1.41±0.38	0.88	4	0.93	21.3	140
Cypermethrin	48	44.9	26.7-100	1.07±0.25	1.05	4	0.90	14.9	140
	72	22.8	10.6-42.9	1.54±0.45	0.26	3	0.97	9.7	120
Deltamethrin	48	32.8	17.8-60.7	1.86±0.56	0.57	3	0.90	10.9	120
	72	14.0	5.32-24.2	1.86±0.51	0.59	3	0.90	5.9	120
Profenofos	48	3.02	1.87-4.13	3.08±0.69	0.53	3	0.91	1.0	120
	72	2.35	1.51-3.15	3.20±0.76	1.86	2	0.39	1.0	100

*CV = comparative value
n = 5 beetles as replicate with 20 per concentration level.

application of acetamiprid, however, led moderate to high acute toxicity in *Deraeocoris* nymphs (Kim *et al*., 2006).

Use of conventional management tactics for sucking insect pests control on different crop regimes comprise regular application of insecticides in organophosphates, pyrethroids and other groups (Townsend *et al*., 2000). Imidacloprid was the safest insecticides compared with pyrethroids, organophosphates and acetamiprid. Rise in concern about environmental and economic issues, stress should be focused on alternate control methods such as biocontrol and microbial controls. However, old generation insecticides can limit the survival and effectiveness of biocontrol tools. Sublethal exposure to insecticides can also alter coccinellid beetles behaviour and reduce their abilities to locate prey (Singh *et al*., 2001). However, merging safer insecticides like imidacloprid with coccinellid beetles might be helpful to implement various IPM strategies and conserve biocontrol agents.

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