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Further Studies on the safety of Pesticides to *Anagyrus dactylopii* (Hym., Encyrtidae) and Cryptolaemus montrouzieri (Coleop., Coccinellidae)

M.MANI and A.KRISHNAMOORTHY
Biological Control Laboratory I
Division of Entomology and Nematology
Indian Institute of Horticultural Research
Bangalore - 560 089

ABSTRACT

Five insecticides and ten fungicides at the recommended field dosages were evaluated for their safety to the encyrtid parasitoid *Anagyrus dactylopii* (How.) and the coccinellid predator *Cryptolaemus montrouzieri* Muls. of *Maconellicoccus hirsutus* (Green). Quinalphos (0.05%), endosulfan (0.07%), malathion (0.1%), carbaryl (0.1%) and fenthion (0.1%) proved highly toxic to both the species. Fungicides except fosetyl-Al, dinobuton and dinocap were found harmless. Carbaryl had significantly high toxic residual activity upto 28 days after treatment against both the biocontrol agents. Fungicides, fosetyl-Al (0.2%) dinobuton (0.1%) and dinocap (0.1%) which inflicted 16- 40% mortality of *Cryptolaemus* adults on the day of application became non-toxic one day after treatment. Toxic residual activity of endosulfan and fenthion against *A. dactylopii* and *C. montrouzieri* decreased significantly in 7 days.

Key Words : *Anagyrus dactylopii, Cryptolaemus montrouzieri,* safety, pesticides

The encyrtid, *Anagyrus dactylopii* (How.) is a key parasitoid of the grape mealybug, *Maconellicoccus hirsutus* (Green) while *Cryptolaemus montrouzieri* Muls. is an effective coccinellid predator used in the suppression of mealybugs infesting citrus, grapes, guava etc. (Mani and Krishnamoorthy, 1989). With a view to develop sound pest management programmes, 16 pesticides were screened earlier for their safety to these two natural enemies (Mani and Thontadarya, 1988a & b). In the present study, five more commonly used insecticides in the orchard ecosystem and ten more fungicides were evaluated for their safety to *A. dactylopii* and *C. montrouzieri.*

MATERIALS AND METHODS

Both *A. dactylopii* and *C. montrouzieri* were multiplied on the laboratory-bred *M. hirsutus* as suggested by Mani and Thontadarya (1988 a & b). The experiments were conducted at 26±1.5°C and 60-70% RH. Five insecticides and ten fungicides were tested at doses recommended for the field (Table 1) to determine their toxicity to the natural enemies following the technique suggested by Mani and Thontadarya (1988b). The pesticides were sprayed on potted grapevine plants separately, and three leaves from each treated plant representing three replications were removed for exposure to the natural enemies. One-to-two day old adults were confined in glass vials in which treated leaves were held. Adults were fed with 50% honey solution. Mortality of adults was recorded 1,3,6 and 24 h after exposure. Tap water spray served as check for correcting the mortality in the treatments. The pesticides which proved toxic to the natural enemies in the first experiment were evaluated for their residual toxicity. Ten adults were exposed to the treated leaf surface at weekly intervals until there was no residual toxicity. The mortality was recorded after 24 h exposure. The data with percentages were converted into corresponding angles for statistical analysis. Zero values were converted to 0.01.

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RESULTS AND DISCUSSION

Contact toxicity

The data in Table 1 indicated that all the insecticides had significant adverse effect on the adults of *A. dactylopii*. Quinalphos, malathion and fenthion though had less knock-down effect, proved highly toxic at 24h but endosulfan showed very high knock-down effect compared to carbaryl. The toxicity of carbaryl to yet another encyrtid Leptomastix dactylopii How. has also been reported earlier (Anonymous, 1985). No mortality of *A. dactylopii* was observed with any of

Table 1. Effect of pesticides on *Anagyrus dactylopii* (Figures in parenthesis are transformed values)

Treatments	% Mortality of adults				Mean
	Hours after application				
	1	3	6	24	
Quinalphos 0.05% (Ekalux 20 EC)	4.00 (7.37)	16.00 (23.30)	76.00 (60.75)	94.00 (78.90)	47.50 (42.58)
Endosulfan 0.07% (Thiodan 35 EC)	96.00 (82.59)	98.00 (86.28)	100.0 (89.96)	100.0 (89.96)	98.50 (87.20)
Malathion 0.05% (Cythion 50 EC)	14.00 (21.67)	28.00 (31.74)	80.00 (63.70)	100.0 (89.96)	55.50 (51.76)
Carbaryl 0.10% (Sevin 50 WP)	36.00 (36.81)	50.00 (44.98)	92.00 (75.22)	100.0 (89.96)	69.50 (61.74)
Fenthion 0.10% (Lebaycid 1000)	4.00 (7.37)	5.00 (8.64)	8.00 (12.68)	92.00 (77.28)	27.25 (26.49)
Metalaxyl + mancozeb 0.20% (Ridomil MZ 72)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Fosetyl-Al 0.20% (Aliette 80 WP)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Triforine 0.10% (Saprol 15 EC)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Hexaconazole 0.05% (Anvil 5 SC)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Dinobuton 0.10% (Acrex 30 EC)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Triazol 0.05% (Impact 5 EC)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Tridemorph 0.10% (Calixin 80 EC)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Triadimefon 0.10% (Bayleton 25 WP)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Dinocap 0.10% (Karathane 50 EC)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Ziram 0.20% (Cuman 30 EC)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Mean	10.27 (10.76)	13.13 (15.38)	23.73 (20.53)	32.40 (28.78)	-

	SEM	Level of Significance	C.D. (P = 0.05)
Pesticides (A)	1.42	0.01	3.99
Period (B)	1.16	0.01	3.26
Interation (A x B)	2.84	0.01	7.99

the fungicides tested even after 24 h exposure. Mani and Thontadarya (1988a) also reported non-toxicity of six fungicides to *A. dactylopii*. Thus the fungicides can be used in vineyards safely without affecting the activity of the parasitoid.

Except for the initial low knock-down effect seen in endosulfan, malathion and fenthion, all the insecticides tested proved highly detrimental to the adults of *C. montrouzieri* (Table 2). Our result on carbaryl closely agrees

Table 2. Effect of pesticides on *Cryptolaemus montrouzieri*

Treatments	% Mortality of adults				Mean
	Hours after application				
	1	3	6	24	
Quinalphos	16.00 (18.59)	96.00 (82.59)	98.00 (86.28)	100.00 (89.96)	77.50 (69.35)
Endosulfan	4.00 (7.37)	10.00 (14.30)	56.0 (48.44)	96.0 (82.59)	41.50 (38.18)
Malathion	2.00 (3.69)	10.00 (14.30)	100.0 (89.96)	100.0 (89.96)	53.00 (49.48)
Carbaryl	98.00 (86.38)	100.0 (89.96)	100.0 (89.96)	100.0 (89.96)	99.00 (89.07)
Fenthion	2.00 (3.69)	32.00 (34.28)	56.00 (48.44)	78.00 (62.08)	42.00 (37.12)
Fosetyl-Al	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	16.00 (23.30)	4.00 (6.25)
Dinobuton	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	40.00 (39.17)	10.00 (10.22)
Dinocap	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	38.0 (38.01)	9.50 (9.93)
Metalaxyl + mancozeb	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Triforine	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Hexaconazole	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Triazol	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Tridemorph	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Triadimefon	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Ziram	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Mean	8.13 (7.12)	16.53 (16.07)	27.33 (24.50)	37.86 (34.60)	-

	SEM	Level of Significance	C.D. (P = 0.05)
Pesticides (A)	1.36	0.01	3.81
Period (B)	0.91	0.01	2.54
Interation (A x B)	2.73	0.01	7.63

with that of Meyerdirk *et al.* (1982) who had also reported high toxicity of carbaryl to *C. montrouzieri.* Only at 24 h exposure, there was mortality of 16, 38 and 40% with fosetyl-Al, dinocap and dinobuton respectively. The remaining fungicides were non toxic to the predator. Bartlett (1963) and Babu and Azam (1987a) also reported varied results with different fungicides on *C. montrouzieri.*

Residual toxicity

The residual toxicity data in Table 3 revealed that carbaryl was the most persisting insecticide causing 85% mortality of *A. dactylopii* even 28 days after treatment. This is in conformity with the results of Meyerdirk *et al.* (1982) who had also observed toxicity of carbaryl to *Anagyrus pseudococci* (Girault) upto 30 days after treatment. There was a dramatic drop in mortality of *A. dactylopii* when exposed to endosulfan at 7 days after treatment. According to Franz *et al.* (1980), endosulfan (0.10%) was slightly harmful to *L. dactylopii.* The residual activity of quinalphos and fenthion lasted for 14 days while malathion became non-toxic to *A. dactylopii* 28 days after treatment.

All the three fungicides included in the residual toxocity study namely fosety1-A1, dinobuton and dinocap became less or non-toxic to *C. montrouzieri* one day after application (Table 4). The data on the residual toxicity of insecticides indicated that carbaryl was highly toxic even upto 28 days post treatment causing 82.50% mortality. This closely agrees with the findings of Meyerdirk *et al.* (1982) who reported carbaryl to be toxic to *Cryptolaemus* upto 23 days post treatment. However, toxic residual activity of fenthion and endosulfan dropped sharply to non significant levels 7 days post treatment. Malathion remained highly toxic to the predator till the 14th day of application but the toxic activity dropped to non significant levels by 21st day. Babu and Azam (1987b) also determined the safe periods for various insecticides and dicofol to *C. montrouzieri.* It is concluded that *Cryptolaemus* adults can be released safely 7

Table 3. Residual toxicity of some insecticides to *Anagyrus dactylopii*

Insecticides	% Mortality of adults					Mean
	Days after application					
	1	7	14	21	28	
Quinalphos	97.50 (85.35)	95.00 (80.75)	22.50 (27.84)	2.50 (4.67)	0.0 (0.57)	43.50 (39.84)
Endosulfan	95.00 (80.75)	2.50 (4.60)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	19.50 (17.41)
Malathion	97.50 (85.35)	40.00 (39.15)	25.00 (29.88)	15.00 (22.49)	0.0 (0.57)	35.50 (34.49)
Carbaryl	100.00 (89.96)	100.0 (89.96)	97.50 (85.36)	92.50 (78.72)	85.0 (67.43)	95.00 (82.48)
Fenthion	97.50 (85.36)	25.88 (29.88)	17.50 (24.52)	2.50 (4.61)	0.0 (0.57)	28.68 (28.99)
Mean	97.50 (85.35)	52.68 (48.87)	32.50 (33.63)	22.50 (22.21)	17.00 (13.94)	-

	SEM	Level of Significance	C.D. (P = 0.05)
Pesticides (A)	1.52	0.01	4.30
Period (B)	1.52	0.01	4.30
Interation (A x B)	3.40	0.01	9.61

Table 4. Residual toxicity of some insecticides to *Cryptolaemus* montrouzieri

Insecticides	% Mortality of adults					Mean
	Days after application					
	1	7	14	21	28	
Quinalphos	100 (89.97)	95.00 (80.75)	2.50 (4.61)	0.0 (0.57)	0.0 (0.57)	39.50 (32.29)
Endosulfan	97.50 (85.46)	14.00 (21.67)	5.00 (8.64)	0.0 (0.57)	0.0 (0.57)	23.30 (23.38)
Malathion	100.0 (89.97)	97.50 (85.36)	75.00 (60.09)	2.50 (4.61)	0.0 (0.57)	55.00 (48.12)
Carbaryl	100 (89.97)	100 (89.97)	100 (89.97)	97.50 (85.36)	82.50 (65.44)	96.00 (84.14)
Fenthion	77.5 (61.75)	6.44 (14.53)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	16.79 (15.60)
Fosetyl-Al	2.5 (4.61)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.50 (1.38)
Dinobuton	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Dinocap	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)	0.0 (0.57)
Mean	59.69 (52.86)	39.12 (36.75)	22.81 (20.63)	12.50 (11.68)	10.31 (8.68)	-

	SEM	Level of Significance	C.D. (P = 0.05)
Pesticides (A)	1.10	0.01	3.09
Period (B)	0.87	0.01	2.44
Interation (A x B)	2.47	0.01	6.91

days after treatment with endosulfan or fenthion, and 14 and 21 days after the application of quinalphos and malathion respectively.

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