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Research Note

Toxicity of insecticides to papaya mealybug parasitoid, *Acerophagus papayae* (Noyes and Schauff) (Hymenoptera: Encyrtidae)

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ABSTRACT: Toxicity of selected insecticides to papaya mealybug parasitoid, *Acerophagus papayae* (Noyes and Schauff) (Hymenoptera: Encyrtidae) was evaluated at 1, 3, 6 and 24h after treatment (HAT). Results showed that Thiamethoxam, Chlorpyriphos and Dichlorvos showed very high knock-down effect (100 % mortality) of *A. papayae* adults within 3 HAT. Fish Oil Rosin Soap (FORS) and Neem oil had very less detrimental effect on adult parasitoids by recording very low mortality percentage at 24 HAT. The residual toxicity data revealed that Thiamethoxam was the most persisting insecticide causing 26.67 per cent mortality of *A. papayae* even after 28 days after treatment (DAT). Neem oil and Fish Oil Rosin Soap became less or non toxic to adults of *A. papayae* at three DAT.

KEY WORDS: Toxicity, insecticides, *Acerophagus papayae*

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Papaya mealybug, *Paracoccus marginatus* (Williams and Granara de Willink) is a polyphagous pest that can damage a large number of economically important field crops, tropical and sub-tropical fruits, vegetables and ornamental plants (Miller and Miller, 2002). It was recorded from 133 host plants (Sakthivel, 2011) and caused an estimated loss of about Rs. 300 crore in each state (Anon, 2010). *P. marginatus* infestation was typically observed as clusters of cotton-like masses on the above-ground portion of plants. Colonization of mealybugs on papaya has been noted along the veins and midribs of older leaves and all areas of tender leaves and fruits (Walker *et al*., 2003). Severely affected older leaves turn yellow and dry up. Tender leaves become bunched and distorted. Heavy mealybug populations produce a large volume of honey dew, which causes black sooty mould on the infested fruits and vegetation (Meyerdirk *et al.,* 2004).

Classical biological control was considered as an important component in the management of *P. marginatus* (Walker *et al.,* 2006). Three species of parasitoids belonging to the family Encyrtidae *viz., Acerophagus papayae* (Noyes and Schauff), *Anagyrus loecki* (Noyes and Menezes) and *Pseudleptomastix mexicana* (Noyes and Schauff) (Hymenoptera: Chalcidoidea) identified in the native range of *P. marginatus* were used in the classical biological control programmes (Amarasekare *et al.,* 2009). Among them, *A. papayae* was the main contributor to the mortality of *P. marginatus* and well established in the field (Sakthivel, 2011). The parasitoids are highly sensitive to insecticidal sprays and need a pesticide free environment for their successful perpetuation. Several insecticides *viz.,* Profenophos, Thiamethoxam, Chlorpyriphos, Dimethoate, Buprofezin and Acephate have beeen proved effective for the management of papaya mealybug (Regupathy and Ayyasamy, 2010). However, Mani and Krishnamoorthy (1990) reported that quinalphos (0.05%), Endosulfan (0.07%), Malathion (0.1%), Carbaryl (0.1%) and Fenthion (0.1%) were toxic to encyrtid parasitoid, *Anagyrus dactylopii* (How.) in guava orchards. Nalini and Manickavasagam (2011) reported that Endosulfan, Monocrotophos, Profenophos and Dimethoate caused 100 per cent mortality within 1 hour on *Aenasius bambawalei* Hayat and *Aenasius advena* Compere. Carbaryl had significant residual toxicity causing 85 per cent mortality of *A. dactylopii* even 28 days after treatment, while residues of Monocrotophos remained toxic to *A. dactylopii* upto 21 days. Meyerdirk *et al.* (1982) observed toxicity of carbaryl to *Anagyrus pseudococci* (Girault) upto 30 days after treatment, but residual activity of Dimethoate reduced after 9 days of treatment. Granular

insecticides did not have any adverse effect on natural enemies like *A. dactylopi* (Mani and Thontadarya, 1991). Lowery and Ishman (1994) observed that neem derived insecticides were relatively benign to beneficial insects in comparison with some synthetic insecticides. Owing to the seriousness of the pest, farmers take up spraying of a variety of insecticides under field condition. But, the release of parasitoid is considered as an economically feasible and environmentally safe option for effective control of *P. marginatus*. Under these circumstances, the present study was conducted to identify the safer insecticides that could be used when the parasitoids are available in the field. Such insecticides would bring down the *P. marginatus* population without affecting the parasitoids and hence providing more efficient control.

The parasitoid, *A. papayae* was mass cultured on *P. marginatus* reared on potato sprouts in the Biocontrol laboratory, Tamil Nadu Agricultural University, Coimbatore. The parasitoid rearing cage of 30 cm x 30 cm x 30 cm covered with kada cloth on three sides of the cage and fitted with glass front door was used to facilitate releasing and handling parasitoids manually. Top of the cage was covered with clean glass. A moist filter paper towel was kept at the bottom of the cage. Fifteen to sixteen sprouted potato tubers containing mealybugs were placed inside the cage. A piece of cotton soaked in fifty per cent honey solution in penicillin vial another soaked in water were placed as adult food inside the cage and replaced on alternate days. Fifty parasitoids (1:1 sex ratio) were released inside the rearing cage containing mealybugs. The rearing cage was covered with black cloth, to avoid light. In order to prevent the entry of ants, the legs of the cages were kept immersed in the water of the ant pan. Ten days after release of the parasitoids, sprouts containing parasitisized mealybugs were carefully removed using scissors. The parasitized sprouts were later transferred to transparent plastic containers and covered with muslin cloth secured with rubber band. *A. papayae* starts emerging from 13th day after release and emergence continued up to ten days. The emerged adults were collected in a test tube by using an aspirator and used for conducting experiments.

Nine commonly used insecticides in the papaya orchards as per the list given below were tested at field recommended doses to determine their toxicity to parasitoid following the technique suggested by Mani and Thontadarya (1988).

Treatment	Conc.
Profenophos 50 EC	1.5 ml / lit
Dimethoate 30 EC	2 ml / lit
Thiamethoxam 25 WG	0.6 gm / lit
Imidacloprid 17.8 SL	0.6 ml / lit
Dichlorvos 76 SC	2 ml / lit
Chlorpyriphos 20 EC	2 ml / lit
Buprofezin 25 EC	0.75 ml / lit
Fish Oil Rosin Soap	25 gm / lit
Neem oil	20 ml / lit
Control	Water spray

An untreated check sprayed with tap water was also maintained for correcting the mortality in the treatments. The insecticides were sprayed on potted papaya plants separately and three leaves from each treated plant representing three replications were removed for exposure to natural enemies. One 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.

The insecticides which proved toxic to the parasitoid in the first experiment were evaluated for their residual toxicity. Ten adults were exposed to the treated leaf surface in a glass vial at three days interval until there was no residual toxicity. Adults were fed with 50 per cent honey. The mortality was recorded after 24 h. exposure. The data from laboratory observations were analysed following the procedure described by Panse and Sukatme (1969). Wherever necessary, the percentage values were transformed into angular (arcsine percentage) values before carrying out the analysis. The mean values of the experiments were separated using by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

The data on the effect of insecticides on *A. papayae* adults (Table 1) indicated that all the insecticides had significant adverse effect on the adults of *A. papayae*. The adult mortality percentage at 24 h. after treatment (HAT) ranged from 16.67 to 100 per cent in the treatments. Thiamethoxam, Chlorpyriphos and Dichlorvos showed very high knock-down effect (100%) after 3 (HAT). Fish Oil Rosin Soap (FORS) and Neem oil had very less detrimental effect on adult parasitoids by recording mortality percentage of 26.67 and 16.67 respectively, even after 24 HAT (Table 1).

Table 1. Toxicity of different insecticides to *Acerophagus papayae* adults

Treatments		Conc.Cumulative mortality of adults (%)* Hours after treatment (HAT)			
		1	3	6	24
Profenophos 50 EC	1.5 ml / lit	16.67 (19.31)	83.33 (66.64)	100.00 (89.74)	100.00 (89.74)
Dimethoate 30 EC	2 ml / lit	3.33 (6.32)	46.67 (43.08)	100.00 (89.74)	100.00 (89.74)
Thiamethoxam 25 WG	0.6 gm / lit	80.00 (68.77)	100.00 (89.74)	100.00 (89.74)	100.00 (89.74)
Imidacloprid 17.8 SL	0.6 ml / lit	6.67 (12.38)	50.00 (44.92)	93.33 (80.97)	100.00 (89.74)
Dichlorvos 76 SC	2 ml / lit	63.33 (52.86)	100.00 (89.74)	100.00 (89.74)	100.00 (89.74)
Chlorpyriphos 20 EC	2 ml / lit	73.33 (63.76)	100.00 (89.74)	100.00 (89.74)	100.00 (89.74)
Buprofezin 25 EC	0.75 ml / lit	6.67 (12.38)	60.00 (50.77)	73.33 (63.76)	93.33 (80.97)
Fish Oil Rosin Soap	25 gm / lit	6.67 (12.38)	13.33 (21.14)	20.00 (26.56)	26.67 (31.00)
Neem oil	20 ml / lit	3.33 (6.32)	6.67 (12.38)	10.00 (15.08)	16.67 (19.31)
Control	–	0.00 (0.25)	0.00 (0.25)	0.00 (0.25)	0.00 (0.25)

Comparison of significance	Level of significance (*P*)	C.D value
Pesticides (A)	0.05	8.32
Period (B)	0.05	5.26
Interaction (A×B)	0.05	16.65

* Mean of three replications
Figures in the parentheses are *Arc sine* transformed values
HAT – Hours after treatment

Among the insecticides evaluated, Thiamethoxam, Chlorpyriphos and Dichlorvos proved highly toxic with high knock-down effect causing 100% mortality of *A. papayae* adults. The toxic nature of Chlorpyriphos to the adults of *Anagyrus dactylopii* (How.) has already been documented by Mani and Thontadarya (1988). However, the present investigation revealed that Dichlorvos resulted in 100% mortality at 3 HAT in contrast to investigation by Ranga Reddy and Lakshminarayana (1986) who reported that it was safer to *A. dactylopii*. Dimethoate, Imidacloprid, Buprofezin and Profenophos initially had less knock-down effect, but, were highly toxic at 24 HAT causing 100 per cent mortality. Similar findings were reported by Nalini and Manickavasagam (2011) on *A. bambawalei* and *A. advena.* In the present investigation, Fish Oil Rosin Soap and Neem oil had very less detrimental effect on adult parasitoids, conforming earlier reports (Mani and Thontadarya 1988).

The residual toxicity data (Table 2) revealed that Thiamethoxam was the most persisting insecticide causing 26.67 per cent mortality of *A. papayae* even after 28 days of treatment (DAT). Neem oil and Fish Oil Rosin Soap were less or non toxic to adults of *A. papayae* at three DAT. There was a significant drop in the mortality of *A. papayae* when exposed to Profenophos, Dimethoate, Dichlorvos and Buprofezin at seven DAT. Imidacloprid and Chlorpyriphos remained highly toxic to *A. papayae* till the seventh day of application and gradually dropped

Table 2. Residual toxicity of different insecticides to *Aurophagus papayae* adults

Treatments		Conc.Cumulative mortality of adults (%)* Hours after treatment (HAT)					
		1	3	7	14	21	Mean
Profenophos 50 EC	1.5 ml / lit	100.00 (89.74)	100.00 (89.74)	46.67 (43.07)	0.00 (0.25)	0.00 (0.25)	49.33[e] (44.62)
Dimethoate 30 EC	2 ml / lit	100.00 (89.74)	100.00 (89.74)	50.00 (45.00)	0.00 (0.25)	0.00 (0.25)	50.00[e] (45.00)
Thiamethoxam 25 WG	0.6 gm / lit	100.00 (89.74)	100.00 (89.74)	100.00 (89.74)	86.67 (68.86)	26.67 (30.79)	82.67[a] (73.93)
Imidacloprid 17.8 SL	0.6 ml / lit	100.00 (89.74)	100.00 (89.74)	60.00 (50.77)	43.33 (41.15)	0.00 (0.25)	60.67[c] (54.39)
Dichlorvos 76 SC	2 ml / lit	100.00 (89.74)	100.00 (89.74)	86.67 (68.86)	0.00 (0.25)	0.00 (0.25)	57.33[d] (49.72)
Chlorpyriphos 20 EC	2 ml / lit	100.00 (89.74)	100.00 100.00	93.33 93.33	13.33 13.33	0.00 0.00	61.33[b] 61.33[b]
Buprofezin 25 EC	0.75 ml / lit	93.33 (80.98)	83.33 (70.00)	56.67 (48.84)	0.00 (0.25)	0.00 (0.25)	46.67[f] (37.95)
Fish Oil Rosin Soap	25 gm / lit	26.67 (31.00)	0.00 (0.25)	0.00 (0.25)	0.00 (0.25)	0.00 (0.25)	5.33[g] (6.22)
Neem oil	20 ml / lit	16.67 (23.85)	0.00 (0.25)	0.00 (0.25)	0.00 (0.25)	0.00 (0.25)	3.33[g] (4.82)

Comparison of significance	Level of significance (*P*)	C.D value
Pesticides (A)	0.05	4.02
Period (B)	0.05	3.00
Interaction (A×B)	0.05	9.00

* Mean of three replications
Figures in the parentheses are *Arc sine* transformed values
HAT – Hours after treatment

to low levels at 14th day and was non toxic by 21st day after application.

Residues of Thiamethoxam remained toxic (26.67%) to *A. papayae* up to 28 days. The present results on the residual toxicity of dimethoate to *A. papayae* is in agreement with Meyerdirk *et al.* (1982) who reported that the residual toxicity of Dimethoate dropped sharply to non significant levels after nine days of treatment to *Anagyrus pseudococci* (Girault). Similar findings were also reported by Mani and Thontadarya (1988) on *A. dactylopii.* In the present study, residues of Chlorpyriphos remained highly toxic to *A. papayae* (93.33%) till seven DAT but, the toxicity dropped to low levels at 14 DAT (13.33%), contradicting the earlier investigation (Mani and Thontadarya, 1988). Neem oil and Fish Oil Rosin Soap was less or non toxic to adults of *A. papayae* at one DAT. In general, all the insecticides evaluated in the study remained toxic up to 21 days, while Thiamethoxam showed even longer residual toxicity up to 28 days. Based on the results, it could be observed that almost all the insecticides are persistent up to 21 days and hence the parasitoid release should be made only three weeks after application of insecticides.

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