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In vitro TOXICITY ASSESSMENT OF SYNTHETIC ACARICIDES AGAINST YELLOW MITE, *Polyphagotarsonemus latus* (Banks), AND PREDATORY MITE, *Amblyseius ovalis* (Evans), ON CHILLI PLANTS

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ABSTRACT

The study was conducted to assess the toxic effect of topical use of different synthetic acaricides on yellow mite (*Polyphagotarsonemus latus*) and its predatory mite (*Amblyseius ovalis*). Both the mites were collected and cultured separately on chilli plants grown in cups of 6 cm dia. during early winter of 2014 and 2015, under ventilated glass-house conditions. Acaricide application under laboratory conditions showed that fenpyroximate 5 EC @ 1 mL L^{-1} and propargite 57 EC @ 2 mL L^{-1} were most toxic and caused highest mortality of *P. latus* i.e. 98.2 and 96.8% with LC_{50} values of 12.09 and 21.95 ppm, respectively. The least mite reduction was shown by sulphur 80 WP (81.55%) with LC_{50} value of 210.3 ppm. Comparing the acaricides applied, fenpyroxi-mate 5 EC and propargite 57 EC were less toxic to predatory mites inflicting 49.1 and 54.1% mortality with respective LC_{50} values of 96.1 and 164.2 ppm.

Key words: Acaricides, $LC_{50,}$ predatory mite, yellow mite, toxicity analysis

INTRODUCTION

The chilli productivity in India is low due to several constraints including insect and mite pests infestation (Tatagar *et al.*, 2009). Chilli mite/yellow mite (*Polyphagotorsonemus latus* Banks) is a potential serious pest, which was initially reported from India on potato (Mann *et al*., 1920) and then on chilli (Kulkarni, 1922). The initial symptom of mite infestation appears as downward leaf curling along with coppery or brownish marks. Later, floral buds abort, plants become stunted and terminal leaves and flower buds become malformed and are unable to open properly. The infested fruits become rigidly bronzed outside and deformed. The characteristic 'S' shaped leaf twisting and epinasty is frequently noticed in many varieties (Sathua *et al.*, 2016). Damage is more in hot and humid seasons (Krishna Kumar *et al*., 2009). In combination, thrips and yellow mite may cause yield reduction to the tune of 50% (Roy and Sarkar, 2017). The estimated yield loss in chilli due to the mite infestation has been reported to be more than 60% (Varghese, and Mathew, 2013).

The frequent pesticides use to combat target pests also results in killing of several natural enemies. Intermittent/consecutive insecticide use for pest control in chilli leads to the deposition of toxic pesticides on crop that reduce the population of beneficial insects and, in return, increase the cost of cultivation. For phytoseiids mite group the development of pesticide resistance against several insecticides, acaricides and fungicides has been reported (Pralavorio *et al.*, 1985). The only way to control mites is through use of selective acaricides which have detrimental effect on pest *P. latus* without harming predatory species. The present study was aimed to assess the toxicity of some acaricides against *P. latus* and its predatory mite, *Amblyseius ovalis*, under laboratory conditions.

MATERIALS AND METHODS

The experiment was conducted in the Department of Entomology and Agricultural Zoology, BHU, Varanasi (India). For culturing of mites, chilli seedlings [variety 'G-4'] were grown in medium size cups of 6 cm dia. The plants were grown under isolated glass-house conditions to prevent any infestation by other insect pests and to forbid the migration of mites outside. The recommended doses of fertilizer and irrigation were given as per the requirement of plants (Peter *et al.*, 2004).

Mite culture preparation

The yellow mites, *P. latus,* were collected from the nearby vegetable farm and chilli growing areas, where no pesticides were applied. The mites were brought along with leaves and released on the underside of chilli leaves on plants potted under glasshouse. The temperature and relative humidity of well-ventilated rearing house was maintained at 27±1°C and 65±5%, respectively (Çobanoglu and Alzoubi, 2013) while availing a photoperiod of 16/8 light: darkness. The population growth was observed intermittently under binocular stereoscopic microscope (Dewinter Zoomstar- III) with 1.5 to 3x magnification. To prepare a homogenous mite population, the nymphs or adult yellow mites of similar stage were periodically transferred on separate chilli seedlings for mating and production of next generations. The predatory mite, *A. ovalis,* was collected from vegetable flora and reared under laboratory conditions on chilli plants infested by *P. latus* under similar conditions as above. The predatory mite population was maintained on chilli seedlings infested with mites periodically.

Acaricide details, their preparation and toxicity assessment

For toxicity analysis, 6 commercially available acaricides evaluated were propargite 57 EC (Omite) @ 2 mL L^{-1}, dicofol 18.5 EC (Might) @ 2.5 mL L^{-1}, sulphur 80 WP (Sulfex) @ 3.15 g L^{-1}, abamectin 9 EC (Abacin) @ 1 mL L^{-1}, pyridaben 57 EC (NC 129) @ 2 mL L^{-1} and fenpyroximate 5 EC (Pyromite) @ 1 mL L^{-1} water. Also, a control (water spray) was maintained. Each acaricide was diluted in water to prepare the desired concentration and 'leaf-spray' method of IOBC/WRPS was followed (Helle and Overmeer, 1985). The freshly detached chilli leaves were kept on semi-wet filter paper (Grade No. HM-1) in Petri-dishes and then placed under a Potter Precision Laboratory Spray Tower™ that was calibrated @ 2 mL aliquot of acaricide at 50 pKa. Bioassay was done to estimate LC_{50} of a particular acaricide. After spray, the adults and nymphs of 20 mites (10 each) were released to the leaf with the help of a fine brush and the edges of Petri-dishes were applied with vaseline to prevent their escape (Çobanoğlu and Alzoubi, 2013). The experiment was conducted in a completely randomized design with each treatment replicated three times.

Observations and analysis

The mite count was done under a stereoscopic binocular microscope 1, 3 and 7 days after treatment. The %mortality of mites was calculated as per Henderson Tilton's formula:

$$Corrected\ mortality\ (\%) = 1 - \left[\frac{Ta \times Cb}{Tb \times Ca}\right] \times 100$$

where, *Ta* = No. of insects in treatment after spray, *Tb* = No. of insects in treatment before spray, *Ca* = No. of insects in untreated check after spray, and *Cb* = No. of insects in untreated check before spray.

The data was analysed for analysis of variance by using a statistical software programme SPSS (version 20). The treatment means were compared at CD value of 0.05 and 0.01.

RESULTS AND DISCUSSION

The study on the efficacy of acaricides against yellow mite, *P. latus* and its predatory mite, *A. ovalis,* on chilli crop revealed overall decrease in the population of both the mites during contact toxicity assessment (Table 1). One day of spray, the maximum reduction in population of yellow mite (*P. latus*) was caused by fenpyroximate 5 EC (94.45%), followed by propargite 57 EC

(90.45%) and abamectin 1.9 EC (88.35%). Nagamani *et al.* (2015) reported almost similar efficacy or mortality in case of propargite and fenpyroximate. Three days after spraying a complete reduction in mite population was seen in case of propargite 57 EC and fenpyroximate 5 EC while >90% mortality was caused by abamectin 1.9 EC and pyridaben 57 EC. After 7 days, a significant reduction in population was found in most of the treatments. There was complete death of mites in treatments sprayed with propargite 57 EC, fenpyroximate 5 EC and abamectin 1.9 EC. Chinniah *et al*. (2016) found fenpyroximate 5 EC quite effective against chilli mite as compared to untreated check. Sulphur 80 WP proved inferior as compared to others acaricides with a reduction of 85.78% mite. Insignificant mortality was noticed in control on 3rd and 7th day. The overall efficacy of synthetic acaricides against *P. latus* showed that the use of fenpyroximate 5 EC and propargite 57 EC caused highest mortality in mites. The results are in line with Smitha and Giraddi (2006) who found fenpyroximate and propargite effective upto 21 days. Abamectin 1.9 EC gave good control of *P. latus* (Nadimi *et al*., 2008) and its efficacy remained unaffected till last day of observation. In relation to the overall percent mortality in mite population, the acaricides can be ranked in order of efficacy as: fenpyroximate 5 EC > propargite 57 EC > abamectin 1.9 EC > pyridaben 57 EC > dicofol 18.5 EC > sulphur 80 WP. Being a novel acaricide fenpyroximate acts effectively against the mites of Tarsonemidae, Tetranychidae and Tenuipalpidae because of its mitochondrial electron transport inhibition (PPDB, 2017). Propergite caused greater mortality due to the inhibition of magnesium-stimulated ATPase in mites (IRAC, 2002). Sulphur powder is one of the most conventional acaricide vigorously used against various mites. Though it is quite effective in managing *P. latus*, but its repeated application induced pest resistance against it.

In case of acaricide toxicity against predatory mite (*A. ovalis*), pyridaben 57 EC inflicted maximum mortality (68%) in predatory mites, followed by sulphur 80 WP (63.46%) and dicofol 18.5 EC (56.54%) 1 day after spray. Propargite 57 EC and fenpyroximate 5 EC caused minimum mortality of 45.35 and 45.55%, respectively. The observation of 3 day after spray showed that pyridaben 57 EC caused highest reduction of 79.87%, followed by dicofol 18.5 EC and sulphur 80 WP which showed almost similar mortality. There was a small reduction in control (10.55%). After 7 days of spray, maximum mortality was found in pyridaben 57 EC (89.95%), followed by sulphur80 WP (83.54%) and dicofol 18.5 EC (80.32%). The lowest population reduction was found in propargite 57 EC (52.34%), followed by fenpyroximate 5 EC (60.36%). A moderate reduction of

Table 1: Toxicity of various synthetic acaricides against *Polyphagotarsonemus latus* and its predator *Amblyseius ovalis* under laboratory condition (pooled 2014 & 2015)

Acaricides	Dose (L^{-1})	PTC	Mean percent mortality in mite population after spraying							
			Polyphagotarsonemus latus				*Amblyseius ovalis*			
			1DAS	3DAS	7DAS	Mean	1DAS	3DAS	7DAS	Mean
Propargite 57 EC	2.0 mL	20	90.45 (72.54)	100 (85.50)	100 (85.50)	96.82	45.35 (38.43)	46.62 (38.82)	52.34 (47.55)	49.10
Dicofol 18.5 EC	2.5 mL	20	81.69 (60.34)	88.43 (67.36)	94.65 (74.62)	88.26	56.54 (49.45)	67.86 (58.78)	80.32 (71.56)	68.24
Sulphur 80 WP	3.15 g	20	78.55 (53.74)	80.32 (59.83)	85.78 (64.33)	81.55	63.46 (52.73)	67.69 (58.51)	83.54 (72.98)	71.55
Abamectin 1.9 EC	1.0 mL	20	88.35 (67.26)	95.85 (79.43)	100 (85.50)	94.73	49.38 (41.65)	58.26 (49.50)	66.12 (57.89)	57.92
Pyridaben 57 EC	2.0 mL	20	85.67 (64.21)	92.55 (73.80)	96.64 (80.43)	91.62	68.64 (60.38)	79.87 (68.84)	89.95 (77.90)	79.49
Fenpyroximate 5 EC	1.0 mL	20	94.45 (78.82)	100 (85.50)	100 (85.50)	98.15	45.55 (38.66)	56.32 (49.24)	60.36 (50.87)	54.08
Control	-	20	0 (0)	0 (0)	0 (0)	-	0 (0)	0 (0)	0 (0)	-
$CD_{0.05}$			2.59	2.43	0.99		1.83	2.80	1.03	
$CD_{0.01}$			3.32	3.46	2.01		2.85	3.64	2.24	

PTC- Pre-treatment count, DAS- Days after spraying, CD- Critical difference, S- Significant,
Values in parenthesis were arc-sine transformed.

Table 2: Laboratory LC_{50} analysis of the synthetic acaricides against *Polyphagotarsonemus latus*

Acaricides	No. of mites treated	χ^2 ($P_{0.05}$)	Regression equation (slope)	LC_{50} (ppm)	Fiducial limit (95%)	
					LL	UL
Propargite 57 EC	20	0.35	1.35 + 2.71	164.23	132.17	180.54
Dicofol 18.5 EC	20	1.31	1.22 + 2.38	37.45	20.45	68.44
Sulphur 80 WP	20	0.72	0.19 + 0.44	71.20	50.75	92.33
Abamectin 1.9 EC	20	2.83	0.38 + 1.67	95.23	72.02	129.73
Pyridaben 57 EC	20	0.46	0.10 + 0.31	19.75	9.85	28.46
Fenpyroximate 5 EC	20	1.07	0.27 + 0.19	96.10	104.24	132.05

LC - Lethal concentration, LL - Lower limit, UL - Upper limit

Table 3: Laboratory LC_{50} analysis of the synthetic acaricides against *A. ovalis*

Acaricides	No. of mites treated	χ^2 ($P_{0.05}$)	Regression equation (slope)	LC_{50} (ppm)	Fiducial limit (95%)	
					LL	UL
Propargite 57 EC	20	0.39	1.35 + 2.71	21.95	10.49	53.38
Dicofol 18.5 EC	20	0.27	1.22 + 2.38	105.61	95.64	137.23
Sulphur 80 WP	20	0.71	0.19 + 0.44	210.32	180.38	250.63
Abamectin 1.9 EC	20	2.20	0.30 + 0.41	80.23	62.12	114.80
Pyridaben 57 EC	20	0.98	0.20 + 0.25	36.57	13.61	57.31
Fenpyroximate 5 EC	20	0.72	0.22 + 0.16	12.09	8.57	24.72

LC = Lethal concentration, LL = Lower limit, UL = Upper limit

(2008). As per the efficacy of acaricides against *A. ovalis* they can be ranked as: pyridaben 57 EC > sulphur 80 WP > dicofol 18.5 EC > abamectin 1.9 EC > fenpyroximate 5 EC > propargite 57 EC. Abamectin 1.9 EC provides mild control of *P. latus* with a fare efficacy rate, but simultaneously caused greater harm to predatory mites. So, it may not be recommended for mite control. The Perti-dishes sprayed with pyridaben 57 EC caused maximum mortality of *A. ovalis* (89.95%), so its frequent field application must be avoided. Sulphur in WP formulation acted as contact poison for both the mites. But during predation the *A. ovalis* became sluggish so get exposed to chemical for a longer period and get affected much more than the pest i.e. *P. latus.*

The LC_{50} values indicated that fenproximate 5 EC was most toxic to chilli/broad mites with a concentration of 12.09 ppm (Table 2). This was followed by propargite 57 EC with LC_{50} of 21.95 ppm, pyridaben 57 EC (36.57 ppm), abamectin 1.9 EC (78.23 ppm), dicofol 18.5 EC (105.61 ppm) and least toxic effect was observed in case of sulphur 80 WP with LC_{50} value of 210.32 ppm. Tomar and Singh (2011) also found propargite and fenproximate effective in reducing mite population upto 15 days. The study showed that among treatments the LC_{50} value of pyridaben 57 EC was lowest i.e. 19.75 ppm and proved more toxic to predatory mites of *A. ovalis* (Table 3). Dicofol 18.5 EC proved more toxic next to pyridaben with LC_{50} value of 37.45 ppm. In case of sulphur 80 WP the toxicity was less in comparison to the toxicity shown against *P. latus.* The LC_{50} of sulphur was 71.20 ppm. The LC_{50} value of abamectin 1.9 EC was 95.23 ppm in case of *A. ovalis.* The toxicity of fenpyroximate 5 EC against *A. ovalis* was quite less (LC_{50} of 96.1 ppm) as compared to the toxicity against *T. urticae.* Propargite 57 EC was found least toxic against *A. ovalis.*

The study revealed that fenpyroximate 5 EC and propargite 57 EC proved superior in controlling yellow mite and were very effective in controlling *P. latus* population upto 7 days after spray. The two acaricides may be recommended for mite management in chilli after proper field evaluation. These chemicals caused less harm to the predatory mite *A. ovalis* as compared to others chemicals with greater LC_{50} values, which could provide selective control of pest only causing less harm to beneficial predatory mites. Fenpyroximate was most effective acaricides against phytophagous yellow mite, *P. latus,* and also relatively beneficial to its predator, *A. ovalis,* in chilli crop ecosystem.

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