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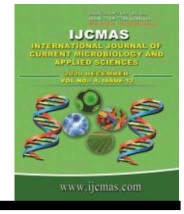

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Monitoring of Acaricide Resistance in Two Spotted Spider Mite, *Tetranychus urticae* Koch in Carnation

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A B S T R A C T

The two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) is the most destructive phytophagous species. *T. urticae* is particularly dominant and destructive in intensive cultivation, high-yield cropping systems, and affect crops by direct feeding. In severe infestations, it reduces the area of photosynthetic activity and causes leaf abscission. Populations can increase rapidly especially during hot and dry periods. *T. urticae* may develop 15–20 generations per crop of open cultivation and up to 30 generations, in protected cultivation where high value flower crops like carnation is grown. Farmers rely only on acaricides and insecticides on the management of *T. urticae* in carnation. Acaricide resistance in phytophagous mites is seriously increasing phenomenon, especially in *T. urticae.* Hence, a survey was carried out in Kothagiri areas to study the acaricide usage pattern in carnation during 2018-19. The results of bioassay revealed that that LC_{50} values for fenazaquin was 418.3 and 599.37 and for propargite it was 373.33 and 319.64, respectively in Kurkuthi and Kapati population. Resistance ratio of 217.86 and 312.17 for fenazaquin and 272.50 and 233.31 for propargite was recorded in Kurkuthi and Kapati population, respectively.

Introduction

Tetranychus urticae Koch is one of the most important pests in many cropping systems worldwide and the most polyphagous species within the family of the Tetranychidae (Migeon and Dorkeld, 2010). Of the more than 1,200 species of spider mites described (Bolland *et al.*, 1998; Milegeon *et al.*, 2010), two-spotted spider mite (TSSM) *Tetranychus urticae* Koch (Acari: Tetranychidae) is the most economically important mite pest in the world (Van Leeuwen *et al.*, 2012). *T. urticae* is a generalist feeder among the most polyphagous arthropod herbivores (Agrawal, 2000), infesting more than 1,100 plant species belonging to more than 140 plant families (Grbic, 2011; Van Leeuwen *et al.*, 2012). In India, *T. uritcae* infests cotton, brinjal, bhendi, cucurbits, castor, spinach and cowpea throughout the year (Fotedar, 1978) and causes significant loss in yield. Though, many non chemical control strategies are advocated under the IPM umbrella, still the farmers in India mainly rely only on chemical pesticides for the management of *T. urticae* due to poor control from cultural and biocontrol methods (Jeyachandran, 2003). Presently, mite control relies overwhelmingly on chemicals; attention must be given to prevent the loss of such potential, which is a key factor in Integrated Mite Management (IMM) programme. However, the ability of this mite to develop high levels of resistance to acaricides rapid even after a few applications (Stumpf *et al*., 2001; Rauch and Nauen, 2003) cannot be ruled out. Resistance to almost all the available groups of acaricides in *T. urticae* is reported from different parts of the world (Nauen *et al*., 2001). *T. uricae* is known to have a high tendency to develop resistance to acaricides among mite species (Schoknecht and Otto, 1992). Development of acaricide resistance is accelerated by high reproductive potential, inbreeding, arrhenotokus reproduction, short life cycle, numerous generations in a year and warmer conditions (Van Leeuwen *et al*., 2009).

Frequent applications of acaricides is required to contain the population below economic thresholds, facilitates rapid resistance development leads to control failures (Nauen *et al*., 2001). *T. urticae* population worldwide had developed resistance to dicofol, amitraz, organotins, propargite, pyrethroids and METI (Mitochondrial Electron Transport Inhibitors: Fenazaquin, fenpyroximate and pyridaben) acaricides (Cho *et al.,* 1995; Campos *et al.*, 1996; Devine *et al.,* 2001; Nauen *et al.,* 2001; Tsagkarakou *et al.*,2002 and Kim *et al.*,2004).

In India, through AINP on Acarology programme monitoring of acaricide resistance for major acaricides was done in flower crops viz.,carnation in which the farmers do spraying of acaricides at weekly interval. Hence, it is highly essential to detect the acaricide resistance development in *T urticae*, which may avoid the unwanted socio-economic disturbances.

Materials and Methods

A survey was carried out in Kothagiri areas to study the acaricide usage pattern in carnation during 2018-19.

Monitoring of acaricide resistance for two spotted mite, *T.urticae* in carnation was carried out with fenazaquin 10 EC (Magister) and propargite 57 EC (Omite), by leaf dip bioassay method. LC_{50} value for susceptible population reared in glass house at the Department of Agriculture, Tamil Nadu Agricultural University, Coimbatore was calculated. Based on the base line LC_{50} value of 1.92 ppm and 1.37 ppm for fenazaquin 10 EC and propargite 57 EC, respectively, the resistance ratio of *T. urticae* population collected from carnation in poly house condition at Kothagiri was worked out. Range of concentrations was fixed to find out the LC_{50} values. Healthy mulberry leaves were cut into 75 mm diameter size and dipped in respective acaricide concentrations *viz*., 100, 200, 400, 600, 800 and 1000 ppm. The leaves were then shade dried and placed on wet cotton wad with filter paper in petri dish of 100 mm dia. The experiment was conducted under laboratory conditions (28 ± 1° C) with three replications. Thirty *T. urticae* adult mites were released on each petri dish and mortality was recorded at 24 hrs and 48 hrs after release to find out LC_{50} and LC_{95} values in order to work out the resistance ratios with reference to a susceptible strain.

Data analysis

LC_{50} and LC_{95} values were calculated by Finneys (1971) method in order to work out the resistance ratios with reference to a susceptible strain.

$$\text{Resistance ratio} = \frac{LC_{50} \text{ of resistant strain}}{LC_{50} \text{ of susceptible strain}}$$

Results and Discussion

The survey revealed that farmers used both insecticides and acaricides and crops in many poly houses were in the range of 1 year to 3 years old. Carnation growers used to spray acaricides at weekly interval to manage red spider mite (Table 1).

The results of the bioassay revealed that LC_{50} values for fenazaquin was 418.3 and 599.37 and for propargite it was 373.33 and 319.64, respectively in Kurkuthi and Kapati population (Tables 2 & 3). Resistance ratio of 217.86 and 312.17 for fenazaquin and 272.50 and 233.31 for propargite was recorded in Kurkuthi and Kapati population, respectively.

Korean population of *T. urticae* showed high levels of resistance to fenpyroximate with resistance ratio of 182, 82 for dicofol and 78 for pyridaben but little or no tolerance to abamectin (RR, 6.5), fenpropathrin (RR, 9.1), propargite (RR, 6.5) and azocyclotin (RR, 5.4) (Cho *et al.,* 1995). In California, the susceptibility of *T. urticae* population varied greatly to abamectin with resistance ratios at LC_{95} ranging from 1 to 658 in a day leaf residual bioassay (Campos *et al*., 1995).

Table.1 Pesticide use pattern in carnations under poly house

Sl. No.	Farmer's Name	Address	Area of poly house	Insecticide/ acaricides used	Dosage	Age of the Poly house
1.	Th. S.Krishnan	S. Kaikatti Kothagiri	2000 sq. m.	Magister Omite Fenpyroximate Vertimec Tracer	1.5ml/l 0.5ml/l 1ml/l 1.5ml/l 1ml/l	2 years
2.	Th. K. Saravanan	S. Kaikatti Kothagiri	2000 sq. m.	New ecomite Magister Omite Sedna Confidor	1.5ml/l 1.5ml/l 1.5ml/l 2ml/l 2ml/l	6 months
3.	Th. S.Rajasekaran	Kurkuthi Kothagiri	2000 sq. m.	Magister Confidor Omite Sedna	1.5ml/l 2ml/l 1.5ml/l 2ml/l	6 months
4.	Mrs. Kavitha	Kapati Kothagiri	1000 sq. m.	Oberon, Omite Score Confidor Magister	2ml/l 2ml/l 2ml/l 2ml/l	3 years

Table.2 LC50 values of fenazaquin 10 EC to *Tetranychus urticae* on carnation at Kothagiri

Location	χ2*	Regression equation	LC_{50} (ppm)	50% fiducial limit		LC_{95} (ppm)	95% fiducial limit		Resistance ratio
				LL	UL		LL	UL	
Kurkuthi	3.61	Y= 2.125 + 0.508	418.3	335.44	521.66	2519.95	1230	5161.10	217.86
Kapati	0.98	Y= 3.354 + 4.318	599.4	499.36	719.41	1853.57	1163.32	2953.39	312.17

Table.3 LC_{50} values of propargite 57EC to *Tetranychus urticae* on carnation at Kothagiri

Location	χ2*	Regression equation	LC_{50} (ppm)	50% fiducial limit		LC_{95} (ppm)	95 % fiducial limit		Resistance ratio
				LL	UL		LL	UL	
Kurkuthi	2.14	Y= 1.619 + 0.635	373.33	281.77	494.65	3872.02	1341.1	11179.63	272.50
Kapati	1.15	Y= 2.25x + 0.635	319.64	263.17	388.24	1720.76	1064.14	2782.57	233.31

T. urticae population in California, Fiorida, varied greatly in their susceptibility to abamectin with resistance ratios at LC_{95} ranging from 0.5 to 175 in leaf residual bioassay with reference to abamectin susceptible Rutgers University strain. The Holland strain showed high levels of resistance to abamectin at diagnostic concentration of 3 ppm (Campos *et al.*, 1996). Japanese strain of *T.urticae* exhibited a strong resistance to mitochondrial electron transport inhibitors. The resistance factors for pyridaben and fenpyroximate were 2000 and > 4000, respectively, and thus represent the highest resistance factors in *T.urticae* (Nauen *et al.*, 2001). The *Tetranychus truncatus* strain in okra (VkOk1) recorded highest LC_{50} value and has developed 8, 13 and 10 fold resistance to spiromesifen, fenazaquin and diafenthiuron, whereas amaranthus strain (VkAm3) recorded 7.0 and 5.53 resistance to spiromesifen and fenazaquin, respectively in Kerala (Bachhar *et al.*, 2019).

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