Himachal Journal of Agricultural Research 45(1&2) : 62-65 (2019)

Determining resistance level to acaricides in field populations of two spotted spider mite, *Tetranychus urticae* in Himachal Pradesh

Titiksha* and A.K. Sood
Department of Entomology
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur -176 062, India.
*Corresponding author:bhanwaltitiksha@gmail.com

Manuscript Received: 29.07.2019; Accepted: 10.11.2019

Abstract

Two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) is highly polyphagous and cosmopolitan pest attacking wide range of crops, limiting the yield and thus, cause huge economic losses. Mite abundance is increasing in spite of using acaricides in Himachal Pradesh which may be attributed to acaricidal resistance in mites. Studies on *T. urticae* populations collected from six localities were undertaken during 2018-19 against three acaricides, namely, fenazaquin, hexythiazox and propargite. The studies revealed that resistance development was there among field populations collected from different localities. The resistanc for fenazaquin, hexythiazox and propargite were in range of 3.62 to 4.26, 1.88 to 2.45 and 3.47 to 5.63, respectively. The Una population was found most resistant to all the acaricides followed by Kullu and Solan. The Palampur population was observed to be least resistant to acaricides.

Key words: *Tetranychus urticae,* resistance, acaricides.

Two spotted spider mite, *Tetranychus urticae* Koch (1836) (Acari: Tetranychidae) is cosmopolitan in distribution and is present in all parts of the world. It has been reported from many countries in Africa, Asia, Europe, North and South America and has become a serious pest of numerous crops worldwide (Farouk and Osman 2009).

Several species of mites infest many crops throughout the world. But the most common species on a global scale is two-spotted spider mite, *T. urticae.* Kumar *et al.* (2015) reported that two spotted spider mite is herbivore that feeds on numerous crops especially during hot and dry weather which is conducive for the pest outbreak and cause significant yield losses in many horticultural, ornamental and agricultural crops worldwide. It is known to infest over 1100 plant species belonging to more than 140 different plant families (Grbic *et al.* 2011, Leeuwen *et al.* 2012).

Safe and sufficient agricultural production is one of the most important global issues of the 21st century. Along the demands of food safety and minimizing environmental impacts, the idea of pest management is moving towards chemical control. Nevertheless, insect-pests and diseases cause huge yield losses in crop production and pesticides play an important role in mitigating yield losses of agricultural produce. However, repeated use of pesticides ultimately leads to resistance development due to selection pressure. Although, the development of acaricide resistance in spider mites is a long-standing issue in agricultural fields. Owing to short life cycle it increases in large numbers and very small size (0.47-0.48 mm) makes the farmers difficult to diagnose the infestation on time and they generally resort to injudicious use of pesticidal applications.

Keeping in view the amount of acaricides sprayed to keep *T. urticae* under check and reports of occurrence of resistance in the pest in neighbouring state of Punjab, therefore present studies were undertaken to determine the status of acaricidal resistance in field populations of *T. urticae* in Himachal Pradesh.

Materials and Methods

Raising susceptible strain of *T. urticae*

The mites were reared for about 25 generations without exposing them to any chemicals/ pesticides in Department of Entomology, Palampur in controlled environment at 25±1°C temperature, 70±5 per cent relative humidity and photoperiod of 16 hrs (16 L: 8 D). The population obtained thereof was designated as susceptible strain (S-strain). Test acaricides include

fenazaquin (10EC), hexythiazox (5.45EC) and propargite (57EC) were used for bioassay.

Collection of field population

Field populations of *T. urticae* were collected from six localities representing two agro-ecological zones of Himachal Pradesh. The localities were Kangra, Kullu, Palampur, Solan, Sundernagar and Una. The mite infested plant parts were brought to the laboratory and for each locality was pooled and reared for one generation on excised mulberry leaves in controlled environment for further studies to determine the level of resistance development to different chemical acaricides.

Bioassay

Leaf dip method of bioassay as suggested by Erdogan *et al.* (2012) was used to determine lethal toxicity of chemical acaricides. For determining the lethal toxicity, one day old female adult mites were used, except for hexythiazox in which eggs were treated. The leaf discs (dia 3cm) were excised out of mulberry leaves and treated with different concentrations of test acaricides by dipping the discs for 30 sec and drying them in shade. The treatments comprised of 5-6 acaricide concentrations resulting in 20-80 per cent mortality. In control treatment, leaves were dipped in water. One day old female adults (n=30) were released on each leaf disc gently with the help of camel hair brush. The observations on mortality of individuals were recorded after 24 hours of exposure in fenazaquin and propargite while, for hexythiazox after 5 days of exposure. The dead individuals were checked by giving stimulation with the help of camel hair brush and the mites were considered dead if there is no movement or they were unable to move distance equivalent to their body length as elaborated by Sato *et al.* (2005). For determining toxicity of hexythiazox to *T. urticae*, the leaf discs (dia 3cm) excised from mulberry leaves were kept on moist sponge sheet and thirty adult female mites were released for oviposition. After 24 hours, the adult mites were removed from the leaf discs and the number of eggs laid were counted and treated by dipping the leaf disc along with eggs in different concentrations of hexythiazox for 30 sec as detailed above. Leaves were allowed to dry at room temperature under shade. Egg count was reconfirmed after treatment to ascertain number of eggs retained. One set of eggs was also maintained by dipping in water to act as control.

Statistical analysis

The data obtained were subjected to probit analysis as per Finney (1971) and LC_{50} value along with upper and lower fiducial limits were calculated. The LC_{50} values for all the chemical acaricides were calculated for field and susceptible population and toxicity was considered to be significantly different when 95 per cent confidence limit failed to overlap. The resistance ratio was categorized as low ($\leq$10), moderate (>10-$\leq$40), high (>40-$\leq$160) and extremely high (>160) as per the method suggested by Kim et al. (2004).

Results and Discussion

Susceptibility of *Tetranychus urticae* to fenazaquin

The laboratory raised susceptible strain was more susceptible to other field populations with LC_{50} value of 0.00125 per cent. The highest LC_{50} value was obtained for Una population with value of 0.00532 followed by Kullu (0.00488%) and Solan (0.00472%). The least LC_{50} value (0.00323%) was obtained in Palampur population. The highest resistance ratio (4.26) was obtained for Una population followed by Kullu, Solan, Kangra and Sundernagar with respective ratio 3.90, 3.78, 3.70 and 3.64. The least was obtained for Palampur population (Table 1).

Table 1. Intrinsic toxicity and resistance ratio of fenazaquin for different *Tetranychus urticae* populations from Himachal Pradesh

Mite population	Regression equation (y = a + bx)	LC_{50} (%)*		Resistance ratio
		LC_{50}	Fiducial limits	
Kangra	3.9163 + 1.6310 x	0.00462	0.00331 - 0.00637	3.70
Kullu	4.0172 + 1.4261 x	0.00488	0.00337 - 0.00707	3.90
Palampur	3.9197 + 1.6462 x	0.00453	0.00323 - 0.00624	3.62
Solan	4.0593 + 1.3964 x	0.00472	0.00320 - 0.00687	3.78
Sundernagar	4.0040 + 1.5127 x	0.00455	0.00316 - 0.00642	3.64
Una	3.7984 + 1.6549 x	0.00532	0.00388 - 0.00741	4.26
Susceptible strain	3.2923 + 1.5567 x	0.00125	0.00091 - 0.00172	1.00

*Mortality recorded in adult females after 24 hrs of exposure

Susceptibility of *Tetranychus urticae* to hexythiazox

The median lethal concentration (LC_{50}) of hexythiazox obtained by treating eggs of *T. urticae* ranged from 0.00105 (Palampur population) to 0.00137 (Una population) with fiducial limits varying between 0.00078 to 0.00180 per cent (Table 2). Fiducial limit overlapped for all the mite populations revealing them to be on a par to each other, while they fail to overlap with S-strain significantly differing to it. The order of resistance developed to hexythiazox was Una ≥ Kullu ≥ Sundernagar ≥ Solan ≥ Kangra ≥ Palampur. The resistance ratio varied from 1.88 to 2.45 being minimum for Palampur and Una population and variations being non-significant to different populations.

Susceptibility of *Tetranychus urticae* to Propargite

The LC_{50} values of propargite obtained for adult females of Una population was 0.03837 per cent being maximum and minimum value of 0.02364 per cent for Palampur population. The fiducial limits ranged from 0.01655 to 0.04064 per cent being significantly different to S-strain (Table 3). The resistance ratio obtained varied from 3.47 to 5.63 when LC_{50} values of field populations were compared to LC_{50} value of S-strain. The maximum resistance was observed for Una population (5.63) followed by Kullu (4.19), Solan (4.08), Sundernagar (4.02), Kangra (3.54) and least for Palampur population (3.47).

Table 2. Intrinsic toxicity and resistance ratio to hexythiazox for different *Tetranychus urticae* populations from Himachal Pradesh

Mite population	Regression equation (y = a + bx)	LC_{50} (%)*		Resistance ratio
		LC_{50}	Fiducial limits	
Kangra	3.6148 + 1.3405 x	0.00108	0.00078 - 0.00144	1.93
Kullu	3.4423 + 1.4780 x	0.00113	0.00084 - 0.00150	2.02
Palampur	3.3776 + 1.5880 x	0.00105	0.00079 - 0.00136	1.88
Solan	3.6242 + 1.3224 x	0.00110	0.00078 - 0.00149	1.96
Sundarnagar	3.4183 + 1.5060 x	0.00112	0.00084 - 0.00146	2.00
Una	3.2945 + 1.5007 x	0.00137	0.00101 - 0.00180	2.45
Susceptible strain	3.7966 + 1.6054 x	0.00056	0.00042 - 0.00073	1.00

*Mortality recorded in egg stage of *Tetranychus urticae* after 5 days

Table 3. Intrinsic toxicity and resistance ratio of propargite for different *Tetranychus urticae* populations from Himachal Pradesh

Mite population	Regression equation (y = a + bx)	LC_{50} (%)		Resistance ratio
		LC_{50}	Fiducial limit	
Kangra	2.6627 + 1.6911 x	0.02411	0.01751 - 0.03305	3.54
Kullu	2.6915 + 1.5858 x	0.02856	0.02064 - 0.04064	4.19
Palampur	2.9349 + 1.5033 x	0.02364	0.01655 - 0.03355	3.47
Solan	2.5754 + 1.6793 x	0.02779	0.02032 - 0.03878	4.08
Sundarnagar	2.7069 + 1.5957 x	0.02735	0.01976 - 0.03850	4.02
Una	2.4072 + 1.7749 x	0.03837	0.02159 - 0.03964	5.63
Susceptible strain	3.6753 + 1.5903 x	0.00681	0.00491 - 0.00959	1.00

*Mortality recorded in adult females after 24 hrs of exposure

Earlier also, the resistance in *T. urticae* population to different chemical acaricides has been reported from different parts of India and abroad. Recep *et al.* (2004) observed low resistance for propargite varying from <1 to 2.5 in field population of *T. urticae* in Turkey. Jianlong *et al.* (2016) reported *T. urticae* to be resistant to hexythiazox on strawberries in California. Sharma and Bhullar (2017) also reported low to moderate level of resistance to fenazaquin and propargite varying between 6.67 to 24.65 and 9.03 to 18.36, respectively, in Punjab. Patil *et al.* (2019) recorded low level of resistance in field population of TSSM in grapes for fenazaquin, hexythiazox and propargite with corresponding values 4.45, 5.37 and 4.76.

Conclusion

The level of resistance in TSSM populations from different localities revealed the Una population resulted in highest value of resistance ratio for all the three acaricides evaluated (2.45-5.63). It was followed by Kullu population (3 acaricides), Solan (2), Sundernagar (2), Kangra (3) and Palampur (3). However, in all the acaricides the development of resistance was of low level as per Kim *et al.* (2004), resistance ratio being ≤ 10.

References

Erdogan P, Yildirim A and Sever B 2012. Investigations on the effects of five different plant extracts on the two-spotted mite *Tetranychus urticae* Koch. (Arachnida:Tetranychidae). Psyche **2012**: 1-5.

Farouk S and Osman MA 2009. Induction of resistance in common bean plants *Phaseolus vulgaris* L. using different plant elicitors against spider mite *Tetranychus urticae* Koch infestation. Journal of Agricultural Sciences **34**: 11399-11419.

Finney DJ 1971. Probit analysis 3rd ed. Cambridge University, London, Inc. p 33.

Grbic M, Leeuwen VT, Clark RM, Rombauts S, Rouze P, Grbic V, Osborne EJ, Dermauw W, Phuong CTN, Ortego F, Hernandez CP, Diaz I, Martinez M, Navajas M, Sucena E, Magalhaes S, Nagy l, Pace RM, Djuranovic S, Smagghe G, Iga M, Christiaens O, Veenstra JA, Ewer J, Villalobos RM, Hutter JL 2011. The genome of *Tetranychus urticae* reveals herbivorous pest adaptations. Nature **479**: 487: 492.

JianLong B, Zi-Mian L, Lu Y and Nick CT 2016. Resistance status of the carmine spider mite, *Tetranychus cinnabarinus* and the two spotted spider mite, *Tetranychus urticae* to selected acaricides on strawberries. Insect Science **23**: 88-93.

Kim YJ, Lee SH, Lee SW and Ahn YJ 2004. Fenpyroximate resistance in *Tetranychus urticae* (Acari: Tetranychidae): cross resistance and biochemical resistance mechanisms. Pest Management Science **60**: 1001-1006.

Kumar D, Raghuraman M and Singh Janardan 2015. Population dynamics of spider mite, *Tetranychusurticae* Koch on okra in realtion to biotic factors of Varanasi region. Journal of Agrometeorology **17**: 102-106.

Leeuwen TV, Tirello P, Pozzebon A, Cassaneli S and Duso C 2012. Resistance to acaricides in *Tetranychus urticae:* toxicological and enzymatic assays. Exp. Appl. Acarol. **57**: 53-64.

Patil CM, Udikeri SS and Karabhantanal SS. 2019. Acaricide resistance in *Tetranychus urticae* Koch populations of grapevine orchard in northern Karnataka, India. Journal of Agriculture and Horticulture Research **2** (1):1-4.

Recep AY, Elvan S and Ismail K 2005. Response to some acaricides of the two spotted spider mite (*Tetranychus urticae* Koch) from protected vegetables in Isparta. Turk. Journal of Agricultural For. **29**: 165-171.

Sato ME, Silva MZD, Raga A and Filho MFDS 2005. Abamectin resistance in *Tetranychus urticae* Koch (Acari: Tetranychidae): Selection, Cross-resistance and Stability of resistance. Crop Protection **34**: 991-998.

Sharma RK and Bhullar MB 2018. Status of acaricide resistance in field collected two-spotted spider mite, *Tetranychus urticae* Koch from vegetable growing areas of Punjab, India. Journal of Entomology and Zoological Studies **6**: 328-332.