Research Article

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Acaricide Resistance in *Tetranychus Urticae* Koch Populations of Grapevine Orchard in Northern Karnataka, India

Patil CM[1]*, Udikeri SS[2] and Karabhantanal SS[1]

[1]*College of Agriculture, Vijayapur - 586101, India*

[2]*University of Agricultural Sciences, Dharwad - 580 005, India*

***Corresponding author**
Patil CM, College of Agriculture, Vijayapur - 586101, India.
E-mail: patilmchandru@gmail.com

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Abstract
Studies on Tetranychus urticae Koch population from grapevine orchard in Northern Karnataka resistance to major acaricides viz., dicofol 18.5 EC, fenpyroximate 5 SC, diafenthiuron 50 SC, sulphur 80 WP, abamectin 1.9 EC, hexythiazox 5.45 EC, spiromecifen 240 SC, propargite 57% EC, ethion 50 EC, fenazaquin 10% EC. Acaricidal resistance to sulphur 80 WG was highest with LC_{50} of 17769 ppm for field population and 651 for laboratory susceptible culture. The resistance ratio for sulphur was 27.30. The least resistance ratio of 4.45 folds was observed for fenazaquin 10% EC for which field and laboratory susceptible populations have exhibited LC_{50} of 44.62 ppm and 9.57 ppm, respectively. Based on the resistance co efficient use of sulphur appeared risky with high level of resistance. Propargite 57% EC, dicofol 18.5 EC and fenazaquin 10% EC have been classified as chemicals with low level of resistance for grape mites.

Keywords: Tetranychus urticae, Resistance, Grape, Acaricides.

Introduction
Grape (*Vitis vinifera* L.) is one of the most important fruit crops of temperate zone which has acclimatised to tropical and sub tropical agro climatic conditions prevailing in Indian sub-continent. Grape originated in western Asia and Europe. It is fairly a good source of minerals like calcium, phosphorous, iron and vitamins like B1 and B2. It was introduced to India by the Persian invaders in 1300 A.D. Grape is a non-climatric fruit that grows on the perennial and deciduous woody climbing vine.

Karnataka is the second largest grape growing state in India after Maharashtra, with an area of 20.46 thousand ha with a production of 302.39 thousand tonnes and productivity of 14.78 t/ha [1]. Grape growing regions are located in the following two agro-climatic regions in the state viz., north interior Karnataka and south interior Karnataka.

In 2014-15, Vijayapur district contributed an area of 8906 ha, production of 106 536 t, with average productivity 20 t/ha. Large heactarages of grape cultivation are quite evident in Basavana Bagewadi, Vijayapur, Indi, Muddebihal and Sindgi Talukas of Vijayapur. Despite large area and intensive scientific crop husbandry, pest management issues seriously affect the profitable grape berries production. Among non insect pests, six species of mites viz., *Tetranychus urticae* Koch, *T. cinnabarinus* Boisdual, *T. neocoledonicus* Andre, *Oligonicus mangiferus* Rahmen & Sapra , O. *punicae* Baker and *Eutetranychus orientalis* Klein are found causing damage to grapevine in India [2]. Amongst these mites infestation of *Tetarnychus urticae* Koch (Acariformes: Tetranychidae) is reported to be quite considerable designating it as an emerging sucking pest of grape and it is causing enormous damage to grapevine in Andhra Pradesh and Karnataka. Though *Tetranychus urticae* is a polyphagous mite infesting many crops, the information pertaining to grapes has not been generated so far.

The problem of mite infestation has increased in recent years in Vijayapura district. The severity of mite menace could be due to changing pest scenario, preference of grape as a new host in the area, changing climate which is favourable for their abundant increase and heavy usage of newer pesticides which might have eliminated the natural enemies [3]. For effective management of this pest it is essential to understand the basic causes for heavy incidence. The reasons may be resurgence and resistance to acaricides. So a resistance study with respect to *T. urticae* in the grape ecosystem is essential to schedule the best management practices with acaricides.

Material and Methods
Present investigation on resistance of *T. urtice* to different acaricides was carried out in the entomology laboratory of the College of Agriculture, Vijayapura at ambient temperature of 26 ± 5°C and relative humidity of 74± 5 %.

Culturing of field population of Tetranychus urticae Koch in the laboratory
The field population of *T. urticae* was brought from grape vineyard of Dyaberi village vicinity of (629 m a.s.l, 16.8898°N 75.8414°E)

Vijayapura taluk and district. These field populations were reared on mulberry leaves which were kept upside down on a sponge which were kept in large plastic trays containing water maintained to the surface level of sponge, so that mites were restricted only on the leaves. The leaves were changed as and when required. These mite populations were maintained in the laboratory conditions at 25 ± 1ºC, 70 ± 5% RH and a 14 h photoperiod. These resistant populations were reared for one generation and then used for bioassay study for 10 different acaricides.

Rearing of susceptible strain

The susceptible strain of *T. urticae* was maintained on mulberry under similar conditions at the College laboratory and used in determination of baseline values for susceptibility.

Determination of resistance of *T. urticae* to acaricides

The median lethal concentration (LC_{50}) values were determined for the field and susceptible mite populations following FAO leaf dip bioassay method [4]. The different concentrations of each acaricide were prepared with distilled water in volumetric flasks using a micropipette. A treatment without any acaricide formed the control. All the acaricides used in the study were purchased as formulated products in commercial market. The test concentrations limiting the mortality to 5.0-95.0% range for different acaricides were generated through pilot studies. Within this range six to seven concentrations were used for resistance bioassays. Mulberry leaf discs were prepared using a metal borer which makes exactly 2.0 cm diameter leaf discs. Leaf discs were dipped in desired concentration of acaricides for 10 sec and then exposed for 5 min to a gentle current of air to eliminate excess moisture. Then leaf discs were placed adaxial side down and four leaf discs were placed in a single Petri dish and remaining three were placed on another Petri dish. Using a fine brush (10/0 Taklon), 10 adult *T. urticae* females of the same age were placed on a mulberry leaf disc on water-saturated cotton wool (4 cm x 4 cm) in a Petri dish (6 cm diameter). Water-saturated cotton wool was pushed up against the perimeter of the leaf disc, in order to create a barrier and prevent mites from walking off the disc, since mite movement may be observed in these plates. Four replications were maintained along with a water-treated control.

Observations on the mite mortality in each treatment were recorded after 24 h after treatment which was assessed under a stereo binocular microscope. Mites were scored as dead if they failed to make active movement after a slight disturbance with fine brush [5]. The mortality data were corrected using Abbot's formula depending on the mortality observed in the control [6]. The corrected mortalities were subjected Probit analysis using IBM SPSS Statistics version 21 for determining concentration-mortality responses and the median lethal concentration (LC_{50}) values [7].

The LC_{50} values determined for field populations were compared with LC_{50} values of susceptible laboratory culture and used for detecting and quantifying the level of resistance as the resistance ratio.

$$\text{Resistance ratio} = \frac{LC_{50} \text{ of field population}}{LC_{50} \text{ of susceptible population}}$$

Results and Discussion

The acaricide resistance was assessed in field population of *Tetranychus urticae* Koch of Vijayapur (Karnataka, India) from grape ecosystem collected during November-December, 2014. The FAO leaf dip was followed for the study. The resistance has been noticed for all the 10 acaricides viz., dicofol 18.5 EC, fenpyroximate 5 SC, diafenthiuron 50 SC, sulphur 80 WP, abamectin 1.9 EC, hexythiazox 5.45EC, spiromecifen 240 SC, propargite 57% EC, ethion 50 EC, fenazaquin 10% EC used for the study.

The median lethal concentration (LC_{50}) was 17769.72 ppm for sulphur 80 WP which appeared highest among all the acaricides. The same acaricide had 651.17 ppm median lethal concentration (LC_{50}) for laboratory susceptible culture. Thus 27.30 fold resistance ratio was observed (RR) for sulphur. Similarly 12.54 fold resistance (RR) was observed for ethion 50 EC where LC_{50} 1048.03 ppm was observed against 83.56 ppm for laboratory susceptible culture. All other acaricides tested had resistance ratio less than 10 fold. Among these the least resistance ratio of 4.45 fold was observed for fenazaquin 10% EC. The field and laboratory susceptible population exhibited LC_{50} values of 44.62 ppm and 9.57 ppm, respectively for fenazaquin 10% EC. The frequently used acaricide dicofol 18.5 EC also had LC_{50} of 385.35 ppm in field population and 54.67 ppm for susceptible population, accounting for a resistance ratio of 7.04 fold. The teraonic and tetramic acid derivative acaricide spiromecifen had LC_{50} of 828.75 ppm for field population and laboratory susceptible population exhibited LC_{50} values of 144.46 ppm and accounting for resistance ratio of 5.74 folds. Diafenthiuron had an LC_{50} of 424.86 ppm and 80.023 ppm for field and laboratory susceptible population, respectively, and accounting for resistance ratio of 5.31 folds. The most commonly used acaricide by grape growers was propargite 57% EC which had an LC_{50} values of 604.47 ppm for field population, 112.49 ppm for susceptible population, accounting for resistance ratio of 5.37 folds. The other three acaricides viz., hexythiazox 5.45 EC, fenpyroximate 5 SC, abamectin 1.9 EC had and LC_{50} values of 34.18 ppm, 33.24 ppm, 4.49 ppm, respectively, for field population and susceptible population had LC_{50} values of 7.17 ppm, 4.92 ppm, 0.97 ppm, respectively. The RR values for these three acaricides were 4.76, 5.37 fold and 4.62 folds respectively (Table 1). The present findings are in conformity with Sridhar & Jhansi Rani (2007) who reported 2-3 folds resistance to dicofol and 2 to 12 folds resistance to wettable sulphur in T. urticae populations at Delhi, Pune, Bangalore and Hosur (Tamil Nadu) [8].

Table 1: Resistance in *Tetranychus urticae* Koch population of grape ecosystem to different acaricide

Acaricides	Population	LC_{50} & Fiducial limits (ppm)	Regression equation Y=a=bx	χ^2	Resistance ratio
Abamectin 1.9 EC	Field	4.49 (3.53–5.53)	Y= -1.28+0.21x	0.85	4.62
	Susceptible	0.97 (0.40–1.42)	Y= 0.70+0.37x	0.14	
Diafenthiuron	Field	424.86 (373.57–479.49)	Y= -1.35+0.17x	1.05	5.31
	Susceptible	80.02 (54.76–103.3)	Y= -3.17+2.56x	1.54	
Dicofol	Field	385.35 (362.13–411.52)	Y= -15.07+1.84x	4.73	7.04
	Susceptible	54.67 (34.23–83.52)	Y=-4.39+3.91x	3.23	
Ethion 50 EC	Field	1048.03 (942.97–1161.82)	Y= -11.77+1.78x	4.95	12.54
	Susceptible	83.56 (57.64–107.52)	Y= -4.08 +4.86x	1.44	
Fenpyroximate 5SC	Field	33.24 (27.86–38.84)	Y= -3.87+0.57x	4.37	6.75
	Susceptible	4.92 (0.06–8.77)	Y= - 2.13+ 1.5x	0.49	
Fenazaquin 10 EC	Field	42.62 (35.55–49.62)	Y= -4.08+0.53x	5.44	4.45
	Susceptible	9.57 (6.12–14.81)	Y= - 0.77 +2.05x	5.18	
Hexythiazox 5.45 EC	Field	34.18 (27.89–40.02)	Y= -3.66+0.55x	1.37	4.76
	Susceptible	7.17 (4.82–9.63)	Y= - 1.28 +0.27x	0.07	
Propargite 57 EC	Field	604.47 (543.27–664.05)	Y= -1.63+0.18x	3.48	5.37
	Susceptible	112.49 (73.25–157.31)	Y= - 1.28+0.27x	0.07	
Spiromecifen 240 SC	Field	828.75 (627.12–1017.41)	Y= -6.01+0.73x	4.25	5.74
	Susceptible	114.46 (17.85–289.14)	Y= -0.96+0.15x	3.21	
Sulphur 80 WP	Field	17769.72 (16856.37–18742.35)	Y= -30.51+3.78x	4.67	27.30
	Susceptible	651.17 (572.74–612.13)	Y= -4.76+9.88x	4.74	

N = 40 (Number of mites exposed)

Table 2: Categorisation of *Tetranychus urticae* Koch grape ecosystem field population resistance to different acaricides

Acaricides	Recommended Dosage (ppm)	LC95& Fiducial limits (ppm)	Resistance co-efficient *	Resistance category*
Abamectin 1.9 EC	9.50	30.73 (20.79–56.23)	3.23	Medium Resistance
Diafenthiuron 50 SC	400	940.46 (826.81–1115.27)	2.35	Medium Resistance
Dicofol 18.5 EC	462	719.01 (628.38–885.21)	1.55	Low Resistance
Ethion 50 EC	1000	2768.71 (2187.21–4212.93)	2.76	Medium Resistance
Fenpyroximate 5 SC	50	147.23 (106.33–255.19)	2.94	Medium Resistance
Fenazaquin 10 EC	100	193.06 (146.14–296.78)	1.93	Low Resistance
Hexythiazox 5.45 EC	81.75	166.68 (122.09–280.80)	2.10	Medium Resistance
Propargite 57 EC	1140	1214.70 (1103.78–1372.76)	1.06	Low Resistance
Spiromecifen 240 SC	1200	4201.36 (3495.88–8644.66)	3.50	Medium Resistance
Sulphur 80 WP	1600	30115.03 (30001.87–60951.12)	18.82	Very High Resistance

N = 40 (Number of mites exposed)

* Resistance Co-efficient= LC95 of field strain /Recommended dosage (Somnath et al., 2009)

Resistance categories:
Resistance Co-efficient 0.1 – 1.00 = Lack of resistance,
Resistance Co-efficient 1.1 – 2.0 = Low resistance,
Resistance Co-efficient 2.1 – 5.0 =Medium resistance
Resistance Co-efficient 5.1 – 10.0 = High resistance,
Resistance Co-efficient >10 = Very high resistance.

By resistance co efficient (Table 2), propargite 57% EC, dicofol 18.5 EC and fenazaquin 10% EC have been classified as chemicals with low level resistance having resistance co-efficient in the range of 1.1 - 2. The acaricides viz., hexythiazox 5.45 EC, diafenthiuron 50 SC, ethion 50 EC, fenpyroximate 5 SC, abamectin 1.9 EC, and spiromecifen 240 SC have been classified as chemicals with medium level of resistance having resistance co-efficient in the range of 2.1 – 5. The most widely used acaricide as well a fungicide sulphur has been classified as chemical with very high level of resistance. The acaricide resistance studies in grape ecosystem are not available for comparisons of the present findings. However to some extent results of other workers are in accordance with present findings. Kim et al. (2006) has reported fenpyroximate and pyridaben resistant populations of *T. urticae* selected over 20 generations in the laboratory for their cross resistance to another acaricide of similar mode of action i.e., fenazaquin, the levels of resistance noticed were low (RR,10) [9].

Conclussion

Being a resistant pest *T. urticae* might have experienced a serious selection pressure in grape ecosystem leading acquisition high degree of resistance to conventionally used acaricides and exhibiting cross resistance/multiple resistance to other acaricides also keeping itself un-eliminated. Hence careful resistance management strategies need to be developed [10].

References

1. Anonymous (2014) Indian horticulture database, National Horticulture Board. www.nhb.gov.in
2. Anonymous (2008) Management of Mites on Grapes. Extension folder No.15, National Research Centre for Grapes, Pune, India.
3. Veerendra AC, Udikeri SS, Karabhantanal SS (2014) Comparative biology of two-spotted spider mite, Tetranychus urticae Koch (Acariformes: Tetranychidae) on grape and mulberry. Karnataka Journal of Agricultural Sciences 27: 351-352.
4. Busvine JR (1980) Recomended Methods of pest resistance to pesticides. FAO Plant Production and Protection. Paper No 21.
5. FAO (Food and Agriculture Organization) (1984) Recommended methods for the detection and measurement of resistance of agricultural pests to pesticides. Plant Protection Bulletin 32: 25-27.
6. Abbot WS (1925) A method of computing of effectiveness of an insecticide. Journal of Economic Entomology 18: 256-267.
7. Finney DJ (1971) Probit Analysis. 3rd edition. Cambridge University Press, London, U.K. 383.
8. Sridhar V, Jhansi Rani B (2007) Resistance in two potted spider mite, Tetranychus urticae Koch on rose from different polyhouses to dicofol and wettable sulphur. Journal of Acarology 7: 48-50.
9. Kim YJ, Park HM, Cho JR, Ahn YJ (2006) Multiple resistance and biochemical mechanism of pyridaben resistance in Tetranychus urticae Koch (Acari: Tetranychidae). Journal of Economic Entomology 99: 945-958.
10. Somnath R, Mukopadhyaya A, Gurusubramaniam G (2009) Sensitivity of the tea mosquito bug (Helopeltis theivora Waterhouse), to commonly used insecticides in 2007 in Dooars tea plantations, India and implication for control. American-Eurasian Journal of Agricultural and Environmental Science 6: 244-251.

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