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Evaluation of acaricides against two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) infesting rose under field conditions

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ABSTRACT: Field experiments on evaluating the effectiveness of new molecules of acaricides against *Tetranychus urticae* infestation on rose crop was conducted during summer 2021-22 and 2022-23 at Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India. The results of the experiment indicated that cyenopyrafen 30 SC @ 0.80 ml/l was effective acaricide in reducing the mite population. The next best acaricides in their efficacy were fenpyroximate 5 EC @ 2.0 ml/l and diafenthiuron 50 WP @ 1.0 g/l. In terms of bio-efficacy, considering the pooled data on per cent reduction of the mite population compared to the untreated control, the order is: cyenopyrafen 30 SC (87.04 %) > fenpyroximate 5 EC (82.73 %) > diafenthiuron 50 WP (80.98 %) > chlorfenapyr 10 SC (77.93 %) > spiromesifen 240 SC (75.93 %) and > ethion 50 EC (69.09 %). Higher benefit cost ratio of 2.54 was recorded in cyenopyrafen 30 SC @ 0.80 ml/l followed by fenpyroximate @ 2 ml/ l (2.42) and diafenthiuron @1 gm/l (2.25).

Keywords: Acaricides**,** cyenopyrafen 30 SC, fenpyroximate 5 EC, *Tetranychus urticae,* rose

INTRODUCTION

Rose cultivation in India is gaining increasing popularity due to the rising demand for cut flowers, resulting in higher commercial profits. The major global producers of cut rose flowers include the Netherlands, dominating with 70 per cent share in the world export market, followed by Colombia (12%), Israel (6%) and Italy (8%). In India, roses take the top position in the export trade, generating a market worth $178.60 million in the international arena (Manjula, 2005). In India, the area dedicated to rose production covers 29.41 thousand hectares, with a total rose production of 465.95 thousand metric tons (Anonymous, 2021). Commercial rose cultivation faces numerous challenges including both biotic and abiotic factors. Among the biotic factors, insect-pest infestations are particularly detrimental. Sucking pests, with spider mites like *Tetranychus* spp. being a primary concern, significantly reduce flower yields. The Two-Spotted Spider Mite (TSSM), *Tetranychus urticae* Koch (Acari: Tetranychidae) holds the distinction of being the most economically significant plant-feeding mite globally. TSSM is a major pest in various cropping systems around the world affecting vegetables, fruits and ornamental plantsin both protected and open environments (Migeon and Dorkeld, 2010). It is a generalist feeder, capable of feeding on over 3,800 plant species (Migeon and Dorkeld, 2020). Both nymphs and adults of TSSM feed on plant sap, causing a reduction in chlorophyll levels and results in yield loss. The indiscriminate and continuous use of acaricides for *T. urticae* management has led to the emergence of resistant populations in over 40 countries (Georghiou and Lagunes, 1991).To develop economically viable management strategies aimed at reducing the environmental burden of pesticides and effectively managing resistance, a thorough understanding of effectiveness of newer acaricdes molecules essential. In view of this, a study on evaluation of efficacy of newer acaricdes molecules against spider mite on rose under field conditions was carried out.

MATERIALS AND METHODS

The field experiment was conducted in a farmer's field at Surahonne, Nyamati taluk, Davangere district, Karnataka during 2021- 22 and 2022-23. The experiment was laid out in Randomized Complete Block Design (RCBD) with seven treatments including untreated control with three replications. The acaricides evaluated in the study included spiromesifen 240SC @0.80 ml, chlorfenapyr 10SC @ 1.0 ml, diafenthiuron 50WP @ 1.0 gm, fenpyroximate 5EC @ 1.0 ml, cyenopyrafen 30 SC @ 0.80 ml and ethion 50 EC @ 2.50 ml. The treatments were imposed when the rose crop was uniformly infested with natural spider mite population. The acaricides were sprayed by using a hand operated high volume knapsack

sprayer fitted with a hallo cone nozzle. Second spraying of acaricides was taken up 15 days after first spray. The observations on number of mites per leaf were recorded from five randomly selected plants. From each plant, six leaves were sampled representing top, middle and bottom canopy and kept separately in labeled polythene bags and brought to the laboratory. Observations were recorded using stereo-binocular microscope before spraying as pre-count and post-treatment count on third, seventh and tenth day after imposition of treatments. The data was subjected to ANOVA for a Randomized Complete Bock Design (RCBD) with square root transformation. The results were interpreted at a five percent significance level using ICAR WASP (Web Agri Stats Package) 2.0 software. Percent reduction over untreated control was calculated, and the data of two years was pooled for a better interpretation of a valid conclusion.

RESULTS AND DISCUSSION

During 2021-22, the data of before treatment imposition indicated elevated mite counts per leaf across all treatments, with no statistically significant difference among them. Subsequently, a progressive reduction in the mite population was observed subsequent to the implementation of treatments. The mean mite population of first and second spray recorded during 2021-22 indicated that the lowest mean mite population of 7.90 mites per leaf was recorded in the cyenopyrafen 30 SC @ 0.80 ml/L followed by fenpyroximate 5 EC @ 1.0 ml/L with 9.48 mites per leaf and diafenthiuron 50 WP @ 1.0 g/L (11.27 mites per leaf). The highest mean mite population of 56.65 mites per leaf was recorded in control plots followed by ethion 50 EC @ 2.5 ml/L (16.18 mites per leaf) and spiromesifen 240 SC @ 0.80 ml/L (13.61 mites per leaf). However in all the treatments, the mean mite population was significantly lower when compared to control. The per cent mortality of mites was highest in cyenopyrafen 30 SC @ 0.80 ml/L with 86.06 per cent followed by fenpyroximate 5 EC @ 1.0 ml/L which recorded 83.26 per cent mortality and diafenthiuron 50 WP @ 1.0 g/L with 80.10 per cent mortality. The lowest per cent mortality of 71.43 was observed in ethion 50 EC @ 2.5 ml/L followed by spiromesifen 240 SC @ 0.80 ml/L (75.98 per cent) and chlorfenapyr 10 SC @ 1.0 ml/L (78.50 per cent) among different acaricides.

During 2022-23, the mean mite population and the per cent mortality in different treatments followed same trend as in the case of 2021-22. The lowest mean mite population of 6.73 mites per leaf was recorded in the cyenopyrafen 30 SC @ 0.80 ml/L followed by fenpyroximate 5 EC@ 1.0 ml/L with 9.95 mites per leaf and diafenthiuron 50 WP @ 1.0 g/L (10.89 mites per leaf). The highest mean mite population of 53.51 mites per leaf was recorded in control plots followed by ethion 50 EC @ 2.5 ml/L (21.69 mites per leaf) and spiromesifen 240 SC @ 0.80 ml/L (16.48mites per leaf). However in all the treatments, the mean mite population was reduced significantly when compared to control. The highest per cent mortality of 87.42 was recorded in cyenopyrafen 30 SC@ 0.80 ml/L followed by fenpyroximate 5 EC @ 1.0 ml/L which recorded 81.40 per cent and diafenthiuron 50 WP @ 1.0 gl/L (79.65 per cent). The lowest per cent mortality of 59.46 was observed in ethion 50 EC @ 2.5 ml/L followed by spiromesifen 240 SC@ 0.80 ml/L (69.21per cent) among the acaricides treatments.

Table1. Bio-efficacy of acaricides against two spotted spider mite, *Tetranychus urticae* in rose under field condition (2021-22)

Treatments	Dosage ml/g/l	Mean number of mites per leaf									Mean	Per cent reduction
		1st spray					2nd spray					
		DBS	3DAS	7 DAS	10 DAS	14 DAS	3 DAS	7 DAS	10 DAS	14 DAS		
Spiromesifen 240 SC	0.8	41.71 (6.50)	17.80 (4.28)^{e}	10.99 (3.39)^{e}	13.49 (3.74)^{e}	16.89 (4.17)^{e}	13.03 (3.68)^{e}	10.43 (3.31)^{b}	11.11 (3.41)^{e}	15.14 (3.95)^{e}	13.61	75.98
Chlorfenapyr 10 SC	1.0	47.19 (6.91)	16.47 (4.12)^{d}	10.85 (3.37)^{e}	11.76 (3.50)^{d}	15.66 (4.02)^{d}	10.11 (3.26)^{d}	7.47 (2.82)^{d}	11.28 (3.43)^{e}	13.84 (3.79)^{b}	12.18	78.50
Diafenthiuron 50 WP	1.0	47.41 (6.92)	14.42 (3.86)^{e}	9.74 (3.20)^{d}	11.58 (3.48)^{d}	15.46 (3.99)^{d}	6.14 (2.58)^{f}	7.53 (2.83)^{d}	9.79 (3.21)^{d}	15.53 (4.00)^{e}	11.27	80.10
Fenpyroximate 5 EC	1.0	41.66 (6.49)	14.51 (3.87)^{e}	9.40 (3.05)^{d}	10.41 (3.30)^{e}	12.94 (3.67)^{e}	8.25 (2.96)^{e}	3.23 (1.93)^{e}	6.98 (2.73)^{e}	10.14 (3.26)^{e}	9.48	83.26
Cyenopyrafen 30 SC	0.8	49.07 (7.04)	13.55 (3.75)^{e}	8.05 (2.92)^{e}	7.81 (2.88)^{f}	9.54 (3.17)^{f}	5.85 (2.52)^{f}	2.71 (1.79)^{e}	6.40 (2.63)^{e}	9.27 (3.13)^{e}	7.90	86.06

Ethion 50 EC	2.5	41.32 (6.46)	19.79 (4.50)^{b}	16.27 (4.10)^{b}	15.82 (4.04)^{b}	20.02 (4.53)^{b}	14.72 (3.90)^{b}	9.36 (3.14)^{c}	13.12 (3.69)^{d}	16.85 v(4.17)^{b}	16.18	71.43
Control	-	44.15 (6.68)	43.53 (6.63)^{a}	45.14 (6.76)^{a}	50.06 (7.11)^{a}	57.58 (7.62)^{a}	67.15 (8.00)^{a}	74.32 (8.65)^{a}	62.74 (7.95)^{a}	64.95 (8.09)^{a}	56.65	-
CD (p=0.05)		NS	0.29	0.45	0.45	0.30	0.46	0.51	0.58	0.35	-	-
CV (%)		-	8.98	9.87	8.74	14.58	14.99	15.87	14.87	12.58	-	-

DBS: Day before spray; DAS: Day after spray; NS: Non significant; Figures within the parentheses indicates √x+0.5 transformed values;
Treatment means with the letter(s) in common are not significant by DMRT at 5% level of significance.

Table 2.Bio-efficacy of acaricides against two spotted spider mite, *Tetranychus urticae* in rose under field condition (2022-23)

Treatments	Dosage ml/g/l	Mean number of mites per leaf									Mean	Per cent reduction
		1st spray					2nd spray					
		DBS	3DAS	7 DAS	10 DAS	14 DAS	3 DAS	7 DAS	10 DAS	14 DAS		
Spiromesifen 240 SC	0.8	43.65 (6.64)	14.09 (3.82)^{c}	9.63 (3.18)^{c}	17.32 (4.22)^{c}	21.44 (4.68)^{c}	11.28 (3.43)^{c}	11.98 (3.53)^{c}	19.62 (4.49)^{c}	26.44 (5.19)^{c}	16.48	69.21
Chlorfenapyr 10 SC	1.0	45.17 (6.76)	14.54 (3.88)^{c}	6.24 (2.60)^{e}	12.69 (3.63)^{d}	18.81 (4.39)^{d}	8.47 (2.99)^{d}	10.23 (3.28)^{d}	17.78 (4.28)^{d}	23.93 (4.94)^{d}	14.09	73.67
Diafenthiuron 50 WP	1.0	43.99 (6.67)	10.85 (3.37)^{e}	9.56 (3.17)^{c}	10.95 (3.38)^{e}	14.41 (3.86)^{e}	7.51 (2.83)^{e}	7.09 (2.75)^{e}	10.48 (3.31)^{f}	16.27 (4.10)^{f}	10.89	79.65
Fenpyroximate 5 EC	1.0	50.54 (7.14)	9.35 (3.14)^{d}	5.15 (2.38)^{f}	9.56 (3.17)^{f}	13.66 (3.76)^{f}	6.25 (2.60)^{f}	6.66 (2.68)^{f}	11.4 (3.45)^{e}	17.58 (4.25)^{e}	9.95	81.40
Cyenopyrafen 30 SC	0.8	49.14 (7.05)	6.74 (2.69)^{f}	7.03 (2.74)^{d}	6.98 (2.73)^{g}	9.25 (3.12)^{g}	2.35 (1.69)^{g}	3.14 (1.91)^{g}	7.66 (2.86)^{g}	10.71 (3.35)^{g}	6.73	87.42
Ethion 50 EC	2.5	44.67 (6.72)	17.19 (4.21)^{b}	15.41 (3.99)^{b}	19.6 (4.48)^{b}	26.77 (5.22)^{b}	14.23 (3.84)^{b}	20.04 (4.53)^{b}	26.44 (5.19)^{b}	33.86 (5.86)^{b}	21.69	59.46
Control	-	46.90 (6.88)	53.18 (7.32)^{a}	48.25 (6.98)^{a}	55.25 (7.47)^{a}	58.35 (7.67)^{a}	63.25 (8.17)^{a}	61.59 (7.88)^{a}	50.27 (7.13)^{a}	44.55 (6.71)^{a}	53.51	-
CD (p=0.05)		NS	0.36	0.27	0.46	0.48	0.38	0.34	0.24	0.31	-	-
CV (%)		-	11.06	9.88	12.76	13.49	15.69	14.49	12.79	9.80	-	-

DBS: Day before spray; DAS: Day after spray; NS: Non significant; Figures within the parentheses indicates √x+0.5 transformed values;
Treatment means with the letter(s) in common are not significant by DMRT at 5% level of significance.

The pooled data of 2021-22 and 2022-23 indicated that of mean mite population did not vary significantly one day before imposition of treatments, indicating the uniform distribution of mites throughout the experimental field (Table 3). All the acaricides molecules tested proved their superiority in significantly suppressing the spider mite population compared to untreated control up to 14 days of the first and second application of acaricides. The lowest number of the mean mite was recorded in cyenopyrafen @ 0.80 ml/L followed by fenpyroximate @ 1.0 ml/L and diafenthiuron 50 WP @ 1.0 g/L which are on par with each other. The least reduction in mite population was observed in ethion 50 EC @ 2.50 ml/L followed by spiromesifen 240 SC @ 0.80 ml/L and chlorfenapyr 10 SC @ 1.0 ml/L. However, the highest number of mean mite population was observed in the untreated control. The chemicals, cyenopyrafen @ 0.80 ml/L and fenpyroximate @ 1.0 ml/L recorded 87.04 and 82.73 per cent reduction, respectively over untreated control. Next best treatment was diafenthiuron 50 WP

@ 1.0 g/L with 80.98 per cent reduction over control followed by chlorfenapyr 10 SC @ 1.0 ml/L (77.93 per cent). The lowest per cent reduction of mite population was observed in the treatment ethion 50 EC @ 2.5 ml/L (69.09 per cent) followed by spiromesifen 240 SC @ 0.80 ml/L (75.93 per cent). The B: C ratio calculated indicated that cyenopyrafen 30 SC recorded the highest B: C ratio of 2.54 followed by fenpyroximate 5 EC (2.42) and diafenthiuron 50 WP (2.25). The least B: C ratio was recorded for the control treatment with 1.31.

Our findings are in conformation with findings of Bajya and Ranjith (2016) who reported cyenopyrafen's effectiveness against the yellow mite, *Polyphagotarsonemus latus* in chili plants achieving an impressive reduction of 89.15 per cent compared to other treatments. Cyenopyrafen stands out as a newer acaricide capable of targeting early larvae, nymphs and adults by inhibiting mitochondrial electron transport at complex II. Its dual action through contact and ingestion renders cyenopyrafen highly effective against a diverse array of pests, including those that might be hidden within various plant structures. Present research findings are in line with the findings of Rajashekharappa *et al.* (2023) wherein the effectiveness of various acaricides was assessed against *T. urticae* infestations in yard long beans. They reported a remarkable reduction of 84.49 per cent in plots treated with diafenthiuron. These results also corresponds with the research findings of Kumar *et al.* (2010) who assessed the efficacy of specific acaricides against *T. urticae* on brinjal and stated that fenpyroximate 5 SC exhibited a reduction of 78.73% in the overall mite population. Similarly, our current study findings are in line with the observations made by Prakash *et al.* (2022) wherein the bio-efficacy and persistence of acaricides were examined against *T. urticae* in cucumber. Their results demonstrated a significant reduction of 79.61 per cent in plots treated with fenpyroximate 5 SC. In terms of bio-efficacy, considering the per cent reduction of the total mite population compared to the untreated control, the order is: cyenopyrafen 30 SC > fenpyroximate 5 EC > diafenthiuron 50 WP > chlorfenapyr 10 SC > spiromesifen 240 SC and > ethion 50 EC.

Table 3. Bio-efficacy of acaricides against two spotted spider mite, *Tetranychus urticae* in rose under field condition (Pooled)

Treatments	Dosage ml/g/l	Mean number of mites per leaf									Mean	Percent reduction	B:C ratio
		1st spray					2nd spray						
		DBS	3DAS	7 DAS	10 DAS	14 DAS	3 DAS	7 DAS	10 DAS	14 DAS			
Spiromesifen 240 SC	0.8	43.18 (6.57)	3.79 (2.07)^{de}	10.31 (3.28)^{c}	15.40 (3.98)^{c}	19.16 (4.43)^{c}	12.15 (3.55)^{c}	11.20 (3.42)^{c}	15.36 (3.98)^{c}	16.51 (4.12)^{f}	12.63	75.93	2.16
Chlorfenapyr 10 SC	1.0	46.68 (6.83)	5.06 (2.35)^{c}	8.54 (3.00)^{de}	12.22 (3.56)^{d}	17.23 (4.21)^{d}	9.29 (3.12)^{d}	8.85 (3.05)^{d}	14.53 (3.87)^{c}	14.09 (3.81)^{c}	11.58	77.93	2.23
Diafenthiuron 50 WP	1.0	6.20 (6.79)	3.56 (2.01)^{de}	9.65 (3.18)^{cd}	11.26 (3.42)^{de}	14.93 (3.92)^{e}	6.82 (2.70)^{e}	7.31 (2.79)^{e}	10.13 (3.26)^{d}	11.07 (3.40)^{d}	9.98	80.98	2.25
Fenpyroximate 5 EC	1.0	46.60 (6.82)	3.85 (2.08)^{d}	7.27 (2.78)^{f}	9.98 (3.23)^{e}	13.30 (3.71)^{f}	7.25 (2.78)^{e}	4.94 (2.33)^{f}	9.19 (3.11)^{d}	10.62 (3.33)^{d}	9.06	82.73	2.42
Cyenopyrafen 30 SC	0.8	49.61 (7.04)	2.53 (1.74)^{e}	7.54 (2.83)^{ef}	7.39 (2.80)^{f}	9.39 (3.14)^{g}	4.10 (2.14)^{f}	2.92 (1.84)^{g}	7.03 (2.74)^{e}	6.65 (2.67)^{e}	6.80	87.04	2.54
Ethion 50 EC	2.5	42.99 (6.59)	6.44 (2.63)^{b}	15.70 (4.02)^{b}	17.71 (4.26)^{b}	23.39 (4.88)^{b}	14.47 (3.86)^{b}	14.70 (3.89)^{b}	19.78 (4.50)^{b}	20.44 (4.57)^{b}	19.51	69.09	1.86
Control	-	45.52 (6.85)	48.15 (6.68)^{a}	46.69 (6.86)^{a}	52.65 (7.29)^{a}	57.96 (7.64)^{a}	65.20 (8.10)^{a}	67.95 (8.27)^{a}	56.50 (7.54)^{a}	31.71 (5.67)^{a}	52.48	-	1.31
CD (p=0.05)		NS	0.88	3.15	3.46	3.64	4.78	5.08	3.80	1.83	-	-	
CV (%)		-	8.81	11.75	10.78	9.21	15.76	16.96	11.29	6.51	-	-	

DBS: Day before spray; DAS: Day after spray; NS: Non significant; Figures within the parentheses indicates √x+0.5 transformed values;
Treatment means with the letter(s) in common are not significant by DMRT at 5% level of significance.

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