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Bioefficacy of insecticides and plant based oils against red spider mite, *Tetranychus urticae* (Koch) (Acari: Tetranychidae) in okra

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ABSTRACT: Field trials were conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli district, Tamil Nadu, to evaluate the bioefficacy of insecticides and plant-based oils against red spider mite, *Tetranychus urticae* (Koch) in okra during *rabi* 2021 and *summer* 2022. The results revealed that the highest per cent reduction over control of the red spider mite population was recorded in spiromesifen 25 EC @ 0.8 ml/l (73.28% and 67.78%), followed by propargite 57 EC @ 3ml/l (70.82% and 65.51%) in both the seasons, respectively. Among the plant-based oils, karanj oil was most effective against red spider mites, with a per cent reduction over control of 58.7% and 47.98% in *rabi,* 2021 and *summer* 2022, respectively. Mahua oil (54.02% and 41.72%) and camphor oil (51.62% and 38.74%) moderately control the red spider mite in okra. Based on moderate to high efficacy and safer natural enemies and environment, spiromesifen 25 EC @ 0.8 ml/l, propargite 57 EC @ 3ml/l and karanj oil 2ml/l would be used as an effective component in the IPM module for okra red spider mite.

Keywords: Bioefficacy, red spider mite, okra, insecticides, plant-based oils, karanj oil

INTRODUCTION

Okra, commonly known as lady's finger, is one of the predominant vegetables cultivated throughout India. Okra is a rich source of protein, carbohydrates, fat, iron, iodine and vitamins like A, B, and C, essential components of the human diet (Halder *et al.,* 2005). As a nutritious vegetable, okra is the best food to address doubling farmers' income as well as the problem of malnutrition. The production of okra is impacted by several biotic and abiotic factors, including insect pests and diseases (Gulati *et al.,* 2004). The crop is susceptible to various insect and mite pests, of which red spider mite, *Tetranychus urticae* Koch is most predominant In India (Gupta, 1985; Singh *et al.,* 1987). The first sight of infestation by red spiders mite resulted in a chlorotic, stippled appearance on the leaves. Heavily infested leaves turn pale, dry up, and fall off from the plants, which appear weak, and the photosynthetic activity is seriously hampered.

Using conventional insecticides based on the crop stage has proved to be okra's most effective pest control practice (Krishnakumar and Srinivasan, 1987). The time lag between pesticide application and harvesting is critical in vegetable crops like okra. However, the farmers need to be made aware of the use of pesticides at the fruiting stage and non-adoption of a safe waiting period leads to pesticide residues above Maximum Residual Limit (MRL). The residues of non-approved pesticides were detected in 1180 vegetable samples, and okra was found to have a higher level of pesticides above MRL among those vegetables as reported by Monitoring of Pesticide Residues at National Level (MPRNL) (Anon 2015). Considering the limitations of using insecticides alone and pesticide residue accumulation, the present study was conducted to determine the efficacy of new insecticides, plant-based oils, and safer insecticides in managing red spider mites.

MATERIALS AND METHODS

The present field trials were conducted at the experimental farm of Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Tiruchirappalli, Tamil Nadu, to find out the efficacy of insecticides and plant-based oils against red spider mite, *T. urticae*, during the season of *rabi,* 2021 and *summer,* 2022. The experiments are laid out in a Randomized Block Design (RBD) with eight treatments, including untreated control and replicated thrice. The treatments namely neem oil 3%, karanj oil 2ml/l, mahua oil 3%, camphor oil 1ml/l, azadirachtin 0.03WSP 5.0g/10l, spiromesifen 25EC 0.8ml/l, propargite 57EC 3ml/l were evaluated. All the treatments had two sprays except the untreated control. Okra (Summer gold hybrid) seeds were sown

Table 1. Efficacy of insecticides and Plant based oils against red spider mite, *Tetranychus urticae* in okra (Rabi 2021)- First spray

Treatments	Pre-treatment	Mite (1 cm^2/ 3 leaves/plant) *				
		1 DAT	3 DAT	7 DAT	14 DAT	Mean
T_1- Neem oil @ 3%	31.40 (5.65)	15.80 $(4.04)^b$	14.07 $(3.82)^c$	11.80 $(3.51)^d$	15.87 $(4.05)^b$	14.38
T_2- Karanj oil @ 2ml/l	33.00 (5.79)	15.07 $(3.95)^b$	13.00 $(3.67)^b$	10.00 $(3.24)^c$	16.00 $(4.06)^b$	13.52
T_3- Mahuaoil @ 3%	34.67 (5.93)	16.20 $(4.09)^c$	14.13 $(3.83)^d$	12.67 $(3.63)^e$	17.00 $(4.18)^d$	15.00
T_4- Camphor oil @ 1ml/l	31.80 (5.68)	16.87 $(4.17)^d$	15.67 $(4.02)^e$	13.40 $(3.73)^f$	17.33 $(4.22)^d$	15.82
T_5- Azadirachtin 0.03 WSP @ 2.0 g/l	31.20 (5.63)	10.43 $(3.31)^b$	12.07 $(3.54)^b$	14.13 $(3.83)^b$	16.53 $(4.13)^{bc}$	13.29
T_6- Spiromesifen 25 EC @ 0.8 ml/l	31.80 (5.68)	5.13 $(2.37)^a$	6.13 $(2.58)^a$	8.80 $(3.05)^a$	15.20 $(3.96)^a$	8.82
T_7- Propargite 57 EC @ 3 ml/l	31.93 (5.70)	5.80 $(2.51)^a$	6.80 $(2.70)^a$	10.00 $(3.24)^a$	15.80 $(4.04)^a$	9.60
T_8- Untreated control	31.33 (5.64)	33.13 $(5.80)^e$	32.47 $(5.74)^f$	31.13 $(5.62)^g$	32.60 $(5.75)^e$	32.33
SEd	NS	0.07	0.09	0.04	0.06	-
CD (p=0.05)	NS	0.15	0.19	0.09	0.12	-

*Mean of three replications
DAT- Days After Treatment
Figures in the Parentheses are $\sqrt{x+0.5}$ transformed values
Values in the column followed by same letters are not different statistically, (p=0.05) by LSD
NS – Non-significant

Table 2. Efficacy of insecticides and plant-based oils against red spider mite, *Tetranychus urticae* in okra (Rabi 2021)- Second spray

Treatments	Mite (1cm² /3 leaves/plant) *						Reduction over control (%)	Yield(t/ha)
	1 DAT	3 DAT	7 DAT	14 DAT	Mean	Cumulative mean#		
T_1- Neem oil @ 3%	15.20 (3.96)^{b}	13.53 (3.75)^{c}	11.27 (3.43)^{c}	15.60 (4.01)^{b}	13.90	14.14	55.99	3.5
T_2- Karanj oil @ 2ml/l	14.67 (3.89)^{b}	12.53 (3.61)^{b}	9.47 (3.16)^{bc}	15.40 (3.99)^{b}	13.02	13.27	58.70	4.00
T_3- Mahuaoil @ 3%	15.73 (4.03)^{d}	13.73 (3.77)^{e}	12.20 (3.56)^{d}	16.53 (4.13)^{cd}	14.55	14.78	54.02	3.2
T_4- Camphor oil @ 1ml/l	16.40 (4.11)^{d}	15.07 (3.95)^{e}	12.80 (3.65)^{e}	16.80 (4.16)^{d}	15.27	15.54	51.62	3.04
T_5- Azadirachtin 0.03 WSP @ 2.0 g/l	9.73 (3.20)^{c}	11.53 (3.47)^{d}	13.67 (3.76)^{b}	16.00 (4.06)^{bc}	12.73	13.01	59.51	4.48
T_6- Spiromesifen 25 EC @ 0.8 ml/l	4.73 (2.29)^{a}	5.60 (2.47)^{a}	8.33 (2.97)^{a}	14.73 (3.90)^{a}	8.35	8.58	73.28	5.60
T_7- Propargite 57 EC @ 3 ml/l	5.47 (2.44)^{a}	6.33 (2.61)^{a}	9.60 (3.18)^{ab}	15.20 (3.96)^{a}	9.15	9.38	70.82	5.12
T_8- Untreated control	31.60 (5.67)^{e}	31.93 (5.70)^{f}	32.40 (5.74)^{f}	31.80 (5.68)^{e}	31.93	32.13	55.99	2.08
SEd	0.08	0.07	0.06	0.05	-	-	-	-
CD (p=0.05)	0.17	0.16	0.12	0.11	-	-	-	-

*Mean of threereplications
#Mean of first and second spraying
DAT- Days After Treatment
Figures in the Parantheses are √x+0.5 transformed values
Values in the column followed by same letters are not different statistically, (p=0.05) by LSD
NS – Nonsignificant

with a spacing of 60×45cm. All the agronomic packages and practices Tamil Nadu Agricultural University recommended were followed to raise the crop, except the plant protection practices. The treatments were imposed when the red spider mite population crossed ETL. The observations on the incidence of the red spider mite were recorded before treatment and on 1, 3, 7 and 14 days after insecticide application. Mite populations were assessed in one cm^2 area on the top, middle and bottom leaves in each of the five randomly selected and tagged plants from each replication. The reduction of the red spider mite population in respective treatments over control was computed. using the formula (Susheelkumar *et al.,* 2020).

STATISTICAL ANALYSIS

The data was statistically analysed after square root transformation using AGRES software. The treatment mean values were compared by Latin Square Design (LSD).

RESULTS AND DISCUSSION

Field efficacy of insecticides and plant-based oils against red spider mite in okra presented in Table 1, 2, 3 and 4.

Rabi 2021

The pre-treatment population count ranged from 31.2 to 34.67/cm2/3 leaves/plant. Significant differences among the treatments were noted on 1, 3, 7 and 14 DAS; all treatments were superior to untreated control. After the first spraying, the minimum mean population of 8.82/cm^2/3 leaves/plant was recorded in spiromesifen 25EC, followed by propargite 57EC (9.60/cm^2/3 leaves/plant), Azadirachtin 0.03 WSP (13.29/cm^2/3leaves/plant), karanj oil (13.52/cm2/3 leaves/plant), Neem oil @ 3% (14.38/cm^2/3leaves/plant), Mahua oil @ 3% (15.00/cm^2/3leaves/plant), and Camphor oil (15.82/cm^2/3leaves/plant) as against untreated control (32.33/cm^2/3leaves/plant) (Table 1). After imposed second spraying, the mean mite population varied from 8.35 to 31.93/cm^2/3 leaves/plant, and a similar trend in population reduction was observed (Table 2).

The cumulative mean data of two sprayings revealed that spiromesifen 25 EC recorded the minimum population of red spider mite (8.58/cm^2/3 leaves/plant) followed by propargite 57 EC (9.38/cm^2/3 leaves/plant) and azadirachtin 0.03 WSP (13.01/cm^2/3leaves/plant) with per cent reduction over control of 73.28, 70.82 and 59.51, respectively and among the plant-based oils karanj oil recorded the minimum mite population of 13.27/cm^2/3leaves/plant with 58.70 per cent reduction over control. The maximum yield was recorded in the effective treatment spiromesifen 25 EC (5.6 t/ha), followed by propargite 57 EC (5.12 t/ha), azadirachtin 0.03 WSP (4.48 t/ha), karanj oil (4.00 t/ha), neem oil (3.5 t/ha), mahua oil (3.2 t/ha), camphor oil (3.04 t/ha) as against untreated control (2.08 t/ha).

Summer 2022

Before spraying of treatments, the mite population ranged from 49.4 to 50.47/cm^2/3 leaves. After the first spraying was imposed, the mean mite population varied from 16.33 to 31.03/cm^2/3 leaves/plant. The minimum mean mite population was recorded in spiromesifen 25 EC (16.33/cm^2/3 leaves/plant), followed by propargite 57 EC (17.52/cm^2/3 leaves/plant), azadirachtin 0.03 WSP (20.93/cm^2/ 3 leaves/plant), karanj oil (26.43/cm^2/3 leaves/plant), neem oil (28.05/cm^2/3 leaves/plant), mahua oil (29.50/cm^2/3 leaves/plant), camphor oil (31.03/cm^2/3 leaves/plant), as against untreated control (50.25/cm^2/3 leaves/plant) (Table 3). After the second spraying, the mean mite population varied from 15.77 to 49.38/cm2/3 leaves/plant, and a similar trend in population reduction was observed (Table 4). The cumulative mean data of two spraying indicated that spiromesifen 25 EC recorded the minimum population of red spider mite (16.05/cm^2/3 leaves/plant), followed by propargite 57 EC (17.18/cm^2/3 leaves/plant), azadirachtin 0.03 WSP (20.57/cm^2/3 leaves/plant) with per cent reduction over control of 67.78, 65.51 and 58.72 respectively. Among the plant-based oils, karanj oil @ 2ml/l recorded the minimum population of 25.92/cm^2/3 leaves/plant with a 47.98 per cent reduction over control.

The maximum yield was recorded in the effective treatment spiromesifen 25 EC (4.96 t/ha), followed by propargite 57 EC (4.64 t/ha), azadirachtin 0.03 WSP (4.16 t/ha), karanj oil (3.68 t/ha), as against 1.76 t/ha in the untreated control. The results from the present field trial against red spider mites in okra showed that among the treatments, spiromesifen25 EC was the most effective against red spider mites, followed by propargite 57 EC and azadirachtin 0.03 WSP. From the plant oils used, the karanj oil effectively controlled the mite population, followed by neem, mahua, and camphor.

Spiromesifen is a systemic insecticide/acaricides belonging to the class of spirocyclic tetronic acid derivatives, which act as inhibitors of acetyl-coenzyme-A carboxylase and causes a reduction in total lipid biosynthesis. Propargite is a systemic and contact insecticide. It interferes with the key mite enzyme systems, which causes interruption of normal metabolism, respiration, and electron transport functions in the nervous system of mites. Plant-based oils act

Table 3. Efficacy of insecticides and Plant based oils against red spider mite, *Tetranychus urticae* in okra (Summer 2022) - First spray

Treatments	Mite (1 cm^2/ 3 leaves/plant) *					
	Pre-treatment	1 DAT	3 DAT	7 DAT	14 DAT	Mean
T_1- Neem oil @ 3%	49.40 (7.06)	31.60 (5.67)^{b}	27.40 (5.28)^{c}	23.33 (4.88)^{c}	29.87 (5.51)^{c}	28.05
T_2- Karanj oil @ 2ml/l	50.00 (7.11)	30.00 (5.52)^{b}	25.87 (5.13)^{b}	21.73 (4.72)^{b}	28.13 (5.35)^{b}	26.43
T_3- Mahua oil @ 3%	50.47 (7.14)	34.07 (5.88)^{d}	28.60 (5.39)^{e}	24.73 (5.02)^{e}	30.60 (5.58)^{d}	29.50
T_4- Camphor oil @ 1ml/l	50.07 (7.11)	34.80 (5.94)^{e}	30.33 (5.55)^{f}	26.13 (5.16)^{f}	32.87 (5.78)^{e}	31.03
T_5- Azadirachtin 0.03 WSP @ 2.0 g/l	51.07 (7.18)	18.00 (4.30)^{c}	18.13 (4.32)^{d}	20.53 (4.59)^{d}	27.07 (5.25)^{bc}	20.93
T_6- Spiromesifen 25 EC @ 0.8 ml/l	50.00 (7.11)	9.93 (3.23)^{a}	11.53 (3.47)^{a}	18.47 (4.36)^{a}	25.40 (5.09)^{a}	16.33
T_7- Propargite 57 EC @ 3 ml/l	50.33 (7.13)	11.27 (3.43)^{a}	12.33 (3.58)^{b}	19.67 (4.49)^{ab}	26.80 (5.22)^{a}	17.52
T_8- Untreated control	49.93 (7.10)	49.73 (7.09)^{f}	50.60 (7.15)^{g}	50.20 (7.12)^{g}	50.47 (7.14)^{f}	50.25
SEd	NS	0.04	0.05	0.04	0.04	-
CD (p=0.05)	NS	0.09	0.11	0.08	0.08	-

*Mean of three replications
DAT- Days After Treatment
Figures in the Parentheses are $\sqrt{x+0.5}$ transformed values
Values in the column followed by same letters are not different statistically, (p=0.05) by LSD
NS – Non-significant

Table 4. Efficacy of insecticides and plant-based oils against red spider mite, *Tetranychusurticae* in okra (Summer 2022)- Second spray

Treatments	Mite ($1cm^2$ /3 leaves/plant) *						Reduction over control (%)	Yield(t/ha)
	1 DAT	3 DAT	7 DAT	14 DAT	Mean	Cumulative mean#		
T_1- Neem oil @ 3%	30.40 (5.56)^{b}	26.73 (5.22)^{c}	22.27 (4.77)^{c}	28.67 (5.40)^{c}	27.02	27.53	44.73	3.36
T_2- Karanj oil @ 2ml/l	28.67 (5.40)^{b}	24.73 (5.02)^{b}	20.93 (4.63)^{b}	27.27 (5.27)^{b}	25.40	25.92	47.98	3.68
T_3- Mahua oil @ 3%	33.27 (5.81)^{d}	27.27 (5.27)^{e}	23.87 (4.94)^{d}	29.87 (5.51)^{d}	28.57	29.03	41.72	2.88
T_4- Camphor oil @ 1ml/l	33.93 (5.87)^{e}	29.07 (5.44)^{f}	25.07 (5.06)^{e}	31.93 (5.70)^{e}	30.00	30.52	38.74	2.40
T_5- Azadirachtin 0.03 WSP @ 2.0 g/l	17.20 (4.21)^{c}	17.67 (4.26)^{d}	19.60 (4.48)^{c}	26.33 (5.18)^{bc}	20.20	20.57	58.72	4.16
T_6- Spiromesifen 25 EC @ 0.8 ml/l	9.93 (3.23)^{a}	10.73 (3.35)^{a}	17.80 (4.28)^{a}	24.60 (5.01)^{a}	15.77	16.05	67.78	4.96
T_7- Propargite 57 EC @ 3 ml/l	10.67 (3.34)^{a}	11.67 (3.49)^{bc}	18.93 (4.41)^{a}	26.13 (5.16)^{ab}	16.85	17.18	65.51	4.64
T_8- Untreated control	49.27 (7.05)^{f}	49.27 (7.05)^{g}	49.80 (7.09)^{f}	49.20 (7.05)^{f}	49.38	49.82	44.73	1.76
SEd	0.04	0.05	0.05	0.04	-	-	-	-
CD (p=0.05)	0.09	0.12	0.11	0.08	-	-	-	-

*Mean of three réplications

#Mean of first and second spraying

DAT- Days After Treatment

Figures in the Parentheses are $\sqrt{x+0.5}$ transformed values

Values in the column followed by same letters are not different statistically, (p=0.05) by LSD

NS – Non-significant

as feeding deterrents against the mite. Bathani *et al*. (2019) reported similar results that diafenthiuron 50 WP was most effective for controlling mites, followed by abamectin 1.9 EC and propargite 57 EC in sesame. Biradar and Nadaf (2014) reported that bifenazate 240 SC and propargite 57 EC significantly reduced grapes' mite population (0.30 mites/3 leaves). Patel *et al.* (2017) evaluated the bioefficacy of different acaricides against brinjal mite *and Tetranychus urticae* and found that spiromesifen 0.02% and fenazaquin 0.01% were most effective against the mite. The maximum fruit yield was recorded in spiromesifen 0.02% treated plot (37.91 quintal/ha) followed by fenazaquin 0.01% (36.95 quintal /ha).

The effectiveness of plant-based oils against mites, as recorded in the present study, was closely related to Patel *et al.* (2020), who reported that neem oil 0.5% was found to be most effective, followed by NSKE 5% against mites in brinjal. Further, Raghavendra *et al.,* (2017) also proved that tulsi leaf extract @ 10%, neem oil @ 3% and nochi leaf extract @ 5% were found to be the best with per cent reduction over control of 81.15, 80.58 and 79.98 respectively, which can be recommended as an alternative to synthetic chemical acaricides for the management of *Tetranychus urticae.* Baskaran and Sathyaseelan (2019) recorded that Azadirachtin 1 %, neem oil + mahua oil 3% was effective against mites in okra. Bullar *et al.,* (2021) reported that pongamia (karanj) extract was effective against mites in brinjal.

CONCLUSION

The present study showed that spiromesifen 25EC was most effective against red spider mites in okra, followed by propargite 57EC and azadirachtin. Among the plant oils, karanj oil effectively reduced the mite population, which can be used as an effective component in the IPM module for okra red spider mites.

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