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SHORT COMMUNICATION

EFFICACY OF *Hirsutella thompsonii* Fisher WITH CHEMICAL ACARICIDES AGAINST *Tetranychus urticae* Koch. ON OKRA UNDER FIELD CONDITIONS

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ABSTRACT

Okra cultivated during summer season is highly susceptible to mite infestation. These mites thrive in hot and dry conditions, leading to severe damage to the crop. Therefore, proper monitoring and timely management practices are essential to control mite infestation in summer-grown okra. A field experiment was conducted at College Farm, NAU, Navsari (India) from February to May 2021 in a randomized block design with eight treatments including a control so as to evaluate the efficacy of various acaricides against the spotted spider mite, *Tetranychus urticae* infesting okra in field condition. The results revealed that all the test acaricides were significantly superior over untreated control in checking the spider mite population. Among the acaricides, fenazaquin 10 EC @ 2.5 mL L^{-1} was most effective and gave 78.4% control of spider mite, which was at par with spiromesifen 240 SC @ 0.8 mL L^{-1} (76.73%) and propargite 57 EC @ 2 mL L^{-1} (76.62%), which were best, with higher mite mortality in okra. Fenpyroximate 5 EC @ 1 mL L^{-1} (62.22%) and diafenthiuron 50 WP @ 1 mL L^{-1} (51.24%) were positioned in the next order, while the lowest mite mortality was observed in hexythiazox 5.45 EC @ 1 mL L^{-1} (39.72%) and *Hirsutella thompsonii* @ 4 g mL^{-1} (25.69%).

Keywords: Acaricides, bio-efficacy, *Hirsutella thompsonii,* okra, *tetranychus urticae*

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench], also known as "lady's finger" or "bhendi," belongs to family Malvaceae and is native to Africa. The plant produces highly valued edible green pods which have good nutritional value. Okra is cultivated in India throughout the year. However, there are many production constraints in okra including the infestation by numerous insect and mite pests (Kumar, 2004). Sucking pests during early growth stages and fruit borers during later stages of crop growth cause extensive damage to okra fruits, resulting in a yield loss of up to 69% (Mani *et al*., 2005; Jagtap *et al*., 2007). The okra crop is susceptible to several mite pests amongst which red spider mite [*Tetranychus urticae* Koch (Tetranychidae: Acarina)] is most predominant (Ghosh, 2013). Other species of mite *viz.*, *Eutetranychus Orientalis* Klein, *Oligonychus biharensis* Hirst, and *Tetranychus neocaledonicus* Andre cause a significant yield reduction of 17.46% (Ghosh *et al*., 1996). The incidence of two-spotted spider mite, *T. urticae*, especially during summer season, leads to severe crop damage. Regular field monitoring is crucial for effective pest management, as the mite populations can build up rapidly. During initial stages of infestation, mite distribution is often patchy, making early detection essential. Once established, mite populations are difficult to control.

Less experienced farmers may find early identification a challenging task, as the symptoms often resemble with those of nutrient deficiencies or plant diseases. Close examination of the underside of affected leaves can reveal the mites as tiny moving specks - red or yellowish-green depending on the species involved - along with whitish particles, which are the shed skins of mites (Dhaka and Pareek, 2007).

Numerous cultural, mechanical, physical, and chemical methods have been applied to control mite pests to improve the quality and quantity of crop production in agricultural systems. Of these, chemical methods, such as synthetic acaricides, are the main method for mite control because they give quicker and better results for mite management in field than other management tactics. Mostly the newer acaricides are preferred over the conventional ones because these compounds are reasonably promising against a wide range of mite pests with excellent activity at all stages of mites at relatively lower dosages. However, their selectivity towards beneficial insects and natural enemies needs to be closely ascertained. Judicious use of some of these acaricides, with diverse mode of action, may help in effective mite management, and may simultaneously reduce the risk of resistance build-up in mite pests (Gamit and Varma, 2024). Many newly introduced acaricides give good control against mite pest; therefore, the present study was aimed to assess the effectiveness of various acaricides against spider mite, *Tetranychus urticae,* on okra under field conditions.

MATERIALS AND METHODS

Source of acaricides

A commercial formulation of different acaricides, used in the present study, was procured from a local market in Navsari, Gujarat (India). The freeze-dried culture of *Hirsutella thompsonii* in a glass ampoule was purchased from CSIR-Institute of Microbial Technology, Microbial Type Culture Collection & Gene Bank, Chandigarh (India).

Field trial

A field experiment was conducted at College Farm, NAU, Navsari (India) from February to May 2021 (summer season) to evaluate the efficacy of different acaricides against spotted spider mite, *Tetranychus urticae*, infesting okra. The experiment was conducted in a randomized block design with eight treatments including an untreated control. Each treatment was replicated three times. Okra cv. ‘GAO-5’ (Gujarat Anand Okra-5) was sown by dibbling method, maintaining a plant spacing of 60 cm x 30 cm, with gross area 4.5 m x 3.0 m and net area of 3.9 m x 2.4 m. The treatments included T_1 - *H. thompsonii* 1×10^8 cfu mL^{-1} (@ 4 g L^{-1}); T_2 - Propargite 57 EC (@ 2 mL L^{-1}); T_3 - Fenazaquin 10 EC (@ 2.5 mL L^{-1}); T_4 - Spiromesifen 240 SC (@ 0.8 mL L^{-1}); T_5 - Diafenthiuron 50 WP (@ 1 mL L^{-1}); T_6 - Hexythiazox 5.45 EC (@ 1 mL L^{-1}); T_7 - Fenpyroximate 5 EC (@ 1 mL L^{-1}); and T_8 - untreated control.

The treatments were executed at economic threshold level of red spider mites. The two sprays of above acaricides were done at an interval of 15 days. The first spray was applied no sooner the mite-pest incidence was noticed. All the acaricides were applied as foliar spray using a knapsack sprayer (15 L capacity) fitted with a solid cone nozzle. The quantity of fluid required per plot was calculated by spraying the untreated control plot with water. Due care was taken to wash the spray pump with a plenty of water in the beginning and while switching over from one acaricide spray to another spray. Moreover, after acaricide spray the sprayer was thoroughly rinsed with plain water to ensure that no residue of previous treatment was retained.

Observations and data analysis

The population of mites (active stages) was recorded from three randomly selected and tagged leaves representing the top, middle and lower canopy of five tagged plants. The two-spotted red spider mite density (all stages together) was recorded from 1 cm^2 leaf area using magnifying lens.

Pre-treatment counts were made a day before treatment and post-treatment counts at 1, 3, 5, 7 and 15 days after the application of treatment. The mites showing any fungal growth and moribund nymphs and adults were considered dead. The arcsine transformations were applied due to percent mortality data of mites. The corrected mortality (%) data were statistically analysed by factorial analysis of variance (using OPSTAT and WASP 2.0 software) so as to evaluate the effectiveness of acaricides against the two-spotted red spider mite, *T. urticae*

RESULTS AND DISCUSSION

The mite-pest incidence was recorded to evaluate the efficacy of various acaricides against two-spotted spider mite, *T. urticae,* infesting okra. The periodical population of two-spotted spider mite in different treatments were recorded during summer, 2021. The periodical data on two spotted spider mite population recorded during summer 2021 were pooled over periods and sprays (Table 1). The population of two-spotted spider mite (nymph and adult) per 3 leaves was homogeneous before spray in all the treatments as the treatment differences were non-significant during each spray. Then the observations of mite mortality count at 1st and 2nd sprays were analysed using online software (OPSTAT and WASP 2.0).

Among all treatments in 1st spray**,** fenazaquin 10 EC @ 2.5 mL L^{-1} gave 72.23% pest mortality, which was at par with propargite 57 EC @ 2 mL L^{-1} (69.50%), spiromesifen 240 SC @ 0.8 mL L^{-1} (69.37%) and fenpyroximate 5 EC @ 1 mL L^{-1} (68.36%), followed by diafenthiuron 50 WP @ 1 g L^{-1} (45.09%), hexythiazox 5.45 EC @ 1 mL L^{-1} (43.46%) and *H. thompsonii* (1×10^8 cfu L^{-1}) at 4 g L^{-1} (33.06%). The descending order of mite mortality in pooled-over periods of 1st spray was $T_3 \geq T_2 \geq T_4 \geq T_7 > T_5 \geq T_6 \geq T_1$ (Table 1).

In 2nd spray the all over highest mortality of 78.4% mites was observed in fenazaquin 10 EC which was at par with spiromesifen 240 SC (76.73%) and propargite 57 EC (76.62%). Fenpyroximate 5 EC gave 62.22% mortality, which was at par with diafenthiuron 50 WP (51.24%). The lowest mortality of 25.69% was observed in *H. thompsonii* which was, however, at par with hexythiazox 5.45 EC (39.72%). The descending order of mite mortality in pooled-over spray was $T_3 \geq T_4 \geq T_2 > T_7 \geq T_5 > T_6 \geq T_1$ (Table 1).

The perusal of pooled data over periods and sprays revealed that spiromesifen 240 SC, fenazaquin 10 EC, propargite 57 EC, diafenthiuron 50 WP and fenpyroximate 5 EC were equally effective at 1 DAS. However, lowest mite mortality of 5.78% was observed in *H. thompsonii* at 1 DAS which was at par with hexythiazox 5.45 EC and fenpyroximate 5 EC treatments on the same day. At 3 DAS, spiromesifen 240 SC, fenazaquin 10 EC and propargite 57 EC treatment inflicted 100% mortality at 3 and 5 DAS. These were significantly superior over fenpyroximate 5 EC and *H. thompsonii* at 3 DAS; diafenthiuron 50 WP, hexythiazox 5.45 EC and *H. thompsonii* at 3, 5 and 7 DAS in the 1st spray. The data on acaricidal effect on mite mortality in different periods revealed that spiromesifen 240 SC, fenazaquin 10 EC and propargite 57 EC were quicker in action against mites than fenpyroximate 5 EC, diafenthiuron 50 WP, hexythiazox 5.45 EC and *H. thompsonii*. A slightly quicker result of fenpyroximate 5 EC and diafenthiuron 50 WP over the effect of hexythiazox 5.45 EC and *H. thompsonii* on mites was noticed in the 1st spray. The effect of hexythiazox 5.45 EC and *H. thompsonii* on mites was very slow as it recorded highest mortality at 7 DAS in both the 1st and 2nd spray.

The present study revealed that among all the acaricides fenazaquin 10 EC, spiromesifen 240 SC and propargite 57 EC were superior in inflicting higher mortality in mites in okra. Fenpyroximate 5 EC and diafenthiuron 50 WP were positioned in next order, while lowest mite mortality in okra was observed in *H. thompsonii* and hexythiazox 5.45 EC because both acaricides are slow reacting against mites. Among them, *H. thompsonii* is an acaropathogenic fungus, but its performance under field conditions appears limited during harsh summer seasons. In contrast, hexythiazox 5.45 EC acts as a mite growth regulator, inhibiting the development of mites rather than causing immediate mortality. Therefore, it may not produce rapid results at the initial stage of application like other acaricides; however, it provides effective and long-lasting control of mite population over time.

Table 1: Field efficacy of *Hirsutella thompsonii* and chemical acaricides against *Tetranychus urticae* on okra under field conditions

Treatments	Dose (mL L^{-1})*	1st spray						2nd spray						Overall mean
		1 DAS	3 DAS	5 DAS	7 DAS	15 DAS	Mean	1 DAS	3 DAS	5 DAS	7 DAS	15 DAS	Mean	
H. thompsonii	4.0	13.70^{d}	27.40^{c}	50.16^{b}	50.44^{c}	26.22^{c}	33.72^{b}	14.96^{d}	14.64^{d}	29.61^{d}	37.75^{c}	18.9^{b}	23.53^{d}	28.63^{c}
(1×10^{8} cfu mL^{-1})		(5.8)	(22.2)	(58.7)	(59.1)	(19.5)	(33.1)	(6.75)	(7.1)	(25.5)	(39.5)	(12.7)	(18.3)	(25.7)
Propargite	2.0	25.56^{ab}	85.95^{a}	85.95^{a}	69.98^{a}	40.36^{ab}	63.18^{a}	25.53^{a}	85.95^{a}	85.95^{a}	85.95^{a}	85.95^{a}	77.11^{a}	70.15^{a}
57 EC		(18.8)	(100.0)	(100.0)	(86.8)	(41.9)	(69.5)	(18.7)	(100.0)	(100.0)	(100.0)	(100.0)	(83.7)	(76.6)
Fenazaquin	2.5	27.40^{a}	85.95^{a}	85.95^{a}	74.22^{a}	44.09^{a}	65.14^{a}	28.49^{a}	85.95^{a}	85.95^{a}	85.95^{a}	85.95^{a}	77.70^{a}	71.42^{a}
10 EC		(21.2)	(100.0)	(100.0)	(91.5)	(48.5)	(72.2)	(22.8)	(100.0)	(100.0)	(100.0)	(100.0)	(84.6)	(78.4)
Spiromesifen	0.8	28.90^{a}	85.95^{a}	85.95^{a}	68.63^{a}	37.46^{ab}	63.00^{a}	26.86^{a}	85.95^{a}	85.95^{a}	85.95^{a}	85.95^{a}	77.37^{a}	70.19^{a}
240 SC		(23.8)	(100.0)	(100.0)	(85.8)	(37.2)	(69.4)	(20.4)	(100.0)	(100.0)	(100.0)	(100.0)	(84.1)	(76.7)
Diafenthiuron	1.0	24.88^{ab}	38.20^{c}	57.07^{b}	54.09^{bc}	35.16^{b}	42.01^{b}	24.53^{ab}	27.11^{c}	51.75^{c}	68.66^{b}	85.95^{a}	52.64^{b}	47.33^{b}
50 WP		(17.8)	(39.1)	(69.9)	(65.3)	(33.3)	(45.1)	(17.4)	(21.7)	(61.8)	(86.0)	(100.0)	(57.4)	(51.2)
Hexythiazox	1.0	17.43^{cd}	31.33^{c}	54.30^{b}	66.40^{ab}	34.24^{bc}	40.88^{b}	15.66^{cd}	15.05^{d}	44.63^{c}	67.61^{b}	29.76^{b}	34.93^{c}	37.91^{c}
5.45 EC		(8.9)	(28.1)	(64.8)	(83.6)	(31.9)	(43.5)	(7.5)	(8.6)	(49.8)	(84.8)	(29.1)	(36.0)	(39.7)
Fenpyroximate	1.0	21.39^{bc}	69.85^{b}	85.95^{a}	76.05^{a}	43.79^{a}	60.32^{a}	20.22^{bc}	59.41^{b}	65.48^{b}	85.95^{a}	20.00^{b}	51.28^{b}	55.80^{b}
5 EC		(13.4)	(87.5)	(100.0)	(93.0)	(47.9)	(68.4)	(12.0)	(73.3)	(81.9)	(100.0)	(13.3)	(56.1)	(62.2)
SEm ±	T	1.74	3.66	4.34	4.67	2.68	1.73	1.55	3.78	3.87	4.68	4.74	1.79	1.78
	P	-	-	-	-	-	1.46	-	-	-	-	-	1.51	1.00
	T x P	-	-	-	-	-	3.86	-	-	-	-	-	3.99	2.65
	S x P	-	-	-	-	-	-	-	-	-	-	-	-	1.42
	S x P x T	-	-	-	-	-	-	-	-	-	-	-	-	3.75
$CD_{0.05}$	T	5.37	11.29	13.37	14.39	8.25	4.86	4.79	11.66	11.92	14.41	14.61	5.02	5.48
	P	-	-	-	-	-	4.11	-	-	-	-	-	4.24	2.81
	T x P	-	-	-	-	-	10.86	-	-	-	-	-	11.23	7.43
	S x P	-	-	-	-	-	-	-	-	-	-	-	-	ns
	S x P x T	-	-	-	-	-	-	-	-	-	-	-	-	10.51
CV%		13.27	10.46	10.41	12.32	12.42	12.74	12.06	12.27	10.13	10.95	13.93	12.33	12.50

* Dosage for *H. thompsonii* and diafenthiuron 50 WP is g L^{-1} instead of mL L^{-1}; DAS = Days after spray;
The figures within parentheses are the original value while the figures outside parentheses are angular transformed values;
Treatment means with same letter(s) in the same column are statistically at par with each other.

The present findings are in agreement with the reports of Misra (2011) from Bhubaneswar, Orissa, and Sangeetha and Ramaraju (2013) from Coimbatore, Tamil Nadu (India) who reported highest reduction 90.27-92.13% in *T. urticae* population in tomato and okra when fenazaquin was applied @ 125-150 g a.i. ha^{-1}. However, Kumar *et al*. (2013) from Varanasi Uttar Pradesh (India) have reported that propargite 57 EC provided highest reduction of 81.78% in *T. urticae* population in certain vegetables. The present findings also corroborative with the work of Reddy *et al*. *(*2014) from Anantharajupet, Andhra Pradesh (India) who recorded 92.39-100% mortality of *T. urticae* in cucumber crop due to fenazaquin 10 EC application as compared to the spiromesifen (88.87% mortality), fenpyroximate (70.03%), hexythiazox (60.80%), propargite (45.06%) applications. They also witnessed decline in the efficacy on the 14th day of treatment. In present study, fenazaquin, spiromesifen and propargite were the best acaricides for mite management which is closely in line with the findings of Jadhav *et al*. (2016), Siddhapara and Virani (2016), Patel and Patel (2017), Shukla and Radadiya (2018) and Baskaran and Sathyaseelan (2019). A lower mite reduction was also noticed in *H. thompsonii* than chemical acaricides in okra by Krishna and Bhaskar (2016).

Based on the results of the efficacy of *H. thompsonii* with chemical acaricides against *T. urticae* on okra under field condition, it may tentatively be recommended that fenazaquin 10 EC @ 2.5 mL L^{-1}, spiromesifen 240 SC @ 0.8 mL L^{-1}, and propargite 57 EC @ 2 mL L^{-1} were significantly more effective than *H. thompsonii* (1 × 10^{8} cfu mL^{-1}) @ 4 g L^{-1}, which recorded the lowest efficacy under field conditions. The comparatively poor performance of *H. thompsonii* may be attributed to its biological nature as an acaropathogenic fungus, whose activity is adversely affected during harsh summer conditions. Chemical acaricides such as fenazaquin, spiromesifen, and propargite provide rapid control of *T. urticae* under field conditions, particularly during high-temperature periods when biocontrol agents like *H. thompsonii* are less effective. Therefore, these acaricides can be prioritized for immediate mite suppression in okra cultivation during summer. Further studies should focus on improving the field efficacy of *H. thompsonii* through formulation enhancement, use of protective adjuvants, or integration with suitable environmental modifications (e.g., evening applications, microclimate management). Besides, its compatibility and integration with selective acaricides needs to be explored to develop sustainable and eco-friendly integrated pest management strategies.

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