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Evaluation of hexythiazox 5.45 EC against red spider mites (*Tetranychus urticae*) on okra

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Abstract
An experiment was conducted to evaluate the performance of hexythiazox 5.45 EC against red spider mites (*Tetranychus urticae*) on okra and to observe its phytotoxicity at higher doses. The treatments included two spray applications of acaricide hexythiazox 5.45 EC @ 15, 20 & 25 g a.i. / ha, propargite 57 EC 850 g a.i. /ha, fenpyroximate 5 EC 25g a.i. /ha and an untreated control (water spray). Observations on pre and post treatment populations of *Tetranychus urticae* were recorded after 3, 7, 14 and 21 days of spray. Two spray applications were given to the crop at ETL level of the red spider mites. All the treatments registered significantly lower population of red spider mites as compared to untreated control. Fenpyroximate 5 EC @ 25g a.i./ha proved the best treatment for the control of the pest, however, treatments viz., propargite 57 EC 850 g a.i /ha and hexythiazox 5.45 EC @ 25 g a.i./ha were also observed to be effective treatments in most of the observations.

Keywords: Hexythiazox, red spider mites, okra, population, phytotoxicity

Introduction
Okra *Abelmoschus esculentus* (Linn.) Moench is an important vegetable crop of Kymore plateau and Satpura hill zone of Madhya Pradesh, grown in *kharif* and summer seasons in the region. The okra crop is attacked by several species of insect pests, right from the germination to the harvest [1]. The crop also suffers losses due to mites.

The two-spotted spider mite (TSSM), *Tetranychus urticae* is a member of the family Tetranychidae that contains many harmful species of plant-feeding mites. It is a ubiquitous and economically important agricultural pest with a global distribution which feeds on a wide range of host plant species throughout the world [4].

The mite is polyphagous in nature and has been reported to infest more than 110 plants including fruits, vegetables and field crops [7]. Phytophagous mites as pests of field crops and mites associated with granaries and warehouses cause heavy financial losses [13].

Among the vegetable crops, okra and brinjal are the crops severely affected by mites causing economic losses throughout the country. The red spider mites viz., *Tetranychus cinnabarinus* (Boisduval), *Tetranychus ludeni* Zacher and *Tetranychus neocaledonicus* Andre are of major significance to vegetable crops in India [5, 11]. Pest status of *T. urticae* on greenhouse vegetables, ornamental and horticultural crops is well documented worldwide [6]. Short generation time, high fecundity and webbing by *T. urticae* are responsible for causing loss in number of fruits and yield in various crops.

Weather conditions play a profound influence on population build up of mites. The incidence of mite, *Tetranychus cinnabarinus* (Boisduval) was studied on okra, *Abelmoschus esculentus* (L.) Moench, at Jobner (Rajasthan), during kharif 2004 and 2005. The peak population of mite was recorded during third week of September. Population of mite was recorded to be lowest (3.05 mites/3 leaves) on crop sown on 28th July [10]. Okra suffers losses due to mites in Kymore plateau and Satpura hill zone especially during hot weather. The crop loss in Parbhani kranti variety of okra was reported to be 23.7%, 11-25%, 13-13.6% and 45-52% per cent at Navsari, Hisar, Varanasi and Pusa, respectively [3].

Several acaricides have been recommended in the past to control mites in vegetable crops and okra. Eleven pesticides were evaluated against *T. neocalidonicus* in arid and semi-arid conditions of Rajasthan infesting brinjal crop and found ethion (0.05%) as most effective followed by monocrotophos (0.03%) [12]. Ethion (0.05%) registered highest mortality of the mite, *Polyphagotarsonemus latus* on chilli crop [2].

In present experiment different doses of the acaricide hexythiazox 5.45 EC were evaluated against red spider mite, *Tetranichus urticae* in okra and its phytotoxicity at higher doses was observed.

Materials and methods

The okra crop (variety VRO- 6) was sown in the first fortnight of March, 2013, at Vegetable Research Farm, Maharajpur, JNKVV, Jabalpur. All standard agronomical practices were adopted in crop cultivation. The use of fertilizers included application of NPK @ 100: 60: 60 Kg / ha. The experiment was conducted in randomized block design with six treatments (listed in table 1) including an untreated control and four replications, to record the effect of hexythiazox

5.45 EC in controlling the red spider mites (*Tetranychus urticae*) in okra. The effect was compared with other standard insecticides, and with untreated control.

There were two sprays of different doses of hexythiazox 5.45 EC and other recommended acaricides listed in table 1. First application of all the treatments was given in last week of May at the economic threshold level of red spider mites. The second spray application was done when the population of red spider mites reached close to ETL (in third week of June).

Observations & sampling for bio-efficacy

Random sampling was conducted to observe the bio efficacy of treatments. The number of red spider mites was recorded on 5 mature random leaves of each sample plant. Five such random sample plants were observed in each treatment and every replication, before spray application and 3, 7, 14 and 21 days after spray (DAS).

The fruit yield (total of all pickings) was recorded under different treatments. The data on population and yield under different treatments was subjected to the analysis of variance at 5% level of significance to draw conclusions.

Phytotoxicity of hexythiazox 5.45 EC was evaluated at 15, 20, 25 & 50 g a.i. /ha dose on okra crop. Weather record during the season (Table 3) was obtained from the JNKVV observatory.

Results and Discussion

The mean population of red spider mites recorded before treatment and after first and second spray applications is presented below.

Pre-treatment: Pre-treatment mite populations ranged between 5.4 and 6.1 individuals per sample and the differences among plots were non-significant.

After 1st spray

3 days: Treatment fenpyroximate 5 EC 25g a.i./ha recorded the lowest mean population of red spider mite (1.45) while all other treatments revealed higher mean population of the pest. Untreated control was significantly different from all other treatments and recorded the highest number of mites (7.91).

7 days: Untreated control recorded significantly higher mean population (11.93) of red spider mites per sample than all other treatments. Hexythiazox 5.45 EC @ 25g a.i. /ha recorded the lowest mean population (1.72 mites per sample), however it was at par to propargite 57 EC 850g a.i./ha application (1.82 mites).

14 days: Untreated control recorded the mean population (6.53) of red spider mites/sample. Treatment fenpyroximate 5 EC 25g a.i./ha recorded the lowest population (1.2) of red spider mites/ sample, however, this treatment was statistically at par to remaining treatments.

21 days: Treatment fenpyroximate 5 EC 25g a.i. /ha recorded significantly lower population (1.18) of red spider mites/sample, while untreated control recorded significantly higher number (6.52).

After 2nd spray

3 days: Treatment fenpyroximate 5 EC 25g a.i./ha recorded the lowest population (1.5) of mites that was at par to hexythiazox 5.45 EC @ 25 g a.i. /ha (2.70 mites). Untreated control recorded highest number (6.52) of mites / sample.

7 days: Treatment hexythiazox 5.45 EC @ 25 g a.i./ha recorded the lowest number (1.75) of red spider mites that was at par to the treatment with propargite 57 EC 850g a.i./ha (2.07 mites). Untreated control recorded the highest number (11.98) of red spider mites per sample.

14 days: Treatment fenpyroximate 5 EC 25g a.i./ha registered lowest number (1.32) of pests / sample. However, this treatment was at par to treatments hexythiazox 5.45 EC @ 25 g a.i./ha, 20g a.i./ha and 15 g a.i./ha. **U**ntreated control recorded highest number (8.78) of red spider mites / sample.

21 days: Treatment fenpyroximate 5 EC 25g a.i./ha expressed lowest number (1.18) of red spider mites/ sample, was at par to the treatments viz., propargite 57 EC 850g a.i./ha (1.79), hexythiazox 5.45 EC @ 25g a.i. /ha (2.01) and 15g a.i. /ha (1.72 mites / sample).

Treatment hexythiazox 5.45% EC @ 20g. a.i./ha recorded highest number of red spider mites, followed by untreated control.

Application of ethion 0.05% was reported to be most effective for its control in okra [9] and brinjal [12]. Ethion application @ 0.05% had also been reported to be effective against *Polyphagotarsonemus latus* on chilli [2]. However in the present experiment ethion was not evaluated against *T. urticae*. Dicofol (0.04%) provided maximum reduction of okra mites, *T. macfarlanei* in Gujarat followed by monocrotophos (0.05%) [11]. Monocrotophos has already been banned by the government now. Thus hexithiazox 5.45 EC may prove to be a good option for the control of *T. urticae* in okra. In the present experiment the apparent losses to yield were negligible as against the losses reported as high as 45-52% [3].

Phytotoxicity

No morphological deformities reflecting phytotoxicity were observed on aerial parts of the plants (viz., stem and branches, leaves, flowers and fruits) in any of the treatments (Table 2).

Table 1: Mean population of red spider mites, *Tetranychus urticae* / sample in okra as influenced by different spray applications

Treatments & dose	Pre-treatment	After 1st spray				After 2nd spray			
		3DAS	7DAS	14DAS	21DAS	3DAS	7DAS	14DAS	21DAS
T1-Untreated control	5.239 (2.28)*	7.91 (2.81)	11.93 (3.51)	6.535 (3.00)	6.52 (2.64)	7.91 (2.81)	11.985 (3.45)	8.785 (2.96)	6.52 (2.55)
T2.Hexythiazox 5.45 EC @ 15 g a.i./ha	5.541 (2.35)	2.7 (1.57)	2.57 (1.89)	1.47 (1.08)	1.47 (1.35)	2.7 (1.57)	2.625 (1.58)	1.385 (1.23)	1.72 (1.29)
T3 Hexythiazox 5.45 EC @ 20 g a.i./ha	6.175 (2.48)	3.05 (1.70)	3.06 (1.87)	1.46 (1.28)	1.59 (1.43)	3.1 (1.72)	3.11 (1.75	1.71 (1.48)	7.36 (2.71)
T4 Hexythiazox 5.45 EC @ 25 g a.i./ha	5.429 (2.33)	2.05 (1.42)	1.725 (1.39)	1.32 (1.29)	1.76 (1.19)	2.075 (1.40)	1.75 (1.30)	1.57 (1.25)	2.01 (1.39)
T5- Propargite 57 EC 850g a.i./ha	6.18 (2.48)	2.9 (1.68)	1.82 (1.38)	1.54 (1.36)	1.42 (1.37)	2.925 (1.68)	2.07 (1.38)	1.79 (2.23)	1.42 (1.17)
T6 Fenpyroximate 5 EC 25g a.i./ha	5.276 (2.29)	1.45 (1.18)	2.43 (1.61)	1.205 (1.07)	1.18 (0.9)	1.5 (1.20)	2.555 (1.65)	1.32 (1.14)	1.18 (1.07)
S.Em ±	0.071	0.195	0.232	0.197	0.139	0.19	0.154	0.243	0.085
CD 5%	N.S.	0.583	0.695	0.591	0.417	0.269	0.217	0.344	0.12

* Figures in parentheses are $\sqrt{x}$ transformed values

Table 2: Phytotoxicity of different doses of hexythiazox 5.45 EC on okra

Treatments	Dose g. a.i./ha	Dose (commercial formulation) ml/ha	Phytotoxicity rating after 0, 1, 3, 7 and 10 days					
			Injury on leaf tips / surface	Wilting	Vein Clearing	Necrosis	Hypo-nasty	Epi-nasty
Hexythiazox 5.45 EC	15	300	0	0	0	0	0	0
Hexythiazox 5.45 EC	20	400	0	0	0	0	0	0
Hexythiazox 5.45 EC	25	500	0	0	0	0	0	0
Hexythiazox 5.45 EC	50	1000	0	0	0	0	0	0
Untreated Control (Water spray)	--	--	0	0	0	0	0	0

Note: Phytotoxicity based on 1-10 scale: (0 = 0%, 1=1 – 10%, 2 =11 -20%, 3 = 21 - 30%, 4 = 31-40%, 5 = 41 – 50%, 6 = 51-60%, 7 = 61-70%, 8 =71 - 80%, 9 = 81 -90%, 10 = 91 -100%)

Table 3: Weather data during the crop season (summer 2013)

Met. Week #	Temperature ^{0}c		Relative humidity (%)		Sunshine Hours.	Rainfall (mm)	No. of rainy days
	Max.	Min.	Max.	Min.			
12	33.4	16.2	77	28	8.2	7.2	1
13	33.8	16.2	76	30	7.8	3.2	0
14	35.3	15.2	68	20	8.9	0.0	0
15	39.5	19.9	57	14	8.7	10.6	1
16	36.5	20.1	51	22	8.6	0.0	0
17	37.6	20.6	64	21	9.0	0.0	0
18	42.1	21.4	42	12	10.8	0.0	0
19	42.1	24.1	31	12	10.6	0.0	0
20	42.7	23.4	36	9	10.6	0.0	0
21	44.1	26.8	27	15	10.0	0.0	0
22	41.8	26.3	44	17	8.2	0.0	0
23	39.7	25.0	68	38	8.5	30.4	3
24	32.8	23.7	89	63	3.8	84.0	4
25	32.1	23.6	89	67	6.3	138.3	4
26	29.3	23.3	92	88	2.0	232.4	5

Conclusion

All the treatments registered significantly lower population of red spider mites as compared to untreated control. Fenpyroximate 5 EC 25g a.i./ha proved the best treatment for the control of mites, however, treatments viz. propargite 57 EC 850 g a.i / ha and hexythiazox 5.45 EC @ 25 g a.i./ha were observed to be effective treatments in most of the observations.

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