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Study of resurgence of *Tetranychus urticae* Koch against synthetic insecticides

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Abstract
In recent year, spider mite, *Tetranychus urticae* Koch, has assumed a major pest status on okra, *Abelmoschus esculentus* L. Moench., during summer months. Therefore some conventional acaridae were evaluated against spider mite for studies of resurgence to determine the most effective. In this study, five pesticides were used at the recommended doses. These pesticides were observed at four different intervals: at 1, 3, 7 and 14 days. The results indicate that the performance of the Clofentazine, Cyflumetofen, Fenpyroximate and Propargite, are completely no resurgence. These chemical did not induced resurgence but Dicofol were showed relatively less effectiveness against the mite.

Keywords: *Tetranychus urticae*, synthetic insecticides, okra, bhindi

Introduction
Vegetables play pivotal role in ensuring food and nutritional security, sustainable development and for alleviation of poverty. It has the key role in generating employment opportunities for the vast majority of the population. Vegetables are also considered to be important ingredients of human diet, especially the huge vegetarian population within the country. Lady's finger or okra or bhindi *(Abelmoschus esculentus)* is the one of most important vegetable crop during summer and rainy season of India belonging to the family Malvaceae. Okra is South-African in its origin. India ranks first in the world with a production of 5.78mt (75.4% of the total world production) of okra from over 0.518 mha land. The global area under okra cultivation has been estimated at 1.08 million hectare with total production of about 8.3 million metric tons (Anonymous -2013) [1]. In Varanasi region crop is attacked by mite pests throughout summer season from growing stage till senescence. Okra plants are also used for treating diseases like stones in kidney, leucorrhoea, backache and goiter in human beings (Nadkarni, 1972). Mucilage extract of stem and root are used for clarifying sugarcane juice for making jaggery (molasses) (Chauhan, 1972) [4]. The fully ripened fruits and stem contain carbohydrate (7.7%), protein (2.2%), fat (0.02%), fibers (1.2%), minerals (0.7%), calcium (0.9%) and are also good source of iron, iodine and vitamins (Chauhan, 1965) [5]. *Tetranychus urticae* has become a destructive pest of okra. It has caused considerable damage in the eastern regions of Uttar Pradesh particularly during summer when the temperature prevails during the month of April –June.

In agriculture, the problem of phytophagous mites became intense after the introduction of large scale use of insecticides during 1950s for the control of many insect pests but at the same time they also destroyed the natural enemies of phytophagous mites which results in the resistance and resurgence problem as well as toxic residues. As a result many mite species which were never seen earlier have become important pests of regular occurrence *i.e.* Two-Spotted Spider-Mites. Broad spectrum pesticides increase mite population as these kill their natural enemies. Selective pesticides allow the survival and viability of natural enemies such as predators and parasitoids (Villanueva-Jiménez and Hoy, 2003) [27].

Materials and method
The experiment was four replication at vegetable research farm in RBD on variety Kashi Lila. The plot size was 2x3 m and row to row spacing was maintained at 45 cm apart. The formulations of synthetic pesticides included in this trial were mentioned in (Table-3). The control plot was treated with water (normal). The amount of proprietary ingredient required was calculated by using the following formula:

$$\text{Amount of pesticide} = \frac{\text{Desired Concentration} \times \text{Amount of Spay fluid Required}}{\text{Per cent Toxicant in Formulation}}$$

Table 1: List of synthetic pesticides and their concentrations

S. No.	Chemical Name	Trade Name	Strength (%) of pesticides	Conc. used in trial (%)	Dosage/liter of water
	Synthetic pesticides				
1.	Propargite	Omite	57 EC	0.18	3.15 ml
2.	Clofentazine	Clofentazine	50 SC	2.5	0.05 ml
3.	Cyflumetofen	Foster	20 SC	0.01	0.50 ml
4.	Fenpyroximate	Pyromite	5 EC	0.0025	0.5 ml
5.	Dicofol	Dicofol	18.5 EC	0.04	2.70 ml
6.	Control (Water)	-	-	-	-

Layout plan: Design: RBD, Replication–4, Number of treatment 5 + control, Plot size-2x3m, Distance between plot to plot-0.50m, Distance between replication – 1m, Block border space-1m, Row to row spacing-45cm, Plant to plant spacing-25cm.

In this experiment cloth screen was used for avoiding drifting from plot to plot. The observation was taken from five randomly selected tagged and numbered plants from each plot. Five leaves plucked from upper, middle and lower portion of the each plant and a total number of twenty five leaves were collected from each plot for taking observation. The mite population was counted on the basis of $2cm^2$ leaf area at four spots per leaf. The mortality of two spotted spider mite was observed in different intervals at pre spray 1, 3, 7, and 14th days after. Fifteenth days observation of first spray was treated as pre spray observation of the 2nd spray and rest observation was recorded similarly as first spray. The per cent mortality was calculated by using following formula:

$$\text{Per cent mortality} = \frac{\text{Average reduction in population}}{\text{Average pre-treatment population}} \times 100$$

The corrected per cent mortality was calculated through Abbot's formula (1925) which is as given below:

$$P = \frac{P_1 - C}{100 - C} \times 100$$

Where,
P = per cent corrected mortality
P_1 = per cent observed mortality
C = per cent mortality in control

The per cent resurgence of mite population will be calculated by Henderson and Tilton (1955) formula as follows:
Resurgence (%) = $\{(Ts \times CF / Cs \times T_F) - 1\} \times 100$
Where,
Ts = Number of live mite in post treatment count
T_F = Number of live mite in pre- treatment count
Cs = Number of mite in untreated check (Post-treatment)
C_F = Number of mite in untreated check (Pre-treatment)

Results and Discussion

The experiment was carried out to study resurgence of TSSM against five acaricides each at recommended dose on okra crop. The performance of the Clofentazine, Cyflumetofen, Fenpyroximate and Propargite, were completely different from the other acaricides used. In this experiment, Clofentazine (-21.34%), Cyflumetofen (-15.94%), Fenpyroximate (-10.01%) and Propargite (-5.46%) were effective in controlling mite after 1st as well as 2nd spray. These pesticides did not induce resurgence. In case of Dicofol (+5.46%), though the chemical didn't induce resurgence but it showed relatively less effectiveness against the mite menace when compared to other acaricides under study. (Table 1, 2, & 3).

Resurgence of insect pests after pesticide application is a well-documented by Huffaker and Spitzer, 1950 [10], Bartett, 1968 [2], Reynolds 1971 [21], Mclure 1977 Spider mite outbreaks on crops plants following the use of broad spectrum insecticide have been reported by Huffaker *et al.*,1970 [11, 17]. There have been instances where in resurgence of mite was met with consequent upon application of synthetic pyrethroids which were extremely toxic to the predatory mite (Hoyt *et al.*, 1978, Hall, 1979) [12, 8] discussed the effect of insecticide on mite resurgence and found that sub lethal rate directly affected the oviposition rate of *T. urticae* Koch. There is now over whelming evidence that the use of broad spectrum pesticide is responsible for the enormous outbreaks of red spider mites that have occurred worldwide since the introduction of DDT (Ripper 1956, Mc Murtry *et al.*, 1970) [22, 11]

The experiment was carried out to study resurgence of TSSM against five acaricides each at recommended dose on okra crops. The performance of the Clofentazine, Cyflumetofen, Fenpyroximate and Propargite were completely different form the other acaricides used. In this experiment, Clofentazine (-21.34%), Cyflumetofen (-15.94%), Fenpyroximate (-10.01%) and Propargite (-5.46%) were effective in controlling mite after 1st as well as 2nd spray. These pesticides did not induce resurgence. In case of Dicofol (+5.46%), though the chemical didn't induce resurgence but it showed relatively less effectiveness against the mite menace when compared to other chemicals under study.

This proves that they did not induce any mite outbreak but did control them up to some extent. The effectiveness of Dicofol against mites has earlier been reported by Jeppson *et al.*, 1975 [13], Mallikarjuna Rao and Khalid Ahmed 1985 and David 1986 [6]. Recently, it was observed that these chemicals failed to control the mite due to higher tolerance of *T. urticae* to dicofol under polyhouse conditions (Jhansi Rani and Sridhar, 2002; Sridhar and Jhansi Rani, 2003) [15, 23], Difference in susceptibility of *T. urticae* to Dicofol and wettable sulphur from different polyhouse populations. The performance of the Propargite, Cyflumetofen, Clofentazine and Fenpyroximate are completely different form the other acaricide. Dicofol was showed poor performance in the management of TSSM. Due to these pesticide the TSSM get resurgence.

Table 1: Influence of acaricides on population of spider mite, *T. urticae* (Koch*)* on Okra (1st Spray & 2nd Spray, 2013-14)

S. No	Acaricides	Dose	Pre- spraying mite pop./ 2cm² leaf area	*T. urticae* population/2 cm² leaf area after 1st spraying					% Increase or Decrease over control	Pre- spraying mite pop./ 2cm² leaf area	*T. urticae* population/2 cm² leaf area after 2nd spraying					% Increase or Decrease over control
				1 DAS	3 DAS	7 DAS	14 DAS	Mean			1 DAS	3 DAS	7 DAS	14 DAS	Mean	
1	Propargite 57 EC	3.15 ml	23.87	11.56* (3.47)**	31.6 (5.67)	35.46 (6.46)	39.32 (6.77)	29.49	-4.79	29.30	10.82 (3.36)	30.52 (6.02)	42.25 (7.00)	40.85 (6.89)	31.11	-11.14
2	Clofentazine 50SC	0.05ml	28.67	5.63 (2.48)	23.68 (4.92)	37.68 (6.18)	32.25 (5.72)	24.81	-19.89	24.87	8.71 (3.03)	25.05 (5.05)	42.33 (6.54)	34.12 (5.88)	27.55	-21.29
3	Cyflumetofen 20 SC	0.50 ml	26.89	9.79 (3.21)	23.57 (4.91)	40.98 (6.44)	32.56 (5.75)	26.73	-13.71	26.46	9.82 (3.21)	24.27 (4.98)	40.98 (6.44)	39.16 (6.30)	28.56	-18.42
4	Fenpyroximate 5 EC	0.5 ml	28.95	7.92 (2.90)	29.55 (5.48)	41.02 (6.44)	38.73 (6.26)	29.31	-5.38	30.56	8.56 (3.01)	21.63 (4.70)	41.46 (6.48)	43.53 (6.64)	28.80	-17.74
5	Dicofol 18.5 EC	2.70 ml	24.56	8.95 (3.07)	35.62 (6.01)	41.25 (6.92)	45.45 (7.24)	32.82	+5.97	32.84	6.96 (2.73)	42.75 (7.03)	42.85 (7.04)	48.87 (7.31)	35.36	+0.99
6	Control (Water)	-	33.54	15.32 (3.98)	29.65 (5.49)	36.56 (6.09)	42.35 (6.55)	30.97		32.82	12.26 (3.57)	31.55 (5.66)	46.45 (6.85)	49.76 (7.09)	35.01	

* Mean of four replication.

**(Figures in parentheses are mean of $\sqrt{X+0.5}$ transformed values) C.D. (0.05)
CD at 5%: 1.39, S.Em.±: 0.46
Significant at one percent level.
DAS**:** Days after Spraying

CD at 5%: 1.21 S.Em.±: 0.40

Significant at one percent level.
DAS**:** Days after Spraying

Table 2: Influence of acaricides on population of spider mite, *T. urticae* (Koch*)* on Okra (1st Spray & 2nd Spray, 2014-15)

Sl. No	Acaricides	Dose	Pre- spraying mite pop./ 2cm² leaf area	*T. urticae* population/2 cm² leaf area after 1st spraying					% Increase or Decrease over control	Pre- spraying mite pop./ 2cm² leaf area	*T. urticae* population/2 cm² leaf area after 2nd spraying					% Increase or Decrease over control
				1 DAS	3 DAS	7 DAS	14 DAS	Mean			1 DAS	3 DAS	7 DAS	14 DAS	Mean	
1	Propargite 57EC	3.15 ml	33.65	11.56* (3.47)**	32.69 (6.22)	41.27 (6.93)	39.63 (6.79)	31.29	-3-64	28.56	9.56 (3.17)	25.61 (5.11)	42.46 (7.00)	37.12 (6.45)	28.68	-3.45
2	Clofentazine 50SC	0.05ml	29.24	7.92 (2.90)	20.55 (4.59)	36.02 (6.04)	31.73 (5.68)	24.06	-25.92	32.42	7.48 (3.24)	21.67 (5.16)	38.97 (6.75)	29.35 (5.92)	24.37	-17.99
3	Cyflumetofen 20SC	0.50 ml	26.84	10.79 (3.36)	23.57 (4.91)	40.47 (6.40)	32.56 (5.75)	26.85	-17.32	29.86	8.84 (3.06)	24.38 (4.99)	36.51 (6.08)	32.43 (5.74)	25.54	-14.04
4	Fenpyroximate 5 EC	0.5 ml	22.68	6.35 (2.62)	18.74 (4.39)	51.54 (7.21)	42.25 (6.54)	29.72	-8.47	28.40	10.22 (3.27)	20.57 (4.59)	43.65 (6.64)	35.5 (6.00)	27.49	-7.48
5	Dicofol 18.5 EC	2.70 ml	28.48	9.24 (3.12)	29.62 (5.49)	46.25 (7.37)	45.51 (7.21)	32.66	+0.57	33.69	5.63 (2.48)	34.68 (5.93)	41.75 (6.96)	42.25 (7.00)	34.33	+4.60
6	Control (Water)	-	29.89	8.33 (2.97)	29.64 (5.49)	42.56 (6.56)	49.35 (7.06)	32.47	-	28.45	11.02 (3.39)	21.46 (4.69)	40.12 (6.37)	46.24 (6.84)	29.71	-

* Mean of four replication.

**(Figures in parentheses are mean of $\sqrt{X+0.5}$ transformed values)
CD at 5%: 1.24, S.Em.±: 0.41
Significant at one percent level.
DAS**:** Days after Spraying

CD at 5%: 1.05, S.Em.±: 0.35

Significant at one percent level.
DAS**:** Days after Spraying

Table 3: Influence of acaricides on population of spider mite, *T. urticae* (Koch*)* on Okra (Pooled data 2013-2014 and 2014-2015)

Sl. No	Acaricides	Dose	Pre-spraying mite pop./ 2cm² leaf area	*T. urticae* population/2 cm² leaf area after spraying							Overall Mean	% Increase or Decrease over control
				2013-14			Pre- spraying mite pop./ 2cm² leaf area	2014-15				
				1st Spray	2nd Spray	Mean		1st Spray	2nd Spray	Mean		
1	Propargite 57 EC	3.15 ml	26.58	29.49* (5.93)**	31.11 (6.07)	30.30	31.10	31.29 (6.09)	28.68 (5.85)	29.99	30.15	-5.89
2	Clofentazine 50 SC	0.05ml	26.77	24.81 (5.17)	27.55 (5.75)	26.18	30.83	24.06 (5.40)	24.37 (5.43)	24.21	25.20	-21.34
3	Cyflumetofen 20 SC	0.50 ml	26.67	26.73 (5.67)	28.56 (5.84)	27.65	28.35	26.85 (5.69)	25.54 (5.56)	26.20	26.93	-15.94
4	Fenpyroximate 5 EC	0.5 ml	29.75	29.31 (5.92)	28.80 (5.87)	29.05	25.54	29.72 (5.95)	27.49 (5.74)	28.60	28.83	-10.01
5	Dicofol 18.5 EC	2.70 ml	28.70	32.82 (6.22)	35.36 (6.44)	34.09	31.08	32.66 (6.21)	34.33 (6.36)	33.49	33.79	+5.46
6	Control (Water)	-	28.72	30.97 (6.06)	35.01 (6.42)	32.99	29.17	32.47 (6.19)	29.71 (5.95)	31.09	32.04	-

*Mean of four replication. CD at 5%: 1.15, S.Em.±: 0.38

**(Figures in parentheses are mean of $\sqrt{X+0.5}$ transformed values) Significant at one percent level.
CD at 5%: 1.30, S.Em.±: 0.43 DAS**:** Days after Spraying
Significant at one percent level.

Summary and concussion

The two spotted spider mite *Tetranychus urticae* Koch is most injurious mite pest and enjoys worldwide distribution wherever the vegetable crops are grown the application and extensive use of pesticide & fertilizers and same cultural practices have probably favored to their out breaks. The present investigation was carried out for two years to know the activities of synthetic pesticides toxicity on *Tetranychus urticae* Koch in India, and to also reveal which provides in more toxicity to this mite. In the present study commercially available pesticides which are better to manage this mite and which are responsible to the resurgence. The result reveals Clofentazine, Cyflumetofen, Fenpyroximate and Propargite did not show resurgence but Dicofol was showed poor performance in the management of TSSM. Due to these pesticide the TSSM get resurgence.

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