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Evaluation of Certain Synthetic Acaricides, Botanicals and Bio-Pesticides against Life Stages of Two Spotted Spider Mite (*T. urticae* Koch) under Poly-House Condition

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A B S T R A C T

Evaluation trail of synthetic acaricides, botanicals and bio-pesticides were conducted against different life stages of two spotted spider mite, *Tetranychus urticae* Koch under poly house condition during summer season of both 2013-14 and 2014-15. Mite population was recorded after 12, 24, 36, 48, 60 and 72 hrs of application. The efficacy of clofentazine 50 SC was found superior against egg, immature stage and adult female mites with reduction of 74.88 %, 74.98 % and 68.93 % respectively. In case of adult male, fenpyroximate 5 EC caused greater mortality (81.98 %) followed by cyflumetofen 20 SC (78.67 %). The efficacy of three botanicals remained very close to each other with performances observed below 50 %. Among the bio-pesticides used the *P. fumosoroseus*1x10^6 EC formulation caused greater percent reduction of egg (23.60 %), immature stages (24.47 %) and adult female mites (27.89 %) than the WP formulation, which was good in controlling adult male population (30.16%). In control plot there was comparatively less mortality.

Introduction

Okra, *Abelmoschus esculents* (L.) (Family: Malvaceae) is one of the world's oldest, traditional cultivated vegetable, grown mainly for its tender green pods which are freshly cooked or dehydrated. Huque (1994) and Kumar (2004) reported that okra plants are attacked by all those insect pests that harm the cotton which almost is attacked by approximately 145 species of insect pests.

Tetranychus urticae Koch has a great mite menace on summer vegetable crops. *Tetranychus urticae* Koch has become a destructive pest of okra and caused considerable damage in the eastern regions of Uttar Pradesh particularly when summer temperature prevails during the month of April – June. The two spotted spider mite, *T. urticae* Koch has now evolved as a major agricultural pest feeding on more than 900 plants including field crops, horticultural crops, green house vegetables and ornamental plants; often causing 50 to 100 percent yield loss (Kumar *et al.*, 2010; Clotuche *et al.*, 2011). The mite produces white spots on leaves due to sucking of plant sap and as feeding continues the white spots coalesce, the leaves loses its green colour, dry and drop. All this leads to decreased vitality, growth, flowering and fruiting. The mites web

profusely, covering the entire plant with thick sheath of webs. The indiscriminate use of chemical pesticides has resulted in three major consequences *i.e.* resistance development in mites to pest control chemical resurgence of pests and accumulation of residues in the environment and food grains. Activities of wild bees and honey bees, which are essential for pollination of many crops, are being suffered due to pesticide exposure that showed the irrational use of pesticides to manage this pest (Parveen and Dhandapani, 2001). Keeping in view the above facts and it was decided to evaluate the acaricidal activity of different botanicals and bio-pesticides along with the synthetic acaricides against different life stages of *T. urticae* on okra in poly house. It is very essential to understand the different life stages of the two spotted spider mite pest in okra ecosystem for better pest management. However, there is limited information on effect of different groups of chemicals and bio-rationals on the life stages of *T. urticae* and hence the present investigation was undertaken for efficacy study.

Materials and Methods

Experimental layouts

The following experiment was conducted during summer season of 2013 and 2014 at polyhouse present in the Institute of Agricultural Sciences, Banaras Agriculture University, Varanasi. In the experiment, okra variety 'Kashi Lila' was replicated three times under poly – house. The sowing of the seeds was done during 15th march of both years. The fertilizer application, irrigation and intercultural operations are conducted as per the recommended practices.

Details of spraying and chemicals used

The experiment was conducted to evaluate the percent reduction of different life stages of mite due to application of synthetic acaricides (clofentezine 50 SC, fenpyroximate 5 EC, cyflumetofen, 20 SC, propargite 57 EC, dicofol 18.5 EC), botanicals (NSKE 5%, azadirachtin 0.03 EC, neem oil 0.03%) and bio-pesticides (*Paeciomyces fumosoroseus* ($1x10^6$) EC and *Paeciomyces fumosoroseus* ($1x10^6$) WP at their recommended field doses. The freshly prepared treatment concentrations were used as foliar spray when mite population reached their ETL level on okra crop grown in pots of 30 cm diameter. The average temperature and relative humidity were maintained at 30^0C and 85% respectively in overall trial period by proper ventilation facility. Two sprays of each acaricides were applied in this trial with hand operated knapsack sprayer.

Collection of data and data analysis

The data were recorded of egg, immature stages and adult male and adult female of *T. urticae* Koch per block after 12, 24, 36, 48, 60 and 72 hrs interval of spray. Pre-spraying data were collected before initiation of acaricidal application on all stages of mites per okra leaf. The observation was taken in laboratory under stereoscopic binocular microscope to assess the uniformity of mite occurrence on the leaf. Sample of five leaves were collected from all treatments and brought to the laboratory for counting population of different stages of mites present per 2.5cm^{2}leaf area. The percent reduction in hatching of eggs and population of imature stages, adult male and female mites were calculated by using Abbots formula (1925).

$$P = \frac{P1 - C}{100 - C} X\ 100$$

Where:
P = percent corrected mortality, P_1 = percent observed mortality, C = percent mortality in control.

The percentage mortality data obtained was transformed to arc sine value and the critical difference (CD) among the various treatments was judged in both 1 % and 5 % level of significance. For statistical analysis of the collected data, SPSS version 16 was used in the experiment.

Results and Discussion

The results on the efficacy of various life stages egg, immature stage, adults male and adult female have been presented in presented in tables 1 to 4. Per cent reductions of egg hatching were varied significantly among different treatment of pesticides over period of 72 hrs (Table 1, Fig. 1). The maximum egg mortality was obtained at 12hrs and 72hrs after by clofentezine 50 SC treated leaves, (37.45%) and (99.90 %) respectively. No egg mortality was observed in azadirachtin 0.03%, neem oil 0.03% *Paeciomyces fumosoroseus* $1x10^6$ EC and *Paeciomyces fumosoroseus* $1x10^6$ WP after 12hrs of treatment. Clofentezine 50 SC, fenpyroximate 5 EC, cyflumetofen 20 SC, propargite 57 EC, dicofol 18.5 EC, NSKE 5%, were showed egg mortality from 12hrsup to 48 hrs after treatment. Azadirachtin 0.03%, and *Paeciomyces fumosoroseus* $1x10^6$ EC after 24 hrs were showed egg mortality up to 72 hrs after the treatment. Efficacy of acaricides after 72 hrs of the treatment in descending order was as follows: clofentezine 50 SC (99.90%) > cyflumetofen 20 SC (80.90%) > fenpyroximate 5 EC (56.98%) >propargite 57 EC (44.94%) >*Paeciomyces fumosoroseus*1 $x10^6$ EC (41.42%) >NSKE 5% (41.00%) > azadirachtin 0.03 % (36.75%)> dicofol 18.5 EC (33.68%) > neem oil (32.60%) and *Paeciomyces fumosoroseus* $1x10^6$ WP (32.42%). Acaricides and treatment effect period showed significant difference at one percent and five per cent level (Table 1).

The result of experiment revealed that after 12hrs of treatment cyflumetofen 20 SC showed maximum reduction of nymph stages (28.34%), followed by clofentezine (27.60%), and fenpyroximate (26.56%) (Table 2, Fig. 1). After 24 hours of application there was not much reduction in mite population as compared to 12 hrs. Only clofentezine showed more than 50 % of control (54.45%). At the 36hrs of spraying, clofentezine showed maximum reduction (82.54%) followed by propargite (79.78%), performed very well. There was no visible reduction in mite population in case of neem oil up to 36 hrs of spray. After 48hrs of spray, propargite, and clofentezine caused greater mortality with reduction of 98.45% and 86.50% respectively. After 60hrs of spray, the highest population reduction was found in clofentezine (98.76%) and the lowest population reduction was caused by neem oil (5.60%). There was nearly 100% reduction in population was found in clofentezine 50 SC, with 92.00 % reduction by cyflumetofen 20SC, followed by fenpyroximate (88.45%).

The data on the contact toxicity of 10 pesticides on adult males are presented in (Table 3, Fig. 1). In 12hrs the except fenpyroximate (41.50%), cyflumetofen (32.60%), the toxicity due to continuous exposure was significantly lower in case of clofentezine 8.90% mean per cent reduction in mite population. In case of 36hrs of spraying comparatively highest reduction in adult mite was obtained by plots treated with cyflumetofen (96.80%), followed by fenpyroximate (95.50%). Again the lowest efficacy was obtained by clofentezine (15.90%). Similar trend was followed after 48 hours of spray. The botanicals and bio-pesticides act moderately against the male mites. The adult mite showed extreme susceptibility to clofentezine causing mortality of about 100%, followed by 99.90% by fenproximate even after 72hrs of spraying of chemicals. All other treatments showed below 50% mortality, with lowest of 34.60% mortality by application of azadirachtin 0.03%.

The study on the contact toxicity of various pesticides against adult female mites resulted that, after 12hrs of spraying there was very less performance by all the treatments ranging from 6.70% to 31.50% mortality (Table 4, Fig. 1). There was zero or no mortality in case of cyflumetofen, azadirachtin, *Paeciomyces fumosoroseus* EC and *Paeciomyces fumosoroseus* WP formulations.

Table.1 Efficacy of acaricides on eggs stage of two spotted spider mite, (2013-14 and 2014-15 Pooled)

Pesticides	Dose per lit	Pre spraying Population/leaf	Mean percent reduction in egg survival						Overall Mean
			12 hrs	24 hrs	36 hrs	48 hrs	60 hrs	72 hrs	
Clofentezine 50SC	0.05 ml	7.12*	37.45 (37.70)	45.35 (42.30)	68.43 (55.80)	98.78 (83.45)	99.34 (85.20)	99.90 (88.19)	74.88
Fenpyroximate 5EC	0.5 ml	6.67	24.54 (29.67)	37.89 (37.94)	48.56 (44.14)	92.34 (73.89)	89.45 (71.00)	56.98 (48.97)	58.29
Cyflumetofen 20SC	0.5 ml	6.83	26.34 (30.85)	27.41 (31.56)	57.56 (49.31)	26.26 (30.79)	98.78 (83.45)	80.90 (64.09)	52.88
Propergite 57 EC	3.15 ml	8.32	12.45 (20.62)	15.34 (23.03)	39.78 (39.06)	89.78 (71.28)	98.45 (82.73)	49.90 (44.94)	50.95
Dicofol 18.5 EC	2.70ml	7.45	11.56 (19.82)	14.27 (22.14)	28.56 (32.27)	42.24 (40.51)	56.89 (48.91)	33.68 (35.43)	31.20
NSKE 5%	5.00ml	6.56	8.76* (17.15)**	14.24 (22.14)	26.56 (30.98)	38.56 (38.35)	56.78 (48.85)	41.00 (39.82)	30.98
Azadirachtin 0.03 %	5.00ml	7.38	0 (0)	11.24 (19.55)	18.45 (25.40)	22.56 (28.32)	28.90 (32.52)	36.75 (37.29)	23.58
Neem oil 0.03 %	2.0 ml	6.58	0 (0)	0 (0)	0 (0)	29.67 (32.96)	30.48 (33.46)	32.60 (34.82)	30.92
*Paeciomyces fumosoroseus*1x10^6 EC	1.50 ml	7.32	0 (0)	11.32 (19.64)	16.24 (23.73)	20.45 (26.85)	28.56 (32.27)	41.42 (40.05)	23.60
*Paeciomyces fumosoroseus*1x10^6 WP	3.0 g	5.74	0 (0)	0 (0)	5.8 (13.94)	0 (0)	3.84 (11.24)	32.42 (34.70)	14.02
Control (Water Spray)		6.82	0 (0)	0 (0)	0 (0)	0 (0)	2.80 (9.63)	14.49 (22.30)	8.65
SEM.±			**0.773**	**0.558**	**1.262**	**0.921**	**1.574**	**2.028**	
C.D. (.05%)			**1.602**	**1.157**	**2.617**	**1.910**	**3.264**	**4.205**	
C.D. (.01%)			**2.178**	**1.573**	**3.558**	**2.596**	**4.437**	**5.715**	

*Means of three replication, **Figures in parentheses are ArcSin √ percentage transform

Table.2 Efficacy of pesticides on immature stages of two spotted spider mite (2013-14 and 2014-15 Pooled)

Pesticides	Dose per lit	Pre spraying population/leaf	Mean percent reduction in nymphal survival						Overall Mean
			12 hrs	24 hrs	36 hrs	48 hrs	60 hrs	72 hrs	
Clofentezine 50SC	0.05 ml	5.86*	27.60 (31.69)	54.45 (47.52)	82.54 (65.27)	86.50 (68.44)	98.76 (83.45)	100.00 (90.00)	74.98
Fenpyroximate 5EC	0.5 ml	5.75	26.56 (30.98)	48.56 (44.14)	61.45 (51.59)	75.45 (60.27)	82.10 (64.97)	88.45 (70.09)	63.76
Cyflumetofen 20SC	0.5 ml	6.70	28.34 (32.14)	40.24 (39.35)	46.45 (42.94)	56.21 (48.56)	60.32 (50.94)	92.00 (73.57)	53.93
Propergite 57 EC	3.15 ml	8.35	24.52 (29.67)	47.56 (43.57)	79.78 (63.22)	98.45 (82.72)	82.00 (64.90)	63.34 (52.71)	65.94
Dicofol 18.5 EC	2.70ml	5.67	18.90 (25.77)	21.45 (27.56)	41.45 (40.05)	42.20 (40.51)	45.56 (42.42)	48.90 (44.37)	36.41
NSKE 5%	5.00ml	6.25	12.45 (19.73)	18.24 (25.25)	22.45 (28.25)	26.78 (31.11)	30.45 (33.46)	36.56 (37.17)	24.49
Azadirachtin 0.03 %	5.00ml	7.38	14.60 (22.46)	21.22 (27.42)	24.42 (29.60)	26.56 (30.98)	28.21 (32.08)	32.12 (34.51)	24.52
Neem oil 0.03 %	2.0 ml	7.23	0 (0)	0 (0)	0 (0)	6.25 (14.42)	5.60 (13.69)	8.25 (16.64)	6.70
*Paeciomyces fumosoroseus*1x10^6 EC	1.50 ml	6.45	10.24* (18.63)**	26.56 (30.98)	28.67 (32.33)	30.48 (33.46)	32.34 (34.63)	36.50 (37.14)	27.47
*Paeciomyces fumosoroseus*1x10^6 WP	3.0 g	7.28	8.90 (17.36)	12.56 (20.70)	20.42 (26.85)	28.80 (32.46)	30.45 (33.46)	35.50 (36.57)	22.77
Control (Water Spray)		6.32	0 (0)	0 (0)	0 (0)	2.35 (8.72)	4.50 (12.25)	5.50 (13.56)	4.12
SEM.±			**0.360**	**1.159**	**0.939**	**1.138**	**0.999**	**1.240**	
C.D. (.05%)			**0.746**	**2.610**	**1.948**	**2.361**	**2.073**	**2.571**	
C.D. (.01%)			**1.013**	**3.547**	**2.647**	**3.209**	**2.817**	**3.495**	

*Means of three replication, **Figures in parenthesis are ArcSin √ percentage transform

Table.3 Efficacy of pesticides on adult male stage of two spotted spider mite (2013-14 and 2014-15 Pooled)

Pesticides	Dose per lit	Pre spraying population/ leaf	Mean percent reduction in adult male survival						Overall Mean
			12 hrs	24 hrs	36 hrs	48 hrs	60 hrs	72 hrs	
Clofentezine 50SC	0.05 ml	17.38*	0 (0)	6.80 (15.12)	15.90 (23.50)	25.90 (30.59)	66.80 (54.82)	100.00 (90.00)	43.08
Fenpyroximate 5EC	0.5 ml	18.33	41.50 (40.11)	56.70 (48.85)	95.50 (77.72)	98.40 (82.73)	99.90 (88.19)	99.90 (88.19)	81.98
Cyflumetofen 20SC	0.5 ml	16.21	32.60 (34.82)	42.90 (40.92)	96.80 (79.70)	99.90 (88.19)	99.90 (88.19)	99.90 (88.19)	78.67
Propergite 57 EC	3.15 ml	16.76	8.90 17.36	18.40 (25.40)	30.90 (33.77)	46.90 (43.22)	59.90 (50.71)	46.90 (43.22)	35.32
Dicofol 18.5 EC	2.70ml	16.56	12.50 (20.70)	14.80 (22.63)	24.70 (29.80)	32.50 (34.76)	41.00 (39.82)	42.00 (40.40)	27.92
NSKE 5%	5.00ml	16.49	22.56 (28.32)	28.63 (32.33)	34.97 (36.21)	39.08 (38.65)	40.42 (39.47)	42.20 (40.51)	34.64
Azadirachtin 0.03 %	5.00ml	16.90	18.54* (25.47)**	22.34 (28.18)	28.00 (31.95)	32.11 (34.51)	34.60 (36.03)	36.80 (37.35)	28.73
Neem oil 0.03 %	2.0 ml	16.40	0 (0)	12.70 (20.88)	22.40 (28.25)	28..50 (32.27)	48.67 (44.20)	45.32 (42.30)	32.27
*Paeciomyces fumosoroseus*1x10^6 EC	1.50 ml	16.51	0 (0)	5.80 (13.94)	20.25 (26.71)	26.45 (30.92)	40.20 (39.35)	38.50 (38.35)	26.24
*Paeciomyces fumosoroseus*1x10^6 WP	3.0 g	16.88	0 (0)	4.70 (12.52)	36.67 (37.23)	33.82 (35.55)	40.65 (39.58)	34.95 (36.21)	30.16
Control (Water Spray)		16.57	0 (0)	0 (0)	7.92 (16.32)	15.21 (22.95)	16.49 (23.89)	11.61 (19.91)	12.81
SEM.±			**0.993**	**1.078**	**0.920**	**1.264**	**1.852**	**1.179**	
C.D. (.05%)			**2.059**	**2.235**	**1.908**	**2.622**	**3.840**	**2.444**	
C.D. (.01%)			**2.799**	**3.038**	**2.593**	**3.563**	**5.220**	**3.322**	

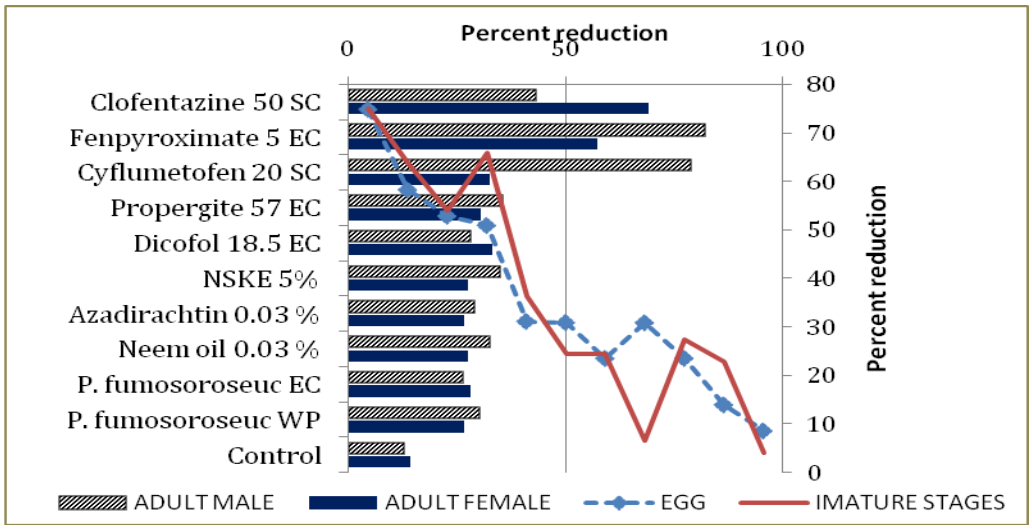
*Means of three replication, **Figures in parenthesis are ArcSin √ percentage transform

Table.4 Efficacy of pesticides on adult female of two spotted spider mite (2013-14 and 2014-15 Pooled)

Pesticides	Dose per lit	Pre spraying population/ leaf	Mean percent reduction in adult female survival						Overall Mean
			12 hrs	24 hrs	36 hrs	48 hrs	60 hrs	72 hrs	
Clofentezine 50SC	0.05 ml	17.38*	31.50 (34.14)	38.90 (38.59)	66.80 (54.82)	89.90 (71.47)	99.90 (88.19)	86.58 (68.44)	68.93
Fenpyroximate 5EC	0.5 ml	18.33	31.50* (34.14) **	46.70 (43.11)	55.50 (48.16)	70.40 (57.07)	80.90 (64.09)	57.83 (49.49)	57.14
Cyflumetofen 20SC	0.5 ml	16.21	0 (0)	4.90 (12.79)	13.70 (21.72)	20.90 (27.20)	56.98 (48.97)	66.49 (54.57)	32.59
Propergite 57 EC	3.15 ml	16.76	6.70 (15.00)	15.20 (22.95)	20.90 (27.20)	37.90 (38.00)	49.90 (44.94)	51.49 (45.80)	30.35
Dicofol 18.5 EC	2.70ml	16.56	20.56 (26.92)	24.5 3 (29.67)	30.97 (33.77)	33.5 8 (35.37)	41.42 (40.05)	39.28 (38.76)	33.06
NSKE 5%	5.00ml	16.49	10.50 (18.91)	12.30 (22.63)	24.70 (29.80)	32.50 (34.70)	41.00 (39.82)	43.11 (41.03)	27.35
Azadirachtin 0.03 %	5.00ml	16.90	0 (0)	9.56 (17.95)	19.78 (26.35)	23.40 (28.93)	36.75 (37.29)	43.90 (41.50)	26.68
Neem oil 0.03 %	2.0 ml	16.40	16.34 (23.81)	21.34 (27.49)	25.89 (30.53)	30.11 (33.27)	32.60 (34.82)	38.20 (38.17)	27.41
*Paeciomyces fumosoroseus*1x10^6 EC	1.50 ml	16.51	0 (0)	4.6 (12.38)	16.56 (23.97)	22.45 (28.25)	33.68 (35.43)	62.18 (52.00)	27.89
*Paeciomyces fumosoroseus*1x10^6 WP	3.0 g	16.88	0 (0)	3.20 (10.30)	24.34 (29.53)	23.58 (29.00)	32.42 (34.70)	49.93 (44.94)	26.69
Control (Water Spray)		16.57	0 (0)	0 (0)	9.52 (17.95)	13.21 (21.30)	14.49 (22.30)	19.49 (26.13)	14.18
SEM.±			**0.947**	**0.951**	**1.098**	**1.141**	**2.028**	**1.497**	
C.D. (.05%)			**1.965**	**1.971**	**2.278**	**2.366**	**4.205**	**3.122**	
C.D. (.01%)			**2.671**	**2.679**	**3.096**	**3.216**	**5.715**	**4.235**	

*Means of three replication, **Figures in parentheses are ArcSin√percentage transform

Figure.1 Effect of various treatments on different life stages of TSSM (*T. urticae* Koch)



After 24hrs of spraying highest mortality was caused by fenpyroximate (46.70%) followed by clofentezine (38.90%). But after 36hrs, clofentezine acts superior against female adult mite with reduction of 66.80% followed by fenpyroximate 55.50%. The lowest performance was by cyflumetofen (13.70%) and by *Paeciomyces fumosoroseus* EC (16.56%). The toxicity stands for a long period against female mites i.e. up to 60 to 72 hrs by the chemicals like clofentezine and fenproximate with reduction of about 99.90% and 80.90% respectively till 60hrs. The other treatments acted moderately and remained below 50% throughout the experiment period.

The study was conducted to determine the effect of certain newer acaricides, botanicals and bio-pesticides against different life stages of two spotted spider mite *T. urticae* Kochunder green house condition in okra. The experiment revealed that among various acaricides tested, clofentezine 50 SC, cyflumetofen 20 SC, and fenpyroximate 5 EC, offered superior control over other treatments. The comparative efficacy regarding eggs by application of 'Apollo' was reported by Pang *et al.,* (1991) that, it effectively kills summer eggs and young mites and was effective on fruit crops. The similar results were also observed by Bhardwaj *et al.,* (2007). The efficacy often proximate and propargite was found excellent against the mites' up to 48hrs of spray by Kumar *et al.,* (2009). The bio-pesticides were not much effective in controlling the infective stages of mite population as compared to the chemicals. The rotation of all these pesticides, having new mode of action could be used in the field for prolonged efficacy and also to avoid resistance development in the long term use against *T. urticae*. We may conclude that the three acaricides, clofentezine, fenproximate and cyflumetofen were very toxic to immature stages of *T. urticae*after from 12-72hrs of treatment, so it can be used to check the mite population at initial level and the botanicals or bio-pesticides must be recommended to use along with the synthetic chemicals in the Integrated Mite Management Programme of spider mites on okra fields. The present study was supported the experiment from Khajuria and Sharma, 2010 who reported the moderate toxicity of clofentezine (0.035 %) and propargite (0.057 %) against to the two spotted spider mite and it to be safer to the predatory mites. These findings are in accordance with those of Sridhar *et al.,* (2011) and can be concluded that above mentioned new acaricides spread with 15 days interval gives best control of okra mite, *Tetranychus urticae* Koch.

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