The Pharma Innovation Journal 2023; 12(4): 466-474

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(4): 466-474

www.thepharmajournal.com
Received: 02-01-2023
Accepted: 03-02-2023

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Bioefficacy of different acaricides against red spider mite, *Tetranychus urticae* Koch on brinjal, *Solanum melongena* L.

VT Shinde, ST Aghav, CS Chaudhari and TR Chavan

Abstract
The present study entitled, bioefficacy of different acaricides against red spider mite, *Tetranychus urticae* Koch on brinjal, *Solanum melongena* L. was carried out during *rabi* 2020-2021. Spiromesifen 22.90 SC @ 96 g a.i./ha was superior treatment with minimum average survival population of mites (0.37 mites/sq.cm/leaf) and also recorded highest marketable fruit yield of brinjal (16.77 tonns/ha). However, it was followed by fenazaquin 10 EC @125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha with 0.53 and 0.90 mites/sq.cm/leaf, respectively and were at par with each other. The treatment with spiromesifen 22.90 SC @ 96 g a.i./ha was also found superior by recording highest reduction in average survival population of mites (96.69%). Highest ICBR (1:21.10) was recorded in fenpropathrin 30 EC @ 75 g a.i./ha, followed by propargite 57 EC @ 570 g a.i./ha (1:13.13) and spiromesifen 22.90 SC @ 96 g a.i./ha (1:12.78).

Keywords: Red spider mite, *Tetranychus urticae* Koch, Brinjal, Bioefficacy

Introduction
Brinjal (*Solanum melongena* Linnaeus) is an annual vegetable crop belonging to Solanaceae family. It is also known as egg plant, aubergine, garden egg, baingan, ringan, vangi and more names. Brinjal (*S. melongena* L.) is originated in India, where a wide range of wild kinds and land races exist (Thompson and Kelly, 1957) [11]. The edible fruits of brinjal contain 92.7 per cent water, 1.1 per cent protein, 0.02 per cent fat, 0.54 per cent ash and 5.5 per cent carbs (Shanmugavelu, 1989) [9]. Unripe fruits are largely eaten as vegetables in the country due to their nutritious content, which includes minerals like iron, phosphorus, calcium and vitamins such as A, B and C. The fruit is a fantastic cholesterol lowering agent. Brinjal also contains a lot of dietary fiber, which helps to lower the risk of coronary heart disease (Wagner, 2006) [12].
Although brinjal is produced all round year, it is attacked by a variety of insect and non-insect pests from the nursery stage until harvest. It is attacked by 44 pests (Lal, 1975) [5]. Besides these, important insects pests includes shoot and fruit borer, leaf hoppers, stem borer, leaf webber, aphids, whitefly, thrips and non insect pest such as mites, particularly red spider mites are among the greatest bottlenecks in brinjal productivity (Rizvi, 1996) [8]. Tetranychid mites have been found on brinjal in 25 different species from around the world (Bolland *et al.*, 1998) [2]. A two spotted spider mite *T. urticae* attacking brinjal, is one of the most important arthropod pest that devastates the crop's output. It has now become a severe threat to the cultivation of brinjal, *S. melongena*. resulting in yield reductions of up to 31%. The careful application of certain of acaricides (with a variety of modes of action) will aid in the more effective management of mite pests while also minimizing the likelihood of mite pest resistance (Aji, 2005) [1].
In light of the foregoing facts and the scarcity of related knowledge on spider mites on brinjal, the investigation was conducted on bioefficacy of different acaricides against red spider mite, *Tetranychus urticae* Koch on brinjal, *Solanum melongena* L.

Materials and Method
Bioefficacy of different acaricides against red spider mite, *Tetranychus urticae* Koch on brinjal, *Solanum melongena* L. was studied at Post Graduate Research Farm, Department of Agril. Entomology, M.P.K.V., Rahuri during *Rabi* season of 2020-21. The crop was raised by following standard recommended agronomical practices. The geographical situation of Rahuri is on 19.380 N latitude and 74.650 N longitude with an elevation of 511 meters above mean sea level.

Experiment Details

Crop	:	Brinjal, *Solanum melongena* L.
Variety	:	Gaurav
Season and year	:	*Rabi* 2020-21
Date of transplanting	:	11/12/2020
Design	:	Randomised Block Design
Treatments	:	Nine
Replications	:	Three
Plot size	:	4.05 m x 3.00 m
Spacing	:	60 cm x 45 cm
No. and date of spraying	:	Two, 18.02.2021 and 05.03.2021
Equipment	:	Hand operated knapsack sprayer with hollow cone nozzle
Spray fluid used	:	500 lit. water/ha
Date of pickings	:	4.3.2021, 12.3.2021, 17.3.2021, 22.3.2021,26.3.2021, 30.3.2021, 5.4.2021, 12.4.2021, 16.4.2021, 22.4.2021, 28.4.2021

Table 1: Details of different acaricides used in bioefficacy study against red spider mite, on brinjal

Sr. No.	Common name and formulation	Trade name	Source
1.	Abamectin 1.9 EC	Abacin	M/s. Crystal Crop Protection Pvt. Ltd., Nagpur
2.	Buprofezin 25 SC	Applaud	M/s. Tata Rallis India Pvt. Ltd., Mumbai
3.	Chlorfenapyr 10 EC	Lepido	M/s. PI Industries Pvt. Ltd., Gujarat
4.	Fenazaquin 10 EC	Magister	M/s. Dupont India Pvt. Ltd., Mumbai
5.	Fenpropathrin 30 EC	Meothrin	M/s. Atoz Agricos Pvt. Ltd., Nashik
6.	Hexythiazox 5.45 EC	Maiden	M/s. Biostand India Ltd., Mumbai
7.	Propargite 57 EC	Omite	M/s. Dhanuka Agritech Ltd., Gulberga
8.	Spiromesifen 22.90 SC	Oberon	M/s. Bayer Crop Science Ltd., Mumbai

Table 2: Treatment details

Tr. No.	Treatment	Dose (g a.i./ha)	Formulation (g or ml/ha)
1	Abamectin 1.9 EC	6	315
2	Buprofezin 25 SC	75	300
3	Chlorfenapyr 10 EC	75	750
4	Fenazaquin 10 EC	125	1250
5	Fenpropathrin 30 EC	75	250
6	Hexythiazox 5.45 EC	25	500
7	Propargite 57 EC	570	1000
8	Spiromesifen 22.90 SC	96	400
9	Untreated control	-	-

Method of Recording Observations

Survival population of mites

The observations on survival population of mite, *T. urticae* on brinjal was recorded at 0 day before foliar spray application as a precount and on 3rd, 7th, 10th and 14th day after foliar spray applications as post count. Post count of previous foliar spray application at last day was treated as the pre-count of next foliar spray application. For recording observations on mites, three leaves (Upper, middle and lower) per plant were selected from randomly selected and tagged five plants in each acaricidal treatment plot. The mite population was recorded in 1.0 cm^2 (1.0 cm x 1.0 cm) area per leaf. Number of mites per 1.0 cm^2 area/leaf during the period of two foliar spray applications at fourteen days interval in various treatments on 0, 3rd, 7th, 10th and 14th day was worked out in square root transformation for statistical analysis.

Yield

The marketable fruit yield of brinjal was recorded at each picking from each plot and finally converted into t/ha.

Statistical Analysis

Data on survival mite population were transformed to square root values to stabilize the heterogeneous variances. The transformed data for the respective evaluation dates were analysed as a Randomized Block Design (RBD). The means of three replicates were compared by using the standard error (S.E.) and critical difference (C.D.) at 5 per cent to decide the significance of individual treatment effect. The yield data was subjected to statistical analysis. Finally, an incremental cost benefit ratio (ICBR) of each treatment was worked out.

Results and Discussion

Bioefficacy of Different Acaricides Against Red Spider Mite, *T. urticae* on Brinjal After First Spray

Data pertaining to survival population of mite/ sq.cm/leaf at 0 day before spray and at 3rd, 7th, 10th and 14th day after first spray is presented in Table 3 and graphically illustrated in Fig. 1.

Precount

The precount observations recorded at 0 day before foliar spray application indicated that, the average survival population of mites ranged between 6.53 to 7.53 mites /sq.cm/leaf and were found statistically non significant, suggesting that, the population of mites on brinjal was uniform in field.

Three days after first spray

It is evident from the data that, average survival population of mites at three days after first spray varied from 0.47 to 9.00 mites /sq.cm/leaf in various treatments (Table 3). All the acaricidal treatments were found to be significantly superior over untreated control in reducing the mites population. Amongst the tested acaricides, spiromesifen 22.90 SC @ 96 g a.i./ha was found to be most effective treatment against red spider mite, *T. urticae* with minimum average survival mite population (0.47 mites/sq.cm/leaf). However, it was followed by the treatments with fenazaquin 10 EC @ 125 g a.i./ha (0.53 mites/sq.cm/leaf) and propargite 57 EC @ 570 ga.i./ha (1.13 mites/sq.cm/leaf) and were at par with spiromesifen 22.90 SC. Next best treatment was abamectin 1.9 EC @ 6 g a.i./ha (1.27 mites/sq.cm/leaf) which was followed by the treatment with fenpropathrin 30 EC @ 75 g a.i./ha (1.93 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 g a.i./ha (2.07 mites/sq.cm/leaf) and chlorfenapyr 10 EC @ 75 g a.i./ha(2.13 mites /sq.cm/leaf) and were at par with each other. Moreover, buprofezin 25 SC @ 75 g a.i./ha was found least effective amongst all tested acaricides with 4.73 mites/sq.cm/leaf.

Seven days after first spray

From the results, it was observed that, average survival population of mites ranged from 0.33 to 10.87 mites/sq.cm/leaf at 7 days after first spray (Table 3). All the acaricidal treatments were significantly superior over untreated control. The treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded least average survival mite population of 0.33 mites/sq.cm/leaf and was at par with the treatments with fenazaquin 10 EC @ 125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha which recorded 0.60 and 1.07 mites/sq.cm/leaf, respectively. However, the treatment with abamectin 1.9 EC @ 6 g a.i./ha was proved to be the next best treatment with 1.53 mites/sq.cm/leaf, followed by the treatment with fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha, chlorfenapyr 10 EC @ 75 g a.i./ha with 2.27, 2.40 and 2.47 mites/sq.cm/leaf, respectively and were at par with each other. However, untreated control recorded maximum of 10.87 mites/sq.cm/leaf.

Ten days after first spray

From the results, it was noticed that, average survival mite population varied from 0.53 to 10.27 mites/sq.cm/leaf at 10 days after first spray (Table 3). All the acaricidal treatments were significantly significant over untreated control. From the data it was revealed that, the treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded minimum average survival mite population of 0.53 mites/sq.cm/leaf and was followed by fenazaquin 10 EC @ 125 g a.i./ha (0.73 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (1.27 mites/sq.cm/leaf) which were at par with each other. The treatment with abamectin 1.9 EC @ 6 g a.i./ha was next effective treatment with 1.80 mites/sq.cm/leaf and was at par with fenpropathrin 30 EC @ 75 g a.i./ha (2.47 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 g a.i./ha (2.60 mites/sq.cm/leaf) and chlorfenapyr 10 EC @ 75 g a.i./ha (2.73 mites/sq.cm /leaf). However, the treatment buprofezin 25 SC @ 75 g a.i./ha found least effective with 5.27 mites/sq.cm/leaf.

Fourteen days after first spray

From the results it was revealed that, all the acaricidal treatments proved to be effective over untreated control and the average survival population of mites ranged from 0.40 to 10.80 mites/sq.cm/leaf at 14 days after first spray (Table 3).

Treatment with spiromesifen 22.90 SC @ 96 g a.i./ha found promising in controlling red spider mite population (0.40 mites/sq.cm/leaf)and it was followed by the treatment with fenazaquin 10 EC @ 125 g a.i./ha (0.87 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (1.20 mites/sq.cm/leaf) which were at par with each other. The treatment with abamectin 1.9 EC @ 6 g a.i./ha found to be next promising treatment with 1.73 mites/sq.cm/leaf and followed by the treatments fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha, chlorfenapyr 10 EC @ 75 g a.i./ha with 2.20, 2.33 and 2.40 mites/sq.cm/leaf and were at par with each other. Buprofezin 25 SC @ 75 g a.i./ha (5.73 mites/sq.cm/leaf) found superior over untreated control (10.80 mites/sq.cm/leaf).

From the results of the mean efficacy of different acaricides against red spider mite on brinjal at first spray revealed that, the treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded least mean average survival population of mites (0.43 mites/sq.cm/leaf) and was followed by the treatments with fenazaquin 10 EC @125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha with 0.68 and 1.17 mites/sq.cm/leaf which were at par with each other. However, next best treatment was abamectin 1.9 EC @ 6 g a.i./ha with 1.58 mites/sq.cm/ leaf and it was at par with fenpropathrin 30 EC @ 75 g a.i./ha (2.22 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 g a.i./ha (2.35 mites/leaf/sq.cm.) and chlorfenapyr 10 EC @ 75 g a.i./ha (2.43 mites/sq.cm/leaf). Moreover, the treatment with buprofezin 25 SC @ 75 g. a.i./ha was found to least effective treatment which recorded 5.20 mites/sq.cm/leaf whereas, untreated control recorded highest mean survival population of mites (10.23 mites/sq.cm/leaf) after first spray.

Bioefficacy of Different Acaricides Against Red Spider Mite, *T. urticae* on Brinjal After Second Spray

Data pertaining to survival population of mites on brinjal at 3rd, 7th, 10th and 14th day after second spray is presented in Table 4 and graphically illustrated in Fig. 2.

Three days after second spray

The data on average survival population of mites on brinjal showed that the average survival population of mites at three days after second spray varied from 0.20 to 10.33 mites /sq.cm/leaf in various treatments (Table 4). All the acaricidal treatments were found to be significantly superior over untreated control in reducing the mites population. Amongst the tested acaricides, spiromesifen 22.90 SC @ 96 g a.i./ha was found to be most effective treatment against red spider mite, *T. urticae* with minimum average survival mite population (0.20 mites/sq.cm/leaf). However, it was followed by the treatments with fenazaquin 10 EC @ 125 g a.i./ha (0.27 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (0.53 mites/sq.cm/leaf) and were at par with spiromesifen 22.90 SC. Next best treatment was abamectin 1.9 EC @ 6 g a.i./ha (0.80 mites/sq.cm/leaf) which was followed by the treatment with fenpropathrin 30 EC @ 75 g a.i./ha (1.20 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 g a.i./ha (1.27 mites/sq.cm/leaf) and chlorfenapyr 10 EC @ 75 g a.i./ha (1.33 mites /sq.cm/leaf) and were at par with each other. Moreover, buprofezin 25 SC @ 75 g a.i./ha was least effective among all tested acaricides with 5.20 mites/sq.cm/ leaf.

Seven days after second spray

From the results, it was observed that, average survival population of mites ranged from 0.27 to 12.80 mites/sq.cm/leaf at 7 days after second spray (Table 4). All the acaricidal treatments were significantly superior over untreated control. The treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded least average survival mite population of 0.27 mites/sq.cm/leaf and was at par with the treatments with fenazaquin 10 EC @ 125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha which recorded 0.33 and 0.67 mites/sq.cm/ leaf, respectively.

However, the treatment with abamectin 1.9 EC @ 6 g a.i./ha was proved to be the next best treatment with 0.87 mites/sq.cm/leaf, followed by the treatment with fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha and chlorfenapyr 10 EC @ 75 g a.i./ha with 1.40, 1.53 and 1.60 mites/sq.cm/leaf, respectively and were at par with each other. However, untreated control recorded maximum of 12.80 mites/sq.cm/ leaf.

Ten days after second spray

From the results, it was noticed that, average survival mite population varied from 0.40 to 12.27 mites/sq.cm/leaf at 10 days after second spray (Table 4). All the acaricidal treatments were significantly significant over untreated control. From the data it was revealed that, the treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded least average survival mite population of 0.40 mites/sq.cm/leaf and was followed by fenazaquin 10 EC @ 125 g a.i./ha (0.47 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (0.73 mites/sq.cm/leaf) which were at par with each other. The treatment with abamectin 1.9 EC @ 6 g a.i./ha was next effective treatment with 1.07 mites/sq.cm/leaf and was at par with fenpropathrin 30 EC @ 75 g a.i./ha (1.47 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 g a.i./ha (1.67 mites/sq.cm/leaf), chlorfenapyr 10 EC @ 75 g a.i./ha (1.73 mites/sq.cm/leaf). However, the treatment buprofezin 25 SC @ 75 g a.i./ha found least effective with 4.33 mites/sq.cm/leaf.

Fourteen days after second spray

From the results it was revealed that, all the acaricidal treatments proved to be effective over untreated control and the average survival population of mites ranged from 0.33 to 12.20 mites/sq.cm/leaf at 14 days after second spray (Table 4).

Treatment with spiromesifen 22.90 SC @ 96 g a.i./ha found promising in controlling red spider mite population (0.33 mites/sq.cm/leaf) and it was followed by the treatment with fenazaquin 10 EC @ 125 g a.i./ha (0.40 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (0.60 mites/sq.cm/leaf) which were at par with each other. The treatment with abamectin 1.9 EC @ 6 g a.i./ha found to be next promising treatment with 0.93 mites/sq.cm/leaf and followed by the treatments fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha, chlorfenapyr 10 EC @ 75 g a.i./ha with 1.33, 1.47 and 1.53 mites/sq.cm/leaf and were at par with each other. Buprofezin 25 SC @ 75 g a.i./ha (4.87 mites/sq.cm/leaf) found superior over untreated control (12.20 mites/sq.cm/leaf).

Results of the mean efficacy of different acaricides against red spider mite on brinjal at first spray revealed that, the treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded minimum mean average survival population of mites (0.30 mites/sq.cm/leaf) and was followed by the treatments with fenazaquin 10 EC @ 125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha with 0.37 and 0.63 mites/sq.cm/leaf, respectively which were at par with each other. Next best treatment was abamectin 1.9 EC @ 6 g a.i./ha with 0.91 mites/sq.cm/ leaf and it was at par with fenpropathrin 30 EC @ 75 g a.i./ha (1.35 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 g a.i./ha (2.35 mites/leaf/sq.cm.) and chlorfenapyr 10 EC @ 75 g a.i./ha (1.48 mites/sq.cm/leaf). Moreover, the treatment with buprofezin 25 SC @ 75 g a.i./ha was found to least effective treatment which recorded 4.57 mites/sq.cm/leaf whereas, untreated control recorded highest mean survival population of mites (11.90 mites/sq.cm/leaf) after second spray.

Bioefficacy of Different Acaricides Against Red Spider Mite, *T. urticae* on Brinjal (Pooled Mean)

Data pertaining to mean survival population of mite at 0 day before spray and at 3rd, 7th, 10th and 14th days after spray is presented in Table 5 and graphically illustrated in Fig. 3.

Three days after spray

It is evident from the data that, mean average survival population of mites at three days after spray varied from 0.33 to 9.67 mites/sq.cm/leaf in various treatments (Table 5). All the acaricidal treatments were found to be significantly superior over untreated control in reducing the mites population. Amongst the tested acaricides, spiromesifen 22.90 SC @ 96 g a.i./ha was found to be most effective treatment against red spider mite, *T. urticae* with minimum mean average survival mite population (0.33 mites/sq.cm/leaf). However, it was followed by the treatments with fenazaquin 10 EC @ 125 g a.i./ha (0.40 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (1.83 mites/sq.cm/leaf) and were at par with spiromesifen 22.90 SC. Next best treatment was abamectin 1.9 EC @ 6 g a.i./ha (1.03 mites/sq.cm/leaf) and it was followed by the treatments with fenpropathrin 30 EC @ 75 g a.i./ha (1.57 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 ml a.i./ha (1.67 mites/sq.cm/ leaf) and chlorfenapyr 10 EC @ 75 g a.i./ha (1.73 mites /sq.cm/leaf) which were at par with each other. Moreover, buprofezin 25 SC @ 75 g a.i./ha was least effective among all tested acaricides with 4.97 mites/sq.cm/leaf.

Seven days after spray

From the results, it was observed that, mean average survival population of mites ranged from 0.30 to 11.83 mites/sq.cm/leaf at 7 days after spray (Table 5). All the acaricidal treatments were significantly superior over untreated control. The treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded least mean average survival mite population 0.30 mites/sq.cm/leaf and was at par with the treatments with fenazaquin 10 EC @ 125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha which recorded 0.47 and 0.87 mites/sq.cm/leaf, respectively.

However, the treatment with abamectin 1.9 EC @ 6 g a.i./ha was proved to be the next best treatment with 1.20 mites/sq.cm/leaf, followed by the treatment with fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha and chlorfenapyr 10 EC @ 75 g a.i./ha with 1.83, 1.97 and 0.87 mites/sq.cm/leaf, respectively and were at par with each other. However, untreated control recorded maximum average mean survival mite population of 11.83 mites/sq.cm/leaf.

Ten days after spray

From the results, it was noticed that, mean average survival mite population varied from 0.47 to 11.27 mites/sq.cm/leaf at 10 days after spray (Table 5). All the acaricidal treatments were found significant in reducing mite population over untreated control. From the data it was revealed that, the treatment with spiromesifen 22.90 SC @ 96 g a.i./ha recorded minimum mean average survival mite population of 0.47 mites/sq.cm/leaf and was followed by fenazaquin 10 EC @ 125 g a.i./ha (0.60 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (1.00 mites/sq.cm/leaf) which were at par with each other. The treatment with abamectin 1.9 EC @ 6 g a.i./ha was next effective treatment with (1.43 mites/sq.cm/leaf) and was at par with fenpropathrin 30 EC @ 75 g a.i./ha (1.97 mites/sq.cm/leaf), hexythiazox 5.45 EC @ 25 g a.i./ha (2.13 mites/sq.cm/leaf) and chlorfenapyr 10 EC @ 75 g a.i./ha (2.23 mites/sq.cm/leaf). However, the treatment with buprofezin 25 SC @ 75 g a.i./ha found least effective with 4.80 mites/sq.cm/leaf.

Fourteen days after spray

From the results it was revealed that, all the acaricidal treatments proved to be effective over untreated control and the mean average survival population of mites ranged from 0.37 to 11.50 mites/sq.cm/leaf at 14 days after spray (Table 5).

Treatment with spiromesifen 22.90 SC @ 96 g a.i./ha found promising in controlling red spider mite population (0.37 mites/sq.cm/leaf) and it was followed by the treatment with fenazaquin 10 EC @ 125 g a.i./ha (0.63 mites/sq.cm/leaf) and propargite 57 EC @ 570 g a.i./ha (0.90 mites/sq.cm/leaf) which were at par with each other. The treatment with abamectin 1.9 EC @ 6 g a.i./ha found to be next promising treatment with 1.33 mites/sq.cm/leaf and followed by the treatments with fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha and chlorfenapyr 10 EC @ 75 g a.i./ha with 1.77, 1.90 and 1.97 mites/sq.cm/leaf, respectively and were at par with each other. Buprofezin 25 SC @ 75 g a.i./ha (5.30 mites/sq.cm/leaf) found superior over untreated control (11.50 mites/sq.cm/leaf).

From the data, it was noticed that mean average survival population of red spider mite on brinjal varied from 0.37 to 11.07 mites/sq.cm/leaf. All the treatments were found statistically significant over untreated control in reducing the mean average survived mites population. The treatment spiromesifen 22.90 SC @ 96 g a.i./ha was found most promising treatment with least average survival population of mite (0.37 mites/sq.cm/leaf) and it was followed by the treatments fenazaquin 10 EC @ 125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha with 0.53 and 1.90 mites/sq.cm/leaf, respectively and were at par with each other. The next best treatments were abamectin 1.9 EC @ 6 g a.i./ha, fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha and chlorfenapyr 10 EC @ 75 g a.i./ha with 1.25, 1.78, 1.92 and 1.99 mean average survived mites/sq.cm/leaf, respectively and which were at par with each other. The treatment buprofezin 25 SC @ 75 g a.i./ha was found least effective (4.88 mites/sq.cm/leaf) but was superior over untreated control which recorded maximum mean average survived mite population of 11.07 mites/sq.cm/leaf.

Data on mean per cent reduction over control showed that, the treatment spiromesifen 22.90 SC @ 96 g a.i./ha recorded highest of 96.69 per cent reduction in average survival population of mites over untreated control. However, the treatments with fenazaquin 10 EC @125 g a.i./ha, propargite 57 EC @ 570 g a.i./ha, fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC, chlorfenapyr 10 EC @ 75 g a.i./ha and buprofezin 25 SC @ 75 g a.i./ha recorded 95.26, 91.87, 88.70, 83.89, 82.68, 82.00 and 55.87 per cent reduction over untreated control, respectively. In the current study, spiromesifen 22.90 SC found most effective treatment in reducing mites population.

The results of the present finding are in conformity with Elbert *et al*. (2005) [3] who reported that, spiromesifen had excellent acaricidal activity against spider mites in vegetables and field crops in the United States. Nauen and Konanz (2005) [6] also reported that, spiromesifen was highly active against the tetranychid mite, *T. urticae* by contact. According to Kavya *et al.* (2015) [4], propargite (0.78 mites/leaf) and spiromesifen (1.05 mites/leaf) significantly reduced the overall mite population, resulting in a higher fruit yield. The present findings are in line with earlier workers.

According to Wale *et al.* (2010) [13] and Patel *et al.* (2017) [7], most effective miticides were fenazaquin and spiromesifen. According to Shukla *et al.* (2018) [10], fenazaquin 10 EC @ 0.01% was most effective in reducing mites population. These findings are nearly identical to the current findings.

Effect of Different Acaricides on Marketable Fruit Yield of Brinjal

The marketable fruit yield of brinjal as influenced by different acaricides is presented in Table 6. The data indicated that, the yield obtained from all the treatments ranged between 11.14 to 16.77 t/ha. Among various acaricidal treatments, significant highest marketable fruit yield (16.77 t/ha) was harvested from the plots sprayed with spiromesifen 22.90 SC @ 96 g a.i./ha, followed by fenazaquin 10 EC @ 125 g a.i./ha (16.37 t/ha) and propargite 57 EC @ 570 g ai/ha (15.61 t/ha) which were at par with each other. Next best treatments were abamectin 1.9 EC @ 6 g a.i./ha, fenpropathrin 30 EC @ 75 g a.i./ha, hexythiazox 5.45 EC @ 25 g a.i./ha and chlorfenapyr 10 EC @ 75 g a.i./ha which recorded 15.27, 14.90, 14.17 and 13.88 t/ha marketable fruit yield of brinjal, respectively.

Buprofezin 25 SC @ 75 g. a.i./ha was found least effective amongst all tested acaricides with 13.57 t/ha marketable fruit yield of brinjal. However, untreated control recorded minimum of 11.14 t/ha marketable fruit yield of brinjal.

According to Patel *et al.* (2017) [7], plots treated with spiromesifen @ 0.02 per cent produced more fruits (37.91 tonnes/ha) than plots treated with fenazaquin @ 0.01 per cent (36.95 tonnes/ha). Shukla *et al.* (2018) [10] reported that, plots treated with fenazaquin 10 EC @ 0.01% had a higher marketable fruit yield of brinjal, followed by propargite 57 EC @ 0.057%. These findings are more or less similar to the present findings.

Incremental Cost Benefit Ratio (ICBR) of Different Acaricidal Treatments on Brinjal

The maximum net profit (Rs. 78230/-) obtained from the treatment with spiromesifen 22.90 SC @ 96 g a.i./ha, followed by fenazaquin 10 EC @ 125 g a.i./ha (Rs. 69850/-) and propargite 57 EC @ 570 g a.i./ha (Rs. 62212/-), abamectin 1.9 EC @ 6 g a.i./ha (Rs. 58990/-), fenpropathrin 30 EC @ 75 g a.i./ha (Rs. 53800/-) and hexythiazox 5.45 EC @ 25 g a.i./ha (Rs. 41230/-). However, the treatment with chlorfenapyr 10 EC @ 75 g a.i./ha (Rs. 34075/-) and buprofezin 25 SC @ 75 g a.i./ha (Rs. 33558/-) showed comparatively less net profit as compared to above treatments.

Results of present findings are in close conformity with Patel *et al.* (2017) [7] and Shukla *et al.* (2018) [10] who reported that, highest net profit was obtained from the treatments with spiromesifen and fenazaquin, respectively.

As regards the Incremental Cost Benefit Ratio (ICBR), the highest ICBR value (1:21.10) was recorded in fenpropathrin 30 EC @ 75 g a.i./ha, followed by propargite 57 EC @ 570 g a.i./ha (1:13.13) and spiromesifen 22.90 SC @ 96 g a.i./ha (1:12.78). Next in order of ICBR were the treatments with buprofezin 25 SC @ 75 g a.i./ha (1:12.02), hexythiazox 5.45

EC @ 25 g a.i./ha (1:10.10), abamectin 1.9 EC @ 6 g a.i./ha (1:8.81) and fenazaquin 10 EC @ 125 g a.i./ha (1:8.22). The least ICBR value was obtained from the treatment with chlorfenapyr 10 EC @ 75 g a.i./ha (1:4.85). Though, the spiromesifen 22.90 SC @ 96 g a.i./ha emerged as most effective against *T. urticae* as well as also registered highest fruit yield with higher net realization, the ICBR was low as compared to fenpropathrin 30 EC @ 75 g a.i./ha and propargite 57 EC @ 570 g a.i./ha and it might be due to very high market price of the acaricide.

Table 3: Field bioefficacy of different acaricides against red spider mite, *T. urticae* on brinjal after first spray

Tr. No.	Treatments	Dose (g a.i./ha)	Number of mites/sq.cm/ leaf/					
			Pre- count	3 DAS**	7 DAS	10 DAS	14 DAS	Mean
1.	Abamectin 1.9 EC	6	7.53 (2.83)*	1.27 (1.33)	1.53 (1.43)	1.80 (1.52)	1.73 (1.49)	1.58 (1.44)
2.	Buprofezin 25 SC	75	6.53 (2.65)	4.73 (2.29)	5.07 (2.36)	5.27 (2.40)	5.73 (2.50)	5.20 (2.39)
3.	Chlorfenapyr 10 EC	75	7.07 (2.75)	2.13 (1.62)	2.47 (1.72)	2.73 (1.80)	2.40 (1.70)	2.43 (1.71)
4.	Fenazaquin 10 EC	125	6.93 (2.73)	0.53 (1.02)	0.60 (1.05)	0.73 (1.11)	0.87 (1.17)	0.68 (1.09)
5.	Fenpropathrin 30 EC	75	7.00 (2.74)	1.93 (1.56)	2.27 (1.66)	2.47(1.72)	2.20 (1.64)	2.22 (1.65)
6.	Hexythiazox 5.45 EC	25	7.07 (2.75)	2.07 (1.60)	2.40 (1.70)	2.60 (1.76)	2.33 (1.68)	2.35 (1.89)
7.	Propargite 57 EC	570	7.47 (2.82)	1.13 (1.28)	1.07 (1.25)	1.27 (1.33)	1.20 (1.30)	1.17 (1.29)
8.	Spiromesifen 22.90 SC	96	7.20 (2.77)	0.47 (0.98)	0.33 (0.91)	0.53 (1.02)	0.40 (0.95)	0.43 (0.97)
9.	Untreated control	-	7.13 (2.76)	9.00 (3.08)	10.87 (3.37)	10.27 (3.28)	10.80 (3.36)	10.23 (3.28)
S. E.(m)±			0.14	0.10	0.15	0.13	0.17	0.14
C. D. at 5%			NS	0.30	0.44	0.39	0.52	0.42

*Figures in the parentheses are ($\sqrt{x+0.5}$) transformations, **DAS-Days after spraying

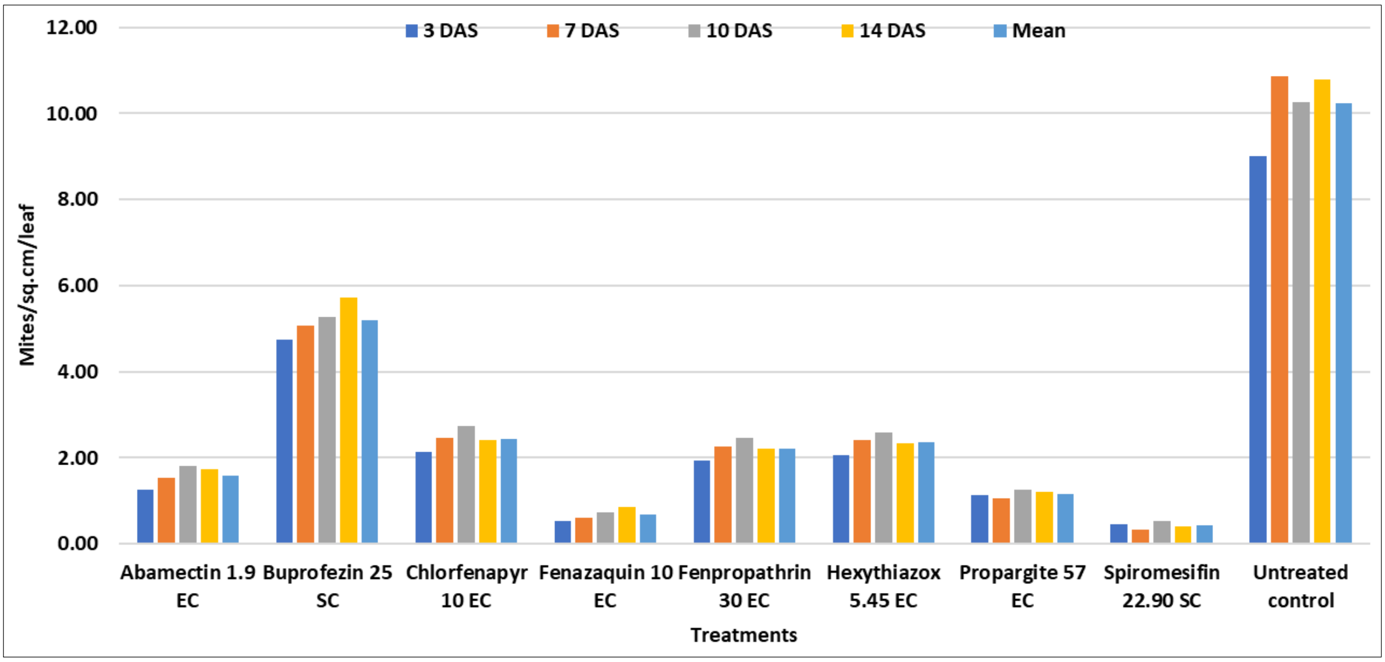

Fig 1: Bioefficacy of different acaricides against red spider mite, *T. urticae* on brinjal after first spray

Table 4: Field bioefficacy of different acaricides against red spider mite, *T. urticae* on brinjal after second spray

Tr. No.	Treatments	Dose (g a.i./ha)	Number of mites/sq.cm/ leaf/				
			3 DAS**	7 DAS	10 DAS	14 DAS	Mean
1.	Abamectin 1.9 EC	6	0.80 (1.14)*	0.87 (1.17)	1.07 (1.25)	0.93 (1.19)	0.91 (1.19)
2.	Buprofezin 25 SC	75	5.20 (2.39)	3.87 (2.09)	4.33 (2.20)	4.87 (2.32)	4.57 (2.25)
3.	Chlorfenapyr 10 EC	75	1.33 (1.32)	1.60 (1.45)	1.73 (1.49)	1.53 (1.43)	1.55 (1.43)
4.	Fenazaquin 10 EC	125	0.27 (0.88)	0.33 (0.91)	0.47 (0.98)	0.40 (0.95)	0.37 (0.93)
5.	Fenpropathrin 30 EC	75	1.20 (1.30)	1.40 (1.38)	1.47 (1.40)	1.33 (1.35)	1.35 (1.36)
6.	Hexythiazox 5.45 EC	25	1.27 (1.33)	1.53 (1.43)	1.67 (1.47)	1.47 (1.40)	1.48 (1.41)
7.	Propargite 57 EC	570	0.53 (1.02)	0.67 (1.08)	0.73 (1.11)	0.60 (1.05)	0.63 (1.06)
8.	Spiromesifen 22.90 SC	96	0.20 (0.84)	0.27 (0.88)	0.40 (0.95)	0.33 (0.91)	0.30 (0.89)
9.	Untreated control	-	10.33 (3.29)	12.80 (3.65)	12.27 (3.57)	12.20 (3.56)	11.90 (3.52)
S. E.(m)±			0.06	0.10	0.08	0.09	0.08
C. D. at 5%			0.18	0.30	0.24	0.27	0.24

*Figures in the parentheses are ($\sqrt{x+0.5}$) transformations, **DAS-Days after spraying

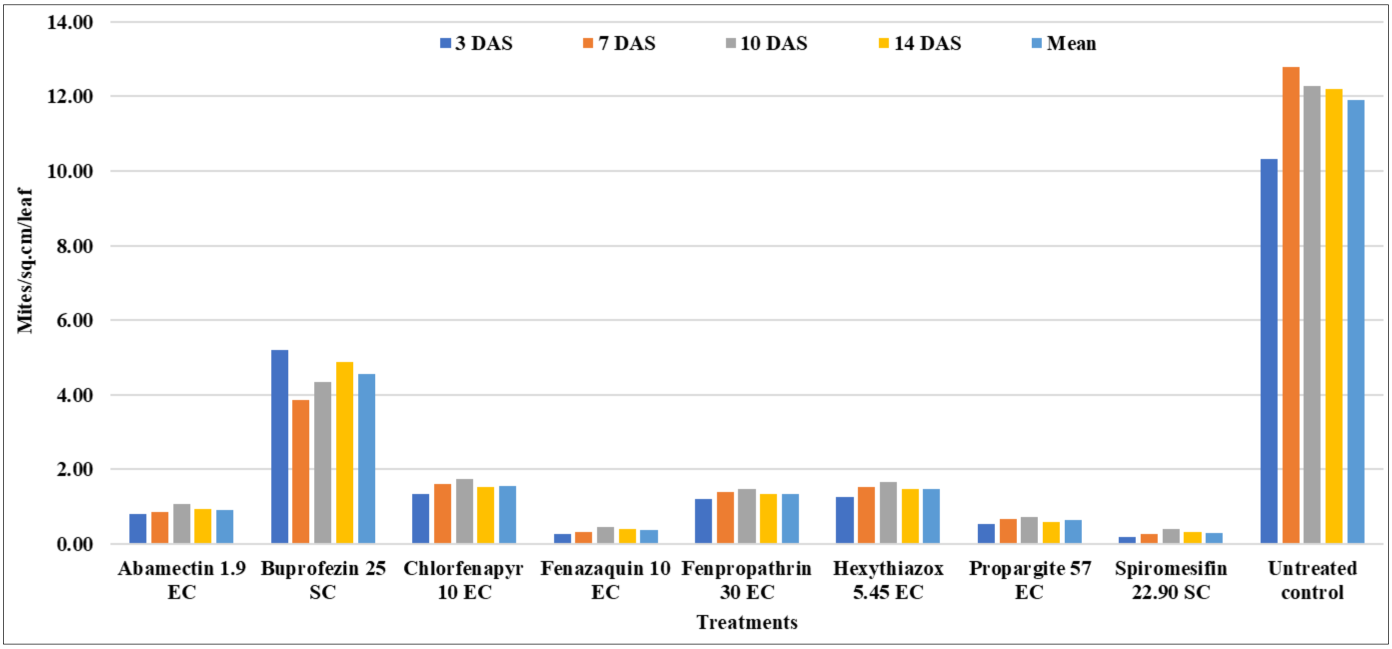

Fig 2: Bioefficacy of different acaricides against red spider mite, *T. urticae* on brinjal after second spray

Table 5: Field bioefficacy of different acaricides against red spider mite, *T. urticae* on brinjal (Pooled mean)

Tr. No	Treatments	Dose (g a.i./ha)	Number of mites/sq.cm/leaf/					Mean per cent reduction over control
			3 DAS**	7 DAS	10 DAS	14 DAS	Mean	
1.	Abamectin 1.9 EC	6	1.03 (1.24)*	1.20 (1.30)	1.43 (1.39)	1.33 (1.35)	1.25 (1.32)	88.70
2.	Buprofezin 25 SC	75	4.97 (2.34)	4.47 (2.23)	4.80 (2.30)	5.30 (2.41)	4.88 (2.32)	55.87
3.	Chlorfenapyr 10 EC	75	1.73 (1.49)	2.03 (1.59)	2.23 (1.65)	1.97 (1.57)	1.99 (1.58)	82.00
4.	Fenazaquin 10 EC	125	0.40 (0.95)	0.47 (0.98)	0.60 (1.05)	0.63 (1.06)	0.53 (1.01)	95.26
5.	Fenpropathrin 30 EC	75	1.57 (1.44)	1.83 (1.53)	1.97 (1.57)	1.77 (1.51)	1.78 (1.51)	83.89
6.	Hexythiazox 5.45 EC	25	1.67 (1.47)	1.97 (1.57)	2.13 (1.62)	1.90 (1.55)	1.92 (1.55)	82.68
7.	Propargite 57 EC	570	0.83 (1.15)	0.87 (1.17)	1.00 (1.22)	0.90 (1.18)	0.90 (1.18)	91.87
8.	Spiromesifen 22.90SC	96	0.33 (0.91)	0.30 (0.89)	0.47 (0.98)	0.37 (0.93)	0.37 (0.93)	96.69
9.	Untreated control	-	9.67 (3.19)	11.83 (3.51)	11.27 (3.43)	11.50 (3.46)	11.07 (3.40)	0.00
S. E.(m)±			0.09	0.13	0.10	0.12	0.11	-
C. D. at 5%			0.27	0.39	0.30	0.36	0.33	-

*Figures in the parentheses are ($\sqrt{x + 0.5}$) transformations, **DAS-Days after spraying

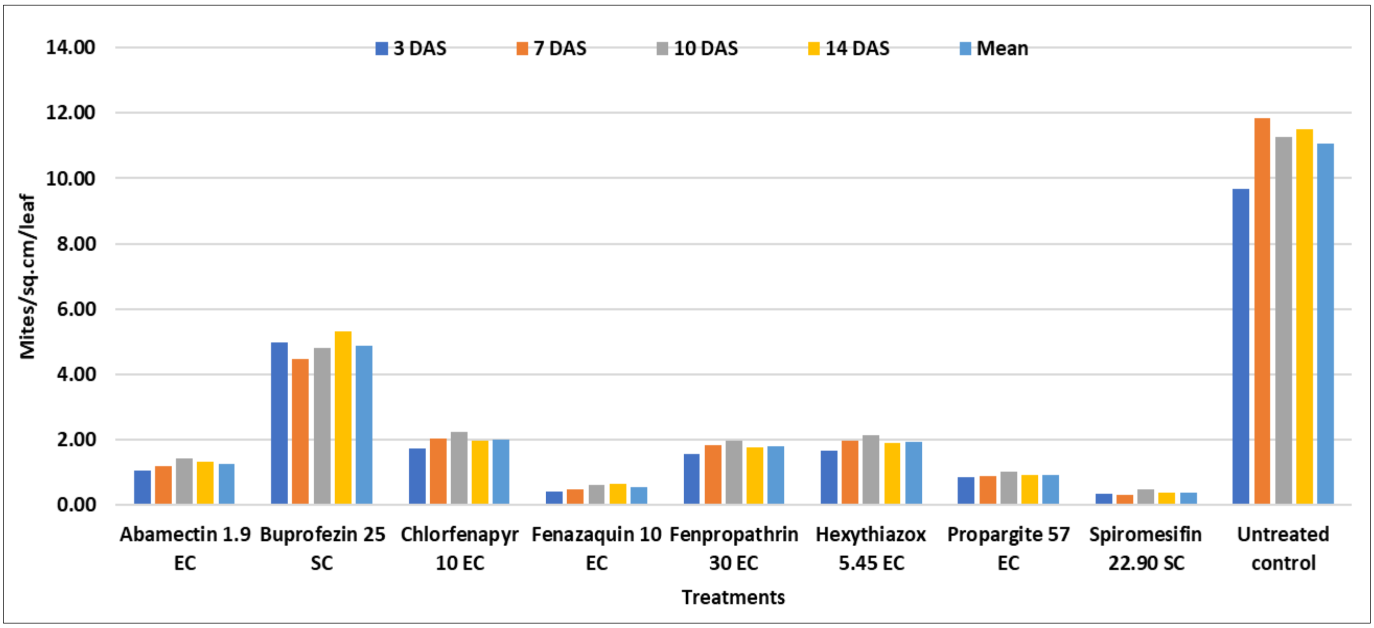

Fig 3: Bioefficacy of different acaricides against red spider mite, *T. urticae* on brinjal (Pooled mean)

Table 6: Effect of different acaricides on marketable fruit yield of brinjal

Tr. No.	Treatments	Dose (g a.i./ha)	Marketable fruit yield (t/ha)	Per cent increase in yield over control
1.	Abamectin 1.9 EC	6	15.27	37.03
2.	Buprofezin 25 SC	75	13.57	21.75
3.	Chlorfenapyr 10 EC	75	13.88	24.59
4.	Fenazaquin 10 EC	125	16.37	46.87
5.	Fenpropathrin 30 EC	75	14.90	33.71
6.	Hexythiazox 5.45 EC	25	14.17	27.13
7.	Propargite 57 EC	570	15.61	40.05
8.	Spiromesifen 22.90 SC	96	16.77	50.46
9.	Untreated control	-	11.14	0.00
	S.E. ±	-	0.49	-
	C.D. at 5%	-	1.47	-

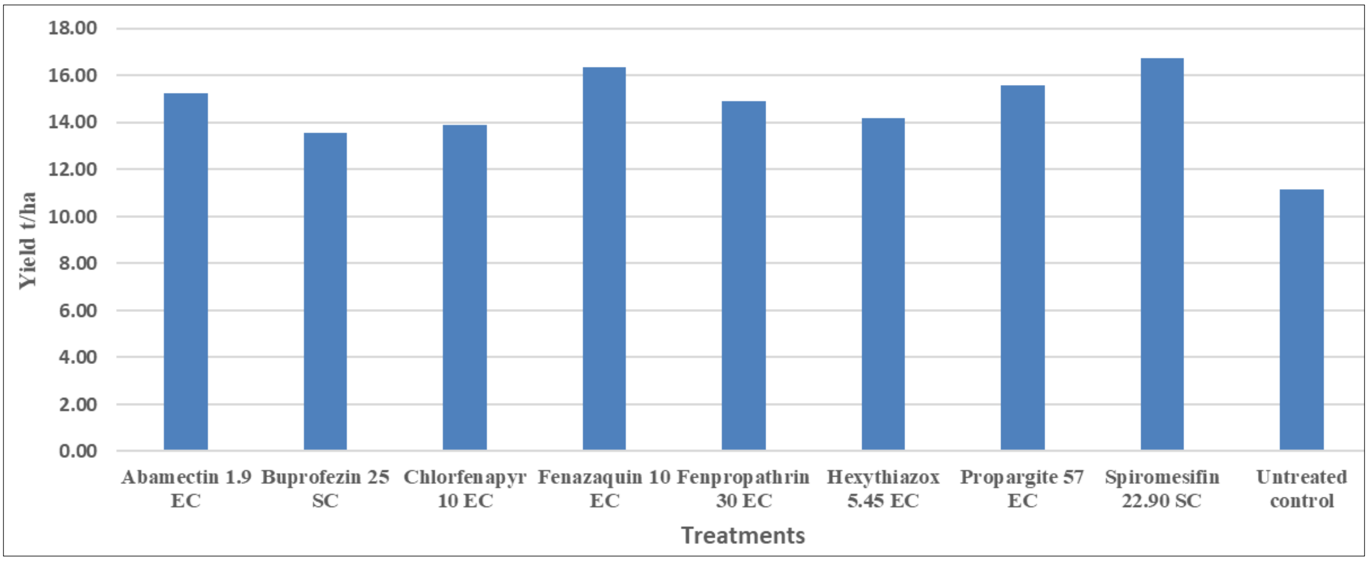

Fig 4: Effect of different acaricides on marketable fruit yield of brinjal

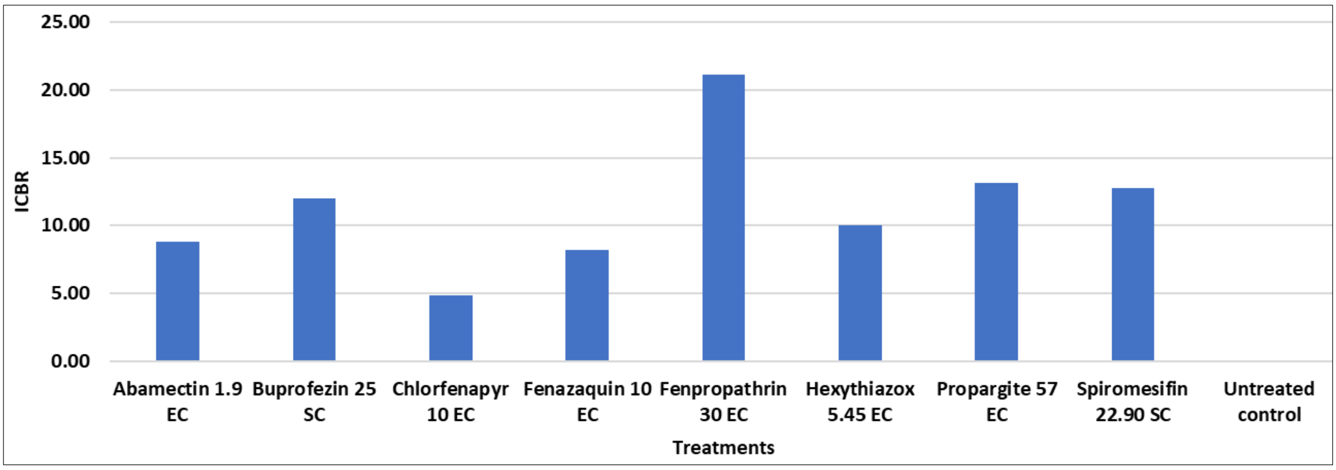

Fig 5: Incremental Cost Benefit Ratio (ICBR) of Different Acaricides on Brinjal

Table 7: Economics of different treatments in brinjal crop

Tr. No.	Treatments	Dose (g a.i./ha)	Quantity of acaricide (g or ml / ha/application)	Yield (t/ha)	Increase in yield over control (t/ha)	Value of increase in yield over control (Rs./ha)	Treatment cost for 2 application (Rs./ha)	Net profit (Rs.)	ICBR
1	Abamectin 1.9 EC	6	315	15.27	4.13	61900	6309	55590	1:8.81
2	Buprofezin 25 SC	75	300	13.57	2.42	36350	2792	33558	1:12.02
3	Chlorfenapyr 10 EC	75	750	13.88	2.74	41100	7025	34075	1:4.85
4	Fenazaquin 10 EC	125	1250	16.37	5.22	78350	8500	69850	1:8.22
5	Fenpropathrin 30 EC	75	250	14.90	3.76	56350	2550	53800	1:21.10
6	Hexythiazox 5.45 EC	25	500	14.17	3.02	45350	4120	41230	1:10.10
7	Propargite 57 EC	570	1000	15.61	4.46	66950	4738	62212	1:13.13

8	Spiromesifen 22.90 SC	96	400	16.77	5.62	84350	6120	78230	1:12.78
9	Untreated control	-	-	11.14	0.00	0.00	-	-	-

Where,1. Labour charges: Rs. 1000 / spray / ha 2. Market rate of brinjal Rs.15/Kg.
Cost of acaricides: 1. Abamectin 1.9 EC @Rs. 6840/- per L 2. Buprofezin 25 SC @Rs.1320/- per kg 3. Chlorfenpyr 10 EC @Rs.3350/- per L 4. Fenazaquin 10 EC @Rs.2600/- per L 5. Fenpropathrin 30 EC @Rs.1100/- per L 6. Hexythiazox 5.45 EC @Rs.2120/- per L 7. Propargite 57 EC @ Rs.1369/- per L 8. Spiromesifen 22.90 SC @ Rs.5150/- per kg.

Conclusion
Treatment spiromesifen 22.90 SC @ 96 g a.i./ha was found most promising with minimum average survival population of mites (0.37 mites/sq.cm/leaf) and was followed by the treatments with fenazaquin 10 EC @ 125 g a.i./ha and propargite 57 EC @ 570 g a.i./ha with 0.53 and 1.90 mites/sq.cm/leaf, respectively which were at par with each other. The treatment spiromesifen 22.90 SC @ 96 g a.i./ha also recorded highest of 96.69 per cent reduction in average survival population of mites over untreated control. Highest marketable fruit yield of brinjal (16.77 t/ha) was harvested from the plots treated with spiromesifen 22.90 SC @ 96 g a.i./ha, followed by fenazaquin 10 EC @ 125 g a.i./ha (16.37 t/ha) and propargite 57 EC @ 570 g a.i./ha (15.61 t/ha) which were at par with each other. Highest ICBR (1:21.10) value was registered inthe treatment with fenpropathrin 30 EC @ 75 g a.i./ha followed by propargite 57 EC @ 570 g a.i./ha (1:13.13) and spiromesifen 22.90 SC @ 96 g a.i./ha (1:12.78).

Acknowledgement
Authers are thankful to Head of Department, Agricultural Entomology, Post Graduate Institute, MPKV, Rahuri for providing the necessary facilities for research work.

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