*Original Research Article*

**Efficacy of synthetic, botanical and microbial pesticides against *Tetranychus urticae* Koch ~~in~~ infesting okra under field condition**


**Abstracts:**

Okra is the most important vegetable crop of the tropical and subtropical regions of the world. To investigate on efficient management of *Tetranychus urticae* Koch infesting okra, synthetic, botanical and microbial pesticides were used in a study established in 2021 and 2022 ~~The present investigation was carried out in 2021 and 2022 the efficacy of synthetic, botanical and microbial pesticides against phytophagous mite, *Tetranychus urticae* Koch. on okra crop under field condition.~~ The crop was treated with propargite (57 EC), clofentazine (50 SC), cyflumetofen (20 SC), fenpyroximate (5 EC), dicofol (18.5% EC), azadirachtin (0.03%), NSKE (5%), neem oil (98%, *Paeciomyces fumosoroseus* (EC) and *Paeciomyces fumosoroseus* (dust). The data evaluate the efficacy of pretreatment, 1, 3, 7 and 14$^{th}$ day after treatment. Overall clofentazine (89.96%) was found effective to control ~~The overall performances in the pooled data clofentazine (89.96%) was found highest per cent reduction in the~~ mite population followed by cyflumetofen (81.04%), fenpyroximate (77.56%), propargite (73.96%), dicofol (71.87%) in synthetic group. In botanical and microbial pesticides NSKE (52.32%) was found effective ~~highest mite population reduction~~ followed by azadirachtin (46.52%), neem oil (37.96%), *Paeciomyces fumosoroseus* 1x10$^9$ dust (31.47%) and *Paeciomyces fumosoroseus* 1x10$^9$ EC (27.95%), respectively. All the treatments are shows significant difference at five per cent probability level. Thus farmers can use such pesticides to reduce mite population in Okra fields.



***Keyword:*** Phytophagous mite, okra, synthetic acaricides, botanical and microbial pesticides


**Introduction:**

During recent years the mite damage to the vegetable crops has been recognized as one of the limiting factor for attaining increased productivity of the vegetables throughout the country (ChannaBasavanna, 1981 ~~and;~~ Singh, 1994). A study revealed mites can cause losses on vegetable production from 2-35% in eastern part of India ~~Reported losses of vegetable~~

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~~production from 2 to 35% in eastern part of India is due to mites~~ (Singh, 1995). Farmers have started realizing the harmful effect of mite infestation on their crop (Anonymous, 1991). The damage caused by many species is very obvious but very limited effort has been made to document the severity of mite problem with changes in agriculture scenario and compound nature of atmosphere.

To control ~~For controlling of the~~ spider mite, *Tetranychus urticae* Koch many acaricides are used. Acaricides affect the environment due to their long residual effect and in some case acaricides resistance has also been developed. Fortunately, the acaricide resistance has not much developed so far due to their limited use. In India only dicofol has been reported as resistant acaricides (Jhansi Rani and Sridhar, 2002; Sridhar and Jhansi Rani, 2003). New cropping pattern in recent years has identified *Tentanychus urticae* ~~have been identified~~ to be the most harmful pest to okra ~~crop~~ in different parts of country. Okra and other vegetables were found to be worst suffered by the attack of this mite in Jaunpur, Uttar and Pradesh. To provide an effective control measure against the pest, this study was then established. The results of the current study will provide to farmers effective pesticides to manage *Tetranychus urticae* in Okra. ~~Therefore, an experiment was conducted on the efficacy of synthetic, botanical and microbial pesticides on okra.~~

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**Materials and Methods:**

The field trial was conducted against two spotted mite population on okra crop variety 'Avantika' at Pili kothi Farm, T. D. P.G. C~~c~~ollege, Jaunpur. The commercial grade formulation of pesticides Propargite 57 EC, Clofentazine 50 SC, Cyflumetofen 20 SC, Fenpyroximate 5 EC, Dicofol 18.5 EC, Azadirachtin 0.03 EC, NSKE, Neem oil, and *Paecilomyces fumosaroseus* (EC). *Paecilomyces famosoroseus* (Dust) were tested at their recommended dose as foliar spray.

**Spraying**

The eleven pesticides including control plot (water) ~~was~~ were sprayed with the help of knapsack power sprayer. The sprays were done early morning or late evening when there was little wind, and the temperature was cool. Besides all the precautions for using pesticides were read from https://ipm.ucanr.edu/GENERAL/precautions.html. The spraying was done when mites were at their peak population. During spray, cloth screen was used to avoid drifting from

**Comment [Ntambo1]:** Should be done when they reached their threshold? What their threshold?

plot to plot. The amount of pesticides proprietary ingredient required was calculated by using the following formula:

$$A = \frac{B \times C}{D}$$

Where,

A = Amount of acaricides and botanicals in grams / ml.

B = Desired concentration.

C = Amount of spray fluid required.

D = Per cent toxicants in formulation.

The proprietary ingredient so determined was mixed with 1 liter of water and sprayed on plants. The actual amount of toxicant and water required to spray is given in table.

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**Observations**

The observations were recorded from five plants selected from each plot, tagged and numbered. Three leaves from each tagged plant were plucked from upper, middle, and lower part and total of three leaves were collected from each plant and 15 leaves from each plot for observations. Collected leaves were kept in polythene bags and brought to laboratory. The mite population was counted on the basis of 2 $cm^2$ leaf area at three spots per leaf with the help of stereoscopic binocular microscope on 1 day before (pre treatment) and after 1, 3, 7 and 14 days of spraying. The data regarding reduction in mite population in field experiment was calculated using following formula:

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

**Statistical analysis**

The percent reduction values were transformed to arcsine values before subjecting to analysis of variance to discriminate the treatment effect. The significant difference between treatments was judged by CD at 5% level of significance.

**Results and Discussion:**

The efficacy of certain synthetic, botanical and microbial pesticides was taken for this trail against phytophagous mite, *Tetranychus urticae* Koch on okra variety 'Avantika' at Pili

Kothi Farm, Tilak Dhari Post Graduate college, Jaunpur during 2021 and 2022. The crop was treated with propargite (57 EC), clofentazine (50 SC), cyflumetofen (20 SC), fenpyroximate (5 EC), dicofol (18.5% EC), azadirachtin (0.03%), NSKE (5%), neem oil (98%, *Paeciomyces fumosoroseus* (EC) and *Paeciomyces fumosoroseus* (dust). The data evaluate the efficacy of pretreatment, 1, 3, 7 and 14$^{th}$ day after treatment. The treatment also included plants sprayed with water and untreated plants in order to study the efficacy of water spray as well.

**Comment [Ntambo3]:** Describe the results and discuss them. What is this? Isn't it in MM section?

~~It is evident from table 1 and fig. 1 during~~During 2021 growing season ~~the~~the study revealed that the increase ~~results that the increase~~ in mite mortality is statistically significant at 5 per cent probability level in comparison to unsprayed control. Even the water spray alone reduced the mite population by 17.35 per cent maximum after first day of treatment. Following one day ~~After one day~~ of treatment, clofentazine 50 SC was found to be effective (80.85%) followed by ~~highest mite population reduction (80.85%) fallowed by~~ propargite 57 EC (78.50%), fenpyroximate 5 EC (75.35%), dicofol 18.5 EC (74.65%) and cyflumetofen 20 SC (70.54%) in synthetic acaricides., ~~but~~Among the botanical and microbial pesticides the most effective were ~~highest population reduction found in~~ azadirachtin 0.03% (53.72%) fallowed by NSKE 5% (45.34%), neem oil (31.45%), *Paeciomyces fumosoroseus* 1x10$^{9}$ dust (17.72%), respectively. These were effective compared to water spray treatment. ~~had significant effect when compared to water spray treatment.~~ However, after 3, 7 and 14 days ~~In third day, seventh day and fourteen days~~ after treatment some synthetic acaricides sequence has change for mite population reduction. Clofentazine 50 SC (92.85%) was found to be the best in managing mite population ~~highest mite population reduction (92.85%)~~ fallowed by cyflumetofen 20 SC, fenpyroximate 5 EC, dicofol 18.5 EC and propargite 57 EC *i.e.* 82.36%, 80.55%, 77.26% and 75.41%, respectively in third day after spray. NSKE 5% showed highest (54.46%) significant mite population reduction in ~~group of~~ botanical and microbial pesticides groups followed by azadirachtin 0.03% (46.93%), neem oil, (36.68%), *Paeciomyces fumosoroseus* 1x10$^{9}$ EC (13.83%) and *Paeciomyces fumosoroseus* 1x10$^{9}$ dust (13.72%) after third day spray. ~~Same~~ similar pattern is shown in seventh and fourteen days after the treatment. In these days only ~~in~~ botanical and microbial pesticides ~~are~~ were showing ~~showing~~ little bit changes, but almost effect are same as the third day. The average performance of synthetic acaricides, botanical and microbial pesticides are as highest mite population reduction in clofentazine 50 SC (91.31%) followed by cyflumetofen 20 SC, fenpyroximate 5 EC, propargite 57 EC, dicofol 18.5 EC,

NSKE 5%, azadirachtin 0.03%, neem oil, *Paeciomyces fumosoroseus* 1x$10^9$ dust and *Paeciomyces fumosoroseus* 1x$10^9$ EC i.e. 81.92%, 78.70%, 74.86%, 73.60%, 55.17%, 48.27%, 39.34%, 29.33% and 25.04%, respectively in compression to control (water spray 12.42%). In general the clofentazine 50 SC ~~shows~~ showed better performance in synthetic group and NSKE 5% in botanical and microbial group of ~~pesticides and~~pesticides and all significantly different at five per cent (Table 1, Fig 1)~~.~~

In 2022 ~~Same trails are repeated in year 2022 on same mite same crop. S~~synthetic acaricides, botanical and microbial pesticides ~~are~~ were used at same concentrations and same intervals. ~~In table 2 and fig. 2 A~~after one day spray of synthetic, botanicals and microbial pesticides the dicofol 18.5 EC shows (77.03%) best performance followed by fenpyroximate 5 EC (76.01%), clofentazine 50 SC (71.30%), propargite 57 EC (71.17%) and cyflumetofen 20 SC (67.95%) in synthetic group. NSKE 5% (44.98%) and azadirachtin 0.03% (44.91%) is found at par highest mite population reduction followed by neem oil (30.31%), *Paeciomyces fumosoroseus* 1x$10^9$ dust (25.76%) and *Paeciomyces fumosoroseus* 1x$10^9$ EC (24.11%) in botanical and microbial group. In third days after treatments pesticides performance sequence are changed. Clofentazine 50 SC has showed highest mite population reduction (92.61%) fallowed by cyflumentofen 20 SC, propargite 57 EC, fenpyroximate 5 EC and dicofol 18.5 EC *i.e.* 84.60%, 81.12%, 80.89% and 75.19% in synthetic group and NSKE 5% which is found 54.64% mite population reduction followed by azadirachtin 0.03%, neem oil, *Paeciomyces fumosoroseus* 1x$10^9$ dust and *Paeciomyces fumosoroseus* 1x$10^9$ EC *i.e.* 45.29%, 36.46%, 22.77% and 21.67%, respectively in botanical and microbial group in compression to control (14.87%). The order of performance is very much similar after seventh and fourteen days after treatments, but in microbial pesticides *Paeciomyces fumosoroseus* 1x$10^9$ dust (48.34%) shows good performance followed by *Paeciomyces fumosoroseus* 1x$10^9$ EC (43.22%) after fourteenth days of spray. In general average overall performance of clofentazine 50 SC is the best (88.60%) followed by cyflumetofen 20 SC, fenpyroximate 5 EC, propargite 57 EC, dicofol 18.5 EC, NSKE 5%, azadirachtin 0.03%, neem oil, *Paeciomyces fumosoroseus* 1x$10^9$ dust and *Paeciomyces fumosoroseus* 1x$10^9$ EC i.e. 80.17%, 76.43%, 73.07%, 70.13%, 49.46%, 44.78%, 36.57%, 33.61% and 30.86%, respectively reduction in mite population in compression of control (water spray) which is 13.26% (Table 2; Fig 2). All synthetic acaricides, botanical and microbial pesticides show statistically significant at five per cent probability level. Result was

supported by Kumar *et al*. (2009), Kumari (2011) supported result of maximum per cent reduction was recorded with fenazaquin (Magister 10EC) @ 400ml/ha (85.63%) followed by propargite (Omite 57EC) @1000ml/ha (83.61%) and dicofol (Kelthane 18.5EC) @ 1000 ml/ha (82.67%), Singh *et al*. (2014) reported the comparative bio-efficacy of clofentezine 50 SC along with acaricides cyflumetofen 20 SC, fenpyroximate 5 EC, propargite 57 EC and dicofol 18.5 EC, including bio pesticides azadirachtin 0.03 EC, NSKE 5%, neem oil and mycopathogen *Paeciomyces fumosoroseus* ($1x10^9$) is used as a form of foliar spray and dust was evaluated against *Tetranychus urticae* on okra. Clofentezine 50 SC (89.94%) was most effective in controlling *Tetranychus urticae* on okra and Singh *et al*. (2017) found 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 performance observed below 50%. Among the bio-pesticides used the *Paeciomyces fumosoroseus* ($1x10^9$) EC formulations caused greeter per cent reduction of egg (23.60%), immature stages (24.47%) and adult female mites (27.89%) than WP formulation, which was good in controlling adult male population (30.16%).

**Comment [Ntambo4]:** Please find more studies to support your findings . why did you use only Kumar et al., 2009 and Singh et al., 2014? Read more papers to support your study

**Conclusion:**

The study showed that Clofentazine (50 SC) was found to be very effective in the management of *Tetranychus urticae* Koch in the synthetic acaricides and botanical and microbial pesticides gave also encouraging response in the management of the pest. ~~It is thus, concluded that the overall performance of our investigation use of synthetic, botanical and microbial pesticides tested against spider mite *Tetranychus urticae* Koch on okra, clofentazine (50 SC) was found to very much effective as synthetic acaricides, and botanical and microbial pesticide gave encouraging response.~~

**References:**

Kumari S., Bhullar M. B. and Kaur P. 2011. Efficacy of acaricides, biopesticides and mineral oil against two-spotted spider mite, *Tetranychus urticae* Koch on okra. *Journal of Research.* 48 (3 and 4):136-139.

Kumar, S. V., Chinniah, C., Muthiah, C. and Sadasakthi, A., 2009. Bio-regional in the management of two spotted spider mite *Tetranychus urticae* Koch in brinjal. *Karnataka Journal of Agricultural Sciences*, 22(3): 682-684.

Singh, S. K., Singh, A. P., and Singh, R. N. 2014, November. Comparative bio efficacy of bio pesticides and new molecules of acaricides in the management of Tetranychus urticae Koch (Acari: tetranychidae) in Okra. In *Proceedings of National Congress on Harmony with Nature in Context of Environmental Issues and Challenges of the 21 st Century*: 28-30.

Singh, S. K., Sathua, S. K., Singh, R. N. and Singh, A. P. 2017. Evaluation of certain synthetic acaricides, botanicals and bio-pesticides against life stages of two spotted spider mite (T. urticae Koch) under poly-house condition. *International Journal of Current Microbiology and Applied Sciences*, 6: 586-594.

Anonymous. 1991. Mites of agricultural importance in India and their management *Technology Bulletin* No.1, *All India Coordinated Research Project on Agricultural Acarology*, UAS, Bangalore, p. 18.

ChannaBasavanna, G. P. 1981. Contribution to acarology in India, *Acarological Society of India Bangalore*, 256.

Jhansi Rani, B. and Sridhar, V. 2002. Efficacy of new formulations of dicofol and sulphur against two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) Kaur. Paramjit & Dhooria.Manjit & Bhullar. Manmeet, Screening of rose (Rosa 3 on rose in polyhouse. *Pestology*, 26: 37-38.

Singh, R. N. 1994. Mites menace on vegetable crops in India. *Shashpa*, 1 (2): 59 - 74.

Singh, R.N. 1995. Mites of deciduous fruits and vegetables of Eastern Part of India and their economic status. *Advanced Agricultural Research, India*, 3: 179 - 193.

Sridhar, V. and Jhansi Rani, B. 2003. Relative susceptibility in open and greenhouse populations of two-spotted spider mite *Tetranychus urticae* Koch on Rose to dicofol, *Resistant Pest Management Newsletter*, 12: 83.

**Table-1: Comparative bio efficacy of synthetic acaricides, botanical and microbial pesticides in the management of *Tetranychus urticae* (Koch) on okra during 2021**

| Bio-pesticides & Acaricides | Mean Pre-spraying population 2 $cm^2$ area | Mean percent reduction in mite population day after spraying | | | | Mean |
|---|---|---|---|---|---|---|
| | | 1 DAS | 3 DAS | 7 DAS | 14 DAS | |
| Propargite 57EC | 18.64 | 78.50 (62.38) | 75.41 (60.27) | 73.75 (59.18) | 71.79 (57.92) | 74.86 (59.91) |
| Clofentazine 50SC | 20.31 | 80.85* (64.05)** | 92.85 (74.49) | 95.09 (77.49) | 96.45 (79.15) | 91.31 (72.86) |
| Cyflumetofen 20SC | 16.31 | 70.54 (57.13) | 82.36 (65.36) | 83.34 (65.91) | 91.43 (72.98) | 81.92 (64.83) |
| Fenpyroximate 5EC | 21.60 | 75.35 (60.23) | 80.55 (63.83) | 80.98 (64.15) | 77.92 (61.97) | 78.70 (62.51) |
| Dicofol 18.5 EC | 20.06 | 74.65 (59.77) | 77.26 (61.52) | 73.25 (58.85) | 69.26 (56.33) | 73.60 (59.08) |
| Azadirachtin 0.03% EC | 21.97 | 53.72 (47.13) | 46.93 (43.24) | 51.75 (46.00) | 40.68 (39.63) | 48.27 (44.01) |
| NSKE 5% | 23.17 | 45.34 (42.33) | 54.46 (47.56) | 67.59 (55.30) | 53.29 (46.89) | 55.17 (47.97) |
| Neem oil | 22.85 | 31.45 (34.11) | 36.68 (37.27) | 46.21 (42.83) | 43.01 (40.98) | 39.34 (38.84) |
| *Paeciomyces fumosoroseus* ($1x10^9$) (EC) | 22.15 | 16.58 (24.03) | 13.83 (21.83) | 31.24 (33.98) | 38.49 (38.35) | 25.04 (30.02) |
| *Paeciomyces fumosoroseus* ($1x10^9$) (Dust) | 20.95 | 17.72 (24.90) | 13.72 (21.74) | 43.36 (41.19) | 42.52 (40.70) | 29.33 (32.79) |
| Control (Water Spray) | 20.96 | 17.35 (24.62) | 12.98 (21.11) | 10.34 (18.75) | 9.02 (17.47) | 12.42 (20.64) |
| **S.E m±** | 2.06 | **8.57** | **8.63** | **3.58** | **1.97** | **4.68** |
| **CD at 5%** | **NS** | **17.46** | **17.57** | **7.29** | **4.02** | **9.53** |

***Mean of three replication each replication consist of 15 leaves drawn randomly from five plant, **Figures in parentheses are Arcsin transformation values.**

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**Table- 2: Comparative bio efficacy of synthetic acaricides, botanical and microbial pesticides in the management of *Tetranychus urticae* (Koch) on okra during 2022**

| Bio-pesticides & Acaricides | Mean Pre-spraying population 2 $cm^2$ area | Mean percent reduction in mite population day after spraying | | | | Mean |
|---|---|---|---|---|---|---|
| | | 1 DAS | 3 DAS | 7 DAS | 14 DAS | |
| Propargite 57EC | 18.64 | 71.17 (57.52) | 81.12 (64.25) | 76.99 (61.34) | 62.99 (52.53) | 73.07 (58.74) |
| Clofentazine 50SC | 20.31 | 71.30* (57.61)** | 92.61 (74.23) | 95.88 (78.28) | 94.61 (76.58) | 88.60 (70.27) |
| Cyflumetofen 20SC | 16.31 | 67.95 (55.52) | 84.60 (66.89) | 85.24 (67.41) | 82.88 (65.56) | 80.17 (63.56) |
| Fenpyroximate 5EC | 21.60 | 76.01 (60.67) | 80.89 (64.08) | 77.28 (61.53) | 71.54 (57.76) | 76.43 (60.95) |
| Dicofol 18.5 EC | 20.06 | 77.03 (61.37) | 75.19 (60.12) | 76.63 (61.09) | 51.68 (45.96) | 70.13 (56.87) |
| Azadirachtin 0.03% EC | 21.97 | 44.91 (42.08) | 45.29 (42.30) | 46.04 (42.73) | 42.87 (40.90) | 44.78 (42.00) |
| NSKE 5% | 23.17 | 44.98 (42.12) | 54.64 (47.66) | 56.10 (48.50) | 42.14 (40.48) | 49.46 (44.69) |
| Neem oil | 22.85 | 30.31 (33.40) | 36.46 (37.14) | 41.59 (40.16) | 37.94 (38.02) | 36.57 (37.21) |
| *Paeciomyces fumosoroseus* ($1x10^9$) (EC) | 22.15 | 24.11 (29.41) | 21.67 (27.74) | 34.43 (35.93) | 43.22 (41.11) | 30.86 (33.75) |
| *Paeciomyces fumosoroseus* ($1x10^9$) (Dust) | 20.95 | 25.76 (30.50) | 22.77 (28.50) | 37.55 (37.79) | 48.34 (44.05) | 33.61 (35.43) |
| Control (Water Spray) | 20.96 | 21.04 (27.31) | 14.87 (22.68) | 10.67 (19.07) | 6.46 (14.72) | 13.26 (21.36) |
| **S.E m±** | 0.93 | **2.66** | **2.15** | **1.38** | **1.21** | **1.22** |
| **CD at 5%** | **1.88** | **5.41** | **4.38** | **2.81** | **2.46** | **2.48** |

***Mean of three replication each replication consist of 15 leaves drawn randomly from five plant, **Figures in parentheses are Arcsin transformation values**

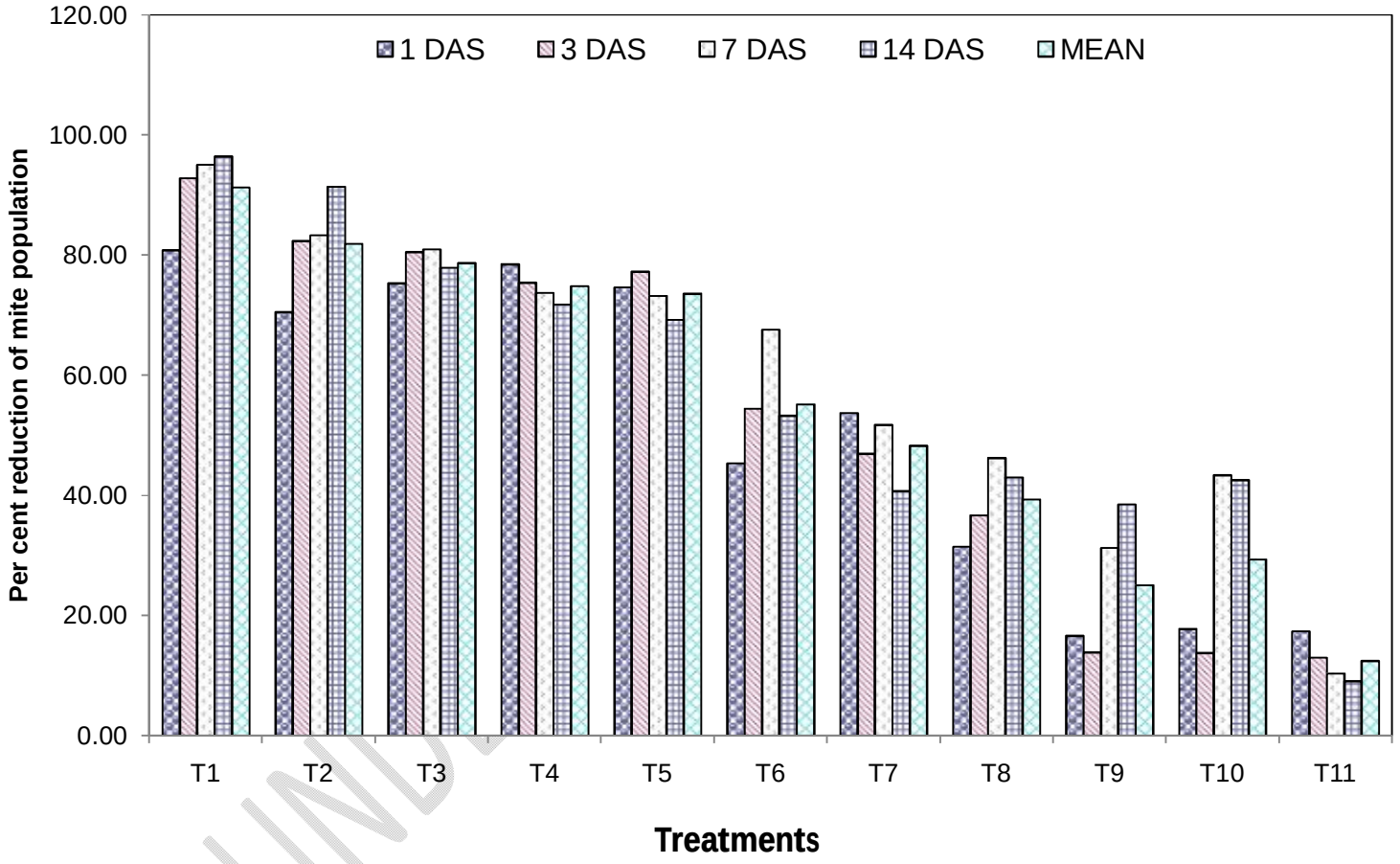


**Fig. 1: Comparative bio efficacy of synthetic acaricides, botanical and microbial pesticides in the management of *T. urticae* (Koch) on okra during 2021**

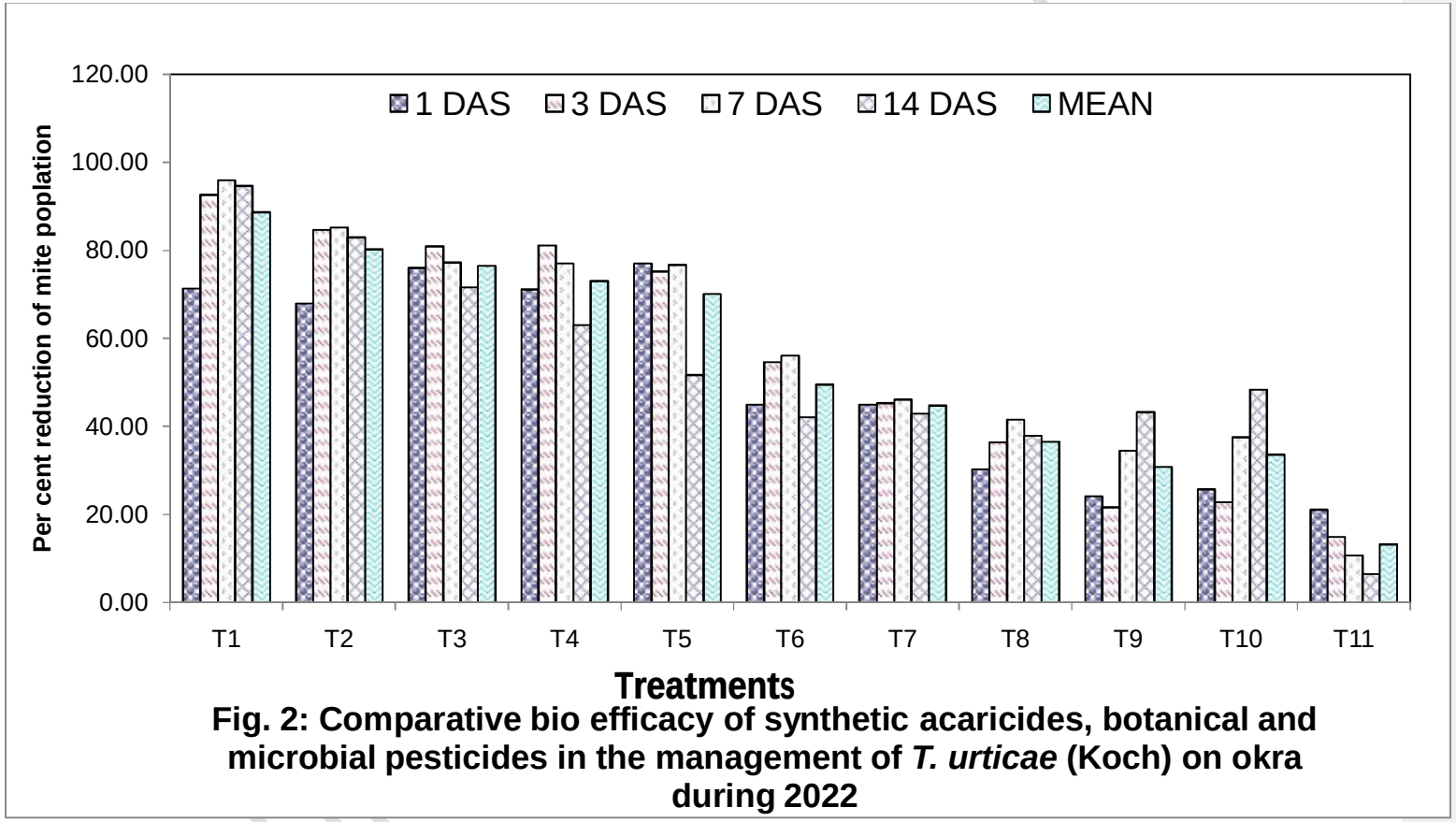


**Fig. 2: Comparative bio efficacy of synthetic acaricides, botanical and microbial pesticides in the management of *T. urticae* (Koch) on okra during 2022**