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POPULATION DYNAMICS OF SPIDER MITE, *Tetranychus urticae* KOCH ON BRINJAL UNDER ORGANIC AND CONVENTIONAL PRODUCTION SYSTEMS

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ABSTRACT

The present study evaluated the population dynamics of the spider mite, *Tetranychus urticae* Koch under organic and conventional brinjal production systems over four consecutive summer seasons (2022–2025) at Navsari, Gujarat, India infesting brinjal. Seasonal population dynamics were assessed using weekly mean density, peak population and area under the pest population curve (AUPPC). The organic production system supported significantly lower spider mite, *T. urticae* populations throughout the cropping period than the conventional system. The seasonal mean mite density was 3.09 ± 0.90 mites per plant under organic cultivation compared with 3.97 ± 0.91 mites per plant under conventional cultivation. Similarly, the AUPPC was lower in the organic system (40.21 ± 11.96 mite-weeks per plant) than in the conventional system (52.88 ± 12.31 mite-weeks per plant), representing reductions of 22.21% and 23.96%, respectively. The peak spider mite abundance was also lower and occurred one week later under organic cultivation (3.87 mites/plant at 17th SMW) than under conventional cultivation (4.98 mites/plant at 16th SMW). Across all four seasons, the organic production system consistently recorded lower AUPPC values with annual reductions ranging from 13.87% to 47.29% relative to the conventional system. These findings demonstrate that organic crop management suppresses the seasonal abundance and cumulative population pressure of spider mite, *T. urticae* in brinjal, thereby contributing to sustainable mite management and reducing the risk of economically damaging infestations.

Key words : Area under the pest population curve (AUPPC), Brinjal, Cultivation system, Organic, Conventional, Population dynamics, Standard meteorological week, Spider mite.

Introduction

Brinjal (*Solanum melongena* L.) is attacked by several phytophagous mite species, although the composition and relative abundance of the mite complex vary across agroecological regions. Field surveys have documented three phytophagous mite species infesting brinjal in Kerala and two tetranychid species in Himachal Pradesh. Among these, *Tetranychus urticae* Koch has been identified as the predominant plant-feeding mite in Kerala and Gujarat, while it is regarded as one of the most destructive mite pests of brinjal in various parts of India (Binisha and Bhaskar, 2013; Shukla *et al.*, 2017; Singh *et al.*, 2024). Spider mite, *T. urticae* feeds primarily

on the undersurface of leaves by piercing epidermal cells and extracting mesophyll cell contents. This feeding results in the development of characteristic chlorotic stippling, which progressively coalesces into yellowing or bronzing of the foliage. Under severe infestations, extensive leaf injury leads to desiccation, premature leaf senescence and defoliation. The destruction of photosynthetically active tissues significantly reduces chlorophyll content, impairs net photosynthetic efficiency and adversely affects plant growth and productivity. Consequently, heavy infestations of spider mite, *T. urticae* can substantially decrease both fruit number and fruit weight, leading to considerable economic losses in brinjal

cultivation (Park and Lee, 2002 and Meck *et al.*, 2013). The population dynamics of spider mite, *T. urticae* vary considerably across brinjal-growing regions and production systems due to differences in climatic conditions, cropping practices and cultivation environments. The peak population densities have been reported during the 11th standard meteorological week (SMW) in Coimbatore, the 18th SMW in Navsari, early June in North Bihar and during several spring weeks under protected cultivation (Monica *et al.*, 2014; Mahendrakumar and Shukla, 2016; Rao *et al.*, 2018; Kumar *et al.*, 2024). While these studies identify periods of maximum infestation, the occurrence of a single population peak does not adequately represent the overall pest pressure experienced by the crop throughout the growing season. In contrast, cumulative insect-day indices, which integrate both pest density and the duration of infestation, provide a more robust and biologically meaningful measure of seasonal pest pressure. By accounting for the cumulative feeding intensity over time, insect-day indices offer a more accurate assessment of pest impact and facilitate improved evaluation of crop losses and pest management strategies (Ruppel, 1983). Crop management practices play a crucial role in influencing the population dynamics of spider mite, *T. urticae* by altering host plant nutritional quality and the crop microenvironment. Enhanced nitrogen availability has been reported to accelerate mite development, increase fecundity and promote rapid population growth, thereby increasing the risk of severe infestations. In contrast, cropping systems based on organic nutrient management or organic production practices generally support lower spider mite populations, likely due to improved plant resistance, reduced tissue nitrogen levels and greater abundance of natural enemies (Wermelinger *et al.*, 1985; Alizade *et al.*, 2016; Hata *et al.*, 2019; Jacobsen *et al.*, 2019). However, the long-term effects of organic and conventional crop management practices, implemented as complete production systems, on the seasonal population dynamics of spider mite, *T. urticae* have not been systematically evaluated under the agro-climatic conditions of South Gujarat. Addressing this knowledge gap is essential for developing sustainable mite pest management strategies tailored to the region. Accordingly, the present study was undertaken to quantify the weekly population dynamics, seasonal mean density, peak population period and area under the pest progress curve (AUPPC) of spider mite, *T. urticae* under organic and conventional brinjal production systems. The study was conducted over four consecutive summer seasons to determine the influence of contrasting cropping systems

on the seasonal abundance and cumulative pest pressure of spider mite, *T. urticae* under the agro-climatic conditions of South Gujarat.

Materials and Methods

Study site and experimental design

The field experiment was conducted at the Agronomy Farm of Navsari Agricultural University, Navsari, Gujarat, India, over four consecutive summer seasons from 2022 to 2025. The brinjal cultivar Gujarat Round Brinjal-10 (GRB-10) was cultivated under organic and conventional production systems in separate experimental plots measuring 20 m × 20 m. Healthy seedlings were transplanted at a spacing of 45 cm × 30 cm following the recommended agronomic practices for each production system.

The experimental treatments consisted of two contrasting crop management systems—organic and conventional—implemented as complete crop-management packages. Each package comprised an integrated set of agronomic practices, including land preparation, nursery and seed treatment, nutrient management and weed management, in accordance with the respective production protocols. Details of the management practices followed under each production system are presented in Table 1.

Sampling and mite enumeration

The population density of spider mite, *T. urticae* was recorded at weekly intervals from the 3-4 leaf stage until the final harvest of the crop. On each observation date, 25 plants were selected at random from each production system. From each selected plant, one fully expanded leaf was collected separately from the upper, middle, and lower canopy. Leaf samples were transported to the laboratory, where mite populations were assessed under a stereo binocular microscope. The number of motile stages of *T. urticae* present within a 2 cm² leaf area was recorded for each leaf. The counts obtained from the three canopy levels were summed to estimate the mite density per plant and the mean population was calculated from the 25 sampled plants for each observation date.

Data analysis

Data analysis was restricted to standard meteorological weeks (SMW) 8–21, the sampling period common to all four experimental seasons. For each production system, the weekly mite population for an individual year was calculated as the mean population per plant based on observations from 25 randomly selected plants. To characterize the overall seasonal population dynamics, pooled weekly mean densities were calculated

Table 1 : Management practices implemented in organic and conventional brinjal cultivation during 2022-2025.

Component	Organic system	Conventional system
Land preparation	Summer deep ploughing followed by soil solarization	Conventional ploughing followed by harrowing
Nursery and seed treatment	Seed treatment with <i>Trichoderma viride</i> 1.5% WP @ 10 g kg ⁻¹ seed; seedling root dip in <i>Pseudomonas fluorescens</i> 2% suspension for 20 min before transplanting	Seed treatment with thiram or carbendazim @ 2 g kg ⁻¹ seed; nursery beds drenched with carbendazim
Transplanting	Thirty- to thirty-five-day-old seedlings transplanted at a spacing of 45 cm × 30 cm	Thirty- to thirty-five-day-old seedlings transplanted at a spacing of 45 cm × 30 cm
Nutrients	Farmyard manure (FYM) @ 25 t ha ⁻¹ + vermicompost @ 5 t ha ⁻¹ + neem cake @ 250 kg ha ⁻¹ + biofertilizer inoculation with <i>Azotobacter</i> and phosphate-solubilizing bacteria (PSB)	Recommended fertilizer dose of 100:50:50 kg NPK ha ⁻¹ , with nitrogen applied in three split doses, supplemented with FYM @ 20 t ha ⁻¹
Weed control	Hand weeding at 20 and 40 days after transplanting (DAT) combined with paddy-straw mulch @ 5 t ha ⁻¹	Pre-transplant application of pendimethalin 30% EC @ 1.0 kg a.i. ha ⁻¹ followed by one hand weeding at 40 DAT

by averaging the corresponding weekly values across the four consecutive years. The associated standard errors were computed using the annual means ($n = 4$) and are presented to describe year-to-year variability in mite populations under each production system.

For each system and year, AUPPC was estimated by trapezoidal integration across SMW 8-21 following Ruppel (1983):

$$\text{AUPPC} = \sum_{i=1}^{n-1} [(Y_i + Y_{i+1})/2] \times (t_{i+1} - t_i)$$

where, Y_i and Y_{i+1} were mite populations recorded at two successive observations and $t_{i+1} - t_i$ was the interval between those observations.

Annual seasonal means and AUPPC values were compared between cultivation systems using two-tailed paired t-tests, with year as the pairing unit ($n = 4$). Statistical significance was assessed at $P \leq 0.05$. Percentage reduction under organic cultivation was calculated as

$$\text{Reduction (\%)} = [(\text{Conventional value} - \text{Organic value}) / \text{Conventional value}] \times 100$$

Results and Discussion

Weekly population dynamics: The seasonal population dynamics of spider mite, *T. urticae* were similar under both production systems during 8th SMW, but diverged thereafter, with consistently lower mite densities under organic cultivation from 9th SMW to 21st SMW (Fig. 1). In the organic production system, the spider mite population declined to a minimum of 2.42 mites per plant at 13th SMW before increasing gradually to a peak of 3.87 mites per plant at 17th SMW, followed by a

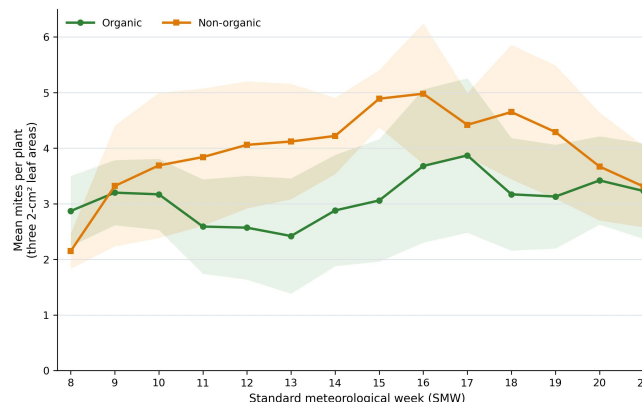


Fig. 1 : Four-year mean population dynamics of spider mite, *T. urticae* on brinjal under organic and conventional cultivation during 8th to 21st SMW. Points are means and shaded bands represent $\pm$ SE across years ($n = 4$).

subsequent decline toward the end of the season. In contrast, the spider mite population under the conventional production system increased steadily, reaching 4.89 mites per plant at 15th SMW and peaking at 4.98 mites per plant during 16th SMW before declining to 3.31 mites per plant by 21st SMW. On a leaf-area basis, the maximum population density was 1.29 mites per 2 cm² leaf area under the organic system compared with 1.66 mites per 2 cm² leaf area under the conventional system, representing a 22.3% lower peak density under organic cultivation.

Seasonal mean density and cumulative pressure: Seasonal mean population density of spider mite, *T. urticae* was significantly lower under the organic production system than under the conventional system (Table 2). The organic system recorded a seasonal mean

Table 2 : Population of spider mite, *T. urticae* under organic and conventional brinjal cultivation (Pooled).

System	Seasonal mean (mites/plant)	AUPPC (mite-weeks/plant)	Peak density (mites/plant)	Peak SMW(s)	Mean reduction (%)	AUPPC reduction (%)
Organic	3.09 ± 0.90	40.21 ± 11.96	3.87	17	22.21	23.96
Conventional	3.97 ± 0.91	52.88 ± 12.31	4.98	16	Baseline	Baseline

Note: Values are mean ± SE across four years. Each density and AUPPC value is based on the plant total from three 2-cm² leaf areas. Paired comparisons used year as the pairing unit (n = 4; df = 3).

of 3.09±0.90 mites per plant, whereas the conventional system averaged 3.97±0.91 mites per plant, representing a 22.21% reduction in seasonal mite abundance. Similarly, cumulative pest pressure, expressed as the area under the pest population progress curve (AUPPC) was significantly lower under organic cultivation (40.21 ± 11.96 mite-weeks per plant) than under conventional cultivation (52.88 ± 12.31 mite-weeks per plant), corresponding to a 23.96% reduction. Paired comparisons of annual means confirmed that both the seasonal mean spider mite population ($t=-3.664$, $df=3$, $P=0.035$) and AUPPC ($t=-4.044$, $df=3$, $P=0.027$) were significantly lower under the organic production system than under the conventional system.

Interannual consistency : Interannual trends in spider mite, *T. urticae* population dynamics were consistent across the two production systems, although the magnitude of infestation varied among years (Table 3). In every experimental season, both the seasonal mean spider mite population and the area under the pest population progress curve (AUPPC) were lower under the organic production system than under the conventional system. The annual reduction in AUPPC under organic cultivation ranged from 13.87% in 2023 to 47.29% in 2024 indicating substantial year-to-year variation in the effectiveness of the production system. The greatest divergence in cumulative spider mite population occurred during 2024, when the AUPPC was 22.60 mite-weeks per plant under organic cultivation compared with 42.88 mite-weeks per plant under conventional cultivation. A similar pattern was observed in 2025, with corresponding AUPPC values of 75.50 and 89.68 mite-weeks per plant under organic and conventional production systems, respectively. These results demonstrate that the organic production system consistently suppressed seasonal mite population pressure across years despite variations in overall infestation intensity.

The present study clearly demonstrated that both the weekly population density and seasonal population accumulation of spider mite, *T. urticae* were consistently lower under the organic production system than under

the conventional production system. Although, spider mite populations were comparable during the initial sampling period (SMW 8), the population trajectories diverged thereafter, with organic cultivation maintaining lower spider mite densities throughout the remainder of the season. This resulted in a 23.96% reduction in the area under the pest population progress curve (AUPPC) and lower cumulative spider mite populations were consistently observed under the organic system across all four experimental years. These findings are consistent with previous reports indicating reduced *T. urticae* abundance under organic production systems. Jacobsen *et al.* (2019) reported significantly lower populations of *T. urticae* in organically managed strawberry fields than in conventionally managed systems. Similarly, Hata *et al.* (2019) observed greater mite infestations on strawberry plants receiving mineral fertilizers compared with those grown under organic compost-based nutrient management. Collectively, these studies support the view that organic crop management can suppress spider mite populations and reduce seasonal pest pressure relative to conventional production systems.

The present findings indicate that the significant differences in *T. urticae* population between the organic and conventional production systems cannot be attributed to any single management practice. Rather, the observed reduction in spider mite abundance under organic cultivation appears to result from the cumulative effects of the entire crop management package, including land preparation, seed and nursery treatment, nutrient management and weed management practices. Among these components, differences in fertilizer and nutrient management are likely to have played a major role in influencing spider mite population dynamics. Organic nutrient sources generally promote balanced plant growth and gradual nutrient release, whereas readily available mineral nitrogen in conventional systems may enhance host plant suitability for phytophagous mites by increasing tissue nutritional quality. The present results are in agreement with previous studies demonstrating the influence of nutrient management on spider mite populations. Wermelinger *et al.* (1985) reported that

Table 3 : Annual population metrics of spider mite, *T. urticae* under organic and conventional brinjal cultivation during 2022–2025 (8–21 SMW).

Year	Organic mean (mites/plant)	Conventional mean (mites/plant)	Organic AUPPC (mite-weeks/plant)	Conventional AUPPC (mite-weeks/plant)	AUPPC reduction (%)
2022	2.34	3.10	29.96	40.90	26.75
2023	2.54	2.87	32.78	38.06	13.87
2024	1.73	3.21	22.60	42.88	47.29
2025	5.75	6.71	75.50	89.68	15.81

nitrogen fertilization accelerated the development and reproductive performance of *T. urticae*, while Alizade *et al.* (2016) observed increased population growth with increasing nitrogen availability. Likewise, Hata *et al.* (2019) found significantly higher *T. urticae* abundance on mineral-fertilized strawberry plants than on organically fertilized plants, even when foliar nitrogen concentrations were comparable. These findings collectively suggest that nutrient management is a key determinant of *T. urticae* population dynamics and may largely explain the lower seasonal spider mite populations observed under the organic production system in the present study.

The peak populations of spider mite, *T. urticae* occurred during 16th SMW under the conventional production system and 17th SMW under the organic production system, indicating that organic crop management delayed peak infestation by approximately one week. These observations are consistent with previous reports from western India, where peak mite populations were recorded during 18th SMW at Navsari (Mahendrakumar and Shukla, 2016) and between 15th to 18th SMW under protected cultivation (Kumar *et al.*, 2024). In contrast, earlier population peaks have been reported during 11th SMW in Coimbatore and early June in North Bihar, while studies conducted during the post-rainy season documented peak infestations during 41st to 43rd SMW (Monica *et al.*, 2014; Rao *et al.*, 2018; Patidar *et al.*, 2023). These regional and seasonal variations suggest that the timing of peak *T. urticae* abundance is strongly influenced by crop season, host phenology, prevailing climatic conditions and local agroecosystem characteristics. Notably, the present study demonstrates that, in addition to these environmental influences, the cropping system itself can modify population dynamics by delaying the occurrence of peak infestation with the organic production system shifting the population peak by approximately one week relative to the conventional system. This delay, coupled with lower peak density may contribute to reduced cumulative pest pressure and lower crop damage under organic cultivation.

The maximum spider mite, *T. urticae* populations recorded in the present study were lower than those reported in several previous investigations on brinjal. Earlier studies have documented peak populations ranging from 5.19 to 5.85 mites cm⁻² under field and screen-house conditions, 6.91 mites cm⁻² in North Bihar and as high as 23.47 and 38.42 mites per 2 cm² leaf area at Navsari and Coimbatore, respectively (Monica *et al.*, 2014; Mahendrakumar and Shukla, 2016; Sonika *et al.*, 2017; Rao *et al.*, 2018). However, direct comparison of absolute population densities among studies should be interpreted with caution because estimates are influenced by differences in sampling methodology, including the leaf area examined, canopy position, crop growth stage, cropping season, environmental conditions and production system. Despite these methodological differences, the use of a standardized sampling protocol throughout the present study enabled a reliable comparison between the two production systems. Under identical sampling conditions, the organic production system consistently exhibited a lower peak spider mite population and reduced cumulative population pressure than the conventional production system, demonstrating the suppressive effect of organic crop management on spider mite, *T. urticae* abundance.

Paired comparisons of annual data demonstrated that the cropping system significantly influenced both the seasonal mean population density and the area under the pest population progress curve (AUPPC) of spider mite, *T. urticae*. Although the analysis was based on four annual observations and the magnitude of the response varied among seasons, the direction of the response was remarkably consistent. The organic production system recorded lower AUPPC values in every year, with annual reductions ranging from 13.87% to 47.29% relative to the conventional production system. These findings indicate that the suppressive effect of organic crop management on spider mite populations was stable across years despite seasonal fluctuations in infestation intensity. Furthermore, the consistent reduction in AUPPC

highlights the value of cumulative population indices over single peak population estimates for assessing seasonal pest pressure. Unlike peak density, which reflects only the maximum level of infestation, AUPPC integrates both the intensity and duration of pest occurrence, thereby providing a more comprehensive measure of crop exposure to pest feeding and potential economic damage (Ruppel, 1983; Kumral and Kovanci, 2005).

Conclusion

Based on four consecutive summer seasons, the organic production system consistently suppressed spider mite, *T. urticae* populations in brinjal compared with the conventional production system. Organic cultivation reduced the seasonal mean mite density and the area under the pest population progress curve (AUPPC) by 22.21% and 23.96%, respectively. In addition, peak mite density was lower and occurred one week later under organic management than under conventional cultivation. Although the intensity of mite infestation varied among years, the direction of the response remained consistent, with lower seasonal mite populations and cumulative pest pressure recorded under the organic production system in every season. These findings demonstrate that organic crop management provides a more effective and consistent approach for suppressing spider mite, *T. urticae* populations than conventional cultivation and can contribute to sustainable spider mite management in brinjal production.

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References

- Alizade, M., Hosseini M., Modarres A.M., Goldani M. and Hosseini A. (2016). Effects of nitrogen fertilization on population growth of two-spotted spider mite. *Systematic and Applied Acarology*, **21**(7), 947-956.
- Binisha, K.V. and Bhaskar H. (2013). Mite fauna associated with major vegetable crops of Thrissur district, Kerala. *Entomon*, **38**(1), 47-52.
- Hata, F.T., Ventura M.U., de Souza M.S.J., de Sousa N.V., Oliveira B.G. and da Silva J.B. (2019). Mineral and organic fertilization affects *Tetranychus urticae*, pseudofruit production and leaf nutrient content in strawberry. *Phytoparasitica*, **47**, 513-521.
- Jacobsen, S.K., Moraes G.J., Sørensen H. and Sigsgaard L. (2019). Organic cropping practice decreases pest abundance and positively influences predator-prey interactions. *Agricult., Ecosyst. Environ.*, **27**(2), 1-9.
- Kumar, D., Kaur P. and Bhullar M.B. (2024). Seasonal incidence of *Tetranychus urticae* Koch on brinjal under protected cultivation. *Indian J. Entomol.*, **86**(4), 1293-1295.
- Kumral, N.A. and Kovanci B. (2005). Seasonal population dynamics of the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), under acaricide constraint on eggplant in Bursa Province (Turkey). *Acarologia*, **45**(4), 295-301.
- Mahendrakumar, B.N. and Shukla A. (2016). Population dynamics of spider mite, *Tetranychus urticae* Koch, infesting brinjal. *J. Exp. Zool.*, **19**(2), 995-998.
- Meck, E.D., Kennedy G.G. and Walgenbach J. F. (2013). Effect of *Tetranychus urticae* (Acari: Tetranychidae) on yield, quality and economics of tomato production. *Crop Protection*, **52**, 84-90.
- Monica, V.L., Kumar A., Chand H., Paswan S. and Kumar S. (2014). Population dynamics of *Tetranychus urticae* Koch on brinjal crop under north Bihar conditions. *Pest Manage. Hortic. Ecosyst.*, **20**(1), 47-49.
- Park, Y.L. and Lee J.H. (2002). Leaf cell and tissue damage of cucumber caused by twospotted spider mite (Acari: Tetranychidae). *J. Econ. Entomol.*, **95**(5), 952-957.
- Patidar, R., Chundawat G.S., Pippal S.S. and Tomar S.P. S. (2023). Effect of abiotic factors on the population dynamics of red spider mite, *Tetranychus urticae* Koch, of brinjal in Malwa region, Madhya Pradesh, India. *Int. J. Environ. Clim. Change*, **13**(11), 889-895.
- Rao, K.S., Vishnupriya R., Ramaraju K. and Poornima K. (2018). Effect of abiotic factors on the population dynamics of two spotted spider mite, *Tetranychus urticae* Koch and its predatory mite, *Neoseiulus longispinosus* (Evans), in brinjal ecosystem. *J. Exp. Zool.*, **21**(2), 797-800.
- Ruppel, R.F. (1983). Cumulative insect-days as an index of crop protection. *J. Economic Entomol.*, **76**(2), 375-377.
- Shukla, A., Radadia G.G. and Hadiya G.D. (2017). Estimation of loss due to two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), infesting brinjal. *Int. J. Curr. Microbiol. Appl. Sci.*, **6**(9), 2145-2150.
- Singh, V., Chauhan U. and Rana V.K. (2024). Diversity of phytophagous and predatory mites in vegetable crops in Himachal Pradesh, India. *J. Biological Control*, **38**(1), 51-59.
- Sonika, Gulati R. and Jangra M. (2017). Incidence of *Tetranychus urticae* Koch on brinjal under field and screen house conditions. *Emerg. Life Sci. Res.*, **3**(2), 16-22.
- Wermelinger, B., Oertli J.J. and Delucchi V. (1985). Effect of host plant nitrogen fertilization on the biology of the two-spotted spider mite, *Tetranychus urticae*. *Entomologia Experimentalis et Applicata*, **38**, 23-28.