IMPACT OF TWO-SPOTTED SPIDER MITE (TETRANYCHUS URTICAE KOCH) INFESTATION LEVELS ON GROWTH METRICS AND YIELD OF SUMMER APPLE CULTIVARS

Rahmanov Ahliddin Xabibullayevich

Assistent of the Tashkent State Agrarian University

email: a.raxmonov@tdau.uz

https://orcid.org/0000-0002-9791-4452

Abstract: This study investigates the effects of varying populations of two-spotted spider mites (Tetranychus urticae Koch) on the growth parameters and yield of summer apple cultivars. Field experiments were conducted to measure the impact of mite infestations at different density levels on leaf chlorophyll content, fruit growth, leaf area, and overall yield. Results demonstrated significant negative correlations between mite populations and apple growth metrics. High mite densities severely decreased leaf chlorophyll content, leaf area, and fruit size, subsequently reducing overall yield. Effective mite management strategies are necessary to maintain optimal apple production levels.

Keywords: tetranychus urticae koch, apple yield, spider mite infestation, leaf chlorophyll, fruit growth, pest management.

Introduction: Apple (Malus domestica Borkh.) is among the most economically important fruit crops worldwide, providing nutritional benefits and supporting agricultural economies. However, apple production faces numerous challenges due to biotic and abiotic stress factors. Among the biotic factors, arthropod pests represent significant threats, causing considerable damage and economic losses in orchards globally. In particular, the two-spotted spider mite (Tetranychus urticae Koch), a widespread polyphagous pest, has increasingly become problematic for apple growers due to its rapid reproductive capacity, adaptability, and resistance to chemical control measures (Van Leeuwen et al., 2015; Dermauw et al., 2018).

Two-spotted spider mites primarily damage apple trees by feeding on the chlorophyll-rich cells of leaf tissues, leading to direct and indirect adverse effects on plant health and productivity. The feeding activity disrupts photosynthetic processes, resulting in leaf discoloration, premature leaf senescence, and reduced leaf area, ultimately impairing the plant's overall growth and fruit development. Recent studies have highlighted the rapid evolution of resistance in Tetranychus urticae populations to commonly used acaricides, emphasizing the necessity for integrated pest management (IPM) approaches combining chemical, biological, and cultural practices to sustainably manage mite populations (Attia et al., 2021; Guedes et al., 2020).

Managing two-spotted spider mite infestations typically involves integrated pest management (IPM), including biological control agents such as predatory mites like Phytoseiulus persimilis and Neoseiulus californicus, selective acaricide applications, and cultural practices aimed at reducing pest populations (Monteiro et al., 2018; Hoy, 2020). Additionally, recent advancements emphasize the potential use of novel, environmentally friendly acaricides derived from natural products and biopesticides as effective tools for managing resistant mite populations (Kumar et al., 2022).

Understanding the relationship between mite infestation levels and apple tree responses, such as leaf chlorophyll content, leaf area, fruit growth, and overall yield, is crucial for developing effective and sustainable management practices. Therefore, the objective of this study was to examine the impacts of varying infestation densities of Tetranychus urticae Koch on critical apple growth parameters and yield, providing essential insights to inform targeted management decisions in apple production.

Figure.1 A-Typical red hybrid F1 females of Tetranychus urticae obtained when crossing GF and RF ; B-rare red with pinkish glow F1 females.

Materials and Methods:

The field experiments were conducted over two consecutive years (2021-2022) in a mature summer apple orchard located in a temperate climate region. Apple cultivars selected for the study were uniform in age and agronomic practices, ensuring consistency across treatments. A randomized complete block design (RCBD) with three replications was implemented to enhance statistical validity (Rana et al., 2021).

Experimental trees were divided into four groups: control (no mites), low (50-100 mites per leaf), medium (101-300 mites per leaf), and high (>300 mites per leaf) infestation densities. Spider mite densities were established using standardized laboratory-cultured mite populations, as described in recent methodologies by Attia et al. (2021). The population density of Tetranychus urticae Koch was assessed bi-weekly through precise leaf sampling techniques involving microscopic examinations and visual counts (Kumar et al., 2022).

Leaf chlorophyll content was quantified using a portable chlorophyll meter (SPAD-502, Minolta Camera Co., Japan) on ten randomly selected leaves per tree from mid-canopy height, following protocols validated by recent studies (Monteiro et al., 2018). Fruit diameter measurements were obtained bi-weekly using digital calipers, and leaf area was determined using an advanced leaf area meter (LI-3100C, LI-COR Biosciences, Lincoln, Nebraska, USA). At harvest, the total yield per tree was meticulously recorded by weighing marketable fruits, adhering to recent guidelines for yield measurement in apple orchards (Hoy, 2020).

Collected data were statistically analyzed using analysis of variance (ANOVA), and significant differences between means were assessed using Tukey's HSD test at $p \leq 0.05$, in alignment with current statistical best practices (Guedes et al., 2020).

Table-1

Table: Spider Mite (Tetranychus urticae) Management Strategies

Management Strategy	**Description**	**References**
Integrated Pest Management (IPM)	Combines biological, chemical, and cultural practices to sustainably manage spider mite populations and resistance	Attia et al., 2021; Guedes et al., 2020
Biological Control	Utilization of predatory mites such as Phytoseiulus persimilis and Neoseiulus californicus to effectively control spider mite populations	Hoy, 2020; Monteiro et al., 2018
Botanical Acaricides	Use of environmentally friendly, plant-derived acaricides as alternatives to synthetic chemicals	Kumar et al., 2022
Genome-Based Management	Development of resistance management strategies based on genomic studies to enhance effectiveness and sustainability	Van Leeuwen et al., 2015

Resistance Monitoring	Regular monitoring and analysis of resistance mechanisms to guide effective management strategies and acaricide use	Dermauw et al., 2018
Statistical and Experimental Designs	Implementation of precise experimental designs and statistical methods to evaluate and optimize pest management practices	Rana et al., 2021

Results: Significant variations were observed across all measured parameters in response to different mite infestation levels. Leaf chlorophyll content was notably reduced with increasing mite density, with mean chlorophyll levels declining by approximately 15% at low infestation, 30% at medium infestation, and 45% at high infestation compared to the control group ($p \leq 0.05$). Leaf area followed a similar trend, decreasing by an average of 10% in low, 25% in medium, and 40% in high mite density groups relative to controls.

Fruit growth metrics were significantly impacted, with fruit diameter reductions of 8%, 18%, and 30% observed in low, medium, and high infestation treatments, respectively. Overall yield per tree sharply declined in correlation with infestation intensity, resulting in yield losses of approximately 12% at low infestation levels, 25% at medium levels, and up to 50% at high infestation levels compared to control treatments ($p \leq 0.05$). These results align with recent studies emphasizing the severe impacts of Tetranychus urticae infestations on apple production (Monteiro et al., 2018; Attia et al., 2021; Kumar et al., 2022).

Conclusion: The study clearly demonstrates that increased populations of Tetranychus urticae Koch significantly impair key apple growth metrics, including leaf chlorophyll content, leaf area, fruit size, and overall yield. These findings underscore the importance of effective and sustainable integrated pest management (IPM) practices, particularly the use of biological control agents, novel acaricides, and cultural management techniques. Adoption of these strategies is essential for minimizing the detrimental impacts of spider mite infestations, ultimately securing apple productivity, quality, and orchard profitability.

References

1. Attia, S., Grissa, K. L., Lognay, G., & Lebdi, K. G. (2021). Acaricide resistance mechanisms and management strategies in Tetranychus urticae. Crop Protection, 140, 105417.
2. Dermauw, W., Van Leeuwen, T., & Feyereisen, R. (2018). Resistance mechanisms and management strategies in spider mites (Acari: Tetranychidae). Annual Review of Entomology, 63, 483-505.
3. Guedes, R. N. C., Roditakis, E., Campos, M. R., Haddi, K., & Bielza, P. (2020). Pesticide resistance in arthropods: Ecology, mechanisms, and management strategies. Insects, 11(12), 877.
4. Hoy, M. A. (2020). Biological Control in Agricultural IPM Systems. CRC Press.
5. Kumar, V., Khan, M. S., Singh, S., & Sharma, A. K. (2022). Eco-friendly management of spider mites (Tetranychus urticae Koch) using botanical acaricides: Recent advances and future prospects. Journal of Environmental Management, 318, 115642.
6. Monteiro, L. B., Oliveira, R. C., Ferreira, M. D., & Silva, R. A. (2018). Biological control of Tetranychus urticae (Acari: Tetranychidae) in apple orchards. Biological Control, 118, 1-7.
7. Rana, R., Sharma, V. K., & Sharma, H. C. (2021). Experimental designs and statistical analyses in horticultural research. Horticultural Reviews, 48, 185-242.
8. Van Leeuwen, T., Dermauw, W., Grbić, M., Tirry, L., & Feyereisen, R. (2015). Spider mite control and resistance management: does a genome help?. Pest Management Science, 71(7), 849-856.