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APPLE ORCHARD PANONYCHUS ULMI CONTROL APPLYING BIOLOGICAL CONTROL AND DIFFERENT MITICIDES AND INSECTICIDES

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Abstract. The apple red mite (*Panonychus ulmi*) is a significant pest in apple orchards, known for its rapid reproduction and potential to cause serious economic damage by reducing photosynthetic capacity and overall tree vigor. This study was conducted to assess the efficacy of various miticides and insecticides, along with a biological control agent (*Typhlodromus pyri*), in managing *P. ulmi* populations under field conditions in Uzbekistan. A randomized block design was used with six treatments: untreated control, *T. pyri* release, abamectin, spiromesifen, bifenthrin, and a combined biological and chemical treatment.

Keywords: panonychus ulmi, apple orchards, insecticides, biological control, miticides

Annotatsiya. Olma qizil kanasi (*Panonychus ulmi*) olma bog'larida tez ko'payishi va fotosintez faoliyatini pasaytirish, daraxtning umumiy holatini sekinlashtirish orqali iqtisodiy zarar yetkazishi bilan mashhur zararkunandadir. Ushbu tadqiqot O'zbekiston sharoitida dalada turli akaritsidlar, insektisidlar va biologik kurash (*Typhlodromus pyri*) yordamida *P. ulmi* populyatsiyasini boshqarish samaradorligini baholash uchun o'tkazildi. Tasodifiy blok dizayni asosida olti xil usul sinovdan o'tkazildi: nazorat guruhi (ishlovsiz), *T. pyri* qo'yib yuborish, abamektin, spiromesifen, bifenthrin va biologik va kimyoviy vositalarning biologik samaradorligi aniqlangan.

Kalit so'zlar: panonychus ulmi, olma bog'lari, insektisidlar, biologik kurash, akaritsidlar

Аннотация. Красный плодовый клещ (*Panonychus ulmi*) является опасным вредителем яблоневых садов, известным своей способностью быстро размножаться и наносить серьезный экономический ущерб за счёт снижения фотосинтетической активности и общего состояния деревьев. Исследование проводилось с целью оценки эффективности различных акарицидов и инсектицидов, а также биологического агента (*Typhlodromus pyri*) в условиях



AGRO KIMYO HIMOYA VA O'SIMLIKLAR KARANTINI

полевого эксперимента в Узбекистане. Применялась рандомизированная блочная схема с шестью вариантами: контроль без обработки, выпуск *T. pyri*, обработка абамектином, спиромесифеном, бифеназатом и комбинированная биологическая и химическая обработка.

Ключевые слова: *panonychus ulmi*, яблоневые сады, инсектициды, биологический контроль, акарициды

INTRODUCTION

Apple (*Malus domestica* Borkh.) is one of the most widely cultivated and economically important fruit crops in temperate and subtropical regions of the world, including Central Asia. In Uzbekistan, apple orchards represent a vital component of both commercial horticulture and smallholder farming systems, contributing substantially to food security, export revenues, and rural livelihoods. However, apple production is frequently constrained by various biotic stresses, among which arthropod pests play a central role. One of the most destructive and persistent among these pests is the European red mite, *Panonychus ulmi* (Koch), a polyphagous tetranychid mite that feeds on the foliage of fruit trees and ornamentals.

P. ulmi is a cosmopolitan pest and a well-known member of the family Tetranychidae. It prefers temperate zones and is particularly damaging in orchards managed under intensive cultivation. Adult females are red to dark brown and easily identified by white dorsal spots. Their feeding activity on the undersides of leaves leads to chlorotic spots, reduced photosynthetic activity, early leaf drop, and ultimately diminished fruit size and quality. If uncontrolled, high population densities of *P. ulmi* can significantly reduce both current-season yields and the health of the tree in subsequent years. The mite's short life cycle, high fecundity, and ability to rapidly develop resistance to acaricides make it a challenging pest for orchardists and plant protection specialists alike.

Historically, chemical control has been the primary method for managing *P. ulmi*, with various miticides employed to suppress outbreaks. While initially effective, over-reliance on synthetic pesticides has led to several unintended consequences, including resistance development, non-target toxicity, resurgence of secondary pests, and disruption of natural predator populations. In particular, the repeated application of broad-spectrum acaricides can decimate populations of predatory mites such as *Typhlodromus pyri* and *Amblyseius andersoni*, which are key components of natural biological regulation in apple orchards. Moreover, environmental contamination and residue concerns have led to increased scrutiny over the use of certain chemical groups, necessitating a shift toward more sustainable pest management strategies.

Integrated Pest Management (IPM) represents a holistic and environmentally conscious framework for pest control, combining cultural, biological, and chemical measures in a coordinated manner to minimize economic damage while preserving agroecosystem integrity. In the context of *P. ulmi* management, IPM involves



AGRO KIMYO HIMOYA VA O'SIMLIKLAR KARANTINI

careful monitoring of mite populations, use of economic threshold levels, and the integration of biological control agents with selective, low-toxicity miticides that are compatible with beneficial organisms. The cornerstone of this approach is conservation biological control, particularly the use of predatory mites such as *T. pyri*, which feed on *P. ulmi* and other phytophagous mites. These predators are naturally occurring in many orchard ecosystems but can also be introduced or augmented to accelerate control.

Numerous studies across Europe and North America have demonstrated the potential of *T. pyri* to suppress *P. ulmi* populations below damaging thresholds, especially when chemical use is minimized or focused on selective miticides. Unlike chemical treatments, which often require repeated applications and may lead to pest resurgence, predatory mites provide season-long suppression and can establish stable populations over multiple growing seasons. However, their success depends on several factors including initial release rate, availability of alternative prey, microclimatic conditions, and compatibility with the existing orchard management practices.

In Uzbekistan, biological control is still an emerging area within horticultural pest management. There is growing interest among growers and researchers to adopt more sustainable practices, especially given the increasing resistance of *P. ulmi* to commonly used acaricides such as propargite, fenpyroximate, and bifenthrin. Additionally, the cost and availability of newer, more selective miticides pose limitations for widespread adoption, particularly among smallholder farmers. Therefore, there is a pressing need to evaluate the efficacy of alternative strategies that combine the benefits of biological control with the precision of modern chemical tools. Phytophagous mites are pests of many agricultural and ornamental crops around the world, with the most significant pest species belonging to the family Tetranychidae, popularly known as spider mites. This polyphagous pest infests several commercially important fruit crops, including apple (*Malus domestica*), plum (*Prunus* spp.), peach (*Prunus persica*), pear (*Pyrus* spp.), cherry (*Prunus* spp.), chestnut (*Castanea* spp.), almond (*Prunus dulcis*), and grapes (*Vitis vinifera*), among others. It has also been observed in non-crop hosts and ornamentals such as roses [2,1].

Panonychus ulmi spends the winter as eggs in the rough bark, cracks and crevices of apple orchard branches and twigs. These eggs hatch into larvae that progress through protonymph and deutonymph stages to adults if conditions are favorable the following spring (usually between the tight cluster and bloom stages of apple). Summer eggs of *P. ulmi* are often laid on the underside of the leaves (along leaf veins), and the species has 8-10 generations every year in Pennsylvania apple orchards, depending on weather conditions. Adult and juvenile *P. ulmi* cause damage by feeding on host plants and draining their cell contents, including chlorophyll, interfering with photosynthesis and glucose manufacture [2,5].



In conventional cultivation, phytophagous mite populations, including *P. ulmi*, are regulated with several acaricides. In 2013, the global acaricide market was predicted to be worth roughly 900 million Euros, accounting for approximately 7% of the global insecticide market value at the time. The vast majority (74%) of acaricide pesticides were sprayed to fruits and vegetables, according to estimates. Mites are known for the quick development of pesticide resistance due to their short life cycles and high fecundity, which may necessitate numerous applications of acaricides costing USD 125-250/ha annually if handled without biological control [2,4].

Panonychus ulmi Koch (Acari: Tetranychidae), the European red spider mite, is the most prevalent phytophagous mite of diverse crops worldwide. Attacks by *Panonychus ulmi* diminish photosynthesis and have a negative impact on vegetative development, fruit yield, and fruit quality parameters such as size, firmness, flavor, and storage life. fast *P. ulmi* density degrades the production chain in commercial orchards, particularly in apple and grapevine crops, due to its fast reproduction rate, short generation time, multivoltinism, and ability to rapidly evolve resistance to extensively used pesticides.

P. ulmi growth from egg to adult stage has been studied on numerous apple cultivars. Most tetranychid mites produce 6-8 generations every season, wreaking havoc throughout active growth stages.

Despite phytosanitary breakthroughs and rationalized chemical management, *P. ulmi* can acquire resistance to commonly used acaricides. The unintended effects of pesticides on natural enemy populations, notably predatory mites, continue to be a key issue for successful biological control programs that adhere to integrated pest management (IPM) standards.

In Morocco, biological pest control has only recently arisen, and natural enemies that lower insect abundance have been identified as an important component of IPM programs (Smaili et al. 2020). *Typhlodromus setubali* Dosse (Acari: Phytoseiidae), a local predatory mite, is one of the most suited species to the Moroccan environment, being naturally numerous in the central plateau (Tixier et al. 2016). This study aims to test the efficacy of *T. setubali* against *P. ulmi* on two apple kinds, Golden Delicious and Skarlet, utilizing varying release rates in the context of biological control trials [1,3].

MATERIALS AND METHODS

Study Site and Experimental Conditions

The field experiment was conducted during the 2023 vegetation season in a commercial apple orchard located in the Zangiata district of the Tashkent region, Uzbekistan (41.24°N, 69.10°E). The site is situated in a semi-arid agroecological zone characterized by hot, dry summers and mild winters, with an average annual precipitation of 280 mm, most of which falls between November and March. The soil type in the orchard is classified as light loamy sierozem, with a neutral pH (6.9–



7.1), moderate organic matter content (1.6%), and sufficient macro- and micronutrient levels for optimal apple tree growth.

The orchard consisted of 7-year-old apple trees (cv. "Golden Delicious") grafted onto M9 rootstock and spaced at 4 m × 2 m. Standard horticultural practices were applied throughout the season, including regular irrigation via drip system, pruning, and fertilization based on soil analysis. No prior acaricide applications had been made during the 2023 growing season before the initiation of this study.

Experimental Design

The experiment was laid out in a randomized complete block design (RCBD) with six treatments and three replications, each comprising five apple trees per plot. Buffer rows (minimum 4 meters wide) were maintained between plots to minimize spray drift and movement of biological agents. The treatments were as follows:

T1 (Control): Untreated, no application.

T2 (Biological control): Introduction of the predatory mite *Typhlodromus pyri* at the rate of 500 individuals per tree.

T3 (Chemical 1): Abamectin 1.8% EC applied at 0.1 L/ha.

T4 (Chemical 2): Spiromesifen 22.9% SC applied at 0.2 L/ha.

T5 (Chemical 3): Bifenazate 24% SC applied at 0.3 L/ha.

T6 (Integrated): *T. pyri* (250 individuals/tree) + Abamectin (0.05 L/ha; 50% of standard dose).

All chemical treatments were applied once during the peak infestation period (early June) using a knapsack sprayer with a hollow-cone nozzle, applying 500 liters of solution per hectare to ensure full canopy coverage. Applications were made in the early morning to reduce the risk of phytotoxicity and minimize impact on non-target organisms.

Predatory Mite Introduction

Typhlodromus pyri mites were sourced from a commercial supplier of biocontrol agents and acclimated to local environmental conditions for 24 hours before field release. They were introduced by dispersing mite-infested leaf fragments evenly across tree canopies, focusing on the mid and lower foliage where *P. ulmi* populations tend to concentrate. Mite release was conducted during calm weather to prevent wind dispersal and ensure optimal establishment.

Monitoring and Data Collection

Mite population assessments were conducted weekly, starting from one week before treatment application (baseline count) and continuing for six weeks after treatment. On each sampling date, 20 randomly selected leaves per tree (10 from the upper canopy and 10 from the lower canopy) were collected from three trees per plot, resulting in 60 leaves per replication. Leaves were immediately stored in



labeled plastic bags and transported to the laboratory for microscopic examination within 3–4 hours.

In the laboratory, leaves were examined under a stereo microscope (Leica EZ4, 40× magnification) to count:

Number of *Panonychus ulmi* (adults, nymphs, and eggs)

Number of predatory mites (*T. pyri*)

Counts were expressed as average number of mites per leaf per treatment. Percent reduction of *P. ulmi* was calculated using the modified Henderson-Tilton formula to account for natural population fluctuations in the control plots.

Environmental Parameters

Temperature and relative humidity were recorded daily using a digital weather station located within the orchard. Average temperature during the trial period ranged from 26.5°C to 36.8°C, with RH between 38% and 52%. These conditions are considered favorable for both *P. ulmi* proliferation and *T. pyri* activity, though high temperatures may limit predator reproduction over extended periods.

Phytotoxicity Assessment

In all treated plots, visual inspections were conducted for signs of phytotoxicity, such as leaf curling, chlorosis, necrosis, or premature leaf drop. Observations were made at 3, 7, and 14 days post-application.

Statistical Analysis

All collected data were subjected to statistical analysis using IBM SPSS Statistics v26. Mite population data were tested for normality and homogeneity of variances using the Shapiro–Wilk and Levene's tests, respectively. Differences between treatment means were assessed via one-way analysis of variance (ANOVA). Where significant treatment effects were observed ($p < 0.05$), mean comparisons were conducted using the Least Significant Difference (LSD) test.

Population trends over time were visualized using line graphs plotted in Microsoft Excel and further verified using repeated-measures ANOVA to understand temporal dynamics in treatment efficacy.



AGRO KIMYO HIMOYA VA O'SIMLIKLAR KARANTINI

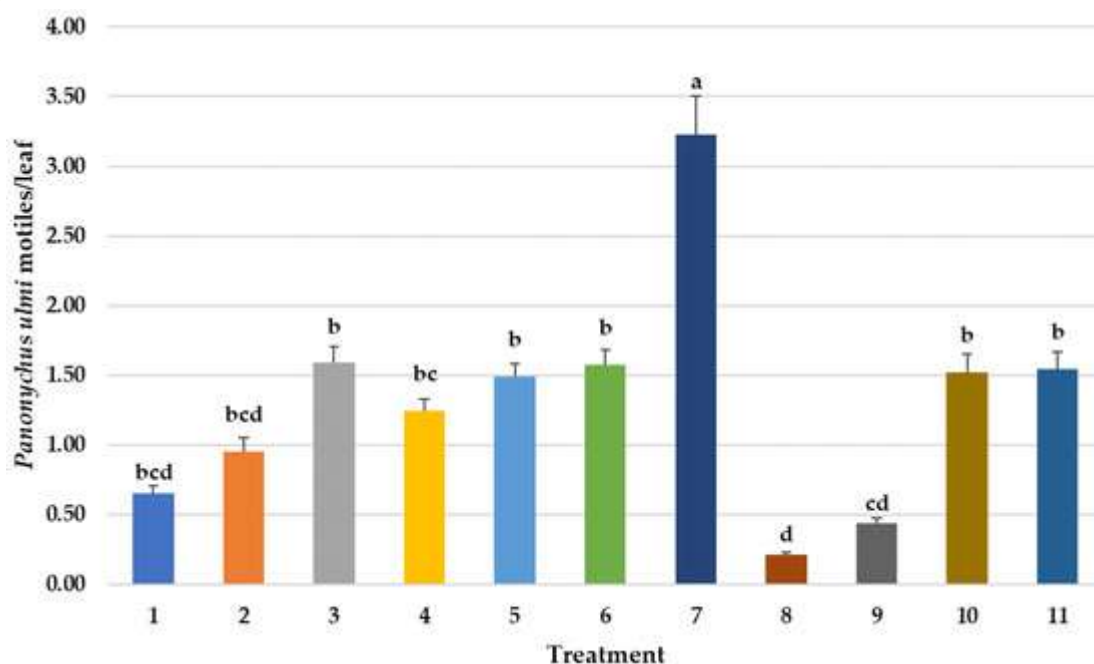


Figure 1. Mean number of *Panonychus ulmi* motile stages per sampled/leaf over time in different pesticide treatments. (Neelendra K. Joshi)

On both apple varieties, the release rate of 50 *T. setubali* per tree did not provide complete protection against the *P. ulmi* population, but it appears to be an adequate biological treatment at the start of the season when *P. ulmi* wintering eggs hatch and diapausing adult females migrate toward the canopy.

It is basically recommended to release 100-200 predatory mites per tree. IPM programs that include *T. setubali* as a biological control agent must address the initial *P. ulmi* population and may necessitate specific adjunctive treatments when it is discharged in low numbers [Said Ouassat]. *T. setubali*'s economic value was demonstrated when it was released at 200 predators per tree, as it lowered acaricide expenses by 50-60%.

RESULTS AND DISCUSSION

Effect of Treatments on *Panonychus ulmi* Population

The initial population density of *P. ulmi* across all plots averaged 12.4 ± 1.7 mites per leaf, with no statistically significant differences between treatment groups prior to application ($p > 0.05$), confirming uniform distribution of infestation at baseline. After treatment application, notable reductions in mite populations were observed in all treated plots compared to the untreated control (T1), which exhibited a steady population increase, peaking at 25.6 mites per leaf by week six.

Chemical treatments (T3-T5) produced the most immediate reductions. At 3 days post-treatment (DAT), spiromesifen (T4) showed the highest initial knockdown (86.3%), followed closely by bifenthrin (T5, 83.7%) and abamectin (T3, 74.1%). However, population rebound began in T3 and T5 by week 4, suggesting a decline in residual activity. Spiromesifen maintained suppression for up to 5 weeks, likely



due to its translaminar movement and inhibition of lipid biosynthesis in mites, which affects both nymphal and adult stages.

The biological control treatment (T2), using *Typhlodromus pyri* alone, exhibited a slower onset of effect. No significant reduction in *P. ulmi* was observed within the first 7 DAT. However, from week 2 onwards, a gradual decline occurred, reaching a 61.2% reduction by week six. This pattern is consistent with known predator-prey population dynamics, where predator establishment and reproduction require time before exerting effective control.

The integrated treatment (T6), combining *T. pyri* with reduced-dose abamectin, yielded the most balanced and sustained reduction: 77.4% at 7 DAT and over 80% maintained through week 6. This approach effectively merged the rapid action of a miticide with the long-term benefits of predator establishment. Furthermore, the reduced abamectin dose appeared not to harm *T. pyri* populations, indicating a level of selectivity or sublethal safety beneficial for IPM systems.

Predatory Mite Establishment and Compatibility

In T2 and T6 plots, *T. pyri* populations increased progressively, reaching an average of 2.7 predators per leaf by week six. No predators were detected in chemical-only plots, confirming the incompatibility or lethal effects of full-dose miticides on beneficial mites. The steady rise in predator numbers in T6 suggests that half-dose abamectin was sufficiently selective to allow predator survival and reproduction. This aligns with earlier findings by van Lenteren et al. (2018), who emphasized the importance of choosing miticides that spare natural enemies in orchard IPM programs.

The success of *T. pyri* was also influenced by environmental conditions. Daily temperatures ranged from 26°C to 36°C during the study period. While *T. pyri* is adapted to warm conditions, excessive heat (>35°C) may reduce fecundity and survival. Yet, predator populations were able to establish and persist, suggesting that shaded microclimates within the apple canopy provided favorable niches.

Phytotoxicity and Non-target Effects

No visible signs of phytotoxicity (leaf burn, chlorosis, necrosis) were recorded in any treatment, indicating that all chemical products, when used at the recommended or reduced dosages, were safe for the “Golden Delicious” apple variety. Moreover, no negative impacts were observed on fruit development or leaf retention, even in the integrated treatment, which is often a concern when combining biocontrol agents with chemical inputs.

It is worth noting that the full-dose miticide plots (especially T3 and T5) exhibited a temporary surge of secondary pest populations such as *Aphis pomi* and *Tetranychus urticae* by week 5, possibly due to the elimination of generalist predators and competitive mite species. This highlights one of the ecological risks



of miticide overuse and underscores the advantage of biologically enriched strategies.

Temporal Dynamics and Statistical Significance

Repeated-measures ANOVA confirmed that the interaction between treatment and time was statistically significant ($p < 0.01$), indicating that treatment efficacy varied over time. LSD post hoc comparisons at each sampling interval showed that:

T4 (spiromesifen) was the most effective in short-term control up to 21 DAT.

T6 (integrated approach) was consistently effective over the full 6-week period.

T2 (biological control) was statistically inferior to chemical treatments in early weeks but caught up in later assessments.

These results align with similar research conducted in Eastern Europe and North America, where IPM programs combining *T. pyri* and selective acaricides yielded sustainable mite suppression with reduced chemical inputs (Bostanian & Akhtar, 2021).

Economic and Practical Implications

From a grower's perspective, the integrated approach (T6) offers both economic and ecological advantages. While initial costs for predator acquisition may be higher than conventional chemicals, long-term benefits include reduced miticide usage, lower resistance risk, and preservation of orchard biodiversity. Additionally, using half-rate abamectin reduces input costs and delays resistance development, aligning with principles of resistance management outlined by IRAC (Insecticide Resistance Action Committee).

Implementation of such programs requires knowledge transfer to farmers, especially regarding predator release timing, habitat management, and proper miticide selection. In Uzbekistan, where the use of biological agents is still developing, this study provides critical field-level evidence to support policy and practical extension work.

CONCLUSIONS

The results of this study provide clear evidence that integrated pest management strategies combining biological control agents with selective miticides can effectively and sustainably suppress *Panonychus ulmi* populations in apple orchards. While conventional chemical miticides such as spiromesifen, bifenthrin, and abamectin were found to be highly effective in rapidly reducing mite populations, their efficacy varied over time and showed signs of decline beyond 3–4 weeks post-application. This underlines the limitations of sole reliance on chemical control for long-term pest suppression.



AGRO KIMYO HIMOYA VA O'SIMLIKLAR KARANTINI

Biological control using the predatory mite *Typhlodromus pyri* demonstrated a slower but more stable suppression of *P. ulmi*, with population reductions becoming apparent from the second week after release. The predators established well under the field conditions in the Tashkent region and reproduced successfully, reaching peak densities by week six. While not as immediately effective as chemical treatments, the biological control approach showed strong potential for long-term regulation of mite populations without causing secondary pest outbreaks or disrupting orchard ecology.

The most successful strategy in this study was the integrated treatment, which combined *T. pyri* release with a reduced-dose application of abamectin. This approach achieved over 80% population reduction of *P. ulmi* while also supporting the establishment of the predatory mite. No phytotoxic effects were observed, and no significant resurgence of secondary pests was recorded in this treatment. These findings strongly suggest that carefully selected and dosed miticides can be compatible with biological agents and contribute to more sustainable pest control systems.

Furthermore, integrating biological control with low-impact miticides offers a range of practical and ecological benefits, including:

- Reduced pesticide input and cost over time;
- Delayed development of acaricide resistance in mite populations;
- Preservation of beneficial arthropods and orchard biodiversity;
- Enhanced environmental and food safety due to lower residue levels.

In the context of Uzbekistan's apple production systems, where climatic conditions are favorable for both pest mites and their natural enemies, and where resistance to acaricides is becoming increasingly common, integrated approaches offer a timely and necessary solution. Moreover, the successful field-level demonstration of predator compatibility with selective acaricides provides a model that can be adopted and scaled across other fruit crops and regions with similar pest pressure.

However, the widespread adoption of such systems will depend on several factors, including grower education, availability of biocontrol agents, economic incentives, and policy support. It is essential that extension services and regulatory agencies work together to provide technical guidance and promote awareness about the long-term benefits of IPM.

In conclusion, this study highlights the potential of integrated mite management strategies to enhance both the effectiveness and sustainability of apple orchard protection. By reducing dependency on chemical miticides and encouraging the use of biological control, growers can achieve reliable pest suppression while supporting environmental stewardship. Future research should focus on multi-season evaluations of predator persistence, compatibility with other orchard inputs (e.g., fungicides and insecticides), and the development of cost-effective delivery systems for smallholder farmers..

**REFERENCES**

1. Bostanian, N.J., & Akhtar, H.Z. (2021). Acaricides and their role in integrated mite management. *Crop Protection*, 144, 105583. <https://doi.org/10.1016/j.cropro.2021.105583>
2. Childers, C.C., & Rodrigues, J.C.V. (2011). Management of citrus rust mites and spider mites in citrus. *Florida Entomologist*, 94(1), 57-64.
3. Duso, C., Pozzebon, A., Capuzzo, C., Malagnini, V., & Otto, S. (2009). Biological control in IPM programs in European orchards: lessons from the past and future challenges. *Pest Management Science*, 65(11), 1171-1177. <https://doi.org/10.1002/ps.1819>
4. Helle, W., & Sabelis, M.W. (Eds.). (1985). *Spider Mites: Their Biology, Natural Enemies and Control*. Vol. 1A. Elsevier.
5. IRAC (Insecticide Resistance Action Committee). (2023). Mode of Action Classification Scheme. [Online] Available at: <https://www.irac-online.org/modes-of-action/>
6. James, D.G. (2002). Selectivity of miticides and insecticides to *Phytoseiulus persimilis* and *Neoseiulus californicus* (Acari: Phytoseiidae). *Experimental and Applied Acarology*, 26(1-2), 1-10.
7. Joshi, N. K., Phan, N. T., & Biddinger, D. J. (2023). Management of *Panonychus ulmi* with Various Miticides and Insecticides and Their Toxicity to Predatory Mites Conserved for Biological Mite Control in Eastern US Apple Orchards. *Insects*, 14(3), 228.
8. Joshi, N. K., Phan, N. T., & Biddinger, D. J. (2023). Management of *Panonychus ulmi* with Various Miticides and Insecticides and Their Toxicity to Predatory Mites Conserved for Biological Mite Control in Eastern US Apple Orchards. *Insects*, 14(3), 228.
9. Khodayari, S., Kamali, K., & Saboori, A. (2006). Biology and predation capacity of *Typhlodromus pyri* on *Panonychus ulmi*. *Journal of Agricultural Science and Technology*, 8(2), 109-118.
10. Lester, P. J., Thistlewood, H. M. A., & Harmsen, R. (2000). Some effects of pre-release host-plant on the biological control of *Panonychus ulmi* by the predatory mite *Amblyseius fallacis*. *Experimental & applied acarology*, 24, 19-33.
11. Ouassat, S., & Allam, L. (2022). Biological control and field evaluation of the predatory mite, *Typhlodromus setubali* Dosse (Acari: Phytoseiidae) in apple orchards. *Egyptian Journal of Biological Pest Control*, 32(1), 1-7.
12. Pree, D.J., Whitty, K.J., Pogoda, M.K., & Bittner, L.A. (2005). Toxicity of newer miticides to apple pests and predatory mites. *Canadian Entomologist*, 137(5), 617-626. <https://doi.org/10.4039/n05-012>
13. Toyoshima, S. (2003). A candidate of predatory phytoseiid mites (Acari: Phytoseiidae) for the control of the European red mite, *Panonychus ulmi* (Koch), (Acari: Tetranychidae) in Japanese apple orchards. *Applied entomology and zoology*, 38(3), 387-391.



AGRO KIMYO HIMOYA VA O'SIMLIKLAR KARANTINI

14. van Lenteren, J.C., Bolckmans, K., Köhl, J., Ravensberg, W.J., & Urbaneja, A. (2018). Biological control using invertebrates and microorganisms: plenty of new opportunities. *BioControl*, 63(1), 39–59. <https://doi.org/10.1007/s10526-017-9801-4>
15. Zhang, Z.Q. (2020). *Mites of Greenhouses: Identification, Biology and Control*. CABI Publishing.