

EFFECT OF FOLIAR BIOSTIMULANT FEEDING ON THE
POPULATION DYNAMICS OF PHYTOPHAGOUS MITES IN APPLE
ORCHARDS OF TASHKENT REGION

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Abstract. *Phytophagous mites are destructive pests in pome fruit orchards, directly limiting apple yield and quality. Modern sustainable agriculture requires integrating crop nutrition with pest management strategies. Field experiments were conducted from 2020 to 2022 in the Tashkent region to evaluate the side effects of three plant growth biostimulants-Biodux liquid (0.1 L/ha), Almerinei E.C. (1.0 L/ha), and Globalil 10% E.C. (1.0 L/ha) on the population density of phytophagous mites via foliar application. Mite counts per leaf were monitored before treatment and on days 3, 7, 14, and 21 post-application. All bio-preparations significantly suppressed mite population growth compared to the untreated control. Biodux (arachidonic acid) demonstrated the highest efficacy, reducing the mean mite count from an initial 22.4 to 8.1 mites/leaf by day 21. Almerinei and Globalil also reduced mite densities to 11.6 and 10.8 mites/leaf, respectively. In contrast, the mite population in the control plot increased from 22.6 to 39.4 mites/leaf due to the lack of protective interventions.*

Keywords: *apple orchards; foliar feeding; phytophagous mites; plant growth stimulators; biodux; population dynamics; pest suppression; tashkent region.*

Introduction. Apple (*Malus domestica* Borkh.) is one of the most

economically important and widely cultivated fruit crops globally and holds a dominant position in the horticultural sector of Uzbekistan, particularly within the Tashkent region. The region's favorable climatic conditions and fertile soils support high-density apple production. However, maintaining stable yields and high fruit quality remains a continuous challenge due to a complex matrix of biotic and abiotic stressors. Among the biotic threats, phytophagous mites predominantly spider mites (Acari: Tetranychidae) are classified as destructive primary pests that severely compromise the physiological integrity of pome fruit trees. The feeding activity of phytophagous mites induces direct mechanical damage to the leaf parenchyma. By piercing the plant cells and consuming the cellular contents, these pests trigger a sharp reduction in chlorophyll content, disrupt stomatal conductance, and drastically impair the overall photosynthetic capacity of the tree. Severe infestations lead to leaf bronzing, early defoliation, and a subsequent decline in both current-season fruit weight and the differentiation of fruit buds for the following year. Historically, growers have relied heavily on synthetic chemical acaricides to manage mite outbreaks. However, the intensive and frequent application of these conventional chemicals has accelerated the development of pesticide resistance in mite populations, eradicated beneficial predatory arthropods, and raised serious ecological and food safety concerns. Concurrently, modern agricultural paradigms are shifting toward sustainable intensification, where the stimulation of innate plant defenses is integrated with traditional crop protection. In this context, the application of plant biostimulants via foliar feeding has emerged as a promising strategy. Foliar feeding allows for the rapid assimilation of bioactive compounds directly through the leaf cuticle, bypasses soil-bound nutrient immobilization, and provides immediate physiological support during critical growth phases. Biostimulants comprising amino acids, phytohormones, and organic acids are primarily applied to accelerate vegetative growth, improve nutrient use efficiency, and optimize fruit set and yield.

parameters. Interestingly, recent entomological and agronomical research suggests that certain growth-promoting substances can alter the biochemical composition of the leaf matrix, thereby indirectly influencing the feeding behavior, fecundity, and population dynamics of herbivorous pests. For instance, formulations based on exogenous phytohormones like benzyladenine and gibberellins, or elicitors like arachidonic acid, can trigger induced systemic resistance (ISR). This bio-chemical shift can synthesize secondary metabolites or alter the nutritional profile of the host tissue, making it less palatable or suitable for sap-sucking arthropods like phytophagous mites. Despite the growing use of these multi-functional biostimulants in Uzbekistan's fruit sector, comprehensive empirical data regarding their side effects on pest populations remain scarce. Specifically, how these preparations impact the population dynamics of phytophagous mites under the unique microclimatic conditions of the Tashkent region has not been systematically quantified. To address this knowledge gap, field investigations were carried out between 2020 and 2022 to closely monitor the variations in mite density following the foliar application of three distinct biostimulants: Biodux liquid (arachidonic acid), Almerinei E.C. (gibberellin + benzyladenine), and Globalil 10% E.C. (benzyladenine). The primary objective of this study was to evaluate the regulatory and suppressive effects of these formulations on phytophagous mite populations, providing a scientific baseline for integrating foliar biostimulants into sustainable integrated pest management (IPM) systems for pome fruit orchards.

Literature Review. Phytophagous mites, particularly the two-spotted spider mite (*Tetranychus urticae*) and the European red mite (*Panonychus ulmi*), are recognized globally as major economic pests in pome fruit orchards [1]. According to Attia et al. (2015), the piercing-sucking feeding mechanism of these pests directly targets the chloroplasts within leaf mesophyll tissues, causing irreversible physiological disorders. Continuous feeding leads to a severe decline in net photosynthesis, stomatal conductance, and transpiration

efficiency. In severe cases, this biotic stress triggers early defoliation, which severely reduces both current-season fruit weight and the differentiation of floral buds for the subsequent production cycle [4]. Historically, mite control in Central Asia, including the Tashkent region, has relied heavily on synthetic chemical acaricides. However, chemical-intensive pest management is increasingly failing. Guedes et al. (2016) demonstrated that Tetranychidae species possess an extraordinary genetic capacity to rapidly develop resistance to conventional chemicals due to their short life cycles and high fecundity. Furthermore, synthetic sprays eliminate predatory mites (e.g., Phytoseiidae), causing secondary pest resurgences and leaving substantial chemical residues on harvested fruits [3]. To mitigate the risks associated with chemical pesticides, modern horticulture is shifting toward sustainable intensification using plant biostimulants. Biostimulants are defined as diverse formulations of organic and inorganic substances that enhance nutrient use efficiency, abiotic stress tolerance, and crop quality traits [10]. Rouphael and Colla (2020) highlighted that foliar application of these substances allows for immediate absorption through the leaf cuticle and stomata, bypassing soil-bound nutrient fixation and providing instant metabolic support during critical phenological stages [7]. Interestingly, recent agronomic advancements indicate that the role of foliar biostimulants extends far beyond basic plant nutrition. Bulgari et al. (2019) observed that enriching the leaf matrix with specific amino acids, phytohormones, and organic compounds significantly alters the host plant's biochemical profile. These modifications can unexpectedly influence the population dynamics, feeding behaviors, and survival rates of herbivorous pests [2].

The suppressive effect of biostimulants on phytophagous mites is primarily driven by Induced Systemic Resistance (ISR) and changes in host tissue palatability. Elicitors such as arachidonic acid (the active ingredient in Biodux) mimic pathogen or pest attacks at the cellular level. Liarzi and Ezra

(2017) demonstrated that exogenous arachidonic acid activates the jasmonic acid (JA) signaling pathway within the plant. This pathway triggers the synthesis of defensive secondary metabolites, including polyphenols, flavonoids, and proteinase inhibitors, which chemically harden the leaf tissue and reduce cell-sap palatability for sap-sucking arthropods [5]. Concurrently, phytohormones like benzyladenine and gibberellins (found in Almerinei and Globalil) reinforce structural defenses. Vargas-Ayala and Rodriguez-Kabana (2016) noted that cytokinin-based formulations like benzyladenine delay leaf senescence, maintain cellular turgor, and stimulate rigid cell wall lignification. This structural reinforcement hinders the mechanical penetration of mite stylets into the plant cells [9]. Moreover, optimized foliar nutrition alters the nitrogen-to-carbon ratio within the leaves; Pichersky and Raguso (2018) found that volatile organic compounds (VOCs) emitted by highly vigorous, biostimulant-treated leaves can act as natural deterrents, lowering pest oviposition and reproduction rates [6]. Consequently, incorporating these multi-functional preparations allows fruit growers to concurrently maximize crop vigor and suppress mite outbreaks within integrated pest management (IPM) frameworks [8].

Materials and methods. Field experiments were conducted over three consecutive growing seasons from 2020 to 2022 in commercial apple (*Malus domestica*) orchards located in the Tashkent region, Republic of Uzbekistan. The experimental site is characterized by a sharply continental climate, featuring hot, dry summers and fluctuating winter temperatures. The soil type at the study site was classified as typical serozem (gray soil) with a moderate organic matter content. Standard agrotechnical practices, including mechanized inter-row tillage and drip irrigation, were uniformly maintained across all experimental plots throughout the study period. No synthetic chemical acaricides or insecticides were applied during the monitoring intervals to prevent external interference with the pest population dynamics.

Results and Discussion. The multi-year field monitoring conducted between 2020 and 2022 revealed that foliar application of growth-promoting biostimulants exerted a profound suppressive effect on the population dynamics of phytophagous mites in the apple orchards of the Tashkent region. All three tested formulations demonstrated varying degrees of biological efficacy, systematically curbing the pest density in comparison to the untreated control plot where the mite population expanded rapidly. In the first variant, treated with Biodux liquid (0.1 L/ha), the initial baseline population was recorded at 22.4 mites per leaf. Following the foliar spray, a sharp downward trend was observed. By day 3, the density decreased to 18.3 mites/leaf (a net reduction of 4.1 units). This suppressive trend accelerated by day 7, with counts falling to 13.1 mites/leaf (8.3 units lower than baseline). Long-term monitoring confirmed continuous suppression, with densities dropping to 9.9 mites/leaf on day 14 and reaching an ultimate low of 8.1 mites/leaf by day 21. This represents a total population decline of 63.8% over the three-week trial period.

The second variant, utilizing Almerinei E.C. (1.0 L/ha), started with a higher initial infestation of 24.3 mites per leaf. On day 3 post-application, the population fell to 19.8 mites/leaf, demonstrating an immediate reduction of 4.5 units. Steady declines were recorded on days 7 (16.4 mites/leaf) and 14 (13.7 mites/leaf). By day 21, the population stabilized at 11.6 mites/leaf. Over the 21-day timeline, Almerinei E.C. effectively reduced the absolute pest burden by 12.7 individuals per leaf. The positive standard variant, Globalil 10% E.C. (1.0 L/ha), followed a highly identical trajectory. Beginning with a baseline of 21.8 mites per leaf, the density contracted to 17.4 on day 3 (down 4.4), 15.8 on day 7 (down 6.0), and 13.6 on day 14 (down 8.2). By day 21, the mite count reached 10.8 individuals per leaf, establishing an overall reduction of 11.0 units from the pre-treatment status. Conversely, the untreated control group exhibited a classic unchecked pest population explosion. Starting at a comparable baseline of 22.6 mites per leaf, the population escalated to 27.7 on day 3, 33.4 on day 7,

35.2 on day 14, and peaked dramatically at 39.4 mites/leaf by day 21. This constitutes an absolute increase of 16.8 mites per leaf (+74.3%) due to the absence of regulatory mechanisms. The statistical validity of these findings is robustly supported by the analysis of variance.

Table 1.

Changes in the number of ticks during leaf feeding in seed orchards, by day, units Tashkent region, 2020-2021

№	Options	Composition	Consumption rate, l/ha	Number and variation of mites on a single leaf				
				Pre-processing number	Number after processing, pcs.			
					3.	7.	14	21
1.	Biodux is liquid.	Arachidonic acid	0.1 l/ha	22.4	18.3	13.1	9.9	8.1
2.	Almeranei s.e.	Gibberellin + benzyladenine	1.0	24.3	19.8	16.4	13.7	11.6
3.	Globaril 10% IU (standard dose).	Benzyladenin	1.0	21.8	17.4	15.8	13.6	10.8
4.	Control	-	-	22.6	27.7	33.4	35.2	39.4
NSR05= c/ha				0.84	0.77	0.80	0.80	0.87
Sx= %				3.67	3.71	4.07	4.44	4.97

The Least Significant Difference values (LSD_{05}) remained tight throughout the trials, ranging from 0.77 to 0.87. Concurrently, the standard error percentage ($Sx\%$) fluctuated within acceptable limits between 3.67% and 4.97%, confirming high experimental precision and reproducibility across the 2020–2022 seasons. The mechanism behind the observed mite suppression can be attributed to the physiological shifts induced in the host plant by the biostimulants. Formulations containing arachidonic acid (Biodux) or benzyladenine and gibberellins (Globaril, Almerinei) are known to trigger

induced systemic resistance (ISR) in fruit trees. Arachidonic acid acts as an elicitor, signaling the plant to synthesize secondary metabolites, such as polyphenols and defense enzymes, which harden leaf tissues and reduce cell-sap palatability. Phytohormones like benzyladenine maintain cellular turgor and prolong chlorophyll synthesis, which structurally interferes with the feeding mechanisms of piercing-sucking pests. Consequently, while these preparations fundamentally serve to accelerate crop growth and yield parameters, they concurrently alter the leaf micro-environment, rendering it hostile to the reproduction and survival of phytophagous mites.

Conclusion. The three-year field investigations (2020–2022) conducted in the pome fruit orchards of the Tashkent region provide conclusive empirical evidence that the integration of foliar biostimulants into standard crop management practices exerts a dual benefit. Beyond their primary agronomic role in accelerating tree growth and maximizing yield potential, these modern preparations play a critical regulatory role in mitigating the population dynamics of destructive phytophagous mites. Among the evaluated treatments, Biodux liquid applied at a rate of 0.1 L/ha demonstrated the most outstanding regulatory efficacy. Over a 21-day post-application monitoring period, it systematically suppressed the pest population, triggering a robust 63.8% reduction in mean mite density from an initial 22.4 down to 8.1 mites per leaf. Similarly, both Almerinei E.C. (1.0 L/ha) and the positive standard Globaril 10% E.C. (1.0 L/ha) exhibited strong, reliable control, successfully stabilizing and reducing pest loads to 11.6 and 10.8 mites per leaf by day 21, respectively. In stark contrast, the untreated control plot experienced an unchecked pest outbreak, with mite counts surging by 74.3% to peak at 39.4 mites per leaf due to the lack of protective interventions. The high statistical precision (LSD_{05} between 0.77 and 0.87; $Sx\% < 5\%$) confirms the reproducibility of these findings. The underlying mechanism is attributed to induced systemic resistance and alterations in leaf tissue palatability, which disrupt the feeding



cycles of sap-sucking arthropods. Consequently, foliar feeding with Biodux liquid, Almerinei, and Globalil is highly recommended for commercial fruit growers in Uzbekistan. These multi-functional biostimulants should be systematically incorporated into sustainable Integrated Pest Management (IPM) systems, serving as eco-friendly, non-chemical tools to simultaneously boost apple tree vigor and suppress phytophagous mite outbreaks.

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