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# The damage caused by whiteflies to vegetable crops and control measures in open field agrocenoses

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***Abstract.*** *Currently, controlling the tobacco whitefly (Bemisia tabaci Gennadius), a highly destructive polyphagous pest that causes severe economic damage to sweet pepper (Capsicum annuum L.) and other valuable members of the Solanaceae family, stands as one of the most pressing and complex challenges in modern sustainable crop protection. This article presents a comprehensive evaluation of the research conducted during the 2026 growing season at the Andijan Experimental Station. The study systematically outlines the specific bioecological features, dynamic demographic shifts, and severe feeding damage mechanics of the tobacco whitefly under open field agrocenosis conditions in the Fergana Valley ecosystem. Furthermore, the paper provides comparative experimental data regarding the biological efficacy of an innovative biological preparation, Bioslip BT powder (applied at 3.0 kg/ha), contrasted against the standard chemical reference insecticide, Ximidor 60% suspension concentrate (applied at 0.135 L/ha). The findings indicate that the specialized piercing-sucking feeding habits of the pest's larval instars lead to substantial physiological degradation of sweet pepper crops, with unmanaged infestations facilitating massive sooty mould proliferation and reducing total yield quality and volume by 13–18%. The integration of targeted biological interventions like Bioslip BT demonstrates significant promise for integrated pest management (IPM) frameworks aiming to secure ecological stabilization and economic viability in vegetable production.*

***Keywords:*** *tobacco whitefly, Bemisia tabaci, sweet pepper, bioecology, population dynamics, economic threshold, biological control, Bioslip BT, Ximidor, integrated pest management.*

## Introduction

Sweet pepper (Capsicum annuum L.) represents one of the foundational and commercially vital vegetable crops cultivated globally, heavily integrated into both greenhouse production systems and open field rotations. Valued for its dense concentration of ascorbic acid, carotenoids, and macro-nutritional elements, its commercial viability dictates agricultural income throughout the Fergana Valley of Uzbekistan. However, stable production of sweet pepper is frequently undermined by an array of aggressive arthropod

pests. Among these, the tobacco whitefly (Bemisia tabaci Gennadius) stands out as an exceptionally destructive economic threat.

The tobacco whitefly is a widely distributed polyphagous insect characterized by an evolutionary capacity for high reproductive output, rapid generation turnover, and plastic adaptations to changing environments. Under favorable environmental conditions, such as elevated temperatures and moderate relative humidity, Bemisia tabaci populations shift exponentially, colonizing large agricultural zones within short periods. The damage inflicted upon sweet pepper plants manifests in dual forms: direct feeding stress and indirect pathological consequences.

Direct damage occurs when adult whiteflies and, more substantially, their localized larval instars utilize their specialized piercing-sucking stylets to penetrate the phloem tissue of the sweet pepper leaves. By extracting massive volumes of essential plant sap containing amino acids and carbohydrates, they trigger profound physiological imbalances. This results in chlorotic spot formation, widespread leaf yellowing, marginal leaf curling, severe stunting of vegetative shoots, and an overall reduction in photosynthetic potential.

Indirect damage, often more devastating financially, is caused by the physiological excretion of excessive, undigested plant sugars known as honeydew. This sticky substance covers the surfaces of leaves and developing sweet pepper pods, forming an ideal substrate for the colonization of saprophytic sooty mould fungi (primarily species belonging to the genus Capnodium). The black fungal mat blocks solar radiation, curtails the plant's net carbon assimilation rate, and causes severe cosmetic damage to the peppers, rendering them unmarketable. Furthermore, Bemisia tabaci acts as a highly effective vector for over one hundred plant viruses, including Geminiviruses and Criniviruses, which can completely decimate crops if not managed early.

Managing whitefly populations in open fields is uniquely challenging compared to greenhouses, as open ecosystems lack environmental boundaries and expose treatments to atmospheric weathering. Consequently, relying exclusively on synthetic chemical insecticides has driven whiteflies to develop rapid resistance, while simultaneously eliminating beneficial insect predators. Modern agricultural priorities therefore mandate the development and implementation of Integrated Pest Management (IPM) strategies. These frameworks combine systematic population monitoring, technical cultural practices, physical monitoring tools like yellow sticky traps, and the deliberate substitution of harsh broad-spectrum chemicals with bio-pesticides and selective biological agents. This study evaluates these dynamics to establish resilient, environmentally sound management options tailored to the regional conditions of Andijan.

## Materials and methods

The experimental field trials were conducted during the 2026 agricultural cultivation cycle within specialized experimental plots allocated at the Andijan Experimental Station of the Research Institute of Vegetable, Melon Crops, and Potato Production. The site provides a representative environment for examining the open field agrocenosis of sweet pepper under typical continental climate regimes.

The target crop utilized for the trial was the high-yielding sweet pepper hybrid 'SP-003 F1', which is extensively grown by local farmers and agro-clusters due to its high yield capacity but remains highly susceptible to piercing-sucking insects. The study prioritized the systematic mapping of harmful arthropod species composition and the parallel assessment of local natural enemy (entomophagous) complex populations within the crop canopy.

To execute precise population assessments

and systematic analyses, standard entomological procedures established by renowned authorities were strictly observed, including the field frameworks outlined by G.Ya. Bey-Bienko, S.M. Volkov, B.P. Adashkevich, and V.I. Tanskiy [1–3]. Sampling was performed utilizing a standardized staggered, systematic sampling grid layout spanning the experimental field blocks. Regular plant inspections were carried out weekly to record initial colonization, peak egg-laying events, larval instar progression, and the presence of natural predators.

The core field experiment aimed to determine and validate the biological efficacy of the specialized biological preparation Bioslip BT powder, applied at a target operational dosage rate of 3.0 kg/ha. The performance of this bio-pesticide was directly contrasted against a recognized chemical industry standard reference treatment, Ximidor 60% suspension concentrate (SC), applied at a rate of 0.135 L/ha, along with an untreated Control block where no pest intervention measures were applied.

The biological efficacy was evaluated during the period of mass whitefly demographic development. To guarantee accurate calculations, absolute pest counts (adults, nymphs, and puparia) were recorded precisely across 100 systematically selected plants per treatment variant. Counts were executed immediately prior to treatment application (0 days), followed by sequential monitoring post-treatment at intervals of 3, 7, and 14 days. The ultimate biological efficacy percentages were calculated utilizing the globally accepted Abbott's formula, which adjusts post-treatment survival values against natural mortality observed within the untreated control blocks.

## Results and discussion

Comprehensive agro-ecological monitoring of the sweet pepper open-field plots revealed a diverse, highly dynamic arthropod community composed of both specialized and highly polyphagous pest complexes. Over the course of the 2026 monitoring window, more than 10 distinct pest species were structurally confirmed. The most prominent dominant threats identified alongside the tobacco whitefly (Bemisia tabaci) included the two-spotted spider mite (Tetranychus urticae), the turnip moth (Agrotis segetum), the cotton bollworm (Helicoverpa armigera), diverse phytophagous bugs (Hemiptera: Pentatomidae/Miridae), and complex aphid colonies primarily dominated by the melon aphid (Aphis gossypii) and the alfalfa/cowpea aphid (Aphis craccivora).

Concurrently, the natural ecosystem balance was supported by over 8 identified species of natural entomophagous predators, including ladybird beetles (Coccinellidae), lacewings (Chrysopidae), hoverfly larvae (Syrphidae), and predatory mites, which provide background suppression but fail to suppress explosive whitefly outbreaks independently [5–7].

The tobacco whitefly's biology underpins its role as a persistent threat. It exhibits high ecological plasticity, enabling it to maintain year-round reproduction loops by alternating between protected greenhouse microclimates and open-field vegetable systems. In regional greenhouses, where temperature and relative humidity remain partially managed, Bemisia tabaci breeds continuously, generating 4 to 5 overlapping generations during the cooler autumn-to-spring period. As spring temperatures warm and greenhouses are ventilated, gravid females migrate outward to open field crops. Over the course of the spring-summer-autumn cycle, the pest successfully completes an additional 7 to 8 generations, culminating in a total annual output of 11 to 13 generations in the regional agro-ecosystem [4–6].

Our biological life-cycle monitoring demonstrated that under optimal ambient

conditions (air temperatures averaging 21–24°C), a single generation completes its full metamorphosis from egg to adult in approximately 21 to 25 days. The primary engine of field crop damage is localized within the immobile larval instars. Equipped with specialized piercing mouthparts, the larvae continuously extract plant sap. Due to the high sugar-to-protein ratio of the phloem fluid, the larvae execute high-volume excretion of sticky honeydew. This substance creates a continuous film over the foliage, which is quickly colonized by opportunistic sooty mould fungi. This fungal layer directly limits the host plant's capacity to intercept sunlight, severely curtailing net photosynthesis, inducing premature leaf drop, and causing severe yield loss quantified at 13–18% in untreated blocks.

Field experiments initiated in May 2026 caught the pest at its critical initial population surge. Microclimatic recording during the early trial phases indicated an average air temperature range of 23–25°C coupled with a relative humidity level of 50–53%, presenting ideal operational conditions for whitefly development. Initial egg-laying activities were formally observed in the field on May 1, 2026. Applying predictive developmental degree-day models, the mass egg-laying peak and the subsequent massive emergence of first-instar larvae were accurately forecast and verified to occur between May 15 and May 20, 2026. This critical bio-fix window was selected to initiate the targeted spray programs.

**Table 1. Biological efficacy of treatments against tobacco whitefly on sweet pepper (Andijan, May 2026)**

| Treatment Variant | Application Rate | Pre-treatment Density | Biological Efficacy (%) after Treatment | | |
|---|---|---|---|---|---|
| | | | 3 Days | 7 Days | 14 Days |
| Control (Untreated) | — | 14.5 | 0.0% | 0.0% | 0.0% |
| Ximidor 60% SC (Reference) | 0.135 L/ha | 15.2 | 88.4% | 92.1% | 85.6% |
| Bioslip BT powder (Test) | 3.0 kg/ha | 14.8 | 82.1% | 89.5% | 87.3% |

The field data demonstrates that the biological preparation Bioslip BT powder exhibits strong, prolonged protective properties. While the chemical reference standard (Ximidor 60% SC) showed a slightly faster initial knockdown effect at Day 3 (88.4% vs 82.1%), by Day 14, Bioslip BT maintained a higher suppression rate (87.3%) compared to Ximidor (85.6%). This highlights the persistent action of biological pathogenetic components which continue to replicate within the whitefly colonies without causing pest resistance or ecotoxicological side-effects.

## Conclusion

The tobacco whitefly (Bemisia tabaci) constitutes an economically significant limiting factor in the production of open-field sweet pepper crops throughout the Andijan region. The pest's high reproductive rate (11–13 generations per year via greenhouse-field crossover) and its destructive feeding habits make it a priority for crop protection. Its destructive impacts stem from phloem sap depletion by feeding larvae and the secondary development of sooty mould fungi on excreted honeydew. This dual stress compromises plant health and causes significant yield losses of 13–18%.

The 2026 field evaluation confirms that integrating bio-rational preparations like Bioslip BT powder at 3.0 kg/ha offers an effective alternative to conventional chemical insecticidal programs (such as Ximidor 60%

SC). Initiating applications during the forecast larval emergence window (May 15–20) suppresses whitefly population spikes, minimizes chemical residues in vegetable products, preserves the local entomophagous predator complex, and supports sustainable vegetable production.

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