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METHODS FOR MANAGING THE PEST *TUTA ABSOLUTA* MEYRICK IN TOMATO CROPS IN GREENHOUSE

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Abstract

Chemical and biological methods are widely used for pest control in tomato crops. In order to manage Tuta absoluta infestations, a greenhouse tomato experiment was conducted in 2025 at RDIVFG Vidra, using the hybrids Tolstoi F1 and Kalina F1, planted at a density of 33.500 plants per hectare. The crops were protected with black plastic mulch to reduce evapotranspiration and limit weed development. The experiments were arranged in four variants, each with three replications, and climatic conditions were monitored using a thermo-hygrometer. In the first variant, treatments were applied exclusively with chemicals; in the second variant, chemical products were combined with plant extract–based products; in the third variant, only biological products were applied throughout the entire growing season; whereas the fourth treatment served as an untreated control, with no phytosanitary applications. The effectiveness of the treatment variants ranged from 64.14% to 90.87%. In reported experimental conditions, the best results were obtained with the variant in which chemical treatments were applied.

Key words*: biological control, chemical products, plant protection.*

INTRODUCTION

Tuta absoluta Meyrick, known as the tomato leafminer, is a destructive moth that prefers to attack tomatoes (*Solanum lycopersicum* L.) but its attack of this insect has also been reported on potatoes (*Solanum tuberosum* L.), tobacco (*Nicotiana tabacum* L.), black nightshade (*Solanum nigrum* L.) (Abbes et al., 2016). The attack is easily noticeable, as the larvae feed on the leaves, creating leaf mines that reduce the plant's photosynthetic capacity. This leads to leaf necrosis and consequently to premature leaf drop or death (Desneux et al., 2010).

Farmers frequently turn to chemical control methods as the initial and main approach to managing *T. absoluta* (Machekano et al., 2020), as these insecticides offer a quick, accessible, and simple solution to control pest populations; however, excessive dependence on them can result in issues such as insecticide resistance, pest resurgence, environmental contamination, and adverse effects on both human health and the ecosystem (Mawcha et al., 2025).

In order to manage pests in an environmentally responsible way, researchers investigate natural compounds as potential sources of insecticidal agents. For centuries, plants with insecticidal properties have been utilized worldwide to control insect populations. Owing to their low toxicity to warm-blooded animals and their high volatility, these natural substances are regarded as viable alternatives to conventional pesticides. Compared to synthetic products, plant-derived insecticides tend to be more eco-friendly and are generally easy for farmers and small-scale industries to process and apply (Ayilara et al., 2023; Rasouli et al., 2025).

The use of biopesticides based on entomopathogenic fungi such as *Beauveria bassiana* represents an important alternative for the sustainable control of *Tuta absoluta*. This fungus infects insect hosts by penetrating the cuticle, proliferating within the body, and ultimately causing death (Vega et al., 2012; Mascarin & Jaronski, 2016).

Under greenhouse and field conditions, *B. bassiana* has shown consistent potential in

reducing pest populations, although its efficacy is generally lower compared to chemical insecticides. However, its advantages, such as environmental safety, low toxicity to non-target organisms, and reduced risk of resistance development, make it a valuable component of sustainable agriculture (Faria & Wraight, 2007; Lacey et al., 2015).

The aim of this study was to analyze the effectiveness of chemical and biological products based on plant extracts for the control of the tomato leaf miner.

MATERIALS AND METHODS

In 2025, under greenhouse conditions, a first-cycle tomato crop was established at RDIVFG Vidra on April 29. The biological material consisted of the hybrids Tolstoi F1 and Kalina F1, with five rows planted for each hybrid.

The tomato crop was established at a density of 33 500 plants per hectare, equivalent to 3.35 plants per m². The planting scheme included a spacing of 0.35 m between plants within the row and 0.50 m between rows, thereby ensuring an optimal balance between plant aeration and efficient space utilization.

The crop was established on soil mulched with black plastic film, a technological measure aimed at reducing evapotranspiration, limiting weed development, and maintaining a uniform soil temperature. Climatic factors were recorded using a CEM DT-172 thermo-hygrometer.

Tolstoi F1 is an indeterminate tomato hybrid exhibiting resistance to *Fusarium oxysporum* f. sp. *lycopersici* races 0 and 1, tomato *mosaic virus* (ToMV), and verticillium wilt. Kalina F1 is an indeterminate tomato hybrid with a growing period of 100-120 days. The plants are resistant to tomato mosaic virus (ToMV), verticillium wilt, fusarium wilt, and nematodes.

The experiments included four treatments, each arranged in three replicates. The greenhouse was divided into four compartments, separated by agryl fabric. The first compartment comprised the chemical treatment experiment, followed by the second compartment containing the integrated chemical + biological treatment, the third compartment with exclusively biological treatments, and the fourth compartment representing the untreated control.

In Treatment 1, throughout the entire growing season, the plant protection scheme consisted exclusively of applications of chemical-based products. In Treatment 2, chemical plant protection products were applied during the early stages of plant development; subsequently, upon the onset of the physiological fruit maturation stage, the treatment program was supplemented and replaced with plant extract-based products. In Treatment 3, during the entire growing period, phytosanitary management was carried out solely through the application of biological products.

The experimental variants for pest control were as follows: V1 - Coragen (chlorantraniliprole 20%) at 175 ml ha^{-1}; V2 - Coragen (chlorantraniliprole 20%) at 175 ml ha^{-1} + Oleorgan (Neem extract 40%) at 300 ml in 100 L, which means a concentration of 3%;

V3 - Oleorgan (Neem extract 40%) at a concentration of 3%; V4 - Untreated control.

The degree of attack caused by *Tuta absoluta* (tomato leaf miner) was calculated in accordance with the S.O.P./Mar. 2010 standard. Damage assessment was performed on five plants per replicate (20 plants per treatment), and five leaves were selected from each plant (25 leaves per replicate, 100 leaves per treatment). The efficacy of the control products was calculated using Abbott's formula.

During the growing season, observations were conducted regarding the occurrence and progression of pathogen attack (frequency and intensity of infection), based on this, the degree of attack (%) and product efficacy (%) were determined. Yield data were recorded dynamically by treatment and replicate and were subsequently statistically processed using the analysis of variance (ANOVA) method.

RESULTS AND DISCUSSIONS

Following the application of the four treatment variants for the control of *Tuta absoluta* (Figures 1, 2, and 3) in the tomato hybrid Kalina F1, the results obtained highlight clear differences among the control methods employed.

The lowest degree of attack was recorded in the variant treated exclusively with chemical products (V1), where the mean value of the degree of attack (DA) was 1.72%.

This represents a reduction of 11.25% compared to the untreated control, while treatment efficacy reached 86.74% (Table 1). The difference compared to the control was statistically highly significant, confirming the high effectiveness of the chemical treatment in reducing pest populations.



Figure 1. *Tuta absoluta* attack on tomato leaf



Figure 2. *Tuta absoluta* attack on tomato fruit



Figure 3. *Tuta absoluta* - adult

Table 1. Efficacy of control products against *T. absoluta* in the Kalina F1 hybrid

Variant	Mean DA (%)	Difference compared to the untreated control	% Compared to Control	Signi-ficance	E (%)
1	1.72	-11.25	13.25	000	86.74
2	2.29	-10.69	17.62	000	82.36
3	4.65	-8.32	35.82	000	64.14
4	12.98	-	100.00	-	-

LD 5% = 0.67; LD 1% = 0.98; LD 0.1% = 1.47

A high efficacy was also observed in the variant combining chemical and biological treatments (V2). In this case, the degree of attack was 2.29%, representing a reduction of 10.69% compared to the control, while the treatment efficacy reached 82.36%. Although slightly lower than V1, these results indicate that integrating biological products into the control scheme significantly contributes to reducing pest attack while promoting a more sustainable approach.

In the variant using only biological products (V3), treatment efficacy decreased to 64.14%, with a recorded degree of attack of 4.65%. While differences compared to the control remain significant, the results indicate that biological treatments, although beneficial, do not achieve the same level of pest control as variants including chemical products. This may be explained by the slower mode of action of biological agents or by the need for more frequent applications to reach maximum efficacy.

The untreated control (V4) exhibited the highest degree of attack, with a mean value of 12.98%, confirming the high pest pressure under the experimental conditions of this year.

Table 2. Efficacy of control products against *T. absoluta* in the Tolstoi F1 hybrid

Variant	Mean DA (%)	Difference compared to the untreated control	% Compared to Control	Signi-ficance	E (%)
1	1.20	-11.95	9.10	000	90.87
2	2.43	-10.72	18.45	000	81.52
3	4.58	-8.57	34.85	000	65.17
4	13.15	-	100.00	-	-

LD 5% = 0.63; LD 1% = 0.91; LD 0.1% = 1.37

In the Tolstoi F1 tomato crop, the lowest degree of attack was recorded in the variant treated exclusively with chemical products (V1), where the DA was only 1.20%. This represents a reduction of 11.95% compared to the control, and the treatment efficacy reached 90.87%, the highest among all analyzed variants (Table 2). Differences compared to the control were statistically highly significant, confirming that the chemical treatment provided the most effective pest control for this hybrid.

The variant receiving a combined chemical + biological treatment (V2) recorded a degree of attack of 2.43%, representing a reduction of 10.72% compared to the untreated control. The

treatment efficacy was 81.52%, demonstrating that integrating biological products into the chemical scheme maintains a high level of control over *Tuta absoluta.* The exclusively biological treatment (V3) achieved an efficacy of 65.17%, with a degree of attack of 4.58%. Although the reduction compared to the control remains statistically significant, the effectiveness of this treatment is lower than that of variants including chemical products. This suggests that biological products, while useful in pest management, require regular applications and may be more sensitive to environmental conditions, providing a moderate level of control over *T. absoluta.*

The untreated control (V4) exhibited the highest degree of attack at 13.15%, reflecting the significant pest pressure in Tolstoi F1.

In the 2025 experiment, for the Kalina F1 tomato crop, Treatment 1 (V1) resulted in an average yield of 3.374 Kg/m², representing a highly significant increase of +2.40 kg/m² compared to the control (348.07%; Table 3), indicating a positive impact on production. Treatment 2 (V2) recorded a yield of 2.868 kg/m², with a difference of +1.90 Kg/m² compared to the control (295.84%). In Treatment 3 (V3), using only biological products, the yield was 1.683 kg/m², with a significant increase of +0.71 kg/m² compared to the control (173.66%).

Thus, treatments involving chemical products, whether applied alone or in combination with biological products, demonstrated significant effectiveness in increasing tomato yield, whereas exclusively biological treatments had a less pronounced effect, and the absence of treatment led to a substantial decrease in yield.

Table 3. Yield obtained in 2025 for the Kalina F1 tomato crop

Variant	Mean (Kg/m²)	Difference compared to the untreated control	% Compared to Control	Significance
1	3.374	+2.40	348.07	***
2	2.868	+1.90	295.84	***
3	1.683	+0.71	173.66	*
4	0.969	-	100.00	-

LD 5% = 0.56; LD 1% = 0.82; LD 0.1% = 1.24

In the Tolstoi F1 tomato crop, the yield obtained in Treatment 1 (Table 4) was 3.330 kg/m², representing a highly significant increase of +2.45 kg/m² compared to the control (377.09%). Treatment 2 recorded a yield of 3.038 kg/m², with a highly significant difference of +2.15 kg/m² compared to the control (344.02%). Treatment 3, with biological products, achieved a yield of 2.210 kg/m², showing a significant increase of + 1.33 kg/m² compared to the control (250.28%). The untreated control (V4) had a yield of 0.883 kg/m², confirming the negative impact of pest attack on production in the absence of curative control measures.

Table 4. Yield obtained in 2025 for the Tolstoi F1 tomato crop

Variant	Mean (kg/m²)	Difference compared to the untreated control	% Compared to Control	Significance
1	3.330	+2.45	377.09	***
2	3.038	+2.15	344.02	***
3	2.210	+1.33	250.28	*
4	0.883	-	100.00	-

LD 5% = 0.98; LD 1% = 1.43; LD 0.1% = 2.15

This study was a comparison between chemical and biological control of the mining moth. The best results were obtained with the chemical variant, but the trend is to eliminate chemicals and try biological control by releasing parasites and predators and using biopesticides.

Microbial biopesticides are generally less damaging to the environment than chemical insecticides, tend to be safer for humans and other vertebrates, and can coexist with other beneficial organisms, such as natural predators of arthropods (Desneux et al., 2022).

Bioinsecticides are pest control agents obtained from living organisms, including bacteria, fungi, and viruses. They are widely used in the management of insect pests and are regarded as environmentally sustainable alternatives to conventional synthetic insecticides (Mawcha et al., 2025). Compared to chemical products, bioinsecticides generally exhibit lower toxicity toward non-target species and demonstrate reduced persistence in the environment. Owing to these advantages, they have attracted considerable interest in their potential role in sustainable agricultural pest management (Fazeli-Nasab et al., 2022; Mawcha et al., 2025). Entomopathogenic agents such as *Bacillus thuringiensis*, *Beauveria bassiana*, spinosad, and neem extract represent environmentally

friendly and efficient solutions for pest control in both high plastic tunnel systems and open-field cultivation (Sridhar et al., 2019; Ali & Muhammad, 2023).

Fungal biocontrol agents, especially *Metarhizium anisopliae* and *Beauveria bassiana*, show strong potential against *Tuta absoluta*. Several *M. anisopliae* strains caused significant mortality, including 37.14% in females, while some *B. bassiana* strains achieved over 90% larval mortality (Shiberu et al., 2018; Basit et al., 2025). Mortality rates of 87%, 57%, and 66% were recorded in second-instar radish leaf miner larvae exposed to *M. anisopliae*, *Verticillium lecanii*, and *B. bassiana*, respectively (Basit et al., 2025). Other fungi, such as *Isaria*, *Lecanicillium*, *Purpureocillium*, *Aspergillus*, and *Clonostachys* spp., have also been used (Basit et al., 2025).

Managing *Tuta absoluta* in tomato crops remains a major challenge for agriculture worldwide. Nevertheless, the use of biotechnological approaches offers promising opportunities for significant advancements.

CONCLUSIONS

The findings of this study confirm that chemical treatments remain the most effective method for controlling *Tuta absoluta* in both Kalina F1 and Tolstoi F1 tomato hybrids, as they ensured the lowest degree of attack and the highest yields. For example, in the Kalina F1 hybrid, the chemical treatment (V1) reduced the degree of attack to 1.72% and achieved an efficacy of 86.74%, while in Tolstoi F1 it reached an even higher efficacy of 90.87% with a degree of attack of only 1.20%. Similarly, these treatments resulted in the highest yields, such as 3.374 kg/m² in Kalina F1 and 3.330 kg/m² in Tolstoi F1. The combined chemical and biological treatment (V2) also showed strong performance, with efficacy values of 82.36% (Kalina F1) and 81.52% (Tolstoi F1), demonstrating that integrating biological products can maintain a high level of control while supporting more sustainable practices. In contrast, the biological-only treatment (V3) provided moderate results, with lower efficacy (around 64–65%) and reduced yields compared to V1 and V2, although still significantly better than the untreated control. The control variants (V4), which recorded high attack levels (up to 13.15%) and very low yields (as low as 0.883 kg/m²), highlight the severe impact of the pest in the absence of treatment. Overall, although chemical control offers the best results, the integration of biological methods represents a viable and increasingly important strategy for sustainable agriculture.

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