



Article

Comparison of the Effectiveness of Some Synthetic Pesticides and a Bio-Pesticide Against the Spider Mite *Tetranychus urticae* Koch, and Their Impact on the Predatory Mites in Eggplant

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<https://doi.org/10.37229/fsa.fja.2026.05.01>

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Future Science Association

Available online free at
www.futurejournals.org

Print ISSN: 2687-8151

Online ISSN: 2687-8216

Received: 27 February 2026

Accepted: 20 April 2026

Published: 1 May 2026

Publisher's Note: FA stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Abstract: The aim of this study was to evaluate the effectiveness of various conventional pesticides in controlling the phytophagous mite *Tetranychus urticae* Koch compared to a bio-pesticide on eggplant plants during the two consecutive growing seasons of 2024 and 2025 in Fayoum Governorate, Egypt. The compounds used were Gold 1.8% EC (Abamectin 1.8% EC), Gate Fast 12% SC (Thiamethoxam 10% + Abamectin 2%), Azomad 23.8% SC (Imidacloprid 30% + Abamectin 2.8%), and Insect Free (*Beauveria bassiana*). The impact of these pesticides on predatory mites was also observed. The treatments were evaluated at different day's intervals, and each treatment comprising four replicates. The results showed that Gold had the highest immediate reduction effect (92% and 86%), followed by Gate Fast, Azomad, and Insect Free during the two application seasons, respectively. Gold also recorded the highest overall mean reduction percentage, 80.1%, followed by Gate Fast at 64%, Insect Free at 57.8%, and Azomad at 49.7% in the first season, while these percentages were 78.9%, 61.5%, 58.6%, and 40.4% for Gold, Insect Free, Gate Fast, and Azomad in the second one, respectively. The results also indicated that conventional compounds were more effective during the first spraying season than during the second one, while the bio-pesticide was more effective in the second spraying season than in the first one. Furthermore, the highest average populations of predatory mites (0.47 and 0.66) were observed with the Insect Free treatment, while the lowest average populations (39.0 and 37.0) were recorded with the Gold treatment during the first and second applications, respectively. These findings suggest that the bio-pesticide could effectively control phytophagous mites while remaining safe for beneficial mites, thus confirming its potential as an alternative to conventional chemical pesticides.

Key words: Pest control, *Tetranychus urticae* Koch, *Beauveria bassiana*, Eggplant.

1. Introduction

Eggplant, *Solanum melongena* L. (Solanaceae) is a warm-weather crop and one of the most prevalent vegetable crops worldwide, especially in Africa, subtropical regions, Southeast Asia and the Middle East (FAO 2017 and Chapman 2019). Eggplant fruit is a rich source of numerous nutrients, carbohydrates, dietary fiber, protein, vitamins, essential minerals and some bioactive compounds (Shanmugavelu 1989; Srinivasan 2009 and Mahamad *et al.*, 2022). In Egypt, the total cultivated area reached 147288 fedden (fed.) in 2023 producing 1813091 tons with an average yield of 12.3 tons/fed. (Anonymous, 2024).

Sucking pests inflict considerable harm on various crops, with spider mites being among the most damaging to global agriculture, resulting in significant losses (McAuslane, 2002; Oliveira *et al.*, 2013 and Lima *et al.*, 2017). *Tetranychus urticae* Koch is recognized as a global pest affecting a wide array of horticultural crops, both in open fields and greenhouses (Mikhail *et al.*, 2015). This pest is one of the primary threats to brinjal, causing extensive damage and loss of yield (Eswara and Srinivasa, 2001 and Dutta *et al.*, 2017).

The swift rise in population densities consequently results in increased use of acaricides, which negatively impact the population of natural enemies. Furthermore, the ongoing development of resistance to commonly used chemical pesticides continues to pose a significant challenge for controlling this pest (López-Manzanares *et al.*, 2022).

Furthermore, imprudent pesticide uses and heavy doses of insecticides pose problems of residue in the fruits, which can cause health hazards upon consumption. Additionally, they can lead to pest resurgence, insecticide resistance, destruction of natural enemies, and environmental pollution. However, chemical pesticide use can be reduced by integrating them with botanical and microbial pesticides to produce healthy, high-quality crops (Miller, 2004; Denholm and Devine, 2013; Tony *et al.*, 2017 and Gad *et al.*, 2021).

Although systemic insecticides can be highly effective, they may also adversely affect beneficial insects and pollinators (Flint, 2002). Relying exclusively on insecticides poses considerable challenges; therefore, it is crucial to develop and adopt bio-rational insecticides that are highly selective, environmentally friendly, and feature novel modes of action for integration into pest management strategies (Horowitz and Ishaaya, 2004; El-Kareim *et al.*, 2015 and Mousa *et al.*, 2025).

Biopesticides, which are based on plants or pathogenic microorganisms and are specific to the target pest, provide an ecologically sustainable and effective solution for pest management (Gupta, 2010; Baker *et al.*, 2020 and Pasupulla *et al.*, 2021). Among biological control agents, *Beauveria bassiana* (Balsamo Crivelli) is a highly effective organism that can be integrated into pest management strategies for controlling piercing and sucking insects (Biswas *et al.*, 2015). This fungus is non-toxic to plants, humans, animals, and non-target insects (Khetan, 2001 and Wu *et al.*, 2014). It has been increasingly applied for the biological control of insect pests (Bruck, 2010; McKinnon *et al.*, 2018). *Beauveria* also can be applied to a wide range of plant hosts without causing damage or disease, while still maintaining the capacity to infect mites and insects (Legaspi *et al.*, 2000; Rohrllich *et al.*, 2018 and Sinno *et al.*, 2021). Fungal pathogens to mites play an important role in regulating of natural mite populations and are sometimes able to decimate populations of phytophagous mites (Van der Geest *et al.*, 2000).

Thus, the purpose of this research is to evaluate the efficacy of certain chemical pesticides against the two-spotted spider mite, *Tetranychus urticae* Koch, compared to a biological pesticide sourced from the fungus *Beauveria bassiana*. The impact of these pesticides on predatory mites also was observed.

2. Materials and Methods

The experiment design

The experiment was carried out during the 2024 and 2025 seasons on eggplant in Sinnuris, Fayoum Governorate, Egypt. The crop was cultivated in an area of around 1200m² divided into four plots of about 300m² each. Each plot was divided into four equal replicates and distributed using a Randomized Complete Block Design.

Pesticides application

As shown in Table (1), four compounds - Gold, Gate Fast, Azomad, and Insect Free - were tested against the phytophagous mite *Tetranychus urticae* Koch (mobile stages). The treatments were applied when the infestation reached the threshold level for treatment, using a knapsack motor sprayer. The side effects on predatory phytoseiid mites were also evaluated.

Table (1). Description of tested pesticides and doses

Trade name	Active Ingrediednt	Application rate
Gold 1.8% EC	Abamectin 1.8% Ec	40 cm ³ /100L water
Gate Fast 12% SC	Thiamethoxam 10%+Abamectin 2%	200 cm ³ /fedden
Azomad 32.8% SC	Imidacloprid 30%+Abamectin 2.8%	50 cm ³ /100L water
*Insect Free	<i>Beauveria bassiana</i>	1Liter/100L water

*Produced by Central Lab. of Organic Agriculture, Agricultural Research Center, Egypt.

Sampling and evaluation

Thirty leaves per replicate were taken randomly at intervals 3, 5, 7, and 10 days after. The picked leaves were hold in separate sample bag which were properly labeled and individually examined in the laboratory under a binocular. The efficiency of tested treatments was evaluated as a percentage of reduction in pest population density using the **Henderson and Tilton formula (1955)**.

Statistical analysis

Obtained data was subjected to one-way analysis of variance (ANOVA), and the values were compered at 5% level. Mean values of variables were separated by Duncan's multiple range test (**Duncan 1955**) ($p \leq 0.05$).

3. Results and Discussion

I- Efficacy of evaluated pesticides against *Tetranychus urticae*

First season, 2024

The data provided in Table (2) indicated that Abamectin was the most potent in decreasing the mite population, achieving the highest reduction rates of 92.0% and 86.7% after the 3rd and 5th day of treatment, respectively. Its effectiveness then steadily declined to 75.4% and 66.4% after the 7th and 10th day, respectively. In contrast, Gate Fast and Azomad demonstrated a moderate level of effectiveness, with the greatest population reduction reaching 78.6% and 68.6% and 58.5% and 55.0% after the 3rd and 5th day of treatment, respectively. The effectiveness noticeably dropped to (60.1 and 48.5%) and (44.1 and 41.3%) after the 7th and 10th day for Gate fast and Azomad, respectively.

Regarding the tested biopesticide Insect Free, significant reduction rates of 80.3% and 63.1% were observed after the 5th and 7th days of treatment, respectively. **Adel *et al.* (2018)** found that the highest control rates were observed after the fourth day following each spraying, but then the efficacy decreased to 57.8% after the 10th day of application (Table 2).

The results aligned with those of Ibrahim and **Al-Shannaf (2017)** who found that the insecticides Dinotefuran and Parathionmethyl achieved the most significant reduction of *T. urticae* after 24 hours, while Spinosad and Azadirachtin showed their greatest impact after three days of treatment. Likewise, **Kumar *et al.* (2023)** observed that the synthetic pesticide Clofentazine was 89.96% effective in reducing *T. urticae* population, followed by Cyflumetofen at 81.04%. In comparison, biopesticides like NSKE achieved a control rate of 52.32%, whereas Azadirachtin recorded 46.52%. Similarly, **Singh *et al.* (2014)** and **Singh *et al.* (2017)** conducted a comparative analysis of synthetic acaricides and biopesticides, concluding that Clofentazine was the most effective treatment against spider mites among all the pesticides evaluated.

Second season, 2025

During the second spray season, comparable results were achieved with Abamectin, although its effectiveness was reduced in comparison to the outcomes observed after the first application. The peak reduction percentages of 86.0% and 83.2% were observed on the 3rd and 5th days, respectively; following this, the effectiveness declined gradually, leading to reduction values of 77.9% and 68.3% recorded on the 7th and 10th days of treatment. Gate fast demonstrated the second highest effect with initial effectiveness values of 72.1%, followed by Azomad at 50.2% after the 3rd day of spraying. Subsequently, the effectiveness decreased progressively, reaching the lowest reduction percentages of 42.2% and 32.0% by the end of their respective evaluation periods. Conversely, Insect Free exhibited a modest initial effect of 47.2%, which gradually increased to a peak reduction ratio of 74.8% by the 7th day, before declining to 65.6% after the 10th day of application (Table 2).

Similar findings were reported by **Ali *et al.* (2016)**, who investigated the impact of chemical and bio-pesticides on mite populations in brinjal. Their findings indicated that chemical agents exhibited the most direct and significant suppressive effect, followed by botanical substances. Additionally, in a related investigation, **Ali *et al.* (2017)** discovered that bio-pesticides demonstrated high effectiveness against mite populations on brinjal in field conditions during two different application periods. Moreover, the results of this study indicate that the efficacy of the biopesticide significantly increased after the third day of application. These findings align with those of **Wakil *et al.* (2025)** and **Wu *et al.* (2016)**, who explained that the effect of the fungus *B. bassiana* takes approximately three days to manifest on *T. urticae* adults. Furthermore, our results indicated that the biopesticide treatment recorded the total average population reduction 61.5% higher than Gate Fast 58.6%, and Azomad 40.4%. Consequently, our results suggest that the biopesticide Insect Free was effective in mite control and can be used as a good alternative or supplementary form of pest control and included in IPM strategies. Several previous studies have shown that *Beauveria bassiana* has demonstrated considerable potential in the management of *T. urticae* and in providing an effective biological control option as an alternative to the broad-spectrum synthetic acaricides (**Horowitz and Ishaaya, 2004; Elhakim *et al.*, 2020** and **Wakil *et al.*, 2024**).

In general, Abamectin demonstrated the highest overall average reduction rates of 80.1% and 78.9% in the two consecutive applications. Regarding the other compounds, their ranking was as follows: Gate Fast, Insect Free, and Azomad, with overall average reduction rates of 64.0%, 57.8%, and 49.7% for the first application, while the second application showed the order of Insect Free, Gate Fast, and Azomad with average reduction rates of 61.5%, 58.6%, and 40.4%, respectively (Table 2). These findings indicate that reassessment throughout the season or the use of a second confirmatory application offers a more precise measure of the effectiveness of the tested substances. Similar

findings were reported by **Ali *et al.* (2017)** who found that the average reduction percentage of whitefly population on brinjal was higher in the 1st spray than in the 2nd one. These results are supported by the findings of **Horowitz and Ishaaya (2004)**, **Biswas *et al.* (2015)** who suggested that bio-rational insecticides are good alternatives and they can be used in the IPM programs.

Table (2). Effects of various substances on *Tetranychus urticae* populations on eggplants under field conditions during the 2024 and 2025 growing seasons

2024 season									
Treatments	Sample Intervals After Spray								R %
	3 day	r %	5 days	r %	7 days	r %	10 days	r %	
Abamectin	3.35 ±0.79a	92.0	4.90 ±2.23a	86.7	11.38 ±2.26a	75.4	18.80 ±2.18a	66.4	80.1
Gate Fast	8.93 ±2.92a	78.6	17.67 ±3.40a	68.6	18.65 ±1.32a	60.1	21.67 ±3.40a	48.5	64.0
Azomad	22.45 ±5.51b	58.5	15.58 ±1.98b	55.0	27.30 ±1.12b	44.1	29.63 ±7.17b	41.3	49.7
Insect Free	30.38 ±6.73c	30.0	11.48 ±1.43a	80.3	16.80 ±1.87a	63.1	14.27 ±1.79b	57.8	57.8
ANOVA	<0.001		<0.001		<0.001		0.005		
LSD5%	7.239		3.197		2.220		6.386		
2025 season									
Treatments	Sample Intervals After Spray								R %
	3 day	r %	5 days	r %	7 days	r %	10 days	r %	
Abamectin	4.25 ±1.42a	86.0	7.10 ±2.10a	83.2	8.40 ±1.48a	77.9	16.75 ±3.93a	68.3	78.9
Gate Fast	8.50 ±2.64a	72.1	13.15 ±1.71a	60.9	19.83 ±2.83a	59.2	23.83 ±2.83a	42.2	58.6
Azomad	27.07 ±5.00b	50.2	23.75 ±2.48b	43.4	19.17 ±5.08b	36.0	32.98 ±6.05b	32.0	40.4
Insect Free	25.67 ±4.18b	47.2	21.78 ±0.81b	58.4	8.03 ±1.64a	74.8	17.20 ±4.84a	65.6	61.5
ANOVA	<0.001		<0.001		<0.001		<0.001		
LSD5%	5.695		2.829		3.753		6.193		

The represented data are means ± SD followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test ($p \leq 0.05$). r % and R % average and overall average reduction of pest population, respectively. LSD5% stands for Least Significant Difference at a 5% significance level.

II. Impact of evaluated pesticides on predatory phytoseiid mites

The findings presented in Table (3) suggest that there was no significant difference among the treatments concerning their impact on the predatory mite population during the first spray season, 2024. The Insect Free displayed the least influence, resulting in the highest population average of 0.47, while Azomad had the most substantial impact, leading to the lowest population average of 0.35. Similarly, during the second season in 2025, Insect Free recorded the highest average phytoseiid population of 0.66, while Abamectin exhibited the lowest average of 0.37. Some other studies, consistent with our findings, reported that abamectin has a more harmful effect on phytoseiid mites. However, the total effect values of all concentrations were below the lower threshold; thus, it can be considered as less harmful acaricide to these predatory mites (**Nadimi *et al.*, 2008; Hamedi *et al.*, 2010; Kaplan *et al.*, 2012**). Accordingly, the bio-pesticide Insect Free is regarded as the safest for predatory mites. Nevertheless, pesticides can influence the predatory and reproductive behaviors of beneficial arthropods without directly impacting their survival (**Hamedi 2022**). Despite this, there are

few studies investigate the sub lethal effects of insecticides beyond their direct toxicity to non-target species (Hamed *et al.* 2010). Consequently, to demonstrate that a pesticide poses minimal risk or has no significant impact, it is essential to conduct further behavioral studies focusing on the effects of sub lethal concentrations (El-Wakeil *et al.*, 2013; Alhewairini and Al-Azzazy, 2022).

Table (3). Mean number of Phytoseiid mites on eggplants observed under field conditions during the 2024 and 2025 growing seasons

2024 season					
Treatments	Sample Intervals After Spray				
	3 day	5 days	7 days	10 days	Average
Abamectin	0.60 ±0.44a	0.23 ±0.22a	0.18 ±0.10a	0.53 ±0.29b	0.39±0.21b
Gate Fast	0.60 ±0.43a	0.30 ±0.08a	0.23 ±0.17a	0.63 ±0.17ab	0.44±0.20ab
Azomad	0.38 ±0.10a	0.23 ±0.13a	0.30 ±0.18a	0.50 ±0.18b	0.35±0.12b
Insect Free	0.30 ±0.26a	0.25 ±0.19a	0.38 ±0.28a	0.93 ±0.22a	0.47±0.31ab
ANOVA	0.144	0.918	0.39	0.076	
LSD5%	0.325	0.280	0.264	0.348	0.227
2025 season					
Treatments	Sample Intervals After Spray				
	3 day	5 days	7 days	10 days	Average
Abamectin	0.28 ±0.10b	0.13 ±0.13a	0.28 ±0.13b	0.78 ±0.29a	0.37±0.28b
Gate Fast	0.30 ±0.14b	0.30 ±0.22a	0.33 ±0.21b	1.03 ±0.21a	0.49±0.36ab
Azomad	0.28 ±0.17b	0.20 ±0.14a	0.35 ±0.13b	1.00 ±0.22a	0.46±0.37ab
Insect Free	0.53 ±0.15a	0.30 ±0.14a	0.85 ±0.29a	0.95 ±0.13a	0.66±0.30a
ANOVA	0.071	0.23	0.005	0.432	
LSD5%	0.214	0.207	0.292	0.359	0.199

The represented data are means ± SD followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test ($p \leq 0.05$). r % and R % average and overall average reduction of pest population, respectively. LSD5% stands for Least Significant Difference at a 5% significance level.

4. Conclusion

The findings from this research indicated that the acaricide Gold was the most effective in the immediate reduction of *T. urticae* populations and achieved the highest overall average reduction. Conversely, the biological pesticide Insect Free demonstrated delayed effectiveness in reducing populations but achieved a higher average reduction than Gate Fast and Azomad by the end of the evaluation period. Additionally, the presence of predatory mites was greater with Insect Free, suggesting that it could be an effective and safe alternative to traditional chemical pesticides for pest control.

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مقارنة فعالية بعض مبيدات الآفات المخالقة ومبيد حيوي ضد الحلم العنكبوتي *Tetranychus urticae* Koch وتأثيرها على الأكاروسات المفترسة في الباذنجان

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الملخص

هدفت هذه الدراسة إلى تقييم فعالية بعض المبيدات الحشرية التقليدية في مكافحة العثّ النباتي *Tetranychus urticae* Koch، مقارنةً بمبيد حيوي على نباتات الباذنجان خلال موسمي 2024 و 2025 في محافظة الفيوم بمصر. وشملت المركبات المستخدمة: Gold 1.8% EC (أبامكتين 1.8%)، و Gate Fast 12% SC (ثياميثوكسام 10% + أبامكتين 2%)، و Azomad 23.8% SC (إيميداكلوبريد 30% + أبامكتين 2.8%)، و Insect Free (فطر *Beauveria bassiana*). كما رُصد تأثير هذه المبيدات على العثّ المفترس. أظهرت النتائج أن Gold حقق أعلى تأثير فوري في خفض الإصابة (92% و 86%)، يليه Gate Fast، ثم Azomad، وأخيراً Insect Free خلال موسمي الرش على التوالي. سجل مبيد "جولد" أعلى نسبة انخفاض إجمالية بلغت 80.1%، يليه "جيت فاست" بنسبة 64%، ثم "إنسكت فري" بنسبة 57.8%، وأخيراً "أزوماد" بنسبة 49.7% في الموسم الأول. بينما في الموسم الثاني فكانت هذه النسب 78.9%، و 61.5%، و 58.6%، و 40.4% لكل من "جولد"، و"إنسكت فري"، و"جيت فاست"، و"أزوماد" على التوالي. كما أظهرت النتائج أن المركبات التقليدية كانت أكثر فعالية خلال الموسم الأول مقارنةً بالموسم الثاني، بينما كان المبيد الحيوي أكثر فعالية في الموسم الثاني مقارنةً بالموسم الأول. علاوة على ذلك، سُجلت أعلى متوسطات أعداد العثّ المفترس (0.47 و 0.66) مع معالجة "إنسكت فري"، بينما سُجلت أدنى متوسطات الأعداد (39.0 و 37.0) مع معالجة "جولد" في الرشتين الأولى والثانية على التوالي. تشير هذه النتائج إلى أن المبيد الحيوي يمكنه التحكم بشكل فعال في العثّ النباتي مع الاحتفاظ بتأثيره المنخفض على العثّ المفيد، مما يوضح إمكاناته كبديل للمبيدات الكيميائية التقليدية.