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Efficacy of the predatory mite *Amblyseius swirskii* (Acari: Phytoseiidae) and selected acaricides in controlling phytophagous mites on eggplant under field conditions

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Abstract

Field trials conducted in Gharbia Governorate during the 2025 summer season evaluated the efficacy of the predatory mite *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) (At 10 and 20 predators/plant) and selected acaricides (Abamectin, bifenazate, spiroticlofen) for controlling key phytophagous mites on eggplant. The release of *A. swirskii* at 20 predators/plant resulted in the most consistent and significant reductions in *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae) (Mean reduction: 77.52%) and *Tetranychus urticae* Koch (Acari: Tetranychidae) (Mean reduction: 86.70%), outperforming all chemical treatments. For *Aculops lycopersici* (Massee) (Acari: Eriophyidae) the 20 predators/plant treatment achieved comparable efficacy to chemical acaricides, with a mean reduction of 70.54%, not significantly different from bifenazate, spiroticlofen, or abamectin. Yield data showed that the 20 predators/plant treatment produced the highest eggplant yield (39,124.77 kg/fed), while the greatest economic return was associated with the abamectin and 10 predators/plant treatments due to lower control costs. Overall, *A. swirskii*, particularly at higher release rates, provided effective and sustainable mite suppression, resulting in improved yield and substantial economic gains. These findings support its integration into integrated pest management (IPM) programs as a viable alternative to chemical acaricides in eggplant production..

Introduction

Eggplant, *Solanum melongena* L. (Solanaceae) is among the most economically significant solanaceous vegetables cultivated worldwide, particularly in tropical and subtropical regions. However, its production is severely constrained by infestations of phytophagous mites, which damage

plant tissues, reduce photosynthetic capacity, and ultimately decrease yield and fruit quality. Among the most destructive species are the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), broad mite *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae) and the tomato russet mite, *Aceria lycopersici*

(Massee) (Acari: Eriophyidae). These pests are notorious for their rapid population growth and ability to thrive in hot and dry conditions, which often prevail in open-field eggplant production systems (Jovicich *et al.*, 2009; Srinivasan, 2009; Stansly and Castillo, 2009; Migeon and Dorkeld, 2022; Dwarka *et al.*, 2024 and Elhalawany *et al.*, 2024b).

Chemical acaricides remain the mainstay of mite management in eggplant fields. Compounds such as abamectin, bifentazate and spirotetramat are commonly applied to suppress phytophagous mites populations (Elhalawany and El-Sayed, 2013; Barbar, 2017 and El-Saiedy *et al.*, 2015). While initially effective, the intensive use of these chemicals has resulted in serious concerns, including resistance development, residue accumulation in the environment, and negative impacts on beneficial arthropods (Andrade *et al.*, 2025). Hence, reliance on acaricides alone is not a sustainable long-term solution.

Biological control using predatory mites offers an environmentally friendly alternative. *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) has emerged as a particularly promising biocontrol agent due to its polyphagous feeding habits, ability to adapt to diverse crops, and proven efficacy against a wide range of pests including thrips, whitefly and phytophagous mites (Calvo *et al.*, 2015). Its compatibility with certain chemical acaricides further enhances its potential within integrated pest management (IPM) programs, where combining chemical and biological tactics may achieve more sustainable suppression of mite populations (Elhalawany *et al.*, 2024 a and b).

A cornerstone of modern IPM is the use of biological control agents, particularly predatory mites. The phytoseiid mite *A. swirskii* has emerged

as a highly effective generalist predator in both protected and open-field agriculture. It is renowned for its voracious appetite for key pests like *T. urticae* and its ability to establish and persist on various crops, including eggplants (Fouly *et al.*, 2025). Its incorporation into pest management programs offers a proactive, biologically based tool to suppress mite populations below economic injury levels (Singh, 2017).

A promising approach to enhance and stabilize mite control is the strategic integration of biological and chemical tactics. This involves combining releases of *A. swirskii* with acaricides that are selective causing minimal harm to the predator while effectively controlling the target pests. Evaluating the compatibility of *A. swirskii* with newer, reduced-risk acaricides like spirotetramat and bifentazate, as well as established ones like abamectin, is critical for designing robust IPM protocols. Therefore, this study was conducted to evaluate the efficacy of the predatory mite *A. swirskii*, both alone and in combination with the selected acaricides (Abamectin, bifentazate and spirotetramat), in controlling populations of *T. urticae*, *P. latus* and *A. lycopersici* on eggplant under field conditions.

The findings aim to provide a scientific basis for developing effective, sustainable, and environmentally responsible mite management strategies for eggplant cultivation.

Materials and methods

1. Experimental site:

Experiments were carried out at Zefta city (30°42'11.07"N, 31°11'0.11"E), Gharbia Governorate, Egypt, during the 2025 summer season, under field conditions. The 'Black Beauty' eggplant cultivar was cultivated during the summer season.

2. Mass rearing of predatory mite:

The predatory mite, *A. swirskii*, colonies were collected from strawberry plants at Zefta City, Gharbia Governorate, Egypt, in November 2024. The colonies of *A. swirskii* were reared on mulberry leaves and fed on *Carpoglyphus lactis* (L.) (Acari: Carpoglyphidae) and *T. urticae* as a food source in the laboratory at $25 \pm 2^\circ\text{C}$ and $65 \pm 5\%$ R.H. and a photoperiod of L16:D 8 hrs. Predatory mites were mass-reared in a plastic-net greenhouse with 20 mesh porosity and dimensions of 4×8 m. By early February 2025, bean plants had been planted and, after 15 days, infested with *T. urticae*, and two weeks later, the predatory mites were moved from the

lab onto kidney bean leaves in an icebox and set free in the greenhouse. The predatory mites were placed on kidney bean leaves, and an estimate of the quantity was stored in plastic bags that were securely fastened with rubber bands. The bags were then kept in an icebox at 10°C until they were released.

3. Chemical acaricides used:

Three acaricides are used for controlling three phytophagous mites: *T. urticae*, *P. latus*, and *A. lycopersici* in eggplant. The details about the recommended dose of application, molecular formula, trade name, and mode of action are provided in Table (1).

Table (1): List of the tested acaricides used and their application rates.

Common name	Trade name	Mode of action	Molecular Formula	Rate of use/ 100 liters of water
Abamectin	Farmactin 1.8% EC	Neurotoxin; disrupts nervous system	$\text{C}_{95}\text{H}_{142}\text{O}_{28}$	40 ml
Bifenazate	Evouly 43% SC	Mitochondrial complex III inhibitor	$\text{C}_{17}\text{H}_{20}\text{N}_2\text{O}_3$	35 ml
Spiromesifen	Concor 24%SC	lipid biosynthesis inhibitor	$\text{C}_{21}\text{H}_{24}\text{Cl}_2\text{O}_4$	25ml

EC = Emulsifiable concentrate, SC= Suspension concentrate.

4. Experimental design and sampling:

The 'Black Beauty' eggplant cultivar was transplanted in an open field in a completely randomized block design in ($\frac{1}{4}$ feddan) with four replicates; each replicate consisted of four rows (10 m long). Plants were spaced 50 cm between plants and 100 cm between rows (Totally 320 plants/ treatment). Plastic sheets were used as barriers between treatments. The seedlings of eggplant were sown in early March 2025, using the recommended agriculture practices. Experiments contained five treatments and a control, conducted in an open field: T1 (10 adults of *A. swirskii*/plant), T2 (20 adults of *A. swirskii*/plant), T3 (Abamectin), T4 (Bifenazate), T5 (Spirodiclofen), and T6 (untreated plot

served as control). The infestation by phytophagous mites occurred naturally. The predatory mite *A. swirskii* was released twice in mid-April and mid-May (After 6 and 10 weeks of plantation) at two levels: 10 and 20 individuals/plant. Whereas the pesticides were applied starting from mid-April and then every two weeks until the end of the experiment, totaling approximately 8 applications.

5. Sampling:

Plants were monitored at weekly intervals for 22 weeks after planting, beginning on 15 April 2025. Population densities of the targeted pests *T. urticae*, *P. latus*, and *A. lycopersici* were estimated weekly throughout the plant growing season. Forty leaves per treatment were randomly picked up weekly. Leaves and samples were

placed into perforated polyethylene bags, closed with rubber bands, and transferred to the laboratory for examination using a stereomicroscope. All motile stages of each pest found on eggplant leaves were counted along with the number of predatory mites.

6. Economic importance:

At the end of the growing season, the eggplant production yields per treatment were calculated. The reduction percentage in yield was

Cost benefit = Costs of yield production – control costs (Price of predator or acaridae + labor cost).

Return (Increase) (LE) = Yield price (LE) in treatment – Yield price (LE) in control

7. Statistical analysis:

The effects of the predatory mite and three acaricides on phytophagous mite populations were compared to control (Untreated) starting from mid-April

calculated according to Abbott's formula (1925) as follows:

Reduction % = $100 \times [(Ta - Tc) / Ta]$

Where: Ta = total yield in biological treatment, Tc = total yield in control (Untreated) treatment.

Yield (kg/feddan) = total number of fruits/feddan * average weight of fruit

As well, cost-benefit analyses of the outcomes of applying biological and chemical control were conducted (El Arnaouty *et al.*, 2020 and Elhalawany *et al.*, 2024 a and b) as follows:

until the end of the experiment after 16 weeks. Reduction percentages were calculated according to Henderson and Tilton (1955) as follows:

$$\text{Reduction\% of population} = 1 - \left[\frac{A}{C} \times \frac{B}{D} \right] \times 100$$

Where:

A = Number of mites in treatment after application

B = Number of mites in control before application

C = Number of mites in treatment before application

D = Number of mites in control after application

Percent reduction of phytophagous mites was analyzed by two-way ANOVA and means were compared by using Tukey's Honestly Significant Difference (HSD) test at a significance level was of $P < 0.05$. Analysis was conducted using SAS statistical software (SAS Institute, 2003).

Results and discussion

Figure (1) illustrates the population dynamics of *A. swirskii* on eggplant leaves under different treatments during the 2025 growing season. The experiment compared two release rates of *A. swirskii* (10 and 20 predators/plant) with three acaricides (Abamectin, bifenazate, and spiromesifen), alongside an untreated control, and monitored the predatory mite population across four subfigures. The population of *A. swirskii* increased gradually following the initial release, peaking between late June and mid-July.

The treatment with 20 predators/plant consistently showed higher mean numbers of *A. swirskii* per leaf compared to the 10 predators/plant group throughout the season, with peak values around 2.8–3.0 mites/leaf.

1. Broad mite *Polyphagotarsonemus latus*:

The mean numbers of *P. latus*, in untreated control experienced a continuous increase in infestation, reaching the highest value of approximately 26 mites/leaf by early August. In contrast, all treatments (Predatory mites and acaricides) significantly suppressed the *P. latus* population, maintaining it below 5 mites/leaf throughout the season. The lowest numbers were observed in the 20 predators/plant treatment, followed by spiromesifen and bifenazate.

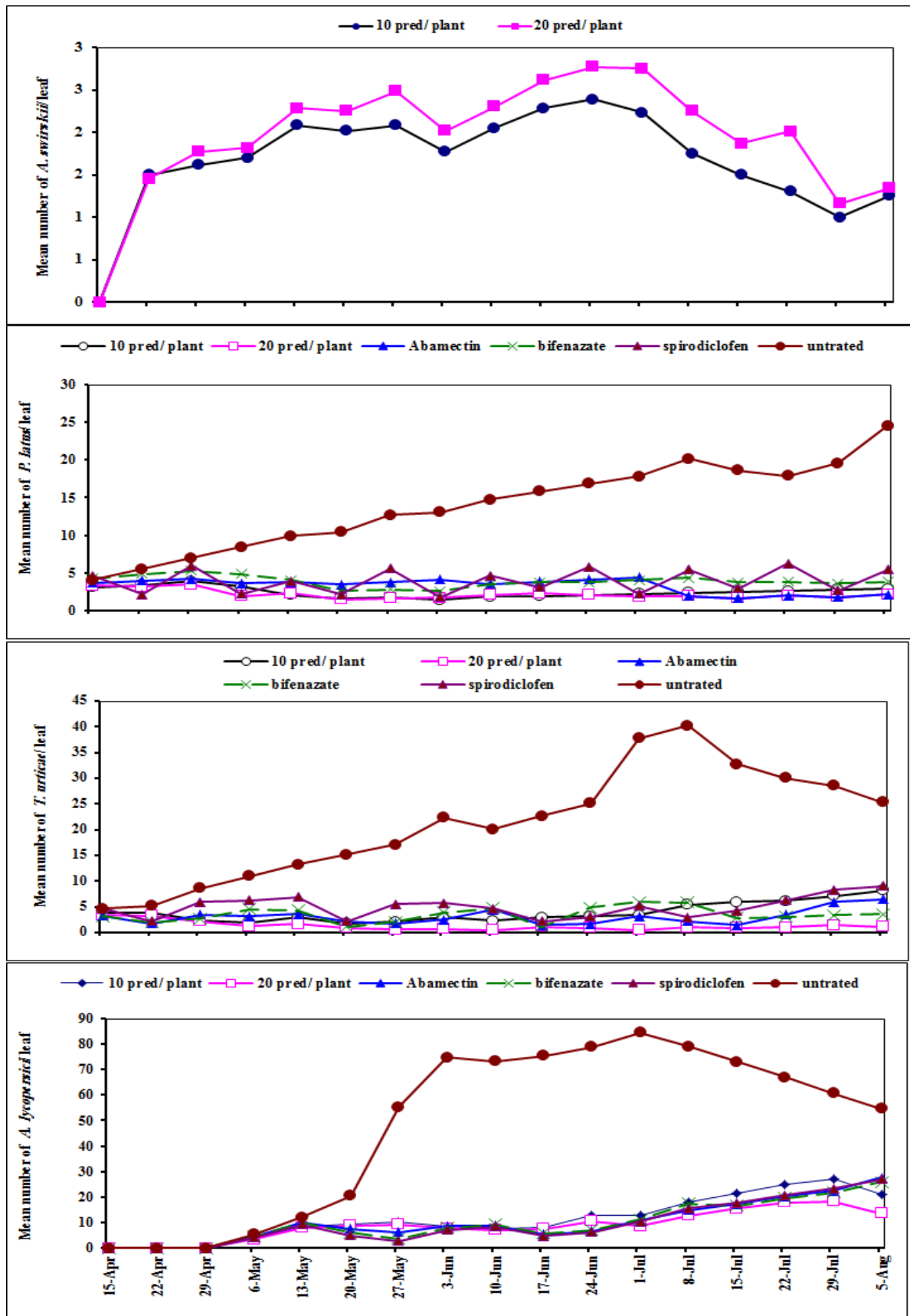


Figure (1): Mean number of *Amblyseius swirskii*/leaf for each sampling date on eggplant in open field infested with *Polyphagotarsonemus latus*, *Aceria lycopersici*, and *Tetranychus urticae* in 2025 season.

Results in Table (2) and Figure (1) present the reduction percentages of the broad mite *P. latus* on eggplant in an open field in Gharbia Governorate during the 2025 summer season following the application of biological and chemical treatments. Five treatments were evaluated: *A. swirskii* at two release rates (10 and 20 predators/plant), and three acaricides abamectin, bifenazate, and spiroticlofen over 16 weekly sampling intervals from April 22 to August 5. The pre-treatment counts on April 15 showed no reductions, as expected. By April 22 (One week after application), reduction percentages were relatively low across treatments, ranging from 17.57% (Bifenazate) to 65.71% (Spiroticlofen). Over time, a noticeable increase in efficacy was observed in all treatments. The release of *A. swirskii* at 20 predators/plant consistently outperformed all other treatments, reaching a peak reduction of 89.39% by August 5, with an overall mean reduction of **77.52%**, which was

significantly higher than that of abamectin (69.08%) and bifenazate (69.44%). The 10 predators/plant treatment showed an average reduction of **72.97%**, while spiroticlofen also performed well, averaging **73.85%** over the season. Statistically, the F-value of 2.99 and a P-value of 0.0255 indicate significant differences among treatments. According to the HSD test at the 5% level, the 20 predators/plant treatment was significantly more effective than abamectin and bifenazate, but not significantly different from the 10 predators/plant treatment or spiroticlofen. The findings demonstrate that both biological and chemical treatments were effective in reducing *P. latus* populations on eggplant under field conditions. Overall, the application of *A. swirskii* at a rate of 20 predators/plant achieved the highest and most consistent reduction in *P. latus* populations on eggplant, surpassing the efficacy of the chemical acaricides abamectin and bifenazate.

Table (2): Reduction percentage of broad mite *Polyphagotarsonemus latus* after application on eggplant in open field at Gharbia Governorate during the 2025 summer season.

Sampling date	Treatments				
	10 Predators/ plant	20 predators/ plant	Abamectin	Bifenazate	Spiroticlofen
Pre-count 15-April					
22-April	18.78	28.89	21.38	17.57	65.71
29-April	27.16	38.60	33.76	28.64	25.44
6-May	51.15	71.50	53.04	45.50	76.95
13-May	72.40	71.60	58.53	61.79	65.71
20-May	80.49	82.46	63.49	75.76	81.95
27-May	82.54	84.24	67.58	79.02	61.74
3-June	85.73	84.10	65.80	81.10	88.23
10-June	83.81	82.58	73.61	77.72	72.62
17-June	83.87	82.28	73.66	77.73	82.99
24-June	83.77	84.99	73.23	78.83	70.01
1-July	83.71	87.21	73.10	78.61	89.26
8-July	84.73	88.28	89.55	79.84	76.40
15-July	82.54	89.07	90.25	81.21	86.30
22-July	80.86	86.34	87.82	79.74	69.52
29-July	81.38	88.76	89.97	82.74	88.14
5-August	84.64	89.39	90.53	85.24	80.63
Mean	72.97 ab	77.52 a	69.08 b	69.44 b	73.85 ab
F-value	2.99				
P-value	0.0255				
HSD at 0.05	7.98				

Means within row followed by the same letter were not significantly different at the 5% level.

2. The two-spotted spider mite *Tetranychus urticae* :

The population trend of *T. urticae* was similar to *P. latus*, with the untreated plot showing a dramatic increase from mid-May, peaking in early July at about 40 mites/leaf. Treatments involving *A. swirskii*, especially 20 predators/plant, showed substantial suppression of *T. urticae*, maintaining numbers under 10 mites/leaf for most of the season. Acaricides were also effective, particularly spiromesifen. The reduction percentages of the two-spotted spider mite, *T. urticae*, on eggplant following different treatments are detailed in (Table 3 and Figure 1). All treatments showed varying degrees of effectiveness in reducing the mite population throughout the 2025 summer season. In the initial weeks post-application, the chemical acaricides, particularly abamectin, bifenazate, and spiroticlofen, demonstrated rapid knockdown effects, with reduction percentages reaching as high as 58.00% (Spiroticlofen) by the first week (April 22nd). In contrast, the biological control treatments (10 and 20 predators/plant) had a slower start. However, from the third week onwards (Starting May 6th), the efficacy of the predator release treatments increased dramatically. The treatment with 20 predators/plant consistently achieved the highest reduction percentages from early May until the end of the experiment. This treatment surpassed 90% reduction by May 20th and maintained this high level of control for most of the season,

peaking at 98.29% on July 1st. The 10 predators/plant treatment also provided strong control, with reduction percentages generally remaining between 70% and 89% for the majority of the season, though its effectiveness declined to 61.72% by the final sampling date. The chemical acaricides showed more variable performance. While they achieved high reduction levels at certain points (e.g., abamectin at 93.88% on July 15th), their efficacy sometimes fluctuated, with notable dips in performance observed for several treatments in late July and early August. The statistical analysis of the mean reduction percentages across the entire season revealed a highly significant difference among the treatments (F-value = 5.42, P-value = 0.0009). The release of 20 predators/plant resulted in a mean reduction of 86.70%, which was statistically superior to all other treatments. The mean reduction percentages for the 10 predators/plant (75.26%), abamectin (75.27%), bifenazate (71.77%), and spiroticlofen (71.19%) were not significantly different from each other. In conclusion, the release of the predatory mite *A. swirskii* at a rate of 20 predators per plant provided outstanding and statistically superior control of the two-spotted spider mite, *T. urticae*, on eggplant. This biological control strategy outperformed both a lower predator release rate and three conventional acaricides (Abamectin, bifenazate, and spiroticlofen) in terms of overall mean pest reduction.

Table (3): Reduction percentage of spider mite *Tetranychus urticae* after application on eggplant in open field at Gharbia Governorate during the 2025 summer season.

Sampling date	Treatments				
	10 Predators/ plant	20 predators/ plant	Abamectin	Bifenazate	Spirodiclofen
Pre-count 15-April	.	.	.	.	.
22-April	13.16	13.63	52.49	44.80	58.00
29-April	68.63	65.66	42.38	52.79	30.27
6-May	78.26	85.17	58.19	38.36	42.55
13-May	73.44	82.52	60.83	51.21	47.31
20-May	85.87	91.56	79.25	88.90	85.55
27-May	85.18	95.17	85.53	81.71	67.15
3-June	84.42	95.88	83.71	73.85	73.98
10-June	86.25	96.38	68.71	64.54	76.80
17-June	84.62	93.14	91.17	92.58	90.21
24-June	84.88	94.92	90.80	71.20	87.58
1-July	89.29	98.29	88.04	76.62	86.19
8-July	83.92	96.58	92.19	78.29	92.66
15-July	78.47	96.09	93.88	87.26	87.08
22-July	75.64	95.12	83.54	84.83	79.02
29-July	70.46	93.28	70.09	82.63	70.60
5-August	61.72	93.87	63.52	78.80	64.11
Mean	75.26 b	86.70 a	75.27 b	71.77 b	71.19 b
F-value	5.42				
P-value	0.0009				
HSD at 0.05	10.68				

Means within row followed by the same letter were not significantly different at the 5% level.

3. The eriophyid mite *Aceria lycopersici*:

The dynamics of eriophyid mite, *A. lycopersici*. The untreated control again showed a steep increase, peaking above 85 mites/leaf by early July. The predatory mite treatments (10 and 20 predators/plant) were effective in reducing *A. lycopersici* populations compared to the control. Although all treatments reduced pest numbers, higher predator release (20/plant) maintained a relatively lower mite population than chemical treatments (Figure 1).

The efficacy of various treatments in reducing the population of the eriophyid mite, *A. lycopersici*, on eggplant was assessed throughout the 2025 summer season, with results presented in (Table 4). Following the pre-count on May 13th, all treatments demonstrated a substantial impact on the mite population. In the initial week of observation (May 20th), the chemical acaricides bifenazate (66.02%) and spiroadiclofen (68.56%) showed the highest immediate reduction, while the biological control treatments (10 and 20 predators/plant) had a more moderate start at approximately 35% reduction. However, by the second week (May 27th), all treatments showed a

dramatic increase in efficacy, with reduction percentages ranging from 74.32% to a high of 93.62% (Spirodiclofen). From late May to mid-June, all treatments, both biological and chemical, maintained a high and comparable level of pest reduction, generally exceeding 84%. During this period, the performance of the predator releases was nearly identical to that of the chemical acaricides. After a peak in efficacy around mid-June, a gradual decline in the reduction percentage was observed across all treatment groups through late July. By the final sampling date on August 5th, the 20 predators/plant treatment retained a notable reduction of 62.04%, while the effectiveness of the 10 predators/plant, abamectin, and spiroadiclofen treatments had fallen to between 35% and 47%.

Statistical analysis of the season-long mean reduction percentages indicated a significant difference between treatments (F-value = 5.42, P-value = 0.0012). The acaricides bifenazate (75.85%), spiroadiclofen (74.14%), and abamectin (73.44%) achieved the highest mean reductions and were statistically similar. The mean reduction of the 20

predators/plant treatment (70.54%) was not significantly different from the acaricide treatments. However, the 10 predators/plant treatment, with the lowest mean reduction of 65.01%, was found to be statistically less effective than all three chemical acaricide treatments. In conclusion, this study confirms that the chemical acaricides bifenthrin, spiromesifen, and abamectin provide highly effective control of the eriophyid mite *Aceria lycopersici* on eggplant. Furthermore, the biological control agent *Amblyseius swirskii*, when released at a rate of 20 predators per plant, delivered a comparable level of pest reduction that was not statistically different from the chemical treatments.

The reviewed literature clearly demonstrates that *A. swirskii* is a highly effective predatory mite for controlling key vegetable pests, including *T. urticae*, *P. latus*, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), and *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), across diverse cropping systems. In both open-field and protected cultivation, *A. swirskii* consistently provided significant pest suppression, often rivaling or surpassing chemical acaricides in efficacy (Elmoghazy *et al.*, 2011; El-Saiedy *et al.*, 2015 and Elhalawany *et al.*, 2024b). Its

ability to feed on alternative sources such as pollen makes it particularly suited for greenhouse environments, where it has been widely adopted in sweet pepper cultivation in Spain (Calvo *et al.*, 2015) and shown to reduce pest populations effectively in Florida (Stansly and Castillo, 2009). Additionally, studies in Egypt confirmed its success on eggplant and cucurbit crops, particularly when combined with other predators like *Phytoseiulus persimilis* and *Neoseiulus californicus* (Abou-Awad *et al.*, 2017 and Basha *et al.*, 2021). Moreover, integration with botanicals or microbial biopesticides, as demonstrated in Lebanon and Mongolia, further enhanced the pest control efficacy of *A. swirskii* (Abou Jawdah *et al.*, 2024 and Zul *et al.*, 2023). While some chemical treatments such as fenbutatin oxide negatively affected beneficial mite populations (Barbar, 2017), biological control using *A. swirskii* offered a sustainable alternative that preserved ecological balance. Overall, the evidence strongly supports the inclusion of *A. swirskii* in integrated pest management (IPM) programs for both greenhouse and open-field vegetable crops, providing effective, environmentally friendly, and economically viable pest control solutions.

Table (4): Reduction percentage of eriophyid mite *Aceria lycopersici* after application on eggplant in open field at Gharbia Governorate during the 2025 summer season.

Sampling date	Treatments				
	10 Predators/ plant	20 predators/ plant	Abamectin	Bifenazate	Spirodiclofen
Pre-count 13-May	.	.	.	.	.
20-May	35.73	35.21	54.99	66.02	68.56
27-May	74.64	74.32	86.06	92.19	93.62
3-June	84.15	84.16	85.91	87.41	87.77
10-June	85.31	85.46	85.22	85.16	85.32
17-June	84.87	84.94	91.41	91.13	91.86
24-June	77.25	79.68	89.63	89.44	89.93
1-July	78.51	84.38	84.28	84.34	84.19
8-July	68.20	75.57	77.05	74.10	74.61
15-July	58.99	67.52	71.19	73.29	68.63
22-July	48.08	59.37	62.85	65.27	59.58
29-July	37.90	53.81	54.65	57.58	50.23
5-August	46.50	62.04	37.98	44.21	35.43
Mean $\pm$ SE	65.01 b	70.54 ab	73.44 a	75.85 a	74.14 a
F-value	5.42				
P-value	0.0012				
HSD at 0.05	7.34				

Means within row followed by the same letter were not significantly different at the 5% level.

4. Economic importance:

The results in Table (5) present the yield production, cost benefits, and yield increase percentage of eggplant following the application of predatory mites and acaricides for controlling phytophagous mites in an open field at Gharbia Governorate during the 2025 summer season. The treatments significantly affected the yield per feddan (Fed.), yield price, cost benefits, and percentage increase in yield compared to the untreated control, as indicated by the statistically significant F-values ($P = 0.0001$). Among the treatments, the highest yield was observed in the plots treated with 20 predators per plant, producing 39,124.77 kg/fed, which was significantly greater than the untreated control (27,753.18 kg/fed) and also higher than 10 predators per plant, abamectin, bifenazate, and spiroticlofen treatments. The 10 predators per plant treatment and abamectin treatment showed similar yields to each other (37,520.76 kg/fed and 37,481.76 kg/fed, respectively), both significantly higher than untreated but slightly less than the 20-predator treatment. Bifenazate resulted in a notably lower yield (34,643.07 kg/fed), although still higher than the untreated control.

In terms of economic returns, the highest cost benefits were gained from the abamectin treatment (109,885.3 LE/fed), closely followed by spiroticlofen (109,099.0 LE/fed) and 10 predators per plant (104,882.3 LE/fed). Despite the higher yield with 20 predators, its cost benefits (102,014.3 LE/fed) were slightly lower due to the higher control cost (15,360 LE/fed). The untreated control generated the lowest yield price and cost benefits (83,259.54 LE/fed), confirming the importance of pest control. Yield increase percentage relative to the untreated control ranged

from 19.89% for bifenazate to 29.06% for 20 predators per plant, indicating substantial improvement across all treatments. Return on investment, measured as return (Increase) in LE per feddan, was highest with the 10 predators/plant and abamectin treatments due to a balance between yield gains and control costs.

In conclusion, the application of predatory mites at both 10 and 20 predators per plant effectively improved eggplant yield and economic returns, providing a viable alternative to traditional acaricides. While chemical treatments such as abamectin also increase yield and cost benefits, predatory mites offer an environmentally friendly control method that can sustain high productivity. Integrated pest management strategies incorporating these biological agents are recommended to achieve optimal control and economic benefit in eggplant cultivation. These results matched those of El Arnaouty *et al.* (2020) on pepper, the cost benefits of the biological control program were (31.61%) higher than the control treatment and (26.45%) higher than chemical treatment. Elhalawany *et al.* (2024a) studied the effects of releasing *N. californicus*, a phytoseiid mite, on guava tree pests in Egypt. The study found that significantly higher fruit yields, suggesting that releasing *N. californicus* is a viable pest management option. Also, Elhalawany *et al.* (2024b) show together, the predatory mites improved biological control of piercing-sucking pests, leading to increased yields and cost reductions for sweet pepper production. The study also found a safe yield free of chemical residues.

Table (5): Yield production, cost benefits and increase yield of eggplant after application of predatory mites and acaricides for controlling phytophagous mites in open field at Gharbia Governorate during the 2025 summer season.

Treatments	Yield (Kg)/fed.	Yield price (LE)/fed.	Control cost (LE)/fed.	Cost benefits (LE)/fed.	Increase yield%/fed.	Return (increase) (LE)†/fed.
10 predators/ plant	37520.76 ab	112562.3 ab	7680	104882.3 a	26.03	104882.28
20 predators/ plant	39124.77 a	117374.3 a	15360	102014.3 a	29.06	102014.31
Abamectin	37481.76 ab	112445.3 ab	2560	109885.3 a	25.96	109885.28
Bifenazate	34643.07 b	103929.2 b	3200	100729.2 a	19.89	100729.21
Spirodiclofen	37166.34 ab	111499.0 ab	2400	109099.0 a	25.33	109099.02
Untreated	27753.18 c	83259.54 c	-	83259.54 b	-	-
F-value	13.48	4.35		8.38		
P-value	0.0001	0.0001		0.0001		
LSD at 0.05	3145.1	9435.3		9435.3		

*LE = Egyptian pound, fed = feddan, Means $\pm$ SE within raw followed by the same letter were not significantly different at the 5% level.

The findings of this study demonstrate that the predatory mite *A. swirskii*, particularly at a release rate of 20 predators per plant, provides highly effective control of major phytophagous mites infesting eggplant namely *P. latus*, *T. urticae*, and *A. lycopersici* under open field conditions. This biological control strategy achieved pest reduction levels comparable to or exceeding those of conventional acaricides, with the added advantage of environmental sustainability. Additionally, treatments involving *A. swirskii* significantly increased yield and economic return, confirming its practical value in commercial eggplant production. Although abamectin offered the highest cost benefit due to its lower application cost, the use of predatory mites provides a promising alternative for reducing chemical input and promoting integrated pest management (IPM) strategies. Therefore, the incorporation of *A. swirskii* into field IPM programs is recommended for sustainable and economically viable control of mite pests in eggplant cultivation.

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