E-ISSN: 2788-8428
P-ISSN: 2788-8436
ZEL 2025; 5(2): 194-203
www.zoologicaljournal.com
Received: 08-07-2025
Accepted: 12-08-2025

Wessam Z Aziz
Department of Research on Vegetable, Medicinal, Aromatic and Ornamental Plants Pests, Plant Protection Research Institute, Agricultural Research Center, Egypt

Lina HE Saad
Department of Cotton Pesticides Evaluation, Plant Protection Research Institute, Agricultural Research Center, Egypt

Elmesawy MG
Department of Research on Vegetable, Medicinal, Aromatic and Ornamental Plants Pests, Plant Protection Research Institute, Agricultural Research Center, Egypt

Nabil M Ghanim
Department of Horticultural Insect Pests, Plant Protection Research Institute, Agricultural Research Center, Egypt

Correspondence
Nabil M Ghanim
Department of Horticultural Insect Pests, Plant Protection Research Institute, Agricultural Research Center, Egypt

Evaluation of certain insect pests response to the application of several types of organic fertilizers on eggplant under rooftop cultivation conditions

Wessam Z Aziz, Lina HE Saad, Elmesawy MG and Nabil M Ghanim

DOI: https://www.doi.org/10.22271/letters.2025.v5.i2c.153

Abstract
Compost and compost tea can be used to combat soil fertility problems by improving its physical, biological and chemical properties, in addition to their indirect effect in controlling pests. The present study showed that compost and compost tea showed significant effects on the tested insects [the green peach aphid, *Myzus persicae* Sulzer (Hemiptera: Aphididae), the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae), and the potato tuber moth, *Phthorimaea operculella* (Zeller) (Lepidoptera, Gelechiidae)] infesting eggplant plants under rooftop conditions; where the inhibitory effects of compost and compost tea on the tested insects were highly significant effect, and significantly increased by the elapsed time after treatments application, unlike the pesticides, which demonstrated a direct effect after its application on the aforementioned pests. This makes both compost and compost tea promising methods that can be combined into an integrated framework with other control methods through integrated pest management (IPM) programs.

Keywords: *Myzus persicae*, *Phthorimaea operculella* certain insect pests

Introduction

Environment-friendly agriculture substitutes (like compost and compost tea) promote increases of soil organic matter, microbial activities, gradual releases of plant nutrients, and reduce the amounts of toxic compounds (such as nitrate) produced by chemical fertilizers; so, improve physical, biological and chemical properties of the soil; which derive plants to more balanced nutrition (Albiach *et al*., 2000; Andrews *et al*., 2001; Baziramakenga & Simard, 2001; Arancon *et al*., 2005; Salman *et al*., 2007 and Mahmoud *et al*., 2009) [4, 10, 16, 12, 71, 48]. Some of organic fertilizers contained toxic agents such as boron, cadmium, cobalt and inorganic salts (Gleason *et al*., 1969; Mousa & El-Sisi, 2001; Abdel-Wahab & El-Sisi, 2001 and Ebaid & Mansour, 2006) [39, 54, 1, 29].; which proved pesticidal activity against some insect pests; so, composts can be used to combat the problems of soil fertility in addition to pest management thereby decrease herbivorous insect populations (Akanbi *at al*., 2009; Mehta *et al*., 2014 and Pane *et al*., 2015) [29, 51, 61]. However, available information on the relative toxicity of some organic additives to insect pests is limited.

The green peach aphid, *Myzus persicae* Sulzer (Hemiptera: Aphididae) is a worldwide polyphagous pest; it has a wide host range and can harm more than 400 plant species from 50 families, mainly Solanaceae, Cruciferae, Compositae, Leguminosae, and Malvaceae (Rajendra *et al.*, 2015; Zienab *et al*., 2021 and Ata, 2024) [70, 75, 13] resulting in serious economic losses (Davis *et al*., 2007 and Bai *et al*., 2015) [27, 15]. This aphis feeding on the sap leads to chlorosis and necrosis spots, honeydew production, transmission of plant viral diseases, and a dramatic reduction in the marketability of crops (Satar *et al*., 2008; He *et al*., 2017; Mulot *et al*., 2018 and Nampeera *et al*., 2020) [72, 41, 55, 57].

The pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) is native to Southern Asia and has established in many countries in tropical and subtropical regions throughout the world. This insect pest is a highly polyphagous insect, feeding on 229 genera of plants belonging to over 78 families, Including some vegetables from the Solanaceae family, such as eggplant, *Solanum melongena* (EPPO, 2025) [32] and tomato, *Solanum lycopersicum* L. (Marsaro Jr. *et al*., 2013) [52], and also some economically important crops from the Malvaceae family, like cotton (Gossypium spp.), which may be significantly affected by *M. hirsutus* (EPPO, 2025) [32], as well as some other hosts in the legume and berry families (CABI, 2015 and Garcia Morales *et al*., 2016) [21, 37].

The potato tuber moth, *Phthorimaea operculella* (Zeller) (Lepidoptera, Gelechiidae) is a serious pest that has been found feeding on more than 60 plants in different parts of the world with the majority of the hosts belonging to the Solanaceae family (Das and Raman, 1994) [25]. This pest causes significant economic losses in potato production (under both field and storage conditions) in subtropical and tropical areas; where more than 50% of plant infestations and 100% damage on tubers were recorded under storage conditions (Das *et al*., 1992 and Ali & Naziri, 2019) [26, 6]. After potato harvest, the pest remains in the field and feeds on other solanaceous plants such as tomato and eggplant (Gilboa and Podoler, 1995 and Primiya *et al.* 2022) [38, 67].

The previously mentioned insect pests (*M. persicae, M. hirsutus* and *P. operculella*) are of the serious insect pests infesting eggplant (*Solanum melongena* L.) plants (Rahouma, 2018; Ata, 2024 and EPPO, 2025) [69, 13, 32]; which is considered as the fifth most economically important solanaceous crop after potato, tomato, pepper, and tobacco (FAO, 2014) [34]. Insect pests play a vital role in lowering eggplant yield, by attacking the plants from the nursery till harvesting stage (Borkakati *et al*., 2019) [19]. About 53 species of pests attack eggplant plants worldwide (CAB International, 2017) [21] including lepidopterans, leafminers, leafhoppers, whiteflies, aphids, thrips, mealybugs, and spider mites; which are considered as important pests affecting eggplant yield (Rahouma, 2018; Kumar *et al*., 2019; Nayak *et al*., 2021; Ata, 2024 and EPPO, 2025) [69, 45, 58, 13, 32].

According to Patriquin *et al.* (1995) [62], Arancon & Edwards (2004) [11] and Arancon *et al*. (2005) [12], the application of organic matters to soils may decrease the populations of insect pests. Therefore, this study aimed to test this approach against the populations of green peach aphid (*M. persicae*), the pink hibiscus mealybug (*M. hirsutus*), and potato tuber moth (*P. operculella*) infesting eggplant through treating the soil by adding compost and compost tea at different rates (as organic fertilizations) to verify their effects on the aforementioned insect pests, under rooftop conditions, compared to the recommended insecticide for each pest.

Materials and Methods

Preparations of rooftop cultivation experiments

As a first step for preparation to carry out these experiments, about of 500 newly seedlings of eggplant were purchased from a nursery at Mansoura district, Dakahlia governorate. After approximately a month, plants of eggplant were divided into three groups. The first and second groups were infested artificially by placing leaves infested with the green peach aphid, *Myzus persicae* Sulzer and the pink mealybug, *Maconellicoccus hirsutus* (Green), respectively, which were collected from eggplant farm at Faculty of Agriculture, Mansoura University. As for the third group, it was naturally infested with the potato tuber moth, *Phthorimaea operculella* (Zeller); therefore, we decided to subject it to test using the same experimental treatments. Furthermore, plastic agricultural basins were prepared (each one measuring as 40 cm length, 40 cm width and 25 cm height), which were designated for rooftop cultivation, where the soil was treated with compost, and the eggplant plants transferred and cultivated in it subsequently to start implementing experiments, with five plants per pot as replication, and all cultivation operations in all groups were carried out according to traditional agricultural management practices for eggplant varieties.

Treatments used in the experiments

Compost and compost tea were obtained from Al Shafei Agricultural Investment Company. According to this company, compost and compost tea (Table, 1) were prepared as recycling farm waste, whether plant or animal, in addition to organic environmental waste, after composting it for a period ranging between 55 and 70 days, in order to activate the work of aerobic bacteria necessary for the decomposition of organic materials and the release of elements present in the components, which ultimately leads to raising the temperature of the product to degrees reaching 70 degrees Celsius; which is capable of eliminating all pathogens and parasites that are harmful to plants and soil alike. The final product is also rich in minerals and all the elements necessary for plants, especially organic farming. Compost tea is a dark brown viscous liquid; it is a natural preparation containing a group of beneficial bacteria, organic compounds, and natural nutritional elements.

Table 1: Main components and some characteristics of compost and compost tea.

Compost		Compost tea	
Cubic meter weight	780 kg	Density	1.24 gm/cm^3
pH (1:10)	6.56	pH (1:10)	6.90
Electrical conductivity (EC) (1:10)	4.39 ds/m	Electrical conductivity (EC) (1:10)	2.8 ds/m
Total nitrogen	0.56%	Total Nitrogen	4.52% (w/v)
Ammonium nitrogen	81 ppm	Potassium	13.10% (w/v)
Nitrate nitrogen	553 ppm	Phosphorus	393.10 mg/L
Organic matter	24.23%	Boron	2.10 mg/L
Organic carbon	14.05%	Manganese	19.10 mg/L
Ash	75.77%		
C:N ratio	1:25	Zinc	0.70 mg/L
Total phosphorus	0.57%		
Total potassium	0.755	Copper	mg/L
Moisture	20%		

For using treatments from different types of organic fertilizers, three rates of compost (50, 60 and 70 gm) and also, three concentrations of compost tea (40, 45 and 50%) were prepared for experimental application by adding to soil. For insecticides, tow types were used as supplementary treatments (Medamec 1.8% EC and Spanfek 10% SC). Medamec 1.8% EC was used against *M. persicae* and *M. hirsutus*, where abamectin belonging to avermectin group of insecticides, whereas, Spanfek 10% SC was utilized against *P. operculella* and belonging to spinosad group of insecticides. Both insecticides were obtained from Plant Protection Research Institute, Agricultural Research Center, Dokki, Egypt, and applied by spraying using hand sprayer at the recommended rates.

Rooftop cultivation experiments applications

For each insect species (*M. persicae*, *M. hirsutus*, and *P. operculella*), eight treatments were applied, including three rates of compost (50, 60, and 70 g per replicate as a soil addition), three concentrations of compost tea (40, 45, and 50% as a soil addition, at 40 ml per replicate), and insecticide treatment by spraying with the recommended rate of use, beside the control where the soil was irrigated only with water without any other additions. Each treatment was repeated four times. According to the recommended estimation protocol of the used insecticides. The number of individual alive insect pests for each of the above-mentioned tested species was counted and recorded immediately before treatment applications and then 3, 5, 7, and 10 days after treatment, and a similar process was also performed in the control.

Statistical analysis

Agricultural basins of all treatments were arranged in a completely randomized design. Numbers of each insect species were analyzed according to analysis of variance (ANOVA) and the standard error (SE) were used for the presents results of the bioassay test by using CoHort software (CoHort, 2004) [24] followed by Duncan multiple range tests to compare means (Duncan, 1955) [28]. Reduction percentages for each insect pest were calculated by the formula of Henderson and Tilton (1955) [42]. Also, regression analysis was performed by using CoHort software.

Results

The current experiments were conducted under rooftop cultivation conditions to assess the effectiveness of soil application of compost and compost tea as organic fertilizers, and verify their role in suppressing the tested pests, green peach aphid (*M. persicae*), the pink hibiscus mealybug (*M. hirsutus*), and the potato tuber moth (*P. operculella*) infesting eggplant plants.

1. The green peach aphid, *M. persicae*

The obtained data (Table, 2) showed that there were no significant differences between *M. persicae* populations before treatment applications in most of the prepared plants for the present experiment; where the highest population was recorded in the control; while the lowest was recorded in compost tea 40%. After three days of treatment applications (initial effect), the highest population of *M. persicae* was in the control where it was highly significant, followed by compost tea 50 and 45%, whereas, the lowest population was recorded with abamectin insecticide. So, the highest reduction percentage after three days of treatment was recorded with abamectin treatment; while, the reduction percentages caused by application of compost or compost tea were obviously low.

With respect to the residual effects of the tested treatments, the effect of abamectin was relatively stable (after 5, 7 and 10 days); while, the effects of compost and compost tea treatments were obviously increased gradually (Table, 2). After ten days of treatments' application, the population of *M. persicae* was significantly low at all treatments of compost and compost tea as well as abamectin treatment in comparison with the control, where reduction percentages reached 94.7 to 97.1% for compost and compost tea treatments, and 99.2% for abamectin, respectively.

The general mean effect revealed that abamectin was obviously the highest effective treatment which showed the lowest mean population of *M. persicae* and highest mean reduction percentage. For compost and compost tea treatments, the mean populations of *M. persicae* was significantly less than control (6.4 to 20.7% of the population in the control) with mean reduction percentages ranged between 62.3 and 70.4% (Table, 2).

Mathematically as shown in Figure (1), reduction percentages caused by the tested treatments on *M. persicae* population increased by the elapsed time. The highest increases were recorded with compost tea 50% and 45% treatments; where each elapsed one day after treatment increased the reduction percentage by 12.0% and 11.9%, respectively (R^2 = 0.8271 and 0.8473). While, the lowest increase of the reduction percentages was recorded with the tested insecticide (abamectin); where each elapsed one day after treatment increased reduction percentage by 7.3% (R^2 = 0.6417).

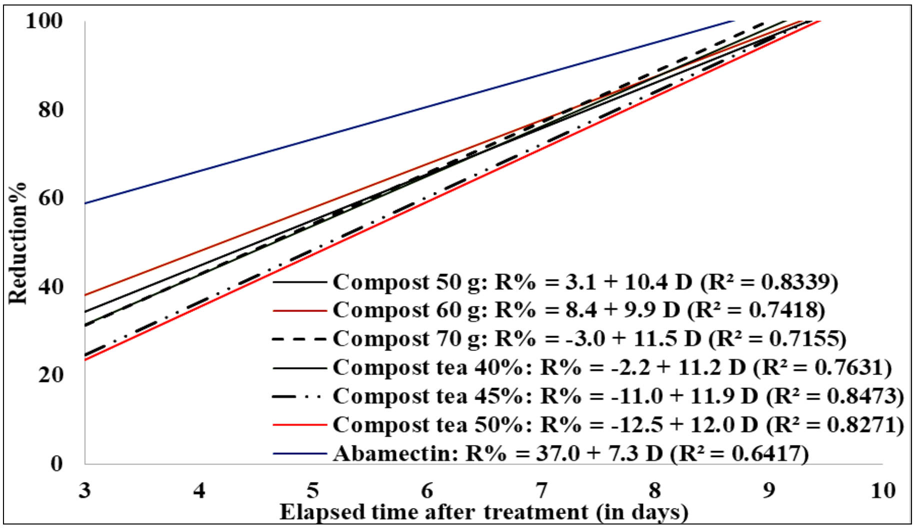

Fig 1: Effect of elapsed time on reduction percentages of *M. persicae* population caused by different rates of compost and compost tea in comparison with abamectin on eggplant plants under rooftop cultivation conditions.

2. The pink hibiscus mealybug, *M. hirsutus*

Data illustrated in Table (3) showed that there were no significant differences between *M. hirsutus* populations before treatment applications in most of the prepared eggplant plants for the present experiment; where the highest population was recorded only in compost tea 40% treatment; while the populations in the rest treatments were statistically equals. After three days of treatment applications (initial effect), the highest population of *M. hirsutus* was significantly higher in the compost tea treatments and the control (with no significant difference between them), while the pest population in the other treatments ranked the second (with no significant difference between them). So, the reduction percentages after three days of treatments' applications were pretty close together; where the reduction percentages ranged between 34.7% (with compost tea 40% treatment) and 53.6% (with compost 60 g treatment).

Table (3) also showed the residual effects of the tested treatments; where the effects of all treatments (rates of compost, compost tea and abamectin) on *M. hirsutus* population were obviously increased gradually. After ten days of treatments' application, the populations of *M. hirsutus* were significantly low at all treatments of compost and compost tea as well as abamectin treatment (with no significant differences between them) in comparison with the control (which had the highest population). Also, reduction percentages were pretty closed together; where it ranged between 88.5% (with compost tea 45% treatment) and 97.8% (with compost tea 40% and 50% treatments).

As indicated in Table (3), the general mean effect revealed that population of *M. hirsutus* was obviously the highest in the control, and the population in compost tea 40% ranked the second (51.8% of the population in the control); while the populations of *M. hirsutus* in the rest treatments were pretty closed together with obvious low values in comparison with treatment of compost tea at 40% or the control. On the another hand, abamectin showed the highest mean reduction percentage of *M. hirsutus* population (75.7%); while the mean reduction percentages caused by compost and compost tea treatments ranged between 67.5% (with compost 50 g treatment) and 74.6% (with compost 60 g treatment).

As shown in Figure (2), reduction percentages caused by the tested treatments on *M. hirsutus* population increased by the elapsed time. The highest increase was recorded with compost 50 g treatments; where each elapsed one day after treatment increased the reduction percentage by 12.2 (R^2 = 0.7858). On contrary, the lowest increase of the reduction percentages was recorded with compost 60 g treatment; where each elapsed one day after treatment increased reduction percentage by 5.0% (R^2 = 0.9017). Regression coefficient values (b) for the other treatments ranged between 7.0 (for compost tea 45% treatment; where R^2 = 0.8989) and 8.7 (for compost tea 40% treatment; where R^2 = 0.9365).

Table 2: Effect of using different rates of compost and compost tea on *M. persicae* population infesting eggplant in comparison with abamectin under rooftop cultivation conditions.

Treatment	Rate	Pre-treatment	Effect of treatments on *M. persicae* population											
			Initial effect (After 3 days)		Residual effect								General mean	
					After 5 days		After 7 days		After 10 days		Mean			
			No.	R%	No.	R%	No.	R%	No.	R%	No.	R%	No.	R%
Compost	50 g	198±27.9	164.2±28.4	21.1	142.2±20.7	65.6	59.2±9.7	89.3	23.0±12.3	96.5	74.8	83.8	97.1	68.1
	60 g	113.2±5.2	95.0±8.1	20.4	59.2±6.9	75.4	32.2±2.4	90.1	18.2±4.1	95.5	36.5	87.0	51.2	70.4
	70 g	178.0±48.1	169.2±46.6	9.4	82.2±17.6	76.2	42.2±9.9	92.0	21.2±4.9	96.9	48.5	88.4	78.7	68.6
Compost tea	40%	102.0±22.7	95.0±23.6	12.5	53.2±10.4	72.4	23.0±3.2	89.7	5.7±2.1	97.1	27.3	86.4	44.3	67.9
	45%	248.0±5.7	231.2±9.0	11.1	221.5±9.0	57.5	80.7±10.8	88.6	38.2±7.5	95.8	113.5	80.6	143.0	63.2
	50%	241.5±25.7	233.5±24.6	7.7	197.2±15.7	60.1	96.2±13.3	86.6	54.5±20.4	94.7	116.0	80.5	145.4	62.3
Abamectin		110.7±94.9	62.7±31.6	42.2	27.7±21.5	90.7	9.7±9.7	98.3	5.7±5.7	99.2	14.4	96.1	26.5	82.6
Control		282.5±25.5	295.2±23.7	----	587.7±29.6	----	847.7±22.2	----	1079.0±8.9	----	838.1	----	702.5	----
LSD		89.2	78.9	---	52.3	---	34.1	---	28.8	---	---	---	---	---
F-value		5.3	9.0	---	103.5	---	591.1	---	1430.6	---	---	---	---	---
P-value		0.001	0.000	---	0.000	---	0.000	---	0.000	---	---	---	---	---

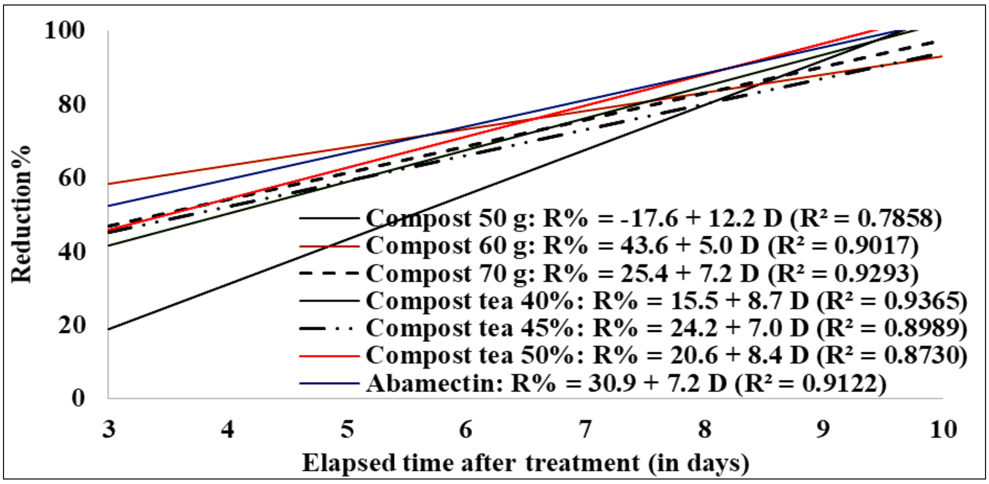

Fig 2: ffect of elapsed time on reduction percentages of *M. hirsutus* population caused by different rates of compost and compost tea in comparison with abamectin on eggplant plants under rooftop cultivation conditions.

Table 3: Effect of using different rates of compost and compost tea on *M. hirsutus* population infesting eggplant in comparison with spinosad under rooftop cultivation conditions.

Treatment	Rate	Pre-treatment	Effect of treatments on *M. hirsutus* population											
			Initial effect (After 3 days)		Residual effect								General mean	
					After 5 days		After 7 days		After 10 days		Mean			
			No.	R%	No.	R%	No.	R%	No.	R%	No.	R%	No.	R%
Compost	50 g	14.0±2.2	10.5±1.8	35.6	6.7±1.5	60.8	3.5±1.3	82.9	2.0±0.4	90.6	4.1	78.1	5.7	67.5
	60 g	10.7±4.7	7.2±4.1	53.6	4.2±2.4	73.0	3.0±1.5	82.1	2.0±1.1	89.7	3.1	81.6	4.1	74.6
	70 g	13.5±1.0	9.2±0.8	41.3	5.7±0.8	66.3	3.7±0.5	81.5	1.5±0.3	93.2	3.6	80.3	5.1	70.6
Compost tea	40%	34.7±20.6	28.0±16.7	34.7	15.0±8.8	65.9	13.2±8.7	80.8	2.5±1.6	97.8	10.2	81.5	14.7	69.8
	45%	6.0±0.8	4.2±0.6	39.0	2.7±0.5	63.1	1.7±0.2	81.0	1.0±0.0	88.5	1.8	77.5	2.4	67.9
	50%	23.2±11.5	16.7±7.9	36.7	8.7±4.4	70.5	4.5±2.4	88.7	1.2±0.9	97.8	4.8	85.7	7.8	73.4
Abamectin		15.2±5.9	9.5±4.0	46.9	6.5±3.2	69.7	3.2±1.9	89.2	1.2±0.9	97.3	3.6	85.4	5.1	75.7
Control		20.0±1.8	23.5±2.1	---	25.0±2.3	---	31.0±3.9	---	34.2±5.3	---	30.1	----	28.4	---
LSD		25.8	20.2	---	11.4	---	10. 6	---	6.0	---	---	---	---	---
F-value		1.0	1.4	---	3.5	---	7.5	---	31.0	---	---	---	---	---
P-value		Ns	Ns	---	0.010	---	0.000	---	0.000	---	---	---	---	---

3. The potato tuber moth, *P. operculella*

Before treatment applications, there were no significant differences between *P. operculella* populations in all of the prepared plants for the present experiment (Table, 4). After three days of treatment applications (initial effect), the highest population of *P. operculella* significantly higher in the control, while the lowest population was recorded with spinosad insecticide (with no significant differences between it and the other tested treatments of compost and compost tea), where the highest reduction percentage after three days of treatment was recorded with spinosad treatment (76.9%); while, the reduction percentages caused by application of compost or compost tea ranged between 60.4% (in compost tea 40% treatment) and 72.9% (in compost tea 45% treatment).

As shown in Table (4), the residual effect of spinosad on *P. operculella* decreased after five days of treatment, and then increased gradually tell the tenth day after treatment. With respect to the residual effects of compost and compost tea treatments, these effects were increased gradually from the first till the end of this experiment (ten days). After ten days of treatments' application, the population of *P. operculella* was significantly low at all treatments of compost and compost tea as well as spinosad treatment in comparison with the control (harbored the highest population). The reduction percentages for compost and compost tea treatments ranged between 92.1% (in compost tea 45% treatment) and 97.5% (in compost 70 g treatment), with the highest reduction rates among the other tested treatments.

The general mean effect revealed that compost and compost tea treatments were obviously higher effective treatments on *P. operculella* population which showed the lowest mean population of the pest and highest mean reduction percentages (ranged between 81.5 and 86.9%). For spinosad treatment, the mean populations of *P. operculella* was significantly less than control (26.5% of the population in the control) with mean reduction percentage of 77.0% (Table, 4).

Mathematically as shown in Figure (3), reduction percentages caused by the tested treatments on *P. operculella* population increased by the elapsed time. The highest increases were recorded with compost 70 g treatment; where each elapsed one day after treatment increased the reduction percentage by 5.1% (R^2 = 0.9312), followed by treatments of compost tea 50 and 40%; where each elapsed one day after treatment increased the reduction percentage by 4.5 and 4.3%, respectively (R^2 = 0.7978 and 7701), whereas the lowest increase of the reduction percentages by elapsed time was recorded with the tested insecticide (spinosad); where each elapsed one day after treatment increased reduction percentage by 1.3% (R2 = 0.4800).

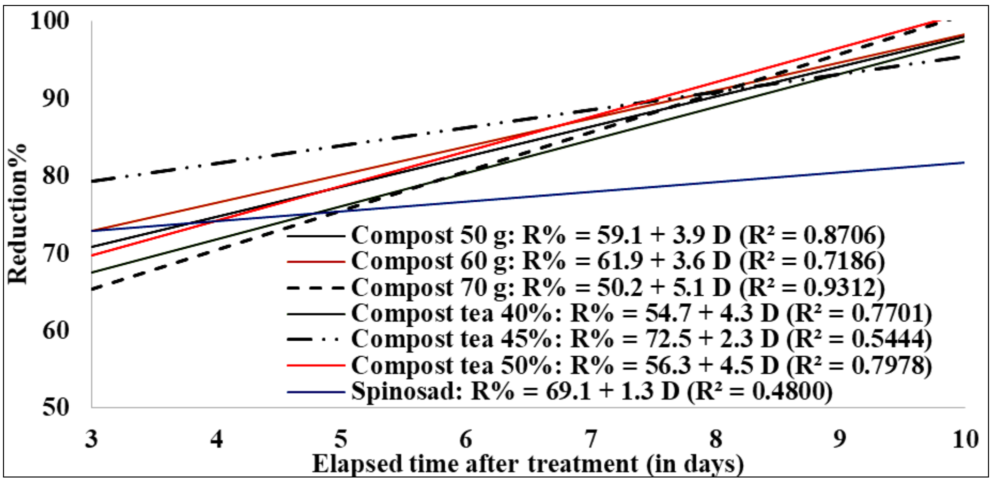

Fig 3: Effect of elapsed time on reduction percentages of *P. operculella* population caused by different rates of compost and compost tea in comparison with spinosad on eggplant plants under rooftop cultivation conditions.

Table 4: Effect of using different rates of compost and compost tea on *P. operculella* population infesting eggplant in comparison with spinosad under rooftop cultivation conditions.

Treatment	Rate	Pre-treatment	Effect of treatments on *P. operculella* population											
			Initial effect (After 3 days)		Residual effect								General mean	
					After 5 days		After 7 days		After 10 days		Mean			
			No.	R%	No.	R%	No.	R%	No.	R%	No.	R%	No.	R%
Compost	50 g	8.5±0.6	3.5±0.5	66.2	2.0±0.0	83.5	1.5±0.3	89.0	0.7±0.2	95.2	1.4	89.2	1.9	83.5
	60 g	10.0±0.9	4.0±0.4	66.0	2.0±0.4	86.7	1.2±0.7	92.6	1.2±0.5	93.6	1.5	91.0	2.1	84.7
	70 g	8.7±0.8	4.0±0.7	62.5	3.2±0.8	76.2	1.5±0.6	91.2	0.5±0.5	97.5	1.7	88.3	2.3	81.9
Compost tea	40%	8.0±1.3	3.7±0.4	60.4	2.2±1.1	83.3	1.5±0.6	89.3	1.0±0.4	92.8	1.6	88.5	2.1	81.5
	45%	8.2±0.9	2.7±0.5	72.9	1.0±0.4	91.8	1.2±0.2	90.8	1.2±0.6	92.1	1.1	91.6	1.5	86.9
	50%	9.7±1.1	4.7±0.7	63.7	2.5±0.5	82.9	1.0±0.6	95.0	0.7±0.5	95.8	1.4	91.2	2.2	84.4
Spinosad		8.7±0.6	2.2±0.7	76.9	4.0±1.1	70.5	3.2±0.8	76.7	2.5±0.9	83.8	3.2	77.0	3.0	77.0
Control		8.0±1.7	9.2±1.2	---	11.5±2.1	---	12.7±1.9	---	14.7±2.6	---	13.0	---	11.3	---
LSD		3.1	2.0	---	3.0	---	2.6	---	3.1	---	---	---	---	---
F-value		0.8	9.4	---	10.7	---	20.2	---	20.6	---	---	---	---	---
P-value		Ns	0.000	---	0.000	---	0.000	---	0.000	---	---	---	---	---

Discussion

Practices of soil fertility can impact the susceptibility of crop plants to insect pests by affecting the resistance of plants to attack or by altering plant acceptability to herbivores (Chau and Heong, 2005) [23]. Compost and compost tea improve physical, biological and chemical properties of the soil by increasing the soil organic matter, microbial activities, gradual releases of plant nutrients, and reduce the amounts of toxic compounds (which produced by chemical fertilizers) (Albiach *et al*., 2000; Andrews *et al*., 2001; Baziramakenga & Simard, 2001; Arancon *et al*., 2005; Salman *et al*., 2007 and Mahmoud *et al*., 2009) [4, 10, 16, 12, 71, 48]. On the another hand, effects of fertilization on the performance of herbivores are well known (Patriquin *et al*., 1995; Herms, 2002; Arancon & Edwards, 2004 and Arancon *et al*., 2005) [62, 43, 11, 12]; so, Pane *et al*. (2015) [61] and Mehta *et al*. (2014) [51] reported that compost can create soil conditions which suppress pest effects, and this was clearly confirmed by the results of the current study, where compost and compost tea showed significant effects on the tested insects (*M. persicae*, *M. hirsutus* and *P. operculella*) infesting eggplant plants under rooftop conditions, where the efficacy of using compost and compost tea was very satisfactory in suppressing the populations of the tested insect pests. These findings are supported by Phelan (1997) [64], Altieri *et al*. (2012) [7], Mehta *et al*. (2014) [51] and Pane *et al*. (2015) [61]; they suggested that that application of compost has negative effects to pest pressures. Also, El-Mogy *et al*. (2021) [31] found that compost showed suppressive effects on the populations of certain insect pests (*Empoasca* spp., *Aphis gossypii*, *Bemisia tabaci*, *Thrips tabaci* and *Nezara viridula*) infesting Roseline plants. According to Arancon & Edwards (2004) [11] and Arancon *et al*. (2005) [12], composts have been shown to suppress populations of insect pests, such as aphids and caterpillars. Also, Najafabadi (2014) [56] and Ibrahim *et al*. (2016) [44] revealed that compost tea had significant effects on the population growth of *Macrosiphum rosae* and *Spodoptera littoralis*. Ibrahim *et al*. (2016) [44] added that compost tea represents insecticidal activity against *S. littoralis* and associated with the death of it. Phelan (2004) [63] reported that plants grown with organic fertilizers are usually attacked by fewer insect pests, and can tolerate pest attacks more than plants that receive conventional fertilizers.

The suppressive effects of compost and compost tea on *M. persicae*, *M. hirsutus* and *P. operculella* populations may be attributed to their contain of many components such as nitrogen, potassium, phosphorus, boron, manganese, copper and zinc which resulted a balanced nutrient for plants; then, plants achieve better growth and lower pest pressures (act as anti-insect infestations). Also, Beanland *et al*. (2003) [17] and Alyokhin *et al*. (2005) [8] reported that fertilizers containing boron, iron and zinc proportions produce largest and healthy plants; accordingly, these components are inversely corelated with certain insect pest infestations. Epstien (1972) [33] and Mortvedt *et al*. (1991) [53] added that the importance of fertilization with micronutrients (*i.e.*, iron, zinc and manganese) can be accounted by its essential role in many biological processes inside plants. So, studies of Fouda & Niel (2021) [35] and Luo *et al*. (2022) [47] revealed that the application of compost tea can significantly influence micronutrient levels in the soil; which play a crucial role in various physiological processes in plants (Bhat *et al*., 2020; Rahman *et al*., 2020 and Cakmak *et al*., 2023) [18, 68, 22].

Abamectin (as one of avermectin group of insecticides) is belonging to macro cyclic lactones metabolites produced by a natural fermentation of the soil bacterium *Streptomyces avermitilis* (Omura & Shiomi, 2007 and Pitterna *et al*., 2009) [59, 66]. Abamectin blocks the transmittance of electrical activity in nerves and muscle cells by stimulating the release and binding of gamma-aminobutyric acid (GABA) at nerve endings, which causes an influx of chloride ions into the cells, leading to hyperpolarization and subsequent paralysis of the neuromuscular system (Longato, 2024) [46]. In the present study, abamectin was evaluated against both *M. persicae* and *M. hirsutus* (as a recommended insecticide against these pests). The obtained data on *M. persicae* revealed that abamectin exhibited the highest reduction percentages on the pest population on eggplant under rooftop cultivation conditions in comparison with compost and compost tea treatments. The results are in agreement with those of Wang & Shen (2007) [74] and Attia *et al*. (2025) [14]; they reported that abamectin exhibited high effects on *M. persicae* under laboratory and field conditions. On *M. hirsutus*, the obtained results showed that abamectin showed an effect which was near to some treatments of compost and compost tea. This means that abamectin showed a relatively low effect on *M. hirsutus* population in comparison with *M. persicae* population. Also, El-Fakharany (2020) [30] and Ahsan *et al*. (2024) [2] found that abamectin showed moderate effects on the cotton mealybug

Phenacoccus solenopsis Tinsley. The present results are in the same line of the studied of Ali & Aly (2020) [5] and Ahsan *et al*. (2024) [2]; these studies concluded that abamectin was highly effective on aphid (*Breviory brassicae* (L)) more than mealybug (*P. solenopsis*).

Spinosad group of insecticides; which alter the function of nicotinic and GABA-gated ion channels, causing rapid excitation of the insect nervous system, leading to involuntary muscle contractions, tremors, paralysis, and death (Orr *et al*., 2009) [60]. In the present study, spinosad showed an effective role in controlling *P. operculella* population infesting eggplant plants in comparison with the control under rooftop cultivation conditions. Meabed *et al.* (2011) [50] were found that spinosad was effective against *P. operculella* population under field conditions; but it was less than other biocontrol agents used, while Temerak (2003), Gomaa & El-Nenaey (2006) [73] and Mandour *et al.* (2009) [49] reported that spinosad was as effective against *P. operculella* (showed 100% protection) up to three months under storage conditions and, Gamal El-din *et al*. (2022) [36] found that spinosad was the highest effective treatment against *P. operculella* under laboratory conditions. The discrepancy between these studies may be attributed to differences in experimental conditions.

The present results showed that the effects of compost and compost tea on *M. persicae*, *M. hirsutus* and *P. operculella* populations increased by the elapsed time after application of treatments more than the increases of the effectiveness of the tested insecticides. This may be attributed to that compost and compost tea take sufficient period to decompose in the soil, and then then get absorbed by the roots of plants; subsequently, delayed it effect on pests' populations (this is supported by the relatively low initial effect of compost and compost tea treatments). For insecticides used, their initial effects on the tested insect pests were relatively high; which may due to the direct effects of these insecticides on the tested pests' populations. These results may be supported by the studies of Phelan *et al.* (1996) [65] and Phelan (1997) [64]; they reported that a better balance of mineral levels is predicted under organic management because the soils have an inherent buffering capacity which results a slowly release nutrients. The same authors added that plants can achieve better growth and lower pest pressures under optimal nutritional conditions; which provide absolute levels and proportions of nutrients in the soil solution. On the other hand, under nutrient imbalances, the metabolic machinery of the plant are impaired resulting accumulate simple structural compounds (such as free amino acids and sugars) which favor insect nutrition (Andersen *et al.*, 2009 and Altieri *et al.*, 2012) [9, 7]. Accordingly, this must be verified and taken into consideration to achieve the desired results regarding pest suppression when incorporating organic fertilizers into integrated pest management (IPM) programs.

Conclusion

Finally, it is evident from the results that compost and compost tea achieved very satisfactory outcome in reducing *M. persicae*, *M. hirsutus* and *P. operculella* populations, which makes the use of these organic fertilizers a promising and respectable method that can be combined with integrated pest management (IPM) programs, especially since this effect, even if indirect, extends to suppressing the pest by making the plant unsuitable and thus undesirable, which is not achieved by insecticides in the long term, as most pests acquire resistance due to their frequent use, which may threaten to cause outbreaks, in addition to their other disadvantages on the agricultural system and the environment that cannot be ignored.

References

1. Abdel-Wahab ES, El-Sisi AG. Mineral salts as an alternative to conventional pesticides for controlling cotton leafworm. Journal of Agricultural Science, Mansoura University. 2001;26(1):435-438.
2. Ahsan MT, Perveen A, Khan N, Karim A. Toxicity of a synthetic pyrethroid lambda-cyhalothrin in comparison to a biopesticide (biocide) abamectin against 2nd and 3rd instar of cotton mealybug *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae), a sucking pest of cotton and vegetables. International Journal of Biology and Biotechnology. 2024;21(4):513-518.
3. Akanbi WB, Olaniyan AB, Togun AO, Ilupeju AEO, Olaniran OA. The effect of organic and inorganic fertilizer on growth, calyx yield and quality of roselle (*Hibiscus sabdariffa* L.). American-Eurasian Journal of Sustainable Agriculture. 2009;3(4):652-657.
4. Albiach R, Canet RR, Pomares F, Ingelmo F. Microbial biomass content and enzymatic activities after the application of organic amendments to a horticultural soil. Bioresource Technology. 2000;75:43-48.
5. Ali AM, Aly MFK. Toxicological effects of five insecticides on cabbage aphid *Brevicoryne brassicae* (L.) (Homoptera: Aphididae) and its parasitoid *Aphelinus* sp. (Hymenoptera: Aphelinidae). Journal of Plant Protection and Pathology. 2020;11(11):531-536.
6. Ali S, Naziri D. Recommended organic practices for the management of Potato Tuber Moth (PTM) in traditional country stores in Meghalaya, India. Lima, Peru: International Potato Center (CIP); 2019. Available from: https://cipotato.org/publications/recommended-organic-practices-for-the-management-of-potato-tuber-moth-ptm-in-traditional-country-stores-in-meghalaya-india/
7. Altieri MA, Ponti L, Nicholls CI. Soil fertility, biodiversity and pest management. In: *Biodiversity and Insect Pests*. John Wiley & Sons Ltd; 2012. p. 72-84.
8. Alyokhin A, Porter G, Groden E, Drummond F. Colorado potato beetle response to soil amendments: A case in support of the mineral balance hypothesis? Agriculture, Ecosystems & Environment. 2005;109(3):234-244.
9. Andersen PC, Brodbeck BV, Mizell RF. Assimilation efficiency of free and protein amino acids by *Homalodisca vitripennis* (Hemiptera: Cicadellidae: Cicadellinae) feeding on *Citrus sinensis* and *Vitis vinifera*. Florida Entomologist. 2009;92(1):116-122.
10. Andrews PK, Glover JD, Reganold JP. Horticultural performance, soil quality, and orchard profitability of integrated, organic, and conventional apple production systems. IOBC/WPRS Bulletin. 2001;24(5):393-400.
11. Arancon NQ, Edwards CA. Vermicomposts can suppress plant pest and disease attacks. Biocycle. 2004;March:51-53.
12. Arancon NQ, Paola AG, Edwards CA. Suppression of insect pest populations and damage to plants by vermicomposts. Bioresource Technology. 2005;95(10):1137-1142.

13. Ata TE. Influence of plant age and weather factors on population density of main insect pests attacking eggplants under open field conditions. Journal of Plant Protection and Pathology, Mansoura University. 2024;15(1):11-19.
14. Attia MMR, Darwish AAE, Abuzeid MAF. Synthesis and characterization of nanoemulsion formulations of some insecticides and their evaluation against the green peach aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae). Journal of Plant Protection and Pathology, Mansoura University. 2025;16(3):187-193.
15. Bai TQ, Zhang LM, Gu XH, Ji SG, Sun YX, Yang SY, *et al*. Rearing of *Myzus persicae* and *Aphidius gifuensis* on cruciferous crops. Journal of Yunnan Agricultural University. 2015;30:541-546.
16. Baziramakenga R, Simard RRS. Effect of deinking paper sludge compost on nutrient uptake and yields of snap bean and potatoes grown in rotation. Compost Science and Utilization. 2001;9(2):115-126.
17. Beanland L, Phelan PL, Salminen S. Micronutrient interactions on soybean growth and the developmental performance of three insect herbivores. Environmental Entomology. 2003;32:641-651.
18. Bhat BA, Islam ST, Ali A, Sheikh BA, Tariq L, Islam SU, *et al*. Role of micronutrients in secondary metabolism of plants. In: *Plant Micronutrients: Deficiency and Toxicity Management*. Springer; 2020. p. 311-329. https://doi.org/10.1007/978-3-030-49856-6_13
19. Borkakati RN, Venkatesh MR, Saikia DK. Insect pests of brinjal and their natural enemies. Journal of Entomology and Zoology Studies. 2019;7(1):932-937.
20. CABI. Invasive Species Compendium: Datasheet on *Maconellicoccus hirsutus* (pink hibiscus mealybug). 2015. Available from: http://www.cabi.org/isc/datasheet/40171#20133220898
21. CABI International. Biocontrol agents: Entomopathogenic and slug parasitic nematodes. In: Abd-Elgawad MMM, Askary TH, Coupland J, editors. 2017. 157 p.
22. Cakmak I, Brown P, Colmenero-Flores JM, Husted S, Kutman BY, Nikolic M, *et al*. Micronutrients. In: *Marschner's Mineral Nutrition of Plants*. Academic Press; 2023. p. 283-385. https://doi.org/10.1016/B978-0-12-819773-8.00017-4
23. Chau LM, Heong KL. Effects of organic fertilizers on insect pest and diseases of rice. Omonrice. 2005;13:26-33.
24. Cohort. CoStat. Monterey, California, USA: Cohort Software; 2004. Available from: www.cohort.com
25. Das GP, Raman KV. Alternate hosts of the potato tuber moth *Phthorimaea operculella* (Zeller). Crop Protection. 1994;13:83-86.
26. Das GP, Magallona ED, Raman KV, Adalla CB. Effects of different components of IPM in the management of the potato tuber moth in storage. Agriculture, Ecosystems & Environment. 1992;4:321-325.
27. Davis JA, Radcliffe EB, Ragsdale DW. Resistance to green peach aphid *Myzus persicae* (Sulzer) and potato aphid *Macrosiphum euphorbiae* (Thomas) in potato cultivars. American Journal of Potato Research. 2007;84:259-269.
28. Duncan DB. Multiple range and multiple F tests. Biometrics. 1955;11(1):1-42.
29. Ebaid GH, Mansour ES. Relative population abundances of sap-sucking pests and associated predators in relation to non-chemical treatments in cotton fields in Egypt. Egyptian Journal of Biological Pest Control. 2006;16(1-2):11-16.
30. El-Fakharany SKM. Cotton mealybug *Phenacoccus solenopsis* (Hemiptera: Pseudococcidae) population density in eggplant and okra plantations and effect of some insecticides. Egyptian Journal of Plant Protection Research Institute. 2020;3(1):377-388.
31. El-Mogy EEAM, Attia KE, Megahed MS, Ibrahim MMA. Evaluate productivity and pest resistance in response to the application of organic fertilizers on *Hibiscus sabdariffa* L. plants. Middle East Journal of Agriculture Research. 2021;10(1):342-357. https://doi.org/10.36632/mejar/2021.10.1.21
32. EPPO. *Maconellicoccus hirsutus*. EPPO datasheets on pests recommended for regulation. 2025. Available from: https://gd.eppo.int
33. Epstein E. Mineral Nutrition of Plants: Principles and Perspectives. New York: John Wiley & Sons; 1972.
34. Food and Agriculture Organization (FAO). FAOSTAT Production Databases. Rome: FAO; 2014. Available from: http://www.faostat.fao.org
35. Fouda SE, Niel EM. Influence of compost tea and potassium humate on soil properties and plant growth. Asian Journal of Soil Science and Plant Nutrition. 2021;7(2):29-40. https://doi.org/10.9734/ajsspn/2021/v7i230109
36. Gamal El-din AH, Abdelmonem AA, Khalifa HM, El-Tawil MF. Efficacy of certain chemical and bio-insecticides on potato tuber moth (*Phthorimaea operculella* Zeller) under laboratory conditions. Al-Azhar Journal of Agricultural Research. 2022;47(2):75-84.
37. Garcia Morales G, Denno BD, Miller DR, Miller GL, Ben-Dov Y, Hardy NB. ScaleNet: A literature-based model of scale insect biology and systematics. Database. 2016;2016:bav118. https://doi.org/10.1093/database/bav118
38. Gilboa S, Podoler H. Presence-absence sequential sampling for potato tuberworm (Lepidoptera: Gelechiidae) on processing tomatoes: selection of sample sites according to predictable seasonal trends. Journal of Economic Entomology. 1995;88:1332-1336.
39. Gleason MN, Gosselin HC, Smith RP. Clinical toxicology of commercial products: Acute poisoning. 3rd ed. Baltimore: The William and Co.; 1969. Catalog Card No. 68-22712.
40. Gomaa AE, El-Nenaey HM. Evaluation of certain controlling measures for *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) on potato in stores. Egyptian Journal of Agricultural Research. 2006;84:31-41.
41. He YQ, Zhang YQ, Chen JN, Chen WL, Zeng XY, Chen HT, Ding W. Effects of *Aphidius gifuensis* on the feeding behavior and potato virus Y transmission ability of *Myzus persicae*. Insect Science. 2017;25:1025-1034.
42. Henderson CF, Tilton FW. Tests with acaricides against the brown wheat mite. Journal of Economic Entomology. 1955;48:157-161.
43. Herms DA. Effects of fertilization on insect resistance

of woody ornamental plants: reassessing an entrenched paradigm. Journal of Environmental Entomology. 2002;31(6):923-933.
44. Ibrahim HAK, Ali EA, Othman IA. Laboratory evaluation of compost tea against cotton leaf worm *Spodoptera littoralis* (Boisd). Middle East Journal of Agriculture Research. 2016;5(4):881-888.
45. Kumar S, Sachan SK, Kumar V, Gautam MP. The abundance of insect pests associated with brinjal (*Solanum melongena* L.) crop. Journal of Entomology and Zoology Studies. 2019;7:1014-1017.
46. Longato GB. Abamectin: Unveiling the potent insecticide’s impact on agriculture and beyond. Annals of Clinical Trials and Vaccines Research. 2024;14(1):202-203. https://doi.org/10.37532/ACTVR.2024.14(1).202-203
47. Luo T, Lu W, Chen L, Min T, Ru S, Wei C, Li J. The effects of acidic compost tea on activation of phosphorus, Fe, Zn, and Mn in calcareous soil and cotton (*Gossypium hirsutum* L.) growth in Xinjiang, China. Journal of Soil Science and Plant Nutrition. 2022;22(3):3822-3834. https://doi.org/10.1007/s42729-022-00933-6
48. Mahmoud EK, Abd El-Kader N, Robin P, Akkal-Corfini N, Abd El-Rahman L. Effects of different organic and inorganic fertilizers on cucumber yield and some soil properties. World Journal of Agricultural Sciences. 2009;5(4):408-414.
49. Mandour NS, Sarhan AA, Ghanem M, Atwa D. Effect of certain bioinsecticides on the infestation rate and biological aspects of *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) in store. Agricultural Research Journal, Suez Canal University. 2009;9(1):109-116.
50. Meabed HAA, Rizk AM, El Hefnawy NN, El-Husseini MM. Biocontrol agents compared to chemical insecticide for controlling the potato tuber moth, *Phthorimaea operculella* (Zeller) in the newly reclaimed land in Egypt. Egyptian Journal of Biological Pest Control. 2011;21(1):97-101.
51. Mehta CM, Palni U, Franke-Whittle IH, Sharma AK. Compost: Its role, mechanism and impact on reducing soil-borne plant diseases. Waste Management. 2014;34(3):607-622.
52. Marsaro Júnior AL, Peronti ALBG, Penteado-Dias AM, Morais EGF, Pereira PRVS. Primeiro registro de *Maconellicoccus hirsutus* (Green, 1908) (Hemiptera: Coccoidea: Pseudococcidae) e do parasitoide associado *Anagyrus kamali* Moursi, 1948 (Hymenoptera: Encyrtidae), no Brasil. Brazilian Journal of Biology. 2013;73(2):413-418.
53. Mortvedt J, Cox F, Shuman L, Welch R. Micronutrients in Agriculture. 2nd ed. Madison: Soil Science Society of America, Inc.; 1991. p. 760.
54. Mousa GM, El-Sisi AG. Pesticidal efficiency of some inorganic salts against sucking pests infesting *Phaseolus vulgaris* (L.) seedlings. Egyptian Journal of Agricultural Research. 2001;79(3):835-845.
55. Mulot M, Monsion B, Boissinot S, Rastegar M, Meyer S, Bochet N, Brault V. Transmission of Turnip yellows virus by *Myzus persicae* is reduced by feeding aphids on double-stranded RNA targeting the ephrin receptor protein. Frontiers in Microbiology. 2018;9:457.
56. Najafabadi SM. Effect of various vermicompost-tea concentrations on life table parameters of *Macrosiphum rosae* L. (Hemiptera: Aphididae) on rose (*Rosa hybrida* L.) flower. Journal of Ornamental and Horticultural Plants. 2014;4(2):81-92.
57. Nampeera EL, Blodgett S, O’Neal ME, Nonnecke GR, Murungi LK, Abukutsa-Onyango MO, Wesonga JM. Resistance of *Amaranthus* spp. to the green peach aphid (Hemiptera: Aphididae). Journal of Economic Entomology. 2020;113:1299-1306.
58. Nayak SB, Rao KS, Mekala S. Management of important insect-pests of eggplant (*Solanum melongena* L.). In: *Solanum melongena*: Production, Cultivation and Nutrition. New York: Nova Science Publishers, Inc.; 2021.
59. Omura S, Shiomi K. Discovery, chemistry, and chemical biology of microbial products. Pure and Applied Chemistry. 2007;79:581-591.
60. Orr N, Shaffner AJ, Richey K, Crouse GD. Novel mode of action of spinosad: receptor binding studies demonstrating lack of interaction with known insecticidal target sites. Pesticide Biochemistry and Physiology. 2009;95(1):1-5. https://doi.org/10.1016/j.pestbp.2009.04.009
61. Pane C, Celano G, Piccolo A, Villecco D, Spaccini R, Palese AM, Zaccardelli M. Effects of on-farm composted tomato residues on soil biological activity and yields in a tomato cropping system. Chemical and Biological Technologies in Agriculture. 2015;2(1):4.
62. Patriquin DG, Baines D, Abboud A. Diseases, pests and soil fertility. In: Soil Management in Sustainable Agriculture. Wye: Wye College Press; 1995. p.161-174.
63. Phelan PL. Connecting below-ground and above-ground food webs: the role of organic matter in biological buffering. In: Magdoff F, Weil RR, editors. Soil Organic Matter in Sustainable Agriculture. Boca Raton: CRC Press; 2004. p.199-226.
64. Phelan PL. Soil-management history and the role of plant mineral balance as a determinant of maize susceptibility to the European corn borer. Biological Agriculture and Horticulture. 1997;15:25-34.
65. Phelan PL, Norris KH, Mason JF. Soil-management history and host preference by *Ostrinia nubilalis*: evidence for plant mineral balance mediating insect-plant interactions. Environmental Entomology. 1996;25(6):1329-1336.
66. Pitterna T, Cassayre J, Hüter OF, Jung PMJ, Maienfisch P, Kessabi FM, Quaranta L, Tobler H. New ventures in the chemistry of avermectins. Bioorganic and Medicinal Chemistry. 2009;17(12):4085-4095. https://doi.org/10.1016/j.bmc.2008.12.069
67. Primiya RL, Kennedy N, Mahesh P, Rajesh T, Veronica K. Biology of potato tuber moth, *Phthorimaea operculella* (Zeller) on three solanaceous host plants. Indian Journal of Hill Farming. 2022;35(2):147-151.
68. Rahman R, Sofi JA, Javeed I, Malik TH, Nisar S. Role of micronutrients in crop production. International Journal of Current Microbiology and Applied Sciences. 2020;8:2265-2287.
69. Rahouma AK. The most economic lepidopterous pests attacking vegetable crops in Egypt. Journal of Plant Protection and Pathology, Mansoura University. 2018;9(7):417-421.
70. Rajendra S, Garima S, Ajeet KT, Akhilesh S, Shveta P, Pratibha. *Myzus (Nectarosiphon) persicae* (Sulzer,

1776) (Homoptera: Aphididae): updated checklist of host plants in India. International Journal of Zoological Investigations. 2015;1(1):9-27.
71. Salman AMA, Abdel-Moniem ASH, Obidalla-Ali HA. Influence of certain agricultural practices on the cowpea aphid, *Aphis craccivora* Koch, infesting broad bean crops and the relation between the infestation and yield of plants in Upper Egypt. Archives of Phytopathology and Plant Protection. 2007;40(6):395-405.
72. Satar S, Kersting U, Uygun N. Effect of temperature on population parameters of *Aphis gossypii* Glover and *Myzus persicae* (Sulzer) (Homoptera: Aphididae) on pepper. Journal of Plant Diseases and Protection. 2008;115:69-74.
73. Temerak SA. Spinosad, a new naturally derived potato tuber worm control agent in comparison to certain conventional insecticides. Assiut Journal of Agricultural Sciences. 2003;34:153-162.
74. Wang X, Shen Z. Potency of some novel insecticides at various environmental temperatures on *Myzus persicae*. Phytoparasitica. 2007;35:414-422. https://doi.org/10.1007/BF02980705
75. Zienab R, Jabraiel R, Bahram N, Asgar E, Patcharin K. Evaluation of the susceptibility of some eggplant cultivars to green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae). Agriculture. 2021;11:31. https://doi.org/10.3390/agriculture11010031