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Influence of Plant Age and Weather Factors on Population Density of Main Insect Pests Attacking Eggplants under Open Field Conditions

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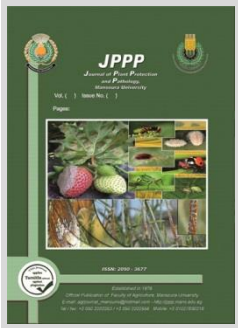

ABSTRACT

Eggplant (*Solanum melanogena* L.) is an important vegetable crop that is attacked by many insect pests; therefore, this research was conducted to study the seasonal abundance of eggplant insect pests under open field conditions. The results showed that the eggplant crop was exposed to many insect pests, the most important of which are: onion thrips, *Thrips tabaci* L., the cotton and tomato whitefly *Bemisia tabaci* (Genn.), leafhoppers (*Empoasca* spp.), cotton aphid, *Aphis gossypii* (Glover), green peach, *Myzus persicae*, leafminer, *Liriomyza sativae* (Blanchard) and the cotton mealybug. *Phenacococcus solenopsis* tinsley. The highest average number of insects attacking eggplant leaves was *Thrips tabaci* L (120.4 individuals), followed by *Bemisia tabaci* (48.9 individuals), while the least numerous insect was *P. solenopsis* (6.8 individuals). The cotton thrips *Thrips tabaci* and *L. sativae* recorded one infestation peak, while *Bemisia tabaci*, *Empoasca* spp., and *Phenacoccus solenopsis* recorded two infection peaks, and finally, *Aphis* spp. recorded three peaks of infestation.

Keywords: *Eggplant, insect pests, population density, weather factors, Egypt.*

INTRODUCTION

Eggplant (*Solanum melanogena* L.) is an important vegetable crop grown in various tropical and temperate parts of the world (Kashyap *et al*., 2003). It is a good source of vitamins and minerals (particularly iron making its total nutritional value comparable with tomato (Kalloo, 1993, Matsubara *et al*., 2005). Eggplant fruits contain a considerable amount of carbohydrates, protein, and vitamins (Mahamoud, 2000). Eggplant has been used in traditional medicines (Khan, 1979). For example, tissue extracts have been used for the treatment of asthma, bronchitis, cholera, and dysuria; fruits and leaves are beneficial in lowering blood cholesterol.

Generally speaking, eggplant is classified as a traditional commodity for both domestic and international trade. In Egypt, it is grown in the majority of agricultural areas (Rakha, 2014). Five countries account for 90% of production: China produces 24.5 million tons annually, India 10.6 million, and Egypt 1.2 million tons. Globally, about 1.7 million hectares are planted with eggplant (FAO, 2010). In 2012, ninety percent of the world's eggplant was produced in five countries, according to the Food and Agriculture Organization. With a total production of about 1.229.790 million tons, Egypt ranks third in the world. It is among the most significant crops grown in Egypt throughout the summer.

It has been discovered that several insect pest species infest eggplants, a few species induce mild to severe depressant effects and host plant damage, including *B. tabaci*, aphids, *Myzus persicae* and thrips. At different phases of plant growth, *Tetranychus cinnabarinus*, the spider mite, and *Thrips palmi* cause significant harm. The leaf-feeding ladybird beetle (*Epilachna indica*), fruit and shoot borer (*Leucinodes orbonalis*), green peach aphid (*M. persicae*), red spider mite (*T. cinnabarinus*), and thrips (*T. palmi*) are the common insects that consistently target this crop (Khoo *et al*., 1991). The population of whiteflies, the primary pest throughout plant development and growth, was significantly impacted by the interaction between insect and pest. According to Li *et al*. (2011), the whitefly, *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae), is detrimental to a wide variety of plants, especially in Malaysia's lowland agricultural areas.

In Egypt, aphids, whiteflies, and leafhoppers are among the homopterous insects that cause economic damage to a variety of crops. These pests infest solanaceous vegetable plants, affecting both the quantity and quality of produce due to the bugs' direct feeding on the plants. At Sharkia Governorate, six species of Cicadellidae leafhoppers were attacking eggplant. Hegab (2007). Aphid species *Myzus persicae* (Sulz), *Aphis gossyppii* (Glover), and whitefly *Bemisia tabaci* (Genn) were recorded on eggplant by the same author. Egypt has conducted studies on the fauna of these insects on the majority of field vegetable crops (Herakly, 1970; El Nahal *et al*, 1977 and Hegab *et al.* 1989). The most significant insect pest of eggplant is the whitefly, *Bemisia tabaci* (Genn.) (Yadav and Kumawat, 2013). One of the main elements affecting Argentina's horticulture crop output is aphids (Botto, 1999). Aphids on eggplant crop, *Solanum melongena* L. and pepper crop, *Capsicum annuum* L. in the world are primarily *Myzus persicae* (Sulzer), *Macrosiphum euphorbiae* (Thomas), *Aphis gossypii* Glover, *Aphis fabae* Scopoli, *Aphis nasturtii* Scopoli, and *Aulacorthum solani* (Kaltenbach). (Blackman and Eastop, 2000). Chemical pesticides have been the main method of controlling aphids; however, this approach has negative consequences on non-target animals, the environment, and human health. With over 800 host plant species, the green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae), is one of the most destructive insect pests in the

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world (Van Emden and Harrington 2017). Its consumption of sap results in the formation of honeydew, chlorosis and necrosis patches, and a sharp decline in the marketability of crops (Nampeera, *et al*. 2020). In addition to causing direct losses in plants through nutritional activities, M. persicae can also cause indirect harm by acting as an effective vector for the spread of harmful viruses (Torres-Quintero *et al*. 2013 and Bosquee *et al*. 2018). Of all the pests that affect this crop, A. gossypii, the aphid, is the one that damages eggplant the most (Gallo *et al*. 2002). In the world, one of the most significant pests of ornamentals and vegetables is the onion thrips, or *Thrips tabaci* Lindeman. Its function in the spread of several viruses to a variety of plants, including cucumber, sweet pepper, and eggplant, has been demonstrated. (Madadi and *et al.*, 2006). One of the most frequent pests that attack eggplant crops is the leafminer *Liriomyza sativae* (Blanchard, 1938). Other pests that attack eggplant crops include mites, aphids, whiteflies, and leafminers (Al-Azzawi *et al*. 1990). *Liriomyza sativae* (Blanchard, 1938) is a polyphagous pest of numerous flower and vegetable crops. Although it has been found in 9 different plant families, the Cucurbitaceae, Fabaceae, and Solanaceae families are usually its favored hosts. Solanaceae: pepper, tomato, eggplant, and potato; Brassicaceae: *Brassica spp*.; and Malvaceae: cotton (*Gossypium* sp.) are the principal crops targeted. Certain ornamentals, such *Chrysanthemum* spp., are also host plants (Spencer 1986).

Phenacoccus solenopsis Tinsley, known as the cotton mealybug (Hemiptera: Pseudococcidae), is an insect pest that secretes honeydew, which promotes the growth of black sooty mold Hamlen, (1975) and Jagadish *et al*., (2009). With more than 180 species at present, Phenacoccus is one of the largest genera in the family Pseudococcidae (Ben-Dov, 1994). The infestation with *P. solenopsis* on weeds was observed in Egypt for the first time by Abd-Rabou *et al*. (2010), and as a new pest on tomato crop, by Ibrahim *et al*., (2015) and recorded on the cotton crop *Gossypium hirsutum* L. by El-Zahi *et al.*, (2016). It was first recorded as a new pest on maize, eggplant, pepper and tomato plants at Fayoum by Abd El-Wareth (2016) and by El-Sarand, (2017) on soybean crop.

The aim of this study shed light on the population fluctuation of the main insect pests attacking eggplant and the influence of certain weather factors, (temperature and relative humidity) and age plant on the population density of these insect pests under the open field condition.

MATERIALS AND METHODS

The current study was conducted at Kafr-Saad district, Damietta Governorate, Egypt, on a private farm with one feddan planted with eggplant (*Solanum melongena* L.) Black Beauty verity. The coordinates of the farm are 31.359427°N 31.686452°E. 45-day-old eggplant seedlings were transplanted on May 1st, 2021, during the summer planting season, with 0.5 meter between each plant and 1 meter between rows. All advised agricultural procedures were followed over the whole production period, except for applying pesticides. The experiment area was divided into 4 equal plots 1050 m^2 each. Population of the main insect pests, onion thrips, *Thrips tabaci* L. (Thysanoptera: Thripidae), the cotton and tomato whitefly *Bemisia tabaci* (Genn.) (Hemiptera: Alyrodidae), leafhoppers (*Empoasca* spp.) (Hemiptera: Cicadellidae), aphids; the cotton aphid, *Aphis gossypii* (Glover) & the green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae), the leafminer *Liriomyza sativae* (Blanchard, 1938) (Diptera: Agromyzidae) and the cotton mealybug *Phenacoccus solenopsis* Tinsley (1989) (Hemiptera: Pseudococcidae), were recorded after two weeks of transplanting at weekly intervals until the end of harvest. Five plants representing the four corners and the center of each plot were randomly selected. Five leaves represented the three levels of each plant (lower, middle, and upper) were chosen from each plant. Collected leaves were kept in paper bags and transferred to the laboratory for examination using a stereoscopic microscope. The population density of the aforementioned insect pests population was then determined.

Statistical analysis

The effect of the tested factors; temperatures ◦C, relative humidity%, and plant age on the population abundance of the tested pests was ascertained using one-way analysis of variance (ANOVA) in the SPSS system. To compare the significance between the means, Duncan's Multiple Range Test (Duncan 1955) at 0.05 probability level was employed.

RESULTS AND DISCUSSION

The population density of the main insect pests on eggplant (*Solanum melongena*):

The obtained results showed that six insect pests are the main pests attacking eggplant crops in Damietta Governorate, results illustrated in Figures (1- 7) showed the average numbers of these insect pests on eggplant crops. These numbers were estimated by the leaf sample method during the summer planting season of 2021 in Damietta Governorate. The cotton thrips *Thrips tabac* L. came in the first category and recorded the highest average numbers and the lowest average numbers were recorded by *Phenacoccus solenopsis* Tinsley presented by 49.2 and 19.3 individuals/ sample on eggplan during the investigated season 2021.

The population density of the cotton and onion thrips, *Thrips tabac*:

The results represented in Figure (1), showed average number of *Thrips tabaci* during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. The infestation started on plants after about three weeks of transplanting seedlings at 20th of May 2021 with 165 individuals per 25 eggplant leaves, where the numbers gradually increased to reach the highest average numbers that recorded in 3rd of Jun (plant age = 34 days) and represented with 542.3 individuals per 25 eggplant leaves with daily range of temperature, daily mean of temperature and daily mean of relative humidity 9.3°C, 15.4°C and 49.5%, respectively. Then the number of insects gradually decreased until they reached their lowest number on the 8th of Jul 2021 (plant age = 69 days) with little number and represented 6.7 individuals per 25 eggplant leaves, and no numbers of the pest appeared after that until the end of the season. From the results obtained, the pest only appeared for 8 weeks, from May 20 until July 8, the general average of insects on Eggplant during the growing season has reached 120.4 individuals /25 eggplant leaves.

As for the relationship of the insect to the lifespan of the plant, it is clear that the period from the life of the plant,

which ranges from 20 days to 69 days (From transplanting seedlings, which were transferred from the nursery about 45 days after planting the seeds), is the appropriate period for the insect to feed and increase its numbers on the eggplant leaves, after which the plant becomes Completely unsuitable for insect life.

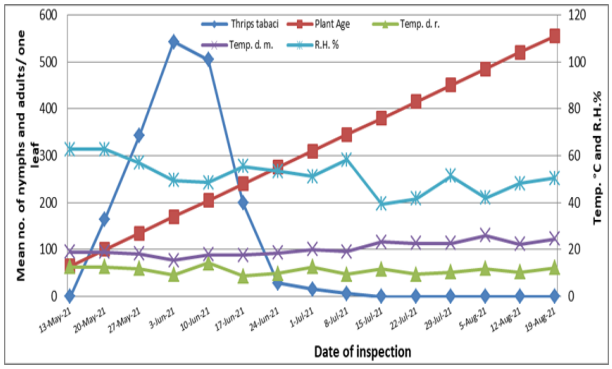

Fig. 1. Weekly average numbers of *Thrips tabaci* per 25 eggplant leaves during 2021at Kafr-Saad region Damietta Governorate.

The population density of the *Bemesia tabaci* insects on eggplant (*Solanum melongena*):

The results represented in Figure (2), showed an average number of *Bemesia tabaci* during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. The infestation started on plants after about two weeks of transplanting seedlings at 13th of May 2021 with 0.9 nymphs per 25 eggplant leaves, where the numbers gradually increased to reach the 1st and highest peak of infestation in 10th of Jun (plant age = 41 days) and represented with 97.2 nymphs per 25 eggplant leaves with daily range of temperature, daily mean of temperature and daily mean of relative humidity 14.2°C, 17.8°C and 48.6%, respectively. The numbers of insects fluctuated for about 6 weeks until they reached the second peak of infestation on the 29th of Jul 2021 (plant age = 90 days) and the insect represented 82.2 nymphs per 25 eggplant leaves with a daily range of temperature, daily mean of temperature and daily mean of relative humidity 10.4°C, 22.6°C and 51.3%, respectively. From the results obtained, the pest appeared all of the planting season; the general average of insects on Eggplant during the growing season has reached 48.9 nymphs /25 eggplant leaves.

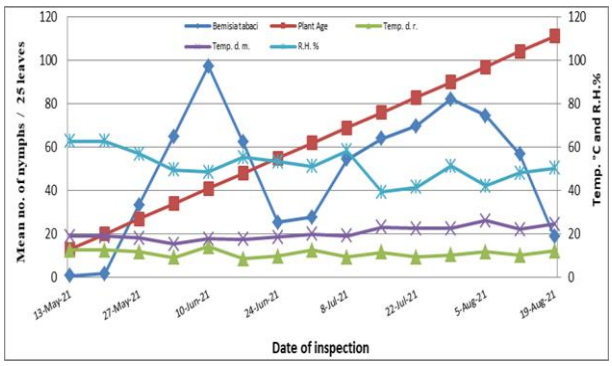

Fig. 2. Weekly average numbers of Bemesia tabaci per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

As for the relationship of the insect to the lifespan of the plant, it is clear that the insect can feed and complete its life cycle on eggplant leaves at all stages of plant growth (vegetative growth stage, flowering, and fruiting stage), even if the period two weeks after transplanting is the period in which the pest begins to increase until End of plant life

The population density of the leafhopper (*Empoasca* spp.) insects on eggplant (*Solanum melongena*):

The results represented in Figure (3), showed an average number of leafhopper species belonging to family Cicadellidae during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. The infestation started on plants after about two weeks of transplanting seedlings at 13th of May 2021 with 3.4 individuals per 25 eggplant leaves, where the numbers gradually increased to reach the 1st and highest peak of infestation in 10th of Jun (plant age = 41 days) and represented with 38.5 individuals per 25 eggplant leaves with daily range of temperature, daily mean of temperature and daily mean of relative humidity 14.2°C, 17.8°C and 48.6%, respectively. The insect's numbers fluctuated for about 5 weeks until it reached the second infestation peak on July 22, 2021 (plant age = 83 days) and the insect was represented by 36.8 individuals per 25 eggplant leaves with a daily range of temperature, daily mean of temperature and daily mean of relative humidity 9.4°C, 22.6°C and 41.6%, respectively. From the results obtained, the pest appeared all of the planting season; the general average of insects on Eggplant during the growing season has reached 388.8 individuals /25 eggplant leaves.

As for the relationship of the insect to the lifespan of the plant, it is clear that the insect can feed and complete its life cycle on eggplant leaves at all stages of plant growth (vegetative growth stage, flowering, and fruiting stage), even if the period two weeks after transplanting is the period in which the pest begins to increase until End of plant life.

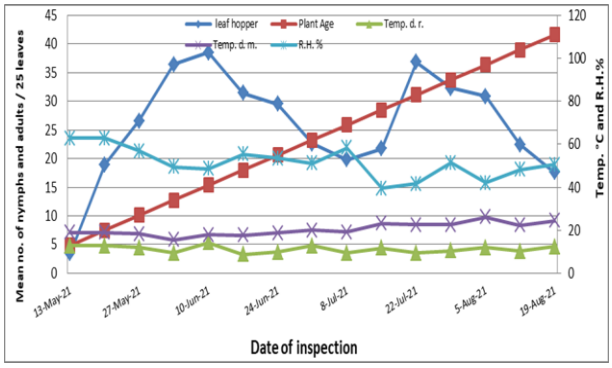

Fig. 3. Weekly average numbers of leafhopper per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

These results are in agreement with those obtained Awadalla *et al.* (2019) in Egypt they recorded four leafhoppers and one planthopper on eggplant, tomato and pepper crops in Gharbia Governorate, eggplant was found the most susceptible crop.

The population density of the *Aphis* spp. insects on eggplant (*Solanum melongena*):

The results represented in Figure (4), showed the average number of Aphids, *Aphis gossypii*, and *Myzus persicae* during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. The infestation started on plants after about

three weeks of transplanting seedlings at 20th of May 2021 with 7.2 individuals per 25 eggplant leaves, where the numbers gradually increased to reach the 1st and highest peak of infestation in 10th of Jun (plant age = 41 days) and represented with 39.5 individuals per 25 eggplant leaves with daily range of temperature, daily mean of temperature and daily mean of relative humidity 14.2°C, 17.8°C and 48.6%, respectively. The insect's numbers fluctuated for about 3 weeks until it reached the second and lowest infestation peak on July 8, 2021 (plant age = 69 days) and the insect was represented by 33.5 individuals per 25 eggplant leaves with a daily range of temperature, daily mean of temperature and daily mean of relative humidity 9.4°C, 19.2°C and 58.3%, respectively. The same thing happened after another 3 weeks, and the third and intermediate infestation peaked on August 5, 2021 (plant age = 97 days) and the insect represents 38.0 individuals per 25 eggplant leaves with a daily range of temperature, daily mean of temperature and daily mean of relative humidity 11.9°C, 26.1°C and 42.1%, respectively. From the results obtained, the pest appeared all of the planting season; the general average of insects on Eggplant during the growing season has reached 23.2 individuals /25 eggplant leaves.

As for the relationship of the insect to the lifespan of the plant, it is clear that the insect can feed and complete its life cycle on eggplant leaves at all stages of plant growth (vegetative growth stage, flowering, and fruiting stage), even if the period three weeks after transplanting is the period in which the pest begins to increase until End of plant life.

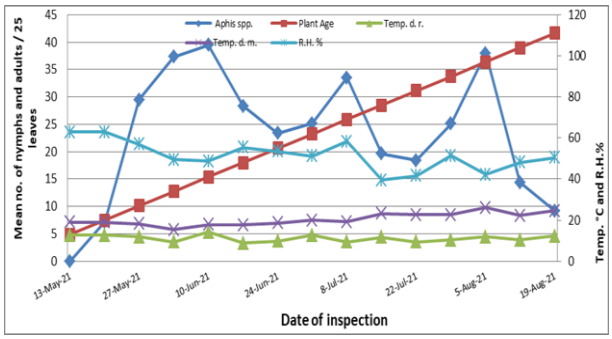

Fig. 4. Weekly average numbers of *Aphis* spp. per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

The population density of the eggplant leafminer *Liriomyza sativae* (Blanchard, 1938) (Diptera, Agromyzidae) on eggplant (*Solanum melongena*):

The results represented in Figure (5), showed an average number of the eggplant leafminer *Liriomyza sativae* during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. The infestation started on plants after about two weeks of transplanting seedlings on the 13th of May 2021 with 4.8 larvae and 15.8 tunnels per 25 eggplant leaves, where the numbers gradually increased to reach the highest average numbers recorded on the 17th of Jun (plant age = 48 days) for larvae and represented with 41.1 larvae per 25 eggplant leaves with a daily range of temperature, daily mean of temperature and daily mean of relative humidity 8.7°C, 17.7°C and 55.4%, respectively, While the highest number of tunnels came about two weeks late, on the first of July (plant age = 62 days), with an average number of 326.5 tunnels for every 25 eggplant leaves. Then the numbers of larvae and tunnels gradually decreased until they reached their lowest number at the end of the season during August of 2021. The general average of insect density (larvae and tunnels) on Eggplant along the growing season has reached 17.0 larvae and 130.9 tunnels /25 eggplant leaves.

As for the relationship of the insect to the lifespan of the plant, it is clear that the period from the life of the plant, which ranges from 27 days to 76 days (From transplanting seedlings, which were transferred from the nursery about 45 days after planting the seeds), is the appropriate period for the insect to feed and increase its numbers on the eggplant leaves.

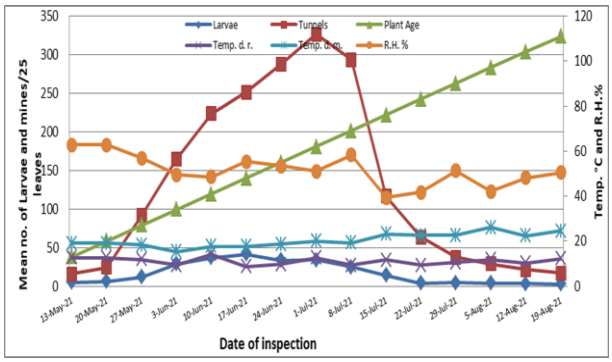

Fig. 5. Weekly average numbers of the leafminer *Liriomyza sativa* per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

The population density of the cotton mealybug *Phenacoccus solenopsis* insect on eggplant (*Solanum melongena*):

The results represented in Figure (6), showed an average number of *P. solenopsis* during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. The infestation started on plants after about three weeks of transplanting seedlings at 20th of May 2021 with 0.93 individuals per 25 eggplant leaves, where the numbers gradually increased to reach the 1st and highest peak of infestation in 17th of Jun (plant age = 48 days) and represented with 9.7 individuals per 25 eggplant leaves with daily range of temperature, daily mean of temperature and daily mean of relative humidity 8.7°C, 17.7°C and 55.4%, respectively.

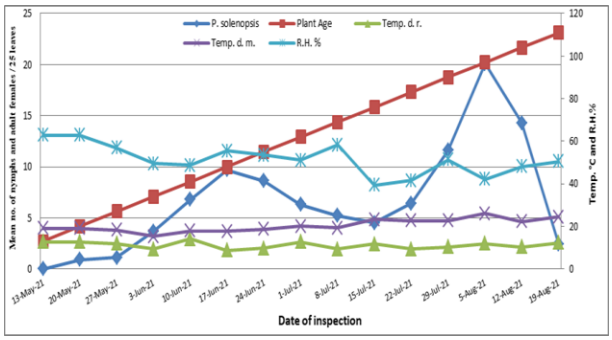

Fig. 6. Weekly average numbers of *P. solenopsis* per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

The insect's numbers fluctuated for about 6 weeks until it reached the second infestation peak on August 5, 2021(plant age = 97 days) and the insect was represented by 36.8 individuals per 25 eggplant leaves with a daily range of temperature, daily mean of temperature and daily mean of

relative humidity 11.9°C, 26.1°C and 42.1%, respectively. From the results obtained, the pest appeared all of the planting season; the general average of insects on Eggplant during the growing season has reached 6.8 individuals /25 eggplant leaves.

As for the relationship of the insect to the lifespan of the plant, it is clear that the insect can feed and complete its life cycle on eggplant leaves at all stages of plant growth (vegetative growth stage, flowering, and fruiting stage), even if the period three weeks after transplanting is the period in which the pest begins to increase until End of plant life.

The population density of the main insect pests on eggplant (*Solanum melongena*):

The results represented in Figure (7), showed an average number of the main insect pests during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. The infestation started on plants after about two and three weeks of transplanting seedlings on the 13th for *L. sativae*, *B. tabaci* & leaf hopper and on the 20th of May 2021 for *T. tabaci*, *Aphis* spp. & *P. solenopsis.*

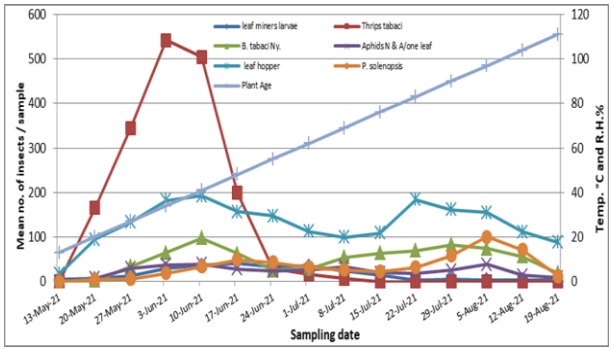

Fig. 7. Weekly average numbers of the main insect pests per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

All insects remained attached to the crop throughout the growing season until the end of the season, except for the cotton thrips, which, although it appeared in the highest numbers at the beginning of the season, completely disappeared on July 8 (plant age = 69 days) and no pest individuals appeared again. The insect has a close relationship with the lifespan of eggplant plants.

Monthly average numbers of the main insect pests on eggplant (*Solanum melongena*):

The results represented in Table (1) and Fig. (8), showed the average numbers of the main insect pests during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. Five insects recorded their highest numbers during June (plant age = 28-55 days): *T. tabaci*, *B. tabaci*, leafhoppers (*Empoasca* spp.), *Aphis* spp., and *L. sativae* and represented by 318.6±123.4, 62.5±14.7, 34.0±2.1, 32.1±3.8 and 35.1±2.5 individuals per plant sample respectively, while the cotton mealybug *P. solenopsis* recorded its highest numbers at the end of the season in August (plant age = 91-111 days) by 12.3±5.21 individuals.

Four insects recorded their lowest numbers during May (plant age = 13-27 days): the whitefly, leafhopper, aphids, and the cotton mealybug *P. solenopsis*, with average numbers of 12.0±10.7, 16.3±6.8, 12.2±8.9, and 0.7±0.3 individuals per plant sample respectively, while *L. sativae*, recorded its lowest number during August (plant age = 91-111 days), with 3.3±0.36 individuals per plant sample. In July (plant age = 56-90 days), the lowest number of *T. tabaci* insects was recorded, with an average number of 4.5±3.11 individuals per sample, and this was the last month in which this insect appeared. The statistical analysis showed that there were significant differences between the numbers of insects during the growing season, where *T. tabaci* recorded the highest numbers, followed by *B. tabaci*, while *P. solenopsis* recorded the lowest numbers on eggplant plants.

Table 1. The monthly average number of the main insect pests on the eggplant during 2021 at Kafr-Saad district Damietta Governorate.

Month	*T. tabaci* / 25L	*B. tabaci* / 25L.	*Empoasca spp.* / 25 L	*Aphis* spp. / leaf	*L. sativae* / 25L	*P. solenopsis* / 25 L	Average insects/25L.
May	169.5±99.2 ab	12.0±10.7 b	16.3±6.8 b	12.2±8.9 b	7.6 ±2.1 b	0.7±0.3 b	36.4±26.72 a
Jun	318.6±123.4 a	62.5±14.7 a	34.0±2.1 a	32.1±3.8 a	35.1±2.5 a	7.2±1.3 ab	81.6 ±47.95 a
Jul	4.5±3.11 b	59.6±9.14 a	26.6±3.34 ab	24.4±2.67 ab	16.2±5.89 b	6.8±1.3 ab	23.0 ±8.18 a
August	0.0±00 b	50.0±16.38 ab	23.6±3.89 ab	20.5±8.86 ab	3.3 ±0.36 b	12.3±5.21 a	18.3 ±7.38 a
Average	123.2 ±1.5 A	46.0 ±1.5 AB	25.1 ±1.5 B	22.3 ±1.5 B	15.6 ±1.5 B	6.7 ±1.5 B	39.8±17.50

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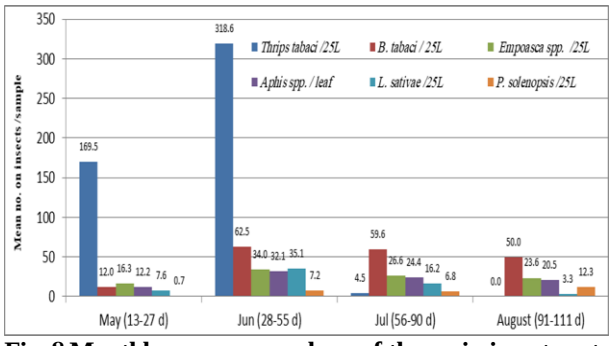

Fig. 8.Monthly average numbers of the main insect pests per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

As for the general rate of insect infestation on eggplant in the various months of the season, the highest overall average number of insects was recorded in June (plant age = 28-55 days) with an average number of 81.6±47.95 individuals, followed by May (plant age = 13-27 days) with an average number of 36.4±26.72 individuals, while August (plant age = 91-111 days), it was the month with the lowest incidence of pests, with 18.3±7.38 individuals recorded.

Seasonal average numbers of the main insect pests on eggplant (*Solanum melongena*):

The results represented in Figure (9), showed the seasonal average numbers of the main insect pests during the summer planting season extended from 13th May 2021 to 19th August 2021 on the Eggplant, *S. melongena* crop. Although the cotton thrips insect only appeared on eggplant plants for eight weeks in the beginning season extended to fifteen weeks, it recorded the highest annual average number of pests that attacked eggplant plants throughout the growing season.

The statistical analysis showed that there were significant differences between the seasonal average numbers of the six insect species on eggplant crop during the growing season, where the cotton thrips *T. tabaci* recorded the highest annual average of 120.4±49.63 individuals, followed by the cotton whitefly, which recorded an annual average of 48.9±7.54 individuals. The cotton mealybug *P. solenopsis* came last in terms of the annual population average, recording 6.8±1.41 individuals.

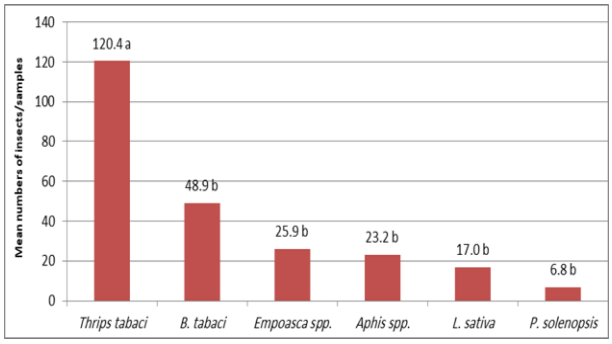

Fig. 9. Seasonal average numbers of the main insect pests per 25 eggplant leaves during 2021 at Kafr-Saad region Damietta Governorate.

Effect of weather factors on the population activities of the main insect pests on eggplant (*S. melongena.*)

Table (2) shows the relation between population densities of the main insect pests attacking eggplant crops (*S. melongena*) and the corresponding tested factors; the daily range of temperature, the daily mean of temperature, relative humidity %, and the plant age. The relation between the population density of *T. tabaci* and the daily range of temperature and relative humidity % are positive and non-significant, simple correlation coefficient values (r.) were 0.117 and 0.112 respectively. This relation for each of daily mean temperature and plant age was significant and negative, simple correlation coefficient values (r.) were -0.707 and -0.566 respectively. The findings of the partial regression values in Table (2) showed the precise impact of the various investigated climatic conditions and plant age. The "F" values in these partial regression results were highly significant, and they revealed the same trend as those seen in simple correlation results. The relation between population densities of *B. tabaci* & Leafhoppers (*Empoasca* spp.) insects and the corresponding tested factors; temperature and the plant age is non-significant, while the relative humidity % was significant and negative relation, simple correlation coefficient values (r.) were -0.655 and -0.525 for the two insects respectively. The partial regression values in Table (2) show the precise impact of the many factors that were investigated. The trend observed in the simple correlation results was also evident in the partial regression results and the "F" values were significant for *B. tabaci* and non-significant for Leafhoppers (*Empoasca* spp.). The relationship between population density of *Aphis* spp. and all corresponding tested factors; Temperature, relative humidity %, and plant age were not significant, in the simple correlation coefficient and also in the partial regression, and the "F" values were not significant. The relation between the population density of *L. sativa* and the corresponding tested factors; temperature and plant age are non-significant, while the relative humidity % was significant and negative relation, simple correlation coefficient values (r.) were -0.672.

Table 2. Simple correlation coefficient, partial regression values and explained variance (E.V.) between tested weather factors and the weekly mean numbers of the main insect pests on eggplant crop during 2021.

Insect	Factor	Simple correlation analysis		Multiple Partial regression analysis				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
T. tabaci	d.r. of Temp.	0.117	0.678	38.95	0.139	6.25	0.009	60.00%
	d.m. Temp.	-0.707	0.003	-72.28	0.011			
	R.H.	0.112	0.692	-13.198	0.054			
	Plant age	-0.566	0.028	0.63	0.795			
B. tabaci	d.r. of Temp.	-0.238	0.393	-0.298	0.95	3.05	0.069	55.00%
	d.m. Temp.	0.138	0.625	-5.746	0.222			
	R.H.	-0.655	0.008	-3.101	0.023			
	Plant age	0.371	0.174	0.3314	0.478			
Empoasca spp.	d.r. of Temp.	-0.319	0.247	-0.541	0.714	3.28	0.058	39.40%
	d.m. Temp.	-0.115	0.684	-2.337	0.119			
	R.H.	-0.525	0.045	-1.0247	0.017			
	Plant age	0.158	0.575	0.071	0.622			
Aphis spp.	d.r. of Temp.	-0.193	0.491	0.479	0.83	1.63	0.242	15.20%
	d.m. Temp.	-0.214	0.443	-3.573	0.116			
	R.H.	-0.337	0.219	-0.9821	0.1			
	Plant age	0.041	0.884	0.1538	0.484			
L. sativae	d.r. of Temp.	-0.162	0.565	1.447	0.504	4.2	0.03	47.80%
	d.m. Temp.	-0.672	0.006	-6.497	0.009			
	R.H.	0.107	0.704	-0.6067	0.271			
	Plant age	-0.367	0.179	0.2625	0.224			
P. solenopsis	d.r. of Temp.	0.117	0.678	-0.5844	0.566	1.78	0.21	18.20%
	d.m. Temp.	-0.707	0.003	0.2258	0.815			
	R.H.	0.112	0.692	-0.1587	0.533			
	Plant age	-0.566	0.028	0.0589	0.552			

d.r. = daily range of temperature d.m. = daily mean of temperature

Table (2) displays the partial regression values that indicate the precise impact of the many factors that were examined. The trend observed in these partial regression results was also evident in the results of the simple correlation

and the "F" value was significant. The relation between the population density of *F. solenopsis* and the daily range of temperature and relative humidity % are positive and non-significant, simple correlation coefficient values (r.) were 0.117 and 0.112 respectively. This relation for each of daily mean temperature and plant age was significant and negative, simple correlation coefficient values (r.) were -0.003 and -0.028 respectively. The partial regression results showed a different trend from the simple correlation results, and the "F" values were not significant.

The statistical analysis revealed that the aforementioned factors are responsible for the population densities of *T. tabaci*, *B. tabaci*, Leafhoppers (*Empoasca* spp.), *Aphis* spp. *L. sativae* and *P. solenopsis* with about 60.00%, 55.00%, 39.40%, 15.20%, 47.80% and 18.20% of the variability in the population respectively.

Our results are in agreement with those obtained by Shah, (2015) in Pakistan, who revealed that population dynamic *T. tabaci* has one peak of infestation on onions during the growth seasons for onions. The peak of thrips insect populations was recorded on onion plants during April with 54.75 thrips/plant and the relation between insect population and the weather factors showed that the mean temperature has a positive correlation with thrips population.The results are consistent with those of (Farmanullah et al., 2010; Edelson et al., 1986), who found that onion thrip populations oscillate from February to May, peaking in April. The findings of Deligeorgidis *et al*. (2005) and Duchovskiene (2006), which indicate that the peak population of onion thrips and western flower thrips on tomato and cumber crops occurs in May and July throughout the cropping season, are likewise comparable with the present data. As the temperature rose, Murai (2000) reported a decline in the *T. tabaci* population. Hussain *et al.* (1997) and Hyder and Sharif (1987) reported nearly identical results, stating that the T. tabaci population peaked in April after beginning in early February. According to the population model, temperature is the primary component that most accurately predicts the population development of T. tabaci and has a strong association (r=0.63) with the thrips population. Similar results were also noted by Farmanullah *et al.* (2010), who stated that air temperature predicted 44% of the total population variability. Additionally, Domiciano *et al.* (1993) noted that 20.29°C is a temperature that is conducive to an increase in thrips in Brazil. These findings concur with those of Rodrigues *et al.* (2022), who discovered that between 30 and 50 days following the emergence of the soybean crop, adult and juvenile whitefly infestations began. Between 90 and 101 days after plant emergence, the maximum population density of ten adults per plant and two nymphs per leaf was reached.

Our findings differed from those of Rasdi *et al*. (2020) in Malaysia, who discovered that the whitefly was the most common insect pest on eggplants, accounting for almost 50% of the pest composition. Aphids, mites, spider mites, and thrips were the next most common insect pests.

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تأثير عمر النبات والعوامل الجوية على الكثافة العددية للآفات الحشرية الرئيسية التي تهاجم الباذنجان تحت ظروف الحقل المفتوح

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الملخص

يعد الباذنجان (*Solanum melanogena* L) من المحاصيل النباتية الهامة التي تتعرض لهجوم العديد من الآفات الحشرية؛ لذلك، أجري هذا البحث لدراسة الوفرة الموسمية للآفات الحشرية على نباتات الباذنجان تحت ظروف الحقل المفتوح. حيث أظهرت النتائج تعرض محصول الباذنجان للإصابة بالعديد من الآفات الحشرية أهمها: تربيس البصل، *Thrips tabaci* L. ، ذبابة القطن والطماطم البيضاء (Genn.) *Bemisia tabaci* ، نطاطات الأوراق *Empoasca* spp. ، حشرات المن، من القطن (Glover.) *Aphis gossypii* و من الخوخ الأخضر *Myzus persicae* ، حفار الأوراق *Liriomyza sativa* ، وبق القطن الدقيقي، *Phenacoccus solenopsis* وكان أعلى متوسط لعدد الحشرات التي تهاجم أوراق الباذنجان هو تربس القطن (120.4) فرداً، يليه ذبابة القطن والطماطم البيضاء (48.9) فرداً، بينما أقل الحشرات عدداً كانت حشرة بق القطن الدقيقي (6.8) فرداً. وسجلت حشرة تربس القطن وصانعة أنفاق أوراق الباذنجان ذروة إصابة واحدة، في حين سجلت ذبابة القطن والطماطم البيضاء ونطاطات الأوراق وحشرة بق القطن الدقيقي ذروتي إصابة، وأخيراً سجلت حشرات المن ثلاث قمم للإصابة.