Influence of Different Vegetable Plants on the Population Density of some Piercing-Sucking Insect pests

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ABSTRACT

These studies were carried out in Kafir-Saad district, Damietta Governorate during 2022 season on four vegetable crops, (cucumber, cowpea, tomato and sweet potato). The present study showed that the different vegetables were attacked by seven piercing-sucking insect species i.e.: Aphis gossypii, Myzus persicae, Bemisia tabaci, Thrips tabaci, Empoasca sp., Phenacoccus solenopsis and Nezara viridula belonging to two insect orders: Thysanoptera and Hemiptera. Five insect species were recorded on each of the investigated crops, while the green peach aphid, Myzus persicae recorded only on cucumber plants, the cotton thrips, Thrips tabaci was not recorded on sweet potato plants. The most attracted host plants for the insect species was cucumber followed by cowpea and tomato, whereas sweet potato ranked the last category and represented by 282.8, 18.6, 10.5 and 5.6 individuals/sample, on cucumber, cowpea, tomato and sweet potato respectively. The cotton aphid, Aphis gossypii was the predominant species on cucumber, cowpea and tomato and represented by 890.1, 47.8 and 29.7 Aphis/sample, respectively with significant differences. Meanwhile, the green stink bug, Nezara viridula occupied the last category on the three vegetable host plants and represented by 1.8, 3.1 and 3.4 individuals/sample, respectively. On the other hand, the cotton mealybug, Phenacoccus solenopsis recorded the highest average number on sweet potato followed by the leafhoppers, Empoasca sp. and represented by 7.4 and 4.4 individuals/sample, respectively.

Keywords: Vegetable crops, piercing-sucking insects, host plants.

INTRODUCTION

Three hundred and ninety two vegetable plants are grown worldwide, according to the global vegetable census (Kays and Dias, 1995). 10.6% of Egypt's arable land in 2009 was used for cultivating vegetable crops (El-Nahrawy, 2011). Given that only 3% of Egypt's land is arable, this is extremely intensive agriculture (FAO, 2012). Egypt exported vegetables worth $1.1 billion in 2019 (UN ComTrade Database, 2019). Cucumber crop (Cucumis sativus L.), is one of the most widely consumed fresh vegetables in the world. In Egypt, 52.67 thousand feddan are planted with cucumbers in 2013–2014, yielding approximately 496.81 thousand tons of fresh fruit. (Agriculture Ministry, 2015). Another one of the most significant vegetable crops in Egypt and the rest of the globe is tomato (Lycopersicon esculentum, Mill.). Egypt is one of the world's top tomato producers with 8,625,219 tons produced annually (FAO, 2012). Cowpea, Vigna unguiculata (L.) Walp., is a member of the Fabaceae family and grown as a grain, vegetable, and fodder crop all over the world, particularly in tropical Africa, South America, and Asia. 20.42-34.60% of proteins are found in cowpea seeds (Bdalla et al., 2001). More one important starchy food crop is sweet potatoes, particularly in poor nations where they rank third in terms of production value and fifth in terms of the number of calories they contribute to diets (FAO, 2015).

Unfortunately, during their different growth phases, these crops are attacked by a variety of insect species. Injurious piercing-sucking insect pests seriously affect yield quality and quantity (Jackai, 1995; Ward et al., 2002; Hassan 2013). They cause harm directly to the plants by sucking plant juice, or indirectly by acting as viral carriers. Vegetable yields are significantly declined by insect pests (Kisha, 1984), and chemical insecticides continue to be the most widely used method of management despite their well-documented detrimental effects on the environment and human health. In actuality, pesticides continue to be the principal tool used to manage pests. According to Shelton et al. (2008), 30% of all insecticides used globally are used to control insects in vegetable crops. According to Mansour et al. (2017), there were still traces of extremely hazardous pesticides in the environment in Egypt since 2017. Although the use of biopesticides is becoming more common in field crops, indoor pesticide use is still common but often poorly regulated (Mansour, 2008). Many insect species have been identified as pests of sweet potatoes; include members of the orders of Thysanoptera, Orthoptera, Hemiptera, Lepidoptera, and spider mites (Kay, 1973; Chalfant, et al. 1990; Ekman and Lovatt, 2015). The cotton thrips, Thrips tabaci L. is a polyphagous insect that seriously damages ornamental and vegetable plants worldwide (Murai, 2000). Nymphs and adults consume the tissue sap of green leaves, directly harming the tissue by damaging the epidermal cells (Koschier et al., 2002).

The host plant has an effective role on the piercing-sucking pest populations and their predators, the natural enemies showed differences of their searching characteristics in response to host plant species Abd El-Kareim (2002).

Therefore, the goal of the current research is to studying the influence of different host plants on the population density of some piercing-sucking insect pests that attacking vegetable crops in the open fields.
MATERIALS AND METHODS

Study area:
This study was conducted in a private farm located at Kafra-Saad region of Damietta Governorate, Egypt. The farm is located at 31.359427° N 31.686452° E. The experimental area was quarter feddan (~1050 m²) and split into four identical plots, each measuring 262.5 m². Each of the four plots was planted with one of the four vegetable crops; i.e. Tomato, (L. esculentum); Cucumber, (C. sativus); Egyptian cowpea, (V. unguiculata); Sweet potato (I. batatas). On April 27th, 2022, during the summer planting season, tomato and cucumber seedlings (about forty-five days old) were transplanted leaving half a meter between each plant and a meter between rows. In case of sweet potato, the area is planted at a rate of 8-12 lines in the two reeds; The cuttings were planted in the presence of water on the upper third of the line at a distance of 25-30 cm. Cowpea seeds were planted 2 inches deep, 3 inches apart, in rows 3 feet apart. Throughout the whole production period, every suggested agricultural practice was followed, with the exception of using pesticides. Fifteen days later of planting, samples were collected from different crops at weekly intervals until the end of harvest. The numbers of insect species were counted and recorded. Five randomly plants of each crop were selected and five leaves were selected from each crop. The collected leaves were placed in paper bags and directly transferred to the lab to be examined using a binocular microscope. Next, the population density of the recorded insect pests was ascertained.

Table 1. The piercing-sucking insect species recorded on the four vegetable crops at Kafra-Saad district, Damietta Governorate.

<table>
<thead>
<tr>
<th>Insect order</th>
<th>Family</th>
<th>Genus/species</th>
<th>Seasonal average no./25 leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thysanoptera</td>
<td>Thripidae</td>
<td>Thrips tabaci</td>
<td>+</td>
</tr>
<tr>
<td>Pseudococcida</td>
<td>Cicadellida</td>
<td>Phenococcus solenopsis</td>
<td>+</td>
</tr>
<tr>
<td>Aleyrodida</td>
<td>Peniaphila</td>
<td>Mycoccus persicae</td>
<td>+</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>Aphididae</td>
<td>Empoasca spp.</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aphis gossypii</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bemisia tabaci</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nezara viridula</td>
<td>+</td>
</tr>
</tbody>
</table>

The symbol (+) indicates that the insect recorded on the plant, while the symbol (-) indicates that the insect does not recorded on the plant.

2. Host preference of the main piercing-sucking insect species on different vegetable crops.

The obtained results in Table (2) and Figure (1) show the average numbers of the main insect species on the four vegetable plants.

According to the statistical analysis, there were significant variations between the general average numbers of the piercing-sucking insects attacking the four vegetable plants during the growing season. The highest attracted host plant for the insect species was cucumber plants (282.8 individuals/sample) followed by cowpea and tomato plants (18.6 and 10.5 individuals/sample) whereas the less attracted host plant was sweet potato (5.6 individuals/sample).

Aphid spp., (A. gossypii and M. persicae) were the predominant species and recorded the highest average numbers (242.4 individuals/sample) followed by B. tabaci (161.4 individuals/sample). Whereas the lowest average numbers were recorded on the four vegetable crops by N. viridula. (3.2 bugs/sample).

Table 2. General average numbers of the main piercing-sucking insects attacking vegetable crops at Kafra-Saad district, Damietta Governorate.

<table>
<thead>
<tr>
<th>Host plant</th>
<th>A. gossypii</th>
<th>B. tabaci</th>
<th>T. tabaci</th>
<th>Empoasca Sp.</th>
<th>P. solenopsis</th>
<th>N. viridula</th>
<th>Total</th>
<th>LSD (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucumber</td>
<td>890.12±39.0 a</td>
<td>631.22±213.5 a</td>
<td>142.44±65.6 a</td>
<td>6.4±0.8 b</td>
<td>24.6±7.3 a</td>
<td>1.8±0.3 b</td>
<td>1696.6±363.9 a</td>
<td>375.9</td>
</tr>
<tr>
<td>Cowpea</td>
<td>47.8±6.9 b</td>
<td>5.1±1.1 b</td>
<td>4.4±1.2 b</td>
<td>47.0±6.7 a</td>
<td>4.3±1.0 b</td>
<td>3.4±0.5 a</td>
<td>111.8±12.9 b</td>
<td>11.3</td>
</tr>
<tr>
<td>Tomato</td>
<td>29.7±8.0 b</td>
<td>5.4±0.7 b</td>
<td>11.0±0.8 b</td>
<td>3.9±0.9 b</td>
<td>9.9±2.6 b</td>
<td>3.4±1.6 ab</td>
<td>63.3±7.9 b</td>
<td>10.4</td>
</tr>
<tr>
<td>Sweet potato 1</td>
<td>1.9±0.5 b</td>
<td>3.9±0.9 b</td>
<td>0.0</td>
<td>4.7±1.0 b</td>
<td>7.4±1.9 b</td>
<td>4.4±0.7 a</td>
<td>22.3±2.3 b</td>
<td>3.4</td>
</tr>
<tr>
<td>Total</td>
<td>969.5</td>
<td>645.6</td>
<td>157.8</td>
<td>62.0</td>
<td>46.2</td>
<td>12.7</td>
<td>1894.0</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>242.4±62.5</td>
<td>161.4±53.3</td>
<td>39.4±15.1</td>
<td>15.5±2.1</td>
<td>11.6±2.9</td>
<td>3.2±0.5</td>
<td>473.5±93.0</td>
<td></td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>304.0</td>
<td>303.7</td>
<td>93.5</td>
<td>9.8</td>
<td>11.4</td>
<td>1.6</td>
<td>518.2</td>
<td></td>
</tr>
</tbody>
</table>

According to Duncan’s Multiple Rang Test, there were no significant differences between means that have the same letters in the same column at 5% probability level.

Statistical analysis

Using the SPSS software, the effect of host plant on population density of each insect species was performed using one-way analysis of variance (ANOVA). Means were separated using Duncan’s Multiple Range Test at 0.05 probability level.

RESULTS AND DISCUSSION

1. Surveying the piercing-sucking insect pests attacking some vegetable crops.

The data obtained in Table (1), indicate that the four vegetable crops i.e. cucumber, (C. sativus), cowpea (V. unguiculata L.), tomato, (L. esculentum L.) and sweet potato, (I. batatas L.), were attacked by many insect species. The insect species that were recorded belonging to two insect orders: Order Thysanoptera [the onion thrips, T. tabaci (Family: Thripidae)] and Order Hemiptera [the green peach aphid, M. persicae and the cotton aphid, A. gossypii; the tomato whitefly, B. tabaci; leafhoppers, Empoasca spp.; green stink bug, N. viridula and the cotton mealybug, P. solenopsis.

There were five insect species; P. solenopsis, A. gossypii, Empoasca spp., B. tabaci and N. viridula were recorded on each of the four crops. While, Myzus persicae recorded only on cucumber, the cotton thrips, T. tabaci was not recorded on sweet potato. Cucumber plant attacked by seven insect species, while, tomato and cowpea were attacked by six insect species, sweet potato attacked by five insect species.

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Fig. 1. Seasonal average number of the insect species on the four vegetable crops during 2022 at Kafr-Saad region Damietta Governorate.

3. Seasonal abundance of the main piercing-sucking insect species on different vegetable crops:

As shown in Figure (2), the timing of insects appearance and the number of peaks varies depending on the type of host plants; cucumber, cowpea, tomato and sweet potato, Aphis spp., B. tabaci, T. tabaci and Empoasca sp. appeared on cucumber, cowpea and tomato plants earlier than on sweet potato plants. On the other hand, P. solenopsis and N. viridula appeared on all tested crops about two and four weeks after the previous insects appear.

The general average number of insects showed two peaks of infestation on the four crops; cucumber, cowpea, tomato and sweet potato. The highest peak, 5336.1 and 171.2 individuals was noticed at 8th of Aug. on cucumber and tomato plants respectively, while on cowpea the highest occurrence 207.6 individuals was noticed at 13th of Jun., the highest occurrence 39.2 individuals was noticed at 6th of Jun on sweet potato.

Fig. 2. weekly average numbers of the main piercing-sucking insect species on different host plants (cucumber, cowpea, tomato and sweet potato) at Kafr-Saad region Damietta Governorate during 2022 season.

Seasonal abundance of Aphis spp. on different host plants:

As shown in Figure (3), Aphis spp. started to visit cucumber, cowpea and tomato plants early on 16th of May, while it appeared later on the 6th of Jun on sweet potato plants. The insect recorded three peaks of infestation on cucumber and two peaks on the other three tested crops, cowpea, tomato and sweet potato. The highest peak, 4175.7, 139.2 and 9.1 individuals was noticed at 8th of Aug. on cucumber, tomato and sweet potato crops respectively, while on cowpea plants the highest occurrence 125.0 individuals was noticed at 13th of Jun.

Fig. 3. weekly average numbers of A. gossypii (Nymphs + Adults) on different host plants (cucumber, cowpea, tomato and sweet potato) at Kafr-Saad region Damietta Governorate during 2022 season.
Seasonal abundance of *B. tabaci* on different host plants:

As shown in Figure (4), *B. tabaci* started to visit cucumber and cowpea plants on 16th of May, while it appeared later on the 23rd of May on tomato and sweet potato plants. Four peaks of *B. tabaci* population occurred on tomato, three peaks on cucumber and two peaks on cowpea and sweet potato. The highest peak occurred at 22nd of Aug. with average number of 3435.8 individuals/ sample on cucumber plants. While on cowpea and sweet potato the highest peak occurred at the 6th of Jun. with average number of 20.5 and 15.8 individuals/ sample respectively, on the case of tomato plants the highest peak was recorded at 29th of Aug. with average number of 11.9 individuals/ sample.

![Fig. 4. weekly average numbers of *B. tabaci* (Nymphs) on different host plants (cucumber, tomato, cowpea and sweet potato) at Kafr-Saad region Damietta Governorate during 2022 season.](image)

Seasonal abundance of *T. tabaci* on different host plants:

As shown in Figure (5), *T. tabaci* started to visit cucumber, cowpea and tomato plants on 16th of May, while this insect has not been recorded on sweet potato plants. During the investigation period *T. tabaci* population had two peaks of seasonal abundance occurred on cucumber plant and one peak on tomato and cowpea. The highest peak of *T. tabaci* population on cucumber was recorded at 30th of May with average number of 983.5 individuals/ sample, while in tomato and cowpea the peak of *T. tabaci* population was occurred on 23rd of May and represented with 46.9 and 18.8 individuals/ sample, respectively.

![Fig. 5. weekly average numbers of *T. tabaci* (Nymphs + Adults) on different host plants (Cucumber, Tomato and Cowpea) at Kafr-Saad region Damietta Governorate during 2022 season.](image)

Seasonal abundance of *Empoasca* spp. on different host plants:

As shown in Figure (6), *Empoasca* spp. started to visit cucumber and cowpea plants on 16th of May, while it appeared later on the 23rd of May on tomato and sweet potato. During the investigation period *Empoasca* spp. population had three peaks of seasonal abundance occurred on cucumber and cowpea whereas, two peaks were recorded on tomato and sweet potato. The highest peak of *Empoasca* spp. population on cucumber was recorded at 23rd of May with average number of 17.3 individuals/ sample, on cowpea the highest peak of was noticed at 27th of Jun. with average number of 103.3 individuals/ sample. While in sweet potato and tomato crops, the highest peak of infection occurred on 6th of Jun., with an average number of 18.9 and 15.8 individuals/ sample, respectively.
Seasonal abundance of *P. solenopsis* on different host plants:

As shown in Figure (7), the last insect to appear on the four crops was the cotton mealybug, as the insect began attacking the four crops late on 6th of June. During the investigation period *P. solenopsis* population had two peaks of seasonal abundance occurred on cucumber plants and one peak on the other three crops tomato, sweet potato and cowpea. The highest peak on cucumber was noticed at 22nd of Aug. with average number of 106.4 individuals/ sample. While in cowpea, the peak of infestation occurred on 1st of Aug., with an average number of 13.8 individuals/ sample on tomato and sweet potato the peak of infestation was noticed at 29th of Aug. with average number of 32.1 and 24.1 individuals/ sample respectively.

Seasonal abundance of *N. viridula* on different host plants:

As shown in Figure (8), *N. viridula* started to visit cucumber on 23rd of May, while it appeared later on the 30th of May on cowpea, tomato and sweet potato. One seasonal abundance peak for the *N. viridula* population occurred on all crops during the experiment period. The peak of *N. viridula* population was recorded at 18th of Jul. with average number of 10.2, 7.9, 7.3 and 3.5 individuals/ sample on sweet potato, tomato, cowpea and cucumber crops respectively.
Discussion

1. Surveying the piercing-sucking insect pests attacking some vegetable crops.

The studies revealed that the different vegetable crops; cucumber, cowpea, tomato and sweet potato were attacked by seven piercing-sucking insect species infesting cucumber plants during spring and summer plantations. However, Ahmed (2003), Hagrass et al. (2008), Ghallab et al. (2011), Abd El-Wahab et al. (2012) and Metwally et al. (2013) reported that B. tabaci, A. gossypii, T. tabaci; Empoasca spp., Phenacoccus solenopsis and Nezara viridula.

These results are in accordance with those obtained by Abo-Elmaged et al. (2020) who reported that onion thrips, T. tabaci, whitefly, B. tabaci and cotton aphid, A. gossypii, are considered to be the most important piercing-sucking arthropod pests infesting cucumber plants during spring and summer plantations. However, Ahmed (2003), Hagrass et al. (2008), Ghallab et al. (2011), Abd El-Wahab et al. (2012) and Metwally et al. (2013) reported that B. tabaci, A. gossypii; T. tabaci; Empoasca spp. are the most important piercing-sucking insects of cucumber crop. El-Khayat et al. (2017) surveyed the Hemiptera insects; A. craccivora, A. gossypii, E. decipiens, E. decedens, C. chinai and B. tabaci on cowpea crop. The most economically important insect pests substantially reducing yield and fruit quality of vegetable crops are whitefly, aphids, caterpillars, leaf miner, fruit borers, thrips and jassids (Filho et al. 2012), A. gossypii, B. tabaci, Jassids, thrips and Liriomyza trifolii are the major insect pests attacking tomato plants Mandloi et al. (2015) and Phenacoccus solenopsis El-Wareth (2016). El-Fakhary et al. (2017) revealed the presence of 26 Arthropods; 16 as pests and 10 as predators on sweet potato crop. B. tabaci was the most occurring followed by Empoasca spp., N. viridula and Eysarcoris ventralis. Nezara viridula is a common polyphagous insect (Ali and Ewiess 1977). First recorded in Egypt as a cotton pest, it is found all across the world and poses a major threat to a variety of economically important crops (Ali and Ewiess, 1977, Kamal 1937). In Egypt N. viridula was found to be harbored on 12 field crops, 10 vegetable crops (okra, eggplant, pepper, tomato, and cowpea) and fourteen weed species according to Khalafallah et al. (2005) and Khattab (2003). (Moraes et al., 1981) stated that cowpea is infested by Empoasca spp. at the seedling stage and that they target the leaves. The two leafhopper species that were most prevalent on cucumber plants were Empoasca decipiens and E. decedens, according to Hashem (2005). The tropical and subtropical regions are home to a large population of Empoasca spp. This genus contains multiple species that are significant on cowpea in various geographical areas. Soratur, et al. (2017).

2. Host preference of the main piercing-sucking insect species on different vegetable crops.

The obtained results revealed that the highest attracted host plant for the insect species was cucumber followed by cowpea and tomato whereas the less attracted host plant was sweet potato.

These results are in accordance with those obtained by El-Wareth (2016) who reported P. solenopsis was initially identified as a novel pest in Egypt and was found to be affecting three significant vegetable crops as well as maize, eggplant, tomato, and pepper; tomato plants were the most attractant crop for P. solenopsis insects. El-Kady et al. (2016). Mentioned that different leguminous plants (broad bean, pea, cowpea and bean plants) as host plants affected on the seasonal abundance of the leathopper and planthopper insects. The leathopper and planthopper insects specially, E. decipiens, E. decedens, Cicadulina chinai, Balclutha hortensis, Nephotettix apicalis and planthoppers, Sogatella furcifera. High population abundance for E. decipiens occurred on broad bean and pea plants.

3. Seasonal abundance of the main piercing-sucking insect species on different vegetable crops:

The obtained results revealed that Aphis spp., (A. gossypii and M. persicae) were the predominant species followed by B. tabaci. Whereas the least average numbers were recorded by N. viridula on the four vegetable crops.

These findings concur with those of Ibrahim et al. (2017) found that Aphis gossypii infestation on cucumbers began 15 days after the date of cucumber plants seedling. Furthermore, these findings agree with those reported by Hegab (2017). The second week of July was when the population density of A. gossypii and M. persicae on cucumber plants peaked, according to records. Conversely, the third week of July was noted as M. persica peak. Hegab-Ola and Hegab (2009) reported that the month of July show the highest number of A. gossypii aphids on cucumber plants. Furthermore, Awadalla et al. (2020). Recorded one peak of population density of A. gossypii and M. persicae. The mean number of B. tabaci nympha recorded four peaks on cucumber Ismail et al. (2020). The cotton aphid, A. gossypii recorded one peak and two peaks yearly on cowpea, E. decipiens, E. decedens and B. tabaci recorded two peaks yearly on cowpea plants El-Khayat et al. (2017). Aphis gossypii, Bemisia tabaci, Jassids and thrips recorded two distinct peaks while Liriomyza trifolii recorded three distinct peaks on tomato plants Mandloi et al. (2015). El-Fakhary et al. (2017) showed that the population density of the pests progressively increased to reach peaks during August and September with leafhoppers, whitefly and A. convolucui while Tetranychus sp., N. viridula and E. ventralis were July and August in the two seasons on sweet potato plants. El-Wareth (2016) recorded one peak of P. solenopsis on tomato plants in the first week of August. T. tabaci infestation started on cucumber in April and one peak occurred in the end of May and in mid-September Abd El-Wahab, et al. (2012) and on cowpea in the first week of September Atakan (2008). However, Shah (2015) found that T. tabaci population recorded a single peak of infestation on onions.

These differences may be attributed to locality, crop rotation, agricultural practices and environmental conditions prevailing during execution of these experiments.

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**Acknowledgments:**

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