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Research Article

New Record of Host Plants of Invasive Mealybug *Phenacoccus solenopsis* Tinsley (Tinsley, 1898), (Hemiptera: Pseudococcidae) in Alexandria and Behaira Governorates

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Abstract

Background: The cotton mealybug *Phenacoccus solenopsis* (Tinsley, 1898), (Hemiptera: Pseudococcidae) was an important plant pest, causing major economic, environmental and social impact. It is a polyphagous pest and multiplies on different hosts like field crops, horticultural, fruit, vegetable and ornamental plants. **Materials and Methods:** A reconnaissance field survey was conducted during the two successive years February, 2014 till February, 2016 in Alexandria and Behaira governorates. Samples were collected from urban and rural areas including planting and implanting host plants. **Results:** Six different localities were investigated in Alexandria and Behaira governorates. In Alexandria the recorded host plants were more diverse including ornamental, vegetables and herbal host plants. Vegetable crops were predominantly cultivated in the investigated area sites of Behaira governorates. **Conclusion:** Obtained result recorded a total of 22 species of host plants belonging to 12 families, among them are: Malvaceae, Tiliaceae, Portulacaceae, Solanaceae and others. Eight species of herbal host plants were recorded as a new record in Egypt for the first time.

Key words: *Phenacoccus solenopsis*, survey, host plants, polyphagous pest, herbal plants

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In a relatively short period time, potentially invasive *Phenacoccus solenopsis* (Tinsley, 1898), (Hemiptera: Pseudococcidae) has been reported occurring in several countries causing severe losses of economically important crops. The cotton mealybug is a polyphagous pest recorded over wide range of plant families all over the world EPPO¹. It has a wide geographical distribution² observed it from approximately 37 various localities from different ecological zones around the world. Hodgson *et al.*³ illustrated the immature stages as well as the adult female and male.

The first record of *P. solenopsis* damaging a crop was made by Fuchs *et al.*⁴ who reported it on cultivated cotton in Texas, USA. Other crops have been damaged in Chile, on *Solanum muricatum* (Ait.) By Larrain⁵ and in Brazil on *Solanum lycopersicum* L., Solanaceae by Culik and Gullan⁶. De Willink⁷ recorded it from Argentina on false ragweed, *Ambrosia tenuifolia* Spreng. (Asteraceae). It was first found in Asia (Pakistan) in 2005^{8,9} and soon afterwards¹⁰ recorded it from India. Hodgson *et al.*³ recorded it from Thailand and Taiwan in (2006). Cotton (*Gossypium hirsutum* L., Malvaceae) is one of its most favored hosts, the economic impact of *P. solenopsis* in Asia are from Pakistan and India, there have been many damaging outbreaks, severely affecting their cotton industries¹¹.

In Egypt, it was first recorded on unknown host plant by Abd-Rabou *et al.*¹². Then the invasive cotton mealybug recorded on new hosts of family: Solanaceae in Qalyoubia governorate¹³. In Alexandria governorate, Abou-Ghoneim¹⁴ recorded it on two ornamental plants, afterwards based on information reported from field researchers in the region Southern of Behaira governorate and from Burg El-Arab and Alexandria governorate, high infestations was detected at these regions on hosts of families Malvaceae, Tiliaceae, Portulacaceae, Solanaceae and more.

Keeping in view the outbreak of the cotton mealybug on cotton and other economically important host plants around the world, the proposed study was carried out to survey host plants of cotton mealybug *P. solenopsis* in surrounding areas. This study will help to recognize different host plants of cotton mealybug for researchers, extension workers, farming community and all the stakeholders related to cotton crop and other field crops.

MATERIALS AND METHODS

Study area: Several field surveys were carried out of the two governorates Alexandria, Behaira and North coast from

February, 2014-2016. The entire area were located between latitude: 31°12'56" N and longitude: 29°57'18" E. The areas of the studied farms ranged between 0.52 and 1.56 acres. Samples of vegetables crop and ornamental plants were collected from urban and rural localities. The samples including planting and implanting host plants.

Examined plants are identified in Herbarium Unit of Agriculture Museum (Herbarium CAIM) at Giza by specialists.

Sample collection: Samples were picked up at monthly intervals throughout the period of study. Samples sizes were 10 cm² from branches. The samples collected at random from shrubs. All alive mealybugs found on twigs, leaves, branches, stems and roots were assorted and recorded. The plant samples kept in polythene bags. The mealybugs were kept in alcohol (70%). Specimens were slide-mounted for identification using the method outlined in Williams and Granara de Willink¹⁵. Identification of the genus was carried out using the key of the Pseudococcidae family (Hemiptera: Coccoidea) according to Mckenzie¹⁶.

A literature study of host plants species of *Phenacoccus solenopsis* was performed on the scale net website, www.sel.barc.usda.gov/SCALENET/scalenet.htm, used to determine historical records of the pest. In addition, a cross search at Cabi website cabi.org/isc/datasheet/109097 and EPPO websites¹ in order to determine the proper information about the pest's host plants species. Due to technical problems in the field, pictures are insufficient.

RESULTS AND DISCUSSION

The present study surveyed the host plants of the cotton mealybug *Phenacoccus solenopsis* (Tinsley 1898), (Hemiptera: Pseudococcidae) at Alexandria and Behaira governorates during the two successive years February, 2014-2016. Field work was carried out including 5 localities at Alexandria, Asafra, Amriya, Burg El-Arab, Nahda and North coast. At Behaira governorate field work done at Abu Homos. The study revealed the infestation including diversity of vegetable crops ornamental plants and many kinds of herbal plants (wild shrubs and weeds of arable lands). A total of 22 host plants in 18 families were reported. The following species are; *Trianthemportula castrum* of family: Aizoaceae, *Amaranthus lividus* and *Amaranthus* of family: Amaranthaceae, *Nerium oleander* of family: Apocynaceae, *Helianthus annuus*, *Xanthium spinosum* and *Xanthium strumarium* of family: Asteraceae, *Atriplex lindleyi*, *Atriplex* sp. and *Chenopodium* sp. of family: Chenopodiaceae,

Convolvulus althaeoides of family: Convolvulaceae, *Medicago laciniata* of family: Fabaceae, *Alcea rosea* and *Hibiscus rosa-sisensis* of family: Malvaceae, *Anagallis* sp. of family: Primulaceae, *Lycopersicon lycopersicum*, *Abelmoschus esculentus* and *Nicotiana glauca* of family: Solanaceae and *Lantana camara* of family: Verbenaceae. The species within each family are listed alphabetically from Alexandria district.

The following species from Abu Homos site Behaira Governorate *Corchoru solitorius* and *Hibiscus rosa-sisensis* of family: Malvaceae, *Portulaca oleracea* of family: Portulacaceae and *Abelmoschus esculentus*, *Lycopersicon esculentus* and *Solanum melongena* of family: Solanaceae The species within each family are listed alphabetically.

The previous results of this study have been summarized in two table. Table 1 shows the list of host plant species in alphabetical order at Alexandria governorate in order of their vicinity and their type ranking. Table 2 gave the similarity at Behaira governorate.

Table 1 included 20 host plant species belonging to 11 families found in different localities throughout Alexandria governorate arranged alphabetically. Eighteen host plants of them were recorded in this study during the survey. Three of

them *Codiaeum variegatum* and *Nerium oleander*, host plants species were recorded from literature¹⁴ and the third host plant *Artemisia annua* which recorded from^{3,17}. Its medicinal benefits was reported by El-Askary *et al.*¹⁸ and Hodgson *et al.*³.

Vegetable crops: Six vegetable crops were predominantly cultivated in the investigated area sites. These include, *Abelmoschus esculentus* (Okra lady's finger), *Corchorus olitorius* L. (Mulukhiyah), *Lycopersicon esculentum* (Tomato), *Solanum melongena* L. (Egg-plant) and *Portulaca oleracea* L. (Regla common purslane) from families: Malvaceae, Solanaceae and Portulacaceae, respectively.

Also, Ibrahim *et al.*¹³ recording *P. solenopsis* infesting members of family Solanaceae, egg-plant (*Solanum melongena*), tomato (*Lycopersicon esculentum*) in Qalubia and Dakahlia governorates.

Vegetable crops of these families were of economic important in our local and international markets. The infestation was detected in the cultivated okra crop (*Abelmoschus esculentus*), decreasing the quality of the yield product in the market. According to the last estimates

Table 1: Localities and host plants of the mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in Alexandria governorate, Egypt during 2014-2016

Families	Host plants	Localities	Plant types
Aizoaceae	<i>Trianthemaportula castrum</i>	Burg El-Arab	Weeds of arable lands
Amaranthaceae	<i>Amaranthus lividus</i>	Asafa	Ornamental
Amaranthaceae	<i>Amaranthus</i> sp.	Burg El-Arab-Amriya	Weeds of arable lands
Apocynaceae	<i>Nerium oleander</i> ^A	Faculty of Nursary	Ornamental
Asteraceae	<i>Artemisia annua</i> Lierature website	Burg El-Arab	
Asteraceae	<i>Helianthus annus</i> (Sunflower)	Burg El-Arab	Ornamental
Asteraceae	<i>Xanthium spinosum</i> L.	Burg El-Arab and North coast	Ornamental
Asteraceae	<i>Xanthium strumarium</i> (Cocklebur)	Burg El-Arab	Ornamental
Chenopodiaceae	<i>Atriplex</i> sp.	Burg El-Arab	Weed
Chenopodiaceae	<i>Atriplex lindleyi</i>	Burg El-Arab and North coast	Weed
Chenopodiaceae	<i>Chenopodium</i> sp.	Burg El-Arab	Weeds of arable lands
Convolvulaceae	<i>Convolvulus althaeoides</i> (Ivy khatami)	Burg El-Arab-Amriya	Weeds of arable lands
Fabaceae	<i>Medicago laciniata</i> (Clover)	Burg- El-Arab-Amriya	Weeds of arable lands
Malvaceae	<i>Alcea rosea</i> (Hollyhocks)	Al-Amriya	Ornamental
Malvaceae	<i>Hibiscus rosa-sisensis</i>	All localities	Ornamental
Primulaceae	<i>Anagallis</i> sp.	Amriy	Weed
Solanaceae	<i>Lycopersicon lycopersicum</i> (L.) Karst. ex Farw.	Burg El-Arab-Amriya	Vegetables
Solanaceae	<i>Abelmoschus esculentus</i> (Okra)	Nahda	Vegetables
Solanaceae	<i>Nicotiana glauca</i> (Wild tobacco)	Burg El-Arab	Wild plant
Verbenaceae	<i>Lantana camara</i> L.	Amriya and North coast	Ornamental

Dot represents the literature study

Table 2: Localities and host plants of the mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in Behaira governorate, Egypt during 2014-2016

Families	Host plants	Localities	Plant types
Malvaceae	<i>Corchoru solitorius</i> L. Mulukhiyah	Abu Homos	Vegetables
Malvaceae	<i>Hibiscus rosa-sisensis</i>	All localities	Ornamental
Portulacaceae	<i>Portulaca oleracea</i> L. Regla	Abo Homos	Vegetables
Solanaceae	<i>Abelmoschus esculentus</i> (Okra)	Abu Homos	Vegetables
Solanaceae	<i>Lycopersicon esculentus</i> L. (Tomato)	Abu Homos	Vegetables
Solanaceae	<i>Solanum melongena</i> L. (Egg-plant (Brinjal))	Abu Homos	Vegetables

from the Egyptian Ministry of Agriculture and Land Reclamation in Behaira the total cultivated area of okra was 398.94 acres with average of 52.92% yielding 1122 t. In Alexandria the cultivated area about 35.29 acres only in private sectors in new reclaimed areas at El-Nahda district.

Ornamental plants: Five localities from the visited regions have the major numbers of infested host plants during the survey Table 1 and 2. In Alexandria the mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) was recorded from Asafra, Faculty of Nursery, Amriya, Burg El-Arab, Nahda and North coast. *Hibiscus rosa-sisensis* was only recorded from many sites of investigation and also from Behaira governorate. *Phenacoccus solenopsis* was found causing serious damage to a collection of succulent plants *Hibiscus*, *Lantana*, sunflower and hollyhock at private botanical gardens. These results represented in Table 1 and 2. These findings are in agreement with Arif *et al.*¹⁹ and Ben-Dov²⁰. Abdul-Rassoul *et al.*²¹ recorded it infested *Hibiscus-rosa sisensis* for the first time in Iraq during August, 2014 to July, 2015.

Other incidental host plants of ornamental plants were as fellow, *Amaranthus lividus*, *Codiaeum variegatum*, *Xanthium spinosus* and *X. stramarium* were found in many localities infested by *P. solanopsis* which agreed with Abbas *et al.*⁸. High infestation was found on the ornamental plant

hollyhocks *Alcea rosa* Malvaceae implanted in private garden in Alamriya district (Fig. 1). The species *Nerium oleander* collected from Faculty of Nursery with the *Hibiscus rosa-sisensis* only written from literature study¹⁴.

Wang *et al.*²² suggested that high summer temperature and excessive moisture in autumn were likely to restrict population growth, indicating that areas with extremely high rainfall were unfavorable for serious infestation by the pest. According to Wang *et al.*²² the weather conditions in Egypt makes the environment not suitable for proliferation of *P. solenopsis* as it is mainly a tropical species.

Some ornamental and herbicidal plants at Amriya district were helpful in spreading the infestation widely by humans, either deliberately as an ornamental flower or accidentally and were documented as a new locality for host plants.

Herbal plants: A total of ten host plants species were surveyed from Alexandria governorate during the present study. The recorded eight infested herbal species are: *Trianthemaportula castrum* family: Aizoaceae, *Amaranthus* sp. family: Amaranthaceae, *Chenopodium* sp. family: Chenopodiaceae and *Convolvulus althaeoides* family: Convolvulaceae, they are all considering as weeds of arable lands. The mealybugs are well concealed in protected places as under the succulent leaves, near the stem or the crown and low infestations are easily overlooked. The mealybugs crawl actively from site to another and can spread rapidly when



Fig. 1 (a-d): (a-b) Infestation of adult and premature ages on leaves, stem and branches of *Alcea rosea* and (c-d) Magnified photo of the nymph and adults of *Phenacoccus solenopsis*

favorable conditions, using their own legs or they may hitch a ride on an air current and travel effortlessly over much greater distances. Sticky honeydew is excreted on infested plants, when population levels are high^{11,23}.

In Table 1, the pest recorded infested *Nicotiana glauca* R.C. Graham, wild tobacco shrub family: Solanaceae at Burg El-Arab district in Alexandria^{24,11}. The host plants species of *Anagallis* sp., *Atriplex lindleyi* and *Atriplex* sp. of families Primulaceae and Chenopodiaceae respectively found to be infested with *P. solenopsis*. This is the first record for the previous eight host plants species at Alexandria governorate and in Egypt. This finding is in full agreement with the report of Abbas *et al.*⁸.

Phenacoccus solenopsis has become an aggressively invasive species on agriculture and ornamental plants and has spread rapidly between countries. This may be due to its plasticity in its morphology and ability to live under a wide variety of environmental conditions³.

CONCLUSION

The present study demonstrates that site Alexandria much diverse than site Behaira. Alexandria shows highest diversity of herbal and ornamental host plants with eight host plants for each, due to expansion of urban areas. While at Behaira the vegetable crops represents the dominant host plants with five species. The total host plants of investigated species of all sites represented by 22 host plants from 12 families. Three of them are from literature. The study recorded two vegetable crops and eight ornamental plants in Alexandria governorate and six host plants at Behaira for the first time. This study also recorded eight species of herbal host plants as new record in Egypt.

SIGNIFICANCE STATEMENTS

- The present study surveyed *Phenacoccus solenopsis* at Alexandria and Behaira governorates. A total of 22 host plants of 12 families were recorded
- In Alexandria governorate 2 vegetable crops and 8 ornamental plants were recorded
- Six host plants of vegetable crops were demonstrated at Behaira governorate
- This study revealed new record for the first time of 8 species of herbal host plants in Egypt
- This will encourage stakeholders to put a limit to its movement from one place to another by implementing more laws and legislations

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