

Study on Cotton Host Plants of Mealybug *Phenacoccus solenopsis* (Tinsley) and Efficiency Release the Predator *Chrysoperla carnea* (Stephens) for its Controlling on Cotton Plants in Egypt

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ABSTRACT

Cotton mealybug, *Phenacoccus solenopsis* (Tinsley) has a new distribution and attack important host plants such as cotton (*Gossypium barbadense* L.), okra (*Abelmoschus esculentus* L.) eggplants (*Solanum melongena* L.) ornamental plants and certain weeds growing in Giza and Qalyubia Governorates. This studies carried out in Egypt, during two seasons (March to December, 2014 and 2015). The predators ladybird beetle "*Coccinella septempunctata* L., *Scymnus syriacus* Mars, *Hyperaspis vinciguerrae* Capra, *Orius laevigatus* (Fieber), true spider *Cheiracanthium isiacum* Cambridge (Clubionidae : Arachnida) . and *Chrysoperla carnea* (Stephens) were recorded in association with *P. solenopsis* in previous Governorates. The feeding potential of the predator, *C. carnea* larvae were studied under semi-field conditions on cotton plants grown under green house during summer seasons in environment-controlled chambers. The population of cotton mealybug was recorded before and after release of the predator *C. carnea*. The mean results of the reduction percentage after 1, 3, 5 and 7 days from the release of different rates of predator larvae (5, 10 and 20 larvae) were 90.5 %, 86.8 %, and 86.05 % for adults, and 96.03 %, 92.4 %, and 94.6 % for nymphs of *P. solenopsis*. The results indicate that five larvae *C. carnea* per 100 nymphs of the pest can be used as a biological control against *P. solenopsis* during the management programme.

Keywords: Mealybug, Predators, Vegetables, Weeds, Ornamental plants.

INTRODUCTION

Phenacoccus solenopsis Tinsley (Hemiptera: Pseudococcidae) cotton mealybug, is a polyphagous pest on different crops. It was recorded on different tropical and subtropical countries of the world, inducing damage to a wide variety of agricultural crops such as cotton (*Gossypium hirsutum* Linn.), in India and Pakistan this pest induces reduction of cotton yield about 30 – 60 %. (Ben-Dov *et al.*, 2009, Dhawan *et al.*, 2010, Kedar *et al.*, 2013 Babasaheb and Sachin 2015).

In Egypt, *P. solenopsis* was recorded as a new insect attacking cotton plants (*Gossypium barbadense* var. Giza 86) at Kafr El-Sheikh Governorate, during growing season of 2014 (El-Zahi *et al.*, 2016). In the last years, climatic changes in tropical and sub-tropical areas (temperature increase and relative humidity), subsequently the predicted of spread cotton mealybug to another countries of the world near future, it became a widespread on weed plant and economic crops such as tomato plant in Egypt, (Abd-rabou *et al.*, 2010 & Ibrahim *et al.*, 2015). *Chrysoperla carnea* was more effected bio control agent in management strategy of *P. solenopsis*. (Farhan *et al.*, 2011). In North and Central zones, the cotton mealybug was considered to be a minor pest of cotton but it emerged as a major pest (Tanwar *et al.*, 2011), observing an infestation of ornamentals, weeds, shrubs, cash crops, okra and eggplant was recorded (Sharma, 2007; Ben-Dov *et al.*, 2009; Abbas *et al.*, 2010; Sharma 2010; Wang *et al.* 2010; Khuhro *et al.*, 2012; Vennila *et al.*, 2013).

The cotton mealy bug *P. solenopsis* was not a serious pest on cotton before, the cotton plant (*Gossypium barandense* L.) is considered one of the most important fiber crops; it is one of the main sources of income to farmers as well as to the Egyptian economy. It has a worldwide reputation because of its fiber length, fiber fineness and high yield (Arora *et al.* 2009).

The cotton mealybug, *P. solenopsis* has been has a wide geographical distribution on several countries for instance Argentina, Brazil, Caribbean, Ecuador and Chile causing serious damage to cotton and different crops. (*G. hirsute*) (Fuchs *et al.* 1991; Williams and Granara 1992,

Ben-Dov 1994, Granara de Willink 2003, Culik and Gullan 2005, Hodgson *et al.* 2008, Jagadish *et al.*, 2009, Abbas *et al.*, 2009, Arif *et al.*, 2009 & Abbas *et al.*, 2010). Also in India and Pakistan It is a highly invasive species in Central Asia and China (Hodgson *et al.*, 2008; Wu and Zhang, 2009; Hameed *et al.*, 2012; Kedar *et al.*, 2013).

P. solenopsis has been induced infestation of 22 plant species of ten families including cotton, tomato, brinjal, chilli, grape, fig, date palm, apple, avocado, banana, citrus, congress grass, wild sunflower, *Hibiscus rose* and weeds that aided its faster spread and increasing severity across cotton fields, fewer bolls of smaller size with improper openings, and reduced of seed yield by about half it recorded for the first time in Egypt infested ornamental plants then tomato plant. (Tanwar *et al.*, 2007, Abd-Rabou *et al.*, 2010, Dhawan *et al.* 2010; Vennila *et al.* 2013 Ibrahim *et al.*, 2015).

The predator, *Chrysoperla carnea* was more effective as bio control agent in management strategy of *P. solenopsis* (Farhan *et al.*, 2011). The major objective of this work is to study the new distribution of cotton mealybug at two Governorates on some economic plants (cotton, tomato and okra plants) in Egypt, at semi-field incidence of cotton mealybug attacking cotton and their associated predators.

MATERIALS AND METHODS

1. Plant collection

The nymphs and adult of cotton mealybug were collected from different plants such as cotton, okra, eggplant, some weeds and ornamental from two governorates (Giza and Qalyubia), Egypt. The samples were collected weekly during February 2014 to December 2015 from different parts of the mentioned plant (leaves, stems, roots, branches, buds, flowers and cotton bolls), then kept in paper bags for later examination. At laboratory, the samples of cotton mealybugs *P. solenopsis* and predators were investigated and kept it in glass tubes and preserved in 70 % ethyl alcohol with few drops of glycerin, then were identified by the help of Department of

Insect Taxonomy, Plant Protection Research Institute, Agriculture Research Center, Ministry of Agriculture.

2. Cultures of *Chrysoperla carnea*:

The predator *C. carnea* were collected from the fields and reared under laboratory conditions at 25 ± 5° C and 65 ± 5% R.H. in Plant Protection Research Institute, Agriculture Research Center (Karim, 2003). The 2nd instars larvae of *C. carnea* were released into 5, 10 and 20 larvae / cage/ 4 weeks.

RESULTS AND DISCUSSION

1. Survey studies

As shown in Table (1) and figure 1. A, B,C,D, E and F, the samples of infested plants by the cotton mealybug *P. solenopsis* were collected from two governorates (Giza and Qalyubia) on many plants (tomato, cotton, okra, eggplant and ornamental plants) from February to December during 2014 and 2015 seasons.

Table 1. Host plants of cotton mealybug at two governorates (Giza and Qalyubia) in Egypt.

Collection location	Host plants	Collection dates
Qalyoubia Governorate	Tomato (<i>Lycopersicon esculentum</i> Mill ; Solanaceae)	June - October 2014
	Cotton (<i>Gossypium barbadense</i> L; Malvaceae)	June - October 2014- 2015
	Okra (<i>Abelmoschus esculentus</i> L.; Malvaceae)	June - September 2014- 2015
	eggplants (<i>Solanum melongena</i> L. ; Solanaceae)	August - October 2014- 2015
	<i>Chenopodium berlandieri</i> Moq.; Amaranthaceae)	March- October 2014-2015
	<i>Hibiscus trionusn</i> L.; (Malvaceae)	March- October 2014-2015
	<i>Solanum nigrus</i> Cav. ; (Solanaceae)	March- October 2014-2015
	<i>Portulaca oleracea</i> L.; (Portulaceae)	March- October 2014-2015
	<i>Luffa aegyptiaca</i> Mill (Cucurbitaceae)	March- October 2014-2015
	<i>Emex spinous</i> L. (Polygonaceae)	March- October 2014-2015
	<i>Corchorus olitorius</i> L.; (Tiliaceae)	March- October 2014-2015
	<i>Lantana camara</i> L.; (Verbenaceae)	July - September 2014-2015
Giza Governorate	<i>Hibiscus rosa-sinensis</i> L.; (Malvaceae)	Feb- September 2014-2015
	<i>Datura stramonium</i> L. (Solanaceae)	March - December 2014
	<i>Xanthium brasiliicum</i> Vellozo (Asteraceae)	April - October 2015
	<i>Plantago major</i> L. (Plantaginaceae)	March- October 2014-2015



Fig. 1. Infestation of *P. solenopsis* on ornamental and weed plants.

- A. *Hibiscus rosa-sinensis* L.
- B. *Lantana camara* L.
- C. *Chenopodium berlandieri* Moq.
- D. *Corchorus olitorius* L.
- E. *Xanthium brasiliicum* Vellozo
- F. *Datura stramonium* L.

Photos by Dr. Samah S. Ibrahim at Giza and Qalubia Governorates, Egypt, 2014 - 2015.

Obtained our result recorded that, the cotton mealybug *P. solenopsis* is a polyphagous pest on different field crops such as vegetable, ornamental plants and weeds plant at Qalyoubia and Giza governorates , about 10 families, Solanaceae (tomato , cotton , okra and eggplants) are the major important crops in this location and other families were also as a habitat hosts of this pest such as Malvaceae, Amaranthaceae, Portulaceae, Cucurbitaceae, Polygonaceae ,Tiliaceae ,Verbenaceae, Asteraceae and Plantaginaceae. These results are in parallel with those

reported in other studies, i.e., Prishanthini and Vinobaba (2011); Singh *et al.*, 2012, Babasaheb and Sachin, (2015), Beshr *et al.*, (2016) as the mealybugs were reported on 28 host plant species comprising 10 families in Sri-Lanka. This includes the major field crops of the Malavaceae, Solanaceae and Amaranthaceae families. During field survey, the cotton mealybug *P. solenopsis* was observed on cotton plants as shown in (Fig. 2 A on the right corner of photo). Adult females are covered with a powdery and 2 to 5 mm long 4 mm wide, induced damage to the plant by extracting sap, resulting in leaves becoming chlorotic and shedding, while the adult male has no feeding mouthparts and causes no damage it about 1 mm long is blackish brown in color, with a single pair of transparent wings (Fig. 2 A the left corner of photo) .The cotton mealybug *P. solenopsis* has not been previously noted as a pest of cotton in Egypt since 2012 until 2014. Abd-Rabou *et al.* (2010) was recorded *P. solenopsis* weeds in Egypt, also Ibrahim *et al.*, 2015 observed this insect pest in summer seasons (June to November) and identified first recorded on tomato plants which destroy the plants where all nymphs (crawlers) stages adult females were development by sucking sap from leaves, stems, roots, flowers, fruits of tomato plants.

The study explicated that, a new economic hosts in Egypt were become new hosts for the cotton mealybug *P. solenopsis*. As shown in (Fig. 2 B, C and D), samples were collected from upper and lower surface of cotton leaves, flowers, stems and bolls which infested by nymphs and adult females of *P. solenopsis*.

As mentioned before, this study represents new evidence of the occurrence of this pest on okra and eggplant, these plants very important vegetables in Egypt, as shown in (Fig. 2 E, F, G) adult of *P. solenopsis* on top

of okra foliage and magnified view of many adult female and nymphs (crawlers), adult female, eggs and crawlers affected okra plants and sucking sap as a results plant are damage, nymphs and adults of cotton mealybug *P. solenopsis* on the upper surface leaves of eggplant (Fig.2H). Subsequently, this insect pest infestation attacking cotton, okra, eggplant, was initially noticed in June 2014 and 2015, its population was increased about more than 50 adults and nymphs (crawlers) on the same plant where caused severe damage on the top foliage of all plants. Akintola and Ande (2008) were recorded this pest on *Hibiscus rosasinensis* in Nigeria. Hover Jagadish *et al.*, (2009) instance that the infection of this insect pest appeared on leaves then stems and reached to the terminal bud, based buttons and flowers, the highest population of mealybug cause yellowing , faintness , wrinkle, defoliation of the infested plants.



Fig. 2. A. Magnified view of adult male and female of *P. solenopsis* on cotton ; B – adult and crawlers on cotton leaves and stem ; C –Upper surface infested by cotton mealybug *P. solenopsis* ; D – adult female infested cotton bolls. All photos by Dr. Samah S. Ibrahim, Qalubia, Egypt, 2015.

The obtained results are in agreement with other previous studies i.e., Aggarwal *et al.*, (2009); Monga *et al.*, (2009) and Shahid *et al.*, (2012) who recorded that *P. solenopsis* was infested many host plants distributed in the two governorates, where it infested about 195 host plants in 35 countries of the world. As reported on different host plant species worldwide including, field crops, cotton, vegetables, ornamentals, weeds, bushes and trees by several authors (Culik and Gullan 2005; Hodgson *et al.* 2008; Aheer *et al.* 2009; Arif *et al.* 2009; Abbas *et al.* 2010; Beltra and Soto 2011; EPPO 2011; Singh *et al.*, 2012; Sliva 2012).

2. Survey of natural enemies associated with *P. solenopsis*

Table 2 showed that several predators have been observed to attack the cotton mealybug *P. solenopsis* such as Family Coccinellidae: *Cryptolaemus montrouzieri* (Mulsant), *Brumus suturalis* (Fabricius) *Scymnus syriacus* Marseul , *Hyperaspis vinciguerrae capra* *Coccinella septempunctata* L. and *Coccinella undecimpunctata* L. were recorded on cotton , tomato, weeds and ornamental plants during June-August, also *Chrysoperla carnea*

(Steph.) (Chrysopidae), and the flower bug, *Orius laevigatus* (Ficch) (Anthocoridae).

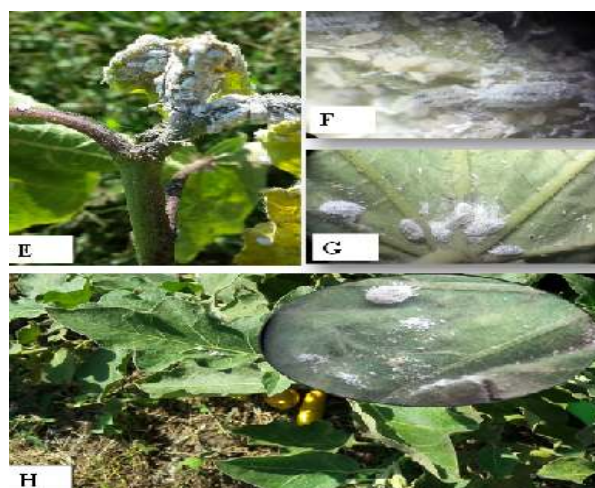


Fig. 3. *P. solenopsis* on okra foliage: E–Crawlers and adult top of okra plant, F–magnified view of many adult female and nymphs; G–Adult female, eggs and crawlers of *P. solenopsis* caused damage on okra plants.; H–*P. solenopsis* nymphs and adults on eggplant, the upper surface of leaves. All photos by Dr.Samah S.Ibrahim, Qalyubia, Egypt, 2015.

The obtained results are in agreement with Patel *et al.*, (2009) who recorded that in India; two coccinellids (*Brumoides suturalis* and *Hyperaspis maindroni*) were identified to be associated with *P. solenopsis*.

3. Semi filed experimental

In the recent years, population of cotton mealybug, *P. solenopsis* has been increased and become problems to many crops in Egypt. Subsequently to rescue the damage of this insect, the predator *Chrysoperla carnea* larvae were investigated under greenhouse conditions. Most predators to complete their development are requiring high populations of prey of *P. solenopsis*. The feeding potential of *C. carnea* larvae on different nymphal instars of cotton mealybug, *P. solenopsis* was investigated. The data presented in Table 3, showed that the mean consumption of *C. carnea* on different number of 2nd instar larvae/ cage (5, 10 and 20 larvae) that released for adult and nymphs of *P. solenopsis*. The 1st released 5 larvae / cage / 4 weeks induced 90.5 % reduction for adult of host while increased reduction to 85.80 % in adults of *P. solenopsis* when used 10 larvae/cage of predator's *C. carnea*. First instar nymphs of *P. solenopsis* were the most preferred food of the 2nd instar larvae of *C. carnea* consumed higher number of 100 total first instar nymphs of *P. solenopsis* when released 20 larvae / cage / 1 weeks, as compared with the total number of adult and nymphs on control (96.2 and 378.8), this results agree with (Rashid *et al.*, 2012, El-Zahi, 2017).

Most predators feed on the eggs or crawlers within the mealybug's ovisac and reduce the number of mealybugs available to extract sap and weaken the plant. Other potential predators, such as the larvae of the lacewing, *Chrysoperla carnea*, were found to consume 30 mealybug eggs daily in developmental laboratory tests (Rabinder Kaur *et al.*, 2008).

Table 2. Predatory insects associated with *P. solenopsis* at Qalyoubia governorate during 2014 and 2015 seasons.

Name	Family	Order	stages	Period of occurrence
<i>Cryptolaemus montrouzieri</i> (Mulsant)	Coccinellidae	Coleoptera	Larvae & Adults	June-Aug.
<i>Brumus suturalis</i> (Fabricius)	Coccinellidae	Coleoptera	Larvae & Adults	June-Aug.
<i>Scymnus syriacus</i> Marseul	Coccinellidae	Coleoptera	Larvae & Adults	June-Aug.
<i>Hyperaspis vinciguerrae capra</i>	Coccinellidae	Coleoptera	Larvae & Adults	June-Oct.
<i>Chrysoperla carnea</i> (Steph.)	Chrysopidae	Neuroptera	Larvae	Aug.-Dec.
<i>Orius laevigatus</i> (Ficoh)	Anthocoridae	Hemiptera	Nymphs & Adults	June-Aug.
<i>Coccinella septempunctata</i> L.	Coccinellidae	Coleoptera	Larvae & Adults	June-Sept.
<i>Coccinella undecimpunctata</i> L.	Coccinellidae	Coleoptera	Larvae & Adults	Nov.-Feb.
<i>Cheiracanthium isiacum</i> Cambridge	Clubionidae	Araneae	Nymphs & Adults	June- Dec.

Table 3. Efficiency of releasing 2nd instars larvae of *C. carnea* in field cage (2014) season to control *P. solenopsis*.

Date of inspection	Number of nymphs on cotton leaves" Control"		No. of <i>C. carnea</i> 2nd instar larvae / cage					
			5		10		20	
	Adult	Nymphs	% Reduction		% Reduction		% Reduction	
	Adult	Nymphs	Adult	Nymphs	Adult	Nymphs	Adult	Nymphs
12/6/2014	43.6	161.2	84.71	99.17	85.80	95.80	81.7	100.0
14/6/2014	109	368	94.50	96.65	82.9	89.6	80.1	83.2
16/6/2014	102.2	518	94.78	89.38	88.8	88.6	90.2	99.5
19/6/2014	130	468	88.24	98.93	90.0	95.9	92.2	95.9
Mean ± Se	96.2±18.5	378.8±78.9	90.5±2.4	96.03±2.2	86.8±1.5	92.4±1.9	86.05±3.01	94.6±3.9

As a consolation, at the last years the climate changes specially temperatures and other factors in Egypt that during the summer season start from May to the end of October, the maximum temperatures reached to 40°C and the air moisture increased also, this conditions may be affective on this insect pest to become widespread from weeds to the economic crops like cotton plant which is more preference to this pest as well as infested the vegetable plants such as okra and eggplant, that indicated this pest may more damage to another economic crops therefore more studies are needed in the future of this insect pest under field conditions.

The cotton mealybug *P. solenopsis* was an invasive and polyphagia's pest and as high reproductive potential on different economic crops, vegetables and weeds in tropical and subtropical counties, the population size of cotton mealybug on different cultivation of host plants has the ability to increase rapidly and spread by other environmental factors such as increased of moisture and temperatures, in a relatively short period of time and feeding by sucking sap of all parts of plants and destroy the economic cultivars. The use of beneficial predators *Chrysoperla carnea* is more effective to control *P. solenopsis* in integrated pest management program.

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دراسة على العوامل النباتية لبق القطن الدقيقى *P. Solenopsis* وكفاءة إطلاق مفترس أسد المن *C. carnea* لمكافحة علي نبات القطن فى مصر

سماح سيد إبراهيم

قسم دودة ورق القطن - معهد بحوث وقاية النباتات - مركز البحوث الزراعية ٧ ش نادى الصيد - دقى - جيزة

يعتبر بق القطن الدقيقى من الافات الحديثة الضرر لكثير من النباتات الاقتصادية مثل القطن ، البامية ، الباذنجان ، النباتات الطبية والعطرية وبعض الحشائش بمحافظة الجيزة والقلوبية بمصر خلال موسمى ٢٠١٤ و ٢٠١٥ . ومن خلال هذه الدراسة تم تسجيل المفترسات المصاحبة لهذه الآفة ومنها أبو العيد ذو ١١ نقطة والعناكب الحقيقية .

Scymnus syriacus Mars; *Hyperaspis vinciguerrae* Capra; *Orius laevigatus* Fieber; *Chrysoperla Carnea* Stephens; *Coccinella undecimpunctata* L. and True spider

وذلك بمحافظة الجيزة والقلوبية بمصر عامي ٢٠١٤ و ٢٠١٥ . ولقد تم تسجيل إطلاق يرقات المفترس اسد المن واستخدامه بالصوب الزراعية كوسيلة لمكافحة بق القطن الدقيقى خلال الموسم الصيفى بداخل غرفة محكمة ، وقد تم تقدير تعداد الافراد " حشرات كاملة - حوريات " قبل الاطلاق مع استخدام ٤ معدلات للاطلاق من يرقات اسد المن . ولقد اشارت النتائج حدوث انخفاض بنسب الإصابة بعد ٣، ٥ و ٧ ايام بنسب ٩٩.١ ، ٩٦.٦ ، ٨٩.٣ و ٩٨.٩ % على التوالي . بينما سجلت المعاملة ب ٥ ، ١٠ و ٢٠ يرقة العمر الثانى للمفترس اسد المن إحداث انخفاض بتعداد البق الدقيقى الى ١٠٠ ، ٨٣ ، ٩٩ و ٩٥.٩ % على التوالي . من النتائج السابقة يتضح ان أفضل معدل لإطلاق يرقات مفترس اسد المن لمكافحة البق الدقيقى بالصوب هو ٥ يرقات/ ١٠٠ حورية من العائل و ذلك من خلال برامج مكافحة المتكاملة للافات و خاصة مكافحة الحيوية باستخدام المفترسات .