Entomology

Impact of ecological conditions on population dynamic of *Phenacoccus solenopsis* Tinsley and associated predators in sweet potato fields ELBeheira Governorate, Egypt

Elsayed A. Refaei[1*], El-sarand E. A.[1], Neveen E. El-Metwaly[1], Abd El-Salam A. Farag[1], Ekram A. Abdou[1] and Ismael M. M.[1]

[1] Plant Protection Research Institute, Agricultural Research Centre, Dokki, Egypt

Correspondence Author: Elsayed A. Refaei

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Abstract

The mealy bug, *Phenacoccus solenopsis* Tinsley is a highly polyphagous sap sucking pests, without a hibernation period, as both are active all the year round. They are destructive pests of important vegetables and field crops. The present study was carried out at Rasheed region, Beheira Governorate during 2021 and 2022 seasons, to monitor the population fluctuations of mealybug and its predators; *Coccinella undecimpunctata* L., *Chrysoperla carnea* Steph, *Scymnus* spp. and *Hippodamia tredecimpunctata* in the first season, the infestation of *P. solenopsis* started on sweet potato plants at low numbers, the population increased gradually to reach its highest peak during 30th July (115.00 individual). This peak was followed by a relatively high population of the three predators, *C. undecimpunctata* (4.00 individual), *Ch. carnea* (8.00 individ.), *Scymnus sp.* (3.00 individ.) and *H. tredecimpunctata* (2.25 individ.). The second peak of the pest was detected on 21st Aug. (259.05 individual), synchronized with the peaks of the four, predators. During 2022, the first incidence of the mealybug was recorded on 30th July (114.97individ.). This peak was associated with the peaks of the four predators. The second peak of *P. solenopsis* was observed on 28th Aug. (196.50 individ.), it coincided with the peaks of the four predators. The infestation of *P. solenopsis* and their predators were highly significantly correlated with weather factors (Min.°c. and RH).

Keywords: *Phenacoccus solenopsis*, sweet potato, predators

Introduction

The mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudoccidae) is one of the most important insects causing severe economic losses to the yields, feeding on a wide variety of more plant species including vegetables, field crops, bushes, maize, weeds and ornamentals (Nagrare 2012; Fallahzadeh *et al*., 2014; Abd razzik *et al*., 2015; Refaei *et al*. 2016 and El-sarand 2018) [23, 12, 3, 25]. El-Zahi and Abd- Elsalam (2017) [10] and Hameed *et al*., (2014) [16] found that the population density of the mealy bug was positively correlated with weather factors. Sweet potato *Ipomoea batatas* L crop is one of the food crops in the Egyptian economy for man and animal. Recently, sweet potato crop is infested with the newly introduced insect pests in Egypt, *P. solenopsis*. Economic damage was recorded on vegetable, cotton, maize and soybean, reached field death in sever conditions (Arif *et al*., 2009, Bader *et al.*, 2020 and El-Zahi 2017 [4, 5, 8] and Abbas *et al.*, 2010) [1]. *P. solenopsis* was appeared for the first time in Egypt in September. Nabil and Hegab (2019) [22] indicated into positive correlation between *P. solenopsis* and temperature and significant negative correlation with relative humidity. El-Fakharany (2020) [9] showed that high population density of *P. solenopsis* was recorded in August and September and the infestation was high and positively correlated with the temperature and negative with relative humidity. In general, during the season, infestations of sweet potato fields, during the growth crop stage, cause severe economic losses to the yield. Ibrahim (2018) [18] found that five larvae of *Ch. carnea*/ 100 individual of the mealy bug can be applied as a biological control with *P. solenopsis*. Farhan *et al*., (2011) [13] found that the lacewing, *Ch. carnea* was more efficient as biological control against. Bakry *et al.*, (2023) [6] showed that *P. solenopsis* infestation in okra plants can be found on all plants parts five weeks after planting. Bader *et al.*, (2020) [5] recorded the pest for the first time in September in Egypt. noticed on sweet potato for many years it is an economic pest of various field crops in Egypt (Jakubwska and Fiedler, 2014) [20]. The information generated may be used for designing a comprehensive pest management program and prediction models for the cotton mealybug. The present study was planned to infestation the population fluctuation of *P. solenopsis* on sweet potato as affected by predators and to determine its, activity to certain synthetic predators under field conditions.

Materials and methods

a) Land preparation and sowing

This experiment was conducted carried out at Edfina Rasheed region, Beheira Governorate during 2021and 2022 summer seasons, in an area 2000 m^2, divided into four equal parts. The land was prepared by laughing three times with calcium superphosphate at the rate of 250 kg /fed. Sweet potato (*Ipomoea batatas* L.) seedlings were Trans in the presence of water at the upper third of the furrows at the beginning of May in both years of study. Sulphur potassium (100 kg/fed.) and nitrogen fertilizer were app as recommended.

b) Sampling for counting the predators

One month after sweet potato Trans planting, 25 plants were pulled out from each plot. The plants were gently confined in plastic bags and transferred to the laboratory of counting the four considered predators, *C. undecimpunctata*, *Ch. carnea*, *Scymnus sp.* and *Hippodamia tredecimpunctata* This sampling technique was followed for four examinatims, as the plants were still young with small size. After that, the sample was one branch of potato plants that was cat gently and confined in plastic bags, as 25 branches were taken from each replicate do visually count the numbers of the three abovementioned predators. The sampling began on June 1st up to June 5th.

c) Sampling for counting mealybug

Mealybug, *Phenacoccus solenopsis* Tinsly (Hemiptera: Pseudoccidae) was counted on 25 leaflets per replicated. The leaflets were weekly picked up and transferred to the laboratory for counting both arthropods, using binocular microscope.

Fig (1): Photographs showing the infestation by *P. solenopsis* on sweet potato plants

The current work depends on examining and identifying all the samples that were examined.

It was collected directly from the field and then transported to the laboratory where it was harvested Learn about them in the Insect Survey and Classification section.

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Fig (2): Photographs showing of the predator, *Hippodamia tredecimpunctata* on sweet potato plants

Results and discussion

a) Population fluctuations of *Phenacoccus solenopsis*

In 2021 season, nymphs and adults of *P. solenopsis* were completely absent throughout June (Table1). By the first week of July, the density of this mealybug was 29.75 nymphs and adults / 25 leaflets. The insect density gradually increased to exhibit the first peak (115.00 individuals / 25 leaflets) on July 30th. However, the highest peak (259.50 nymphs and adults/ 25 leaflets) was found on August 21st.

In 2022 season (Table 2), almost the insect population fluctuation was similar to those of the first season, with a peak of 114.97 nymphs and adults / 25 leaflets on Jul. 30th, with the highest peak (148.25 individuals) on August 28th. Overall mean of the first season was higher than that of the second season; 79.29 and 71.02 nymphs and adults, respectively.

These results agree with Refai (2016) [25] The mealy bug infestation appeared late in low numbers by late June up to mid-July during season 2016.

b) Population fluctuations of predators

i) *Coccinella undeciompunctata*

In 2021 season, population densities of *C. undecimpunctata* were very low up to mid- June, and relatively increased by late June. Then, the predator population fluctuation to exhibited a small peak of 4.00 and adults /25 potato branches on Jul. 30th. In 2022, almost the same trend was detected, but with relatively high two peaks on July 30th and August 28th, with 6.75 and 5.75 predatory individuals, respectively. In a comparison, *C. undeciompunctata* individuals were relatively higher (5.75) in the second season than in the first one (3.50 adults/25 plants or branches).

ii) *Chrysoperla carnea*

In 2021, only two peaks of *C. carnea* with 8.00 and 6.75 larvae/25 potato branches were detected on July 30th and August 21st, respectively. In 2022 season, two peaks were found with 7.75 and 7.00 larvae/25 branches on July 30th and August 28th, respectively. Overall means in both seasons were similar.

iii) *Scymnus interruptus*

Overall mean of 2022 season was obviously higher (4.94 adults/ 25 branches) than that of 2021season (3.86 adults). In 2021 season, the predator was observed with considerable high numbers by late August. In 2022 season, the insect densities were relatively high by late June, late August and early September. Refaei The complex of insect predators and true spiders was detected in two peaks in each season.

iv) *Hippodamia tredecimpunctata*

In 2021 season, population densities of *H. tredecimpunctata*, it appears late in July in small numbers and the population increases in August 21th (4.25 adults/25 plants or branches).

In 2022, It appears late in July in small numbers and the population increases in Jul 30th (5.25 adults/25 plants or branches).

Table 1: Averg numbers of Population fluctuation of *P. solenopsis* and associated predators on sweet potato branches, at Edfina- Rashed region in season 2021

Date of sampling	Av. No. per 25 plant				
	Phenacoccus solenopsis	***Coccinella undecimpunctata***	***Chrysoperla carnea***	***Scymnus* interruptus**	***Hippodamia tredecimpunctata***
Jun., 1	0.00	0.00	0.00	0.00	0.00
8	0.00	1.75	2.75	1.50	0.00
15	0.00	1.25	2.75	1.75	0.00
22	0.00	3.75	2.00	2.50	0.00
30	0.00	3.25	3.75	1.75	0.00
Av. No. per 25 branches					
Jul.,7	29.75	2.75	4.00	2.25	1.25
15	35.75	2.00	3.50	3.00	1.75
22	48.25	2.50	2.75	2.25	1.75
30	115.00	4.00	8.00	3.00	2.25
Aug.7	55.00	3. 50	4.75	3.75	2.25
14	110.25	3.25	5.25	4.25	1.25
21	259.50	3.25	6.75	11.75	4.25
28	201.50	3. 50	4.00	13.75	1.00
Sept., 5	255.25	3.25	4.75	2.50	0.75
Overall ± SE	79.29±3.25	2.58±0.01	3.93±0.21	3.89±0.01	1.180 ±0.33

Table 2: Averg numbers of population fluctuation of *P. solenopsis* and associated predators on sweet potato branches, at Edfina- Rashed region in season 2022

Date of sampling	Av. No. per 25 plants				
	Phenacoccus solenopsis	***Coccinella undecimpunctata***	***Chrysoperla carnea***	***Scymnus* interruptus.**	***Hippodamia tredecimpunctata***
Jun., 1	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00
15	0.00	2.25	2.00	0.00	0.00
22	0.00	3.70	3.00	10.05	1.75
30	0.00	3.50	4.25	10. 75	2.25
Av. No. per 25 branches					
Jul.,7	19.25	2.50	2.25	10.05	3.75
15	50.05	2.75	2.75	2.25	3.00
22	110.25	3.25	7.25	3.00	4.75
30	114.97	6.75	7.75	4.25	5.25
Aug.7	111.00	3.75	4.75	3.05	2.25
14	148.25	3.25	5.50	2.75	1.75
21	81.5	4.75	6.50	2.05	1.25
28	196.50	5.75	7.00	10.75	3.05
Sept., 5	162.52	3.50	4.25	10.25	2.25
Overall ± SE	71.02±3.12	3.26±1.01	4.13±0.20	4.94	1.18±0.32

3. Correlations between populations of pests and their associated predators with some weather factors

Data in Table (3) show that maximum temperature correlated with negative values, in most cases, with populations of *P. solenopsis* and their associated predators. However, the minimum temperatures and relative humidity were usually correlated with positive and highly significant values with the considered insect pests and their associated predators in the two study seasons.

These results disagree with El-sarand *et al.*, (2018) [25]. They found that both temperature (max and min) and relative humidity had a negative and insignificant effect on the population *P. solenopsis* in the two seasons on soybean plants, while El- Fakharany (2020) [9] obtained that a positive significantly correlation between populations of mealy bug, in eggplant and okra, and each of minimum and maximum.

Table 3: Correlation coefficients between some weather factors and main pests and their predators on sweet potato plants

Factor	*Phenacoccus solenopsis*	*Coccinella undecim-punctata*	*Chrysoperla carnea*	*Scymnus* sp.	*Hippodamia tredecimpunctata*
2021					
Max. Tem(°c)	-0.246	+0.321	-0.184	-0.218	+0.352
Min. Tem (°c)	+0.359*	+0.567**	+0.454**	+0.462*	+0.403*
RH%	+0.445*	+0.689**	+0.500**	+0.354*	+0.533**
2022					
Max. Tem(°c)	+0.351	-0.211	-0.213	-0.189	-0.201
Min. Tem (°c)	+0.401*	+0.670**	+0.489**	+0.423*	+0.525**
RH%	+0.390*	+0.712**	+0.514**	+0.462*	+0.477*

*significant, P ≤ 0.05 -** highly significant, P ≤ 0.01

Temperature and relative humidity. Contracting to our results, Ramzan *et al* (2019) [24] observed that both *Chrysoperla sp* and coccinellids spp were active, in cotton fields in June and September, respectively, they also found significant correlations between both predators and *P. solenopsis*). Shahid *et al* (2022) [28] indicated that integrated pest management (IPM) is the best way to control *P. solenopsis*, and they added that biological control is an important compound for the control of scale insects. Hameed *et al* (2012) [15] concluded that *P. solenopsis* caused significant economic losses. The adults and immature stages of *T. urticae*, feeding on sweet potato, result in high levels of plant destruction (Muluken *et al* 2016) [21] damage of 103 million bales, resulting in very large economic damage.

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