POPULATION FLUCTUATION OF SOME PIERCING-SUCKING INSECTS AND ITS RELATION TO ASSOCIATED PREDATORS AND THE PREVAILING WEATHER FACTORS IN SOYBEAN FIELDS AT KAFR EL-SHEIKH GOVERNORATE

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Abstract

In Egypt, aphids, *Aphis* spp.; leafhoppers, *Empoasca* spp. and whitefly, *Bemisia tabaci* (Genn.) are the most important piercing-sucking insect pests infesting soybean plants and a good understanding of their population dynamics is essential to develop an integrated pest management strategy. Therefore, the population densities of these insects and its relation to the common associated predators and the prevailing weather factors were investigated in soybean fields at Kafr El-Sheikh Governorate for 2016 and 2017 seasons. Weekly counts of the considered insects per 15 leaves indicated that whitefly was the most abundant species followed by leafhoppers, while aphids were the least one. Whitefly and leafhoppers appeared on soybean plants all over the growing season. The maximum density of whitefly took place from mid-June to late July in the first season and from the second half of July to the first half of August in the second season. The high number of leafhoppers occurred in the period from mid-July to mid-August for the first season and during August in the second season. Aphid population appeared only in two periods with very low numbers for every season. In the first season, the first period occurred in the second half of June, while the second period took place in the first half of September. In the second season, the population appeared from late June to mid-July and from late August to mid-September. Also, three predaceous insect species: *Chrysoperla carnea* (Steph.); *Coccinella undecimpunctata* L. and *Orius* spp. were observed on soybean plants. *Ch. carnea* was the most abundant predator, while *C. undecimpunctata* was the least one. The total of the predaceous insects attained the highest numbers during July in the first season and during July and August in the second one. The weather factors (temperature, relative humidity and wind speed) had insignificant effect on the cotton whitefly population in the two study seasons. As for leafhoppers, wind speed only had significant effect on the population activity in the second season. Temperature and wind speed in the first season and wind speed in the second season had highly significant effect on aphids activity in the first season. The effect of the predators on the insects was insignificant during the two seasons except effect of the predaceous insects on the leafhoppers which it was significant. The combined effect of both predators and the prevailing weather factors was more pronounced only on aphids in the first season and on leafhoppers in the second season. However, the gained results may provide valuable information for comprehensive integrated insect management of soybean.

INTRODUCTION

Soybean, *Glycine max* (L.) is the most oil seed crop in the world. Its seeds are considered an excellent source of protein (30-50%) and oil (18-22%) (Netam *et al.*, 2013). Also, it can fix a considerable amount of nitrogen of soil and enrich soil fertility (Oerke & Dehne, 2004). In Egypt, the piercing-sucking insects; aphids, *Aphis* spp.; whitefly, *Bemisia tabaci* (Genn.) and leafhoppers, *Empoasca* spp. are of the most important insect pests infesting soybean plants in the field (El-Samahy & Saad, 2010; Khattab *et al.*, 2012 and Salem, 2016).   These insects cause serious damage in yield quality and quantity directly by sucking plant sap or indirectly by viral diseases transmission (Iqbal *et al.*, 2008).

Estimating pest abundance or change in numbers provides the essential measure by which control decisions are often made. Likewise, a good understanding of their population dynamics is vitally important for crop protection. However, the integrated management of the insect pests should consider all factors that may have adverse effects on insect population growth. The natural enemies and climatic conditions are of the most important factors affecting the population dynamic of insects. However, the population densities of the natural enemies and its relation to the insects is believed to be important in enlightening integrated control of the insect pests, as the interaction between the insects and their natural enemies is an essential ecological process that contributes to the regulation of insect population. Also, the environmental conditions at any location influence the seasonal phenology of insect numbers, the number of generations and the level of insect abundance (Dent, 1991) in addition to the geographic range and abundance of various groups of predators (Kogan & Herzog, 1980). Therefore, more information concerning relation of insect pests with their natural enemies and the prevailing weather factors are required to develop and utilize effective pest control strategies (Dent, 1991; Godfrey & Rosenheim, 1996 and Godfrey & Lesser, 1999).

This work aims to study relation of some piercing-sucking insects population with the common predators on soybean plants and the prevailing weather factors at Kafr El-Sheikh Governorate during 2016 and 2017 seasons.

MATERIALS AND METHODS

Two field experiments were carried out at the Farm of Sakha Agricultural Research Station, Kafr El-Sheikh during 2016 and 2017 seasons of soybean to determine the population fluctuations of the main piercing-sucking insects; aphids, *Aphis* spp.; leafhoppers, *Empoasca* spp. and cotton whitefly, *Bemisia tabaci* (Genn.) as well as the common associated predators. For every season, an area of about one

feddan was divided into three equal plots. Seeds of soybean variety Giza 111 were sown in the first week of May during the two seasons. All the normal agronomic practices were adopted without any pesticidal treatments throughout the growing season.

However, El-Hawary *et al*. (1995) and El-Mezaien (1996) showed two aphid species; *Aphis craccivora* (Koch.) and *Aphis gossypii* (Glov.) and two species of leafhoppers; *Empoasca lybica* Paoli and *Empoasca decipiens* Paoli attacking soybean plants at Kafr El-Sheikh region. Because the direct identification of these species in the field is difficult, the total counts of these species were taken into consideration.

To estimate the population density of cotton whitefly (adults); leafhoppers (nymphs and adults) and aphids (nymphs and adults), 15 leaves were weekly sampled at random from each plot early in the morning from three different levels of the plant. The upper and lower surfaces of the chosen leaves were carefully examined using 8x hand lens to count all individuals of the mentioned insects and the data were recorded. The same leaves were picked up and transferred in paper bags to the laboratory for inspection of the whitefly (nymphs and pupae) using a binocular microscope. As for the common associated predators, weekly sample of 5 plants was selected at random from each plot. The numbers of the common predators were directly counted and recorded in the field by aid of hand lens (8x). The common predators were *Chrysoperla carnea* (Steph.) (larvae and adults); *Coccinella undecimpunctata* L. (larvae and adults) and *Orius* sp. (nymphs and adults). The inspection began four weeks after sowing and continued till the end of the season.

To determine the relationship between the population density of the considered insects and both the associated predators and some prevailing weather factors (temperature, relative humidity and wind speed), the daily records of the three weather factors during the inspection period were obtained from the Metrological Department at Sakha Agricultural Research Station. Weekly means of the three considered weather factors during a week preceding sampling date were calculated.

The weekly means of the predaceous insects as well as temperature, relative humidity and wind speed were used to calculate the correlation and regression coefficients values between these factors and the population density of considered insects using SPSS (2006).

RESULTS AND DISCUSSION

1-The population fluctuations of the piercing-sucking insects:

The results in Table (1) reveal the population fluctuations of the considered insects on soybean for 2016 and 2017 seasons. In the first season, the whitefly infestation started relatively in high numbers on 9th June by 168 insects / 15 leaves,

then decreased to reach 124 insects by 16th June. After that, a sharp increase in the population took place forming the highest number of 657.7 insects on 14th July. Then, the population tended to decline sharply until the end of the growing season in the last week of September. Concerning the second season, the population appeared in a few numbers during the first week of June (15.7 insects). After that, the population increased gradually forming one highest peak of abundance in the last week of July by a mean of 599.3 insects. Thereafter, the population declined until the end of the growing season in the third week of September.

These results were supported by El-Samahy & Saad (2010) who found that *B. tabaci* began to appear on soybean plants with higher numbers than the other insects. Also, El-Sarand (2013) in Egypt, reported that *B. tabaci* recorded one peak of abundance on soybean plants during 2009 and 2010 seasons. Similar results were observed by Yadav *et al.,* (2015) who mentioned that infestation of soybean by *B. tabaci* was nearly observed at mid-July, then increased gradually in the third week of July and the second week of August.   Salem (2016) found that *B. tabaci* recorded one to two peaks according to soybean variety at Assuit Governorate during 2013 and 2014 seasons.

With regard to the leafhoppers, *Empoaca* spp., the population started to appear with a few numbers (1.0 insect) on 9th June in the first season.   Then, the population fluctuated during the inspection period recording the highest number in the last week of July (8.7 insects). After that, the population declined gradually till the end of the season. The same trend of results was observed in the second season but, the high abundance occurred on 14th August by 12.0 insects.

This trend of results agreed fully with the findings of El-Sarand (2005) who reported that the leafhoppers started to appear on soybean on June 19th and 10th during 1999 and 2000 seasons, respectively, then increased recording one peak of abundance on August 21st and 26th in 1999 and 2000 seasons, respectively. Also, the same author (2013) revealed that the leafhoppers; *E. decipiens* and *E. decedens* recorded one peak of abundance on soybean plants during seasons of 2009 and 2010. Sutaria *et al.,* (2010) in India, found the maximum population of *Empoasca kerri* (Paoli) between 6-8 weeks after sowing of soybean during 2007 and 2008 seasons**.**

Regarding aphids, in the first season, the infestation appeared firstly on 16th June being 3.7 insects/15 leaves and continued up to late month. After that, the infestation disappeared completely and appeared again during the first half of September. In the second season, the first appearance of infestation occurred at late June with a few numbers (0.7 insect/ 15 leaves) and continued up to mid-July. After

that, the population disappeared completely and observed again from late August to mid-September.

Table 1. Mean number of certain piercing-sucking insects /15 leaves of soybean during 2016 and 2017 seasons at Kafr El-Sheikh Governorate

Inspection date	Season of 2016			Season of 2017			
	Bemisia	*Empoasca*	*Aphis*	Inspection	*Bemisia*	*Empoasca*	*Aphis*
June, 9	168.0	1.0	0.0	June, 5	15.7	0.3	0.0
16	124.0	0.3	3.7	12	24.7	0.7	0.0
23	377.0	1.0	2.3	19	39.7	1.7	0.0
30	440.7	1.7	0.3	26	67.7	1.3	0.7
July, 7	590.3	1.7	0.0	July, 3	72.3	4.7	2.7
14	657.7	2.0	0.0	10	99.7	6.3	1.7
21	332.0	6.0	0.0	17	162.0	7.0	0.7
28	143.7	8.7	0.0	24	235.3	5.7	0.0
August, 4	50.0	4.7	0.0	31	599.3	5.0	0.0
11	36.7	3.3	0.0	August,7	490.3	9.7	0.0
18	16.0	1.3	0.0	14	356.0	12.0	0.0
25	32.0	3.7	0.0	21	209.7	11.0	0.0
Sept., 1	22.7	3.0	0.0	28	77.7	6.3	0.3
8	6.7	2.0	0.7	Sept.4	32.3	6.0	1.3
15	4.7	3.3	0.3	11	7.3	2.0	0.3
22	1.3	1.0	0.0	18	2.7	1.3	0.0
Seasonal	187.7 $\pm$ 4.4	2.8 $\pm$ 0.42	0.5 $\pm$	Seasonal	155.8 $\pm$	5.1 $\pm$ 0.09	0.5 $\pm$

SE*= standard error

The results were in accord with those of Mousa (2004), who mentioned that the population of *A. gossypii* and *A. craccivora* fluctuated on soybean plants throughout the growing season forming two distinct peaks; the first occurred early in 2000 (July) and in 2001 season (August), while the second peak took place late (1st half of September in both seasons). However, El-Samahy & Saad (2010**)** showed one peak of abundance for *A, gossypii* in 2008 season (26th July) and two peaks in 2009 season (12th July and 23rd August).

2- The population fluctuations of the common predators in soybean fields:

The results presented in Table (2) showed three predaceous insect species; *Ch. carnea*; *C. undecimpunctata* L. and *Orius* sp. on soybean plants during the two study seasons. In season of 2016, these predators started to appear at the same time of considered insect species appearance. *Ch. carnea* was the most dominant predator with a seasonal mean of 4.4 individual / 5 plants followed by *Orius* sp. (2.6 individuals/ 5 plants), while *C. undecimpunctata* was the least one (0.8 predator/5

plants). Taking the total number of the predaceous insects into consideration, it was apparent that the population fluctuated throughout the season forming three peaks represented by 10.6, 15.3 and 12.0 predators/ 5 plants on 23rd June, 28th July and on 1st September, respectively.

During season of 2017, the same predaceous species were detected and started to appear at the same time of considered insect's appearance except *Orius* sp. that appeared three weeks later. *Ch. carnea* was the most abundant species with a seasonal mean of 6.1 individuals /5 plants, followed by *Orius* sp. (4.1 individuals), while *C. undecimpunctata* was the least one (0.8 predator). The total population of the predaceous insects fluctuated throughout the inspection period recording two peaks of 14.7 and 19.4 predators on 10th July and 14th August, respectively.

 The results agree with those obtained by Samhan (2003), who found *Ch. carnea* ; *C. undecimpunctata* L.and *P. alfierii* in soybean fields using sweep net during 2000, 2001 and 2002 seasons.   El-Sarand (2005 and 2013) found *Ch. carnea*; *C. undecimpunctata* ; *P. alfierii* and *Scymnus* spp. in soybean fields and the former was the most dominant species.

However, the population of the considered insects and the associated predators differed between the two seasons as shown in Table (3). The results showed a significant increase in whitefly population in the first season than in the second one, while the reverse took place for the leafhoppers. Aphid population did not significantly differ in the two seasons. The population density of *Ch. carnea* and *Orius* sp. were significantly higher in the second season than in the first one, while *C. undecimpunctata* did not differ in the two seasons. The total of predaceous insects recoded significant increase in the second season than in the first one. However, the differences in the levels of infestation with the insects might attribute to the difference in weather factors (mainly temperature and relative humidity) and / or effect of the common natural enemies.

Table 2. Mean numbers of the common predators / 5 soybean plants during 2016 and 2017 seasons at Kafr El-Sheikh Governorate

Season of 2016					Season of 2017				
Inspection date	Ch.	Orius spp.	C.undecim-	Total of	Inspection date	Ch. carnea	Orius spp.	C.undecim-	Total of
June, 9	1.0	0.3	0.3	1.6	June, 5	1.0	0.0	0.3	1.3
16	1.0	0.0	0.0	1.0	12	2.3	0.0	0.3	2.6
23	10.3	0.0	0.3	10.6	19	6.3	0.0	1.0	7.3
30	5.0	2.3	0.0	7.3	26	6.3	1.7	1.3	9.3
July, 7	5.0	1.0	1.3	7.3	July, 3	10.0	1.0	1.7	12.7
14	6.7	3.3	2.7	12.7	10	10.0	4.0	0.7	14.7
21	6.0	4.0	2.0	12.0	17	7.3	3.7	0.3	11.3
28	8.0	6.3	1.0	15.3	24	6.0	3.0	1.0	10.0
August, 4	3.3	5.0	1.0	9.3	31	9.3	6.7	2.0	18.0
11	3.7	2.7	0.7	7.1	August,7	10.0	7.0	1.3	18.3
18	3.7	2.3	0.7	6.7	14	8.7	9.0	1.7	19.4
25	4.0	4.0	1.7	9.7	21	7.0	10.0	1.0	18.0
Sept., 1	4.3	6.7	1.0	12.0	28	5.3	9.0	0.3	14.6
8	3.7	2.0	0.3	6.0	Sept.4	4.0	7.3	0.0	11.3
15	3.3	1.3	0.3	4.9	11	3.0	3.3	0.0	6.3
22*	1.0	0.3	0.0	1.3	18	1.0	0.3	0.0	1.3
Seasonal	4.4 ±	2.6 ±	0.8 ± 0.03	7.8 ± 0.90	Seasonal	6.1± 0.03	4.1± 0.03	0.8± 0.07	11± 1.10

SE*= standard error

Table 3. Seasonal mean of certain piercing-sucking insects and the common predators on soybean during 2016 and 2017 seasons at Kafr El-Sheikh Governorate

Season	No. insects /15 leaves			No. predators/5 plants			
	Bemisia tabaci	*Empoasca* spp.	*Aphis* spp.	1	2	3	4
2016	187.7	2.8	0.5	4.4	2.6	0.8	7.8
2017	155.8	5.1	0.5	6.1	4.1	0.8	11.0
T-calculated	7.21**	3.8*	0.46	3.2*	2.9*	0.32	2.3*

T-tabulated = 2.13 at 5% and = 3.75 at 1%   1= *Chrysoperla carnea*,   2= *Orius* sp.,   3= *Coccinella undecimpunctata*,   4= total of predaceous insects

3-Relation of the piercing-sucking insect populations with the common predators and the prevailing weather factors:

The effect of the common predators and the prevailing weather factors (temperature, relative humidity and wind speed) on the population density of the considered piercing-sucking insects in soybean fields during seasons of 2016 and 2017 are shown in Table (4). It was notable that the three weather factors had insignificant effect on the cotton whitefly population in the two study seasons. This means that these weather factors were within the optimal range for the population activity of whitefly. As for leafhoppers, wind speed only had significant effect on the population activity in the second season. Temperature and wind speed in the first season and only wind speed in the second season had highly significant effect on aphids activity.

Many authors studied the effect of weather factors on the population of piercing-sucking insects on soybean. El-Sarand (2005) showed insignificant effect of relative humidity on *Empoasca* spp. during 1999 and 2000 seasons   Magouz *et al*., (2006) found insignificant effect of temperature and relative humidity on *B. tabaci*. Sutaria *et al*., (2010) showed insignificant effect of temperature, relative humidity and rain on activity of *Empoasca kerii* L. during 2007 and 2008 seasons. El-Sarand (2013) reported insignificant effect of temperature, relative humidity and wind speed on *B. tabaci, Empoasca* spp and *Aphis* spp. on soybean during 2009 and 2010 season at Kafr El-Sheikh governorate except effect of temperature on aphids in season 2009 where it was significant.

Table 4. Statistical parameters for the piercing-sucking insects population in relation to three weather factors, and the predators complex in soybean field during 2016 and 2017 seasons at Kafr El-Sheikh Governorate

Insect	Factor	Season of 2016			Season of 2017		
		(r)	(b)	%EV	(r)	(b)	%EV
Bemisia tabaci	Temp. (°C)	0.12	37.99	36.9	-0.05	-6.99	63.5
	R.H. (%)	-0.35	-17.92		0.20	13.02	
	W.S.(km/hr)	0.18	75.56		-0.37	-96.73	
	Predaceous insects	0.32	19.49		0.25	9.70	
Empoasca spp.	Temp. (°C)	-0.08	-0.22	54.1	0.26	0.46	86.1
	R.H. (%)	0.10	0.04		0.17	0.14	
	W.S. (km/hr)	-0.23	-0.83		-0.55*	-2.03*	
	Predaceous insects	0.62**	0.38**		0.47	0.26	
Aphis spp.	Temp. (°C)	-0.66**	-0.71**	80.9	0.46	0.37	48.8
	R.H. (%)	-0.22	-0.03		0.03	0.01	
	W.S.(km/hr)	0.78**	1.33**		0.62**	1.00**	
	Predaceous insects	-0.51	-0.09		0.27	0.06	

r = correlation coefficient, b = regression coefficient, EV = explained variance,

*= significant, **= high significant

Also, the effect of the predaceous insects on the population of the considered insects was insignificant during the two seasons except effect of the predatory insects on the leafhoppers in the first season as it was high positive significant. Thus, the regression coefficient indicated that an increase of one predatory insect would correlate with an increase in the leafhoppers by 0.38 insects in the first season. The combined effect (expressed as percentage of explained variance) of both predators and weather factors on the insects population was responsible for 36.9; 54.1 and 80.9% of the change in the population of whitefly, leafhoppers and aphids, respectively in the first season, while it was 63.5; 86.1 and 48.8% for the three insects, respectively in the second season.

These results indicate that many unconsidered factors affect the population of the considered insects. In contrast, El-Sarand (2013**)** mentioned a significant effect of

the predatory insects on the piercing- sucking insects (*B. tabaci, Empoasca* spp., *Aphis* spp. and *N. viridula*) in soybean fields. However, the interaction between the insects and their natural enemies is essential ecological process that contributes the regulation of insect population as mentioned by Dent (1991).

From the above mentioned results, it can be noted that whitefly was the most abundant insects in the two seasons followed by leafhoppers, while aphids was the least abundant. Also, *Ch. carnea* was the most dominant predator followed by *Orius* sp., while *C. undecimpunctata* was the least one. The maximum density of whitefly appeared from mid-June to late July in the first season and from the second half of July to the first half of August in the second season. The highest number of leafhoppers took place in the period from mid-July to mid-August for the first season and during August in the second season. Aphid population appeared only in two periods with very low numbers in every season. In the first season, the first period occurred in the second half of June, while the second period took place in the first half of September. In the second season, the population appeared from late June to mid-July and from late August to mid-September.

Finally, the findings of this study could be useful to design a comprehensive integrated management for these insect pests in soybean fields.

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تذبذب تعداد بعض الحشرات الثاقبة الماصة وعلاقته بالمفترسات المصاحبة والظروف الجوية السائدة في حقول فول الصويا في محافظة كفر الشيخ

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تُعتبر حشرات المن ونطاطات الأوراق والذبابة البيضاء من أهم الحشرات الثاقبة الماصة التي تصيب نباتات فول الصويا في مصر. ويلزم لتطوير إستراتيجية المكافحة المتكاملة لهذه الحشرات الفهم الجيد لديناميكية تلك الحشرات. ولذلك أُجريت تجربة حقلية لدراسة كثافة تلك الحشرات وعلاقتها بالمفترسات المصاحبة وكذا بعض العوامل الجوية في حقول فول الصويا بمحافظة كفر الشيخ موسمي 2016،2017 م. وأوضحت نتائج التعداد الأسبوعي للحشرات لكل 15 ورقة فول صويا أن الذبابة البيضاء سجلت أعلي تعداد يليها تعداد نطاطات الأوراق بينما سجل المن أقل تعداد خلال موسمي الدراسة، وقد تواجدت الذبابة البيضاء ونطاطات الأوراق علي النباتات طول الموسم ، ووُجد أعلي تعداد للذبابة البيضاء من منتصف يونيو حتى أواخر يوليو في الموسم الأول ومن النصف الثاني من يوليو حتى النصف الأول من أغسطس في الموسم الثاني. ووُجد التعداد العالي لنطاطات الأوراق في الفترة من منتصف يوليو حتى منتصف أغسطس في الموسم الأول وخلال أغسطس في الموسم الثاني. وظهر المن في فترتين فقط بتعداد قليل جداً في كل موسم ، الفترة الأولي في النصف الثاني من يونيو والفترة الثانية في النصف الأول من سبتمبر في الموسم الأول – بينما ظهر المن في الموسم الثاني من أواخر يونيو حتى منتصف يوليو ومن أواخر أغسطس حتى منتصف سبتمبر. ووُجدت أيضاً ثلاثة أنواع من الحشرات المفترسة علي نباتات فول الصويا وهي أسد المن وخنافس أبو العيد وبقة الأوريس خلال موسمي الدراسة ، وكان المن أكثر تواجداً بينما كان أبو العيد أقل تواجداً ، وسجل مجموع المفترسات أعلي تعداد خلال يوليو في الموسم الأول وخلال يوليو وأغسطس في الموسم الثاني . كان تأثير العوامل الجوية (الحرارة والرطوبة النسبية وسرعة الرياح) غير معنوي علي تعداد الذبابة البيضاء في موسى الدراسة. وكان تأثير الرياح والحرارة علي المن في الموسم الأول وتأثير الرياح في الموسم الثاني عالي المعنوية.

وكان تأثير المفترسات المتواجدة غير معنوي خلال موسمي الدراسة ماعدا تأثير المفترسات الحشرية علي نطاطات الأوراق والذي كان عالي المعنوية – وكان التأثير المشترك للعوامل الجوية والمفترسات الحشرية أكثر وضوحاً علي المن في الموسم الأول وعلي نطاطات الأوراق في الموسم الثاني. وعموماً تفيد النتائج المتحصل عليها في تطوير برامج المكافحة المتكاملة لهذه الحشرات في حقول فول الصويا.