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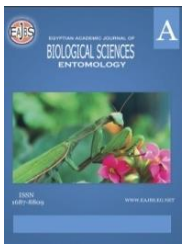

Seasonal Dynamics of Aphids and Their Associated Spiders on Two Field Crops at Qalubyia Governorate, Egypt.

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ABSTRACT

Infestation of the broad bean and maize crop with *Aphis craccivora* and *Rhopalosiphum maidis*, respectively at Qaha research station, Qalubyia started in January and May (or June) during two years of study. The monthly collected number and percent abundance of each and total life stage (s) of *A. craccivora* and *R. maidis* gradually increased to reach peaks in March (or March and February) and August then decreased in the last month of the season of the broad bean and maize, respectively. Immatures were the most prevalent life stages followed by unwinged and winged adult females. Generally, the total collected number of each life stage of *A. craccivora* and *R. maidis* was higher in 2018 than in 2017.

A total of 26 spider species belonging to 20 genera and 10 families of order Araneae were associated with the two aphids, *A. craccivora* and *R. maidis*, on the broad bean and maize at the site of study in 2017 and 2018. About 50% of the collected species were common spiders associated with each of the two aphid species on its host crop. Generally, the total spiders of the collected families on the broad bean and maize crops started appearing with relatively small numbers in January and May, gradually increased in parallel with those of the associated aphid species to reach peaks in March and August, then the numbers of both were decreased at the end of the crop season in April and September, respectively during each year of the study.

INTRODUCTION

The cowpea aphid, *Aphis craccivora* (Koch) and the corn leaf aphid, *Rhopalosiphum maidis* (Fitch) are common pests on broad beans, cowpea and other legumes (Attia *et al.,* 1986; Ali, 2004; Ali *et al.,* 2013) and on maize, wheat and other cereal crops (Ismail *et al.,* 1993; Mannaa, 2000 and El- Heneidy and Abdel-Samad, 2001) respectively, in Egypt.

The two aphids cause direct damage to their host plants (El-Heneidy and Abbas, 1984 and Attia et al., 1986) by sucking plant sap which leads to stunting and distorting growth. The honeydew produced by the aphids and deposited on the plant interferes with pollination and encourages the growth of sooty molds which restrict photosynthesis and attract other harmful insects and fungi (Metcalf & Flint, 1962). Generally, aphids are the

vectors of a number of plant viruses such as maize dwarf mosaic virus (MDMV) transmitted by *Rhopalosiphum maidis* (Straub, 1982) and the necrotic yellow virus in faba beans mostly transmitted and was correlated in Egypt with *Aphis craccivora* (El-Defrawi *et al.*, 2000).

Because aphids are pests of many economically important crops, with worldwide distribution and their infestations can cause considerable yield losses of crops (Darwish, 1989; Naz *et al.*, 2003; Carnea & Glogoza, 2004 and Swaminathan *et al.*, 2015) it was suggested that the control of infestations must be managed through long-lasting eco-safe methods (Al-Eryan and El-Tabbakh, 2004). These methods include biological control and utilizing practices to favor achieving the conservation of natural enemies, especially predators and parasitoids.

Generally, spiders are known to have a wide range of potential as predators of several insects, suppressing their populations on field crops (Mehto *et al.*, 1986; Mansour and Heimbach, 1993; El-Naggar *et al.*, 1999 and Swaminathan et al., 2015) by feeding on all life stages of the prey (Ibrahim et al., 2012 and Abo-zaed *et al.*, 2018). In Egypt, biological, ecological and taxonomical studies concerning spiders as predators of aphids (El-Heneidy & Abbas, 1984; El- Hennawy, 1992 and Abo-zaed *et al.*, 2018) still need further investigations to determine which species can be used as biological control agents. Also, in spite of the available literature on the ecological studies on aphids and their associated enemies, many were not concerned with spiders or identifying the species and families of the associated predatory spiders (Mannaa, 2000; Ali *et al.*, 2013 and Tambe and Kadam, 2015).

The present study aims to investigate the seasonal dynamics and abundance of *Aphis craccivora* (Koch), *Rhopalosiphum maidis* (Fitch), life stages and to survey naturally associated spider families and species on two economically important field crops, the broad bean, *Vicia fabae* and maize, *Zea mays*, at Qaha research station, Qalubyia governorate, Egypt during two successive years, 2017 and 2018.

MATERIALS AND METHODS

Adults and immatures of aphids and associated predatory spiders on broad bean (*Vicia fabae*) and maize (*Zea mays*) crops were bi-weekly collected from 20 plants at Qaha research station, Qalubyia governorate for two successive years, 2017 and 2018. The broad bean and maize crops were planted at Qaha station of research in the last week of November and the second week of April, respectively, in both seasons. The prevailed ambient temperature and relative humidity every month were obtained from the meteorological station in the form of maximum, minimum and average monthly temperature and relative humidity.

Collection Method of Aphids:

Aphids that were found on leaf samples were periodically picked up at random from 20 plants from four selected plots covering the whole experimental area. The experimental plot for this study was a clean non-insecticide sprayed area of 7m x6m. The collected samples of host plant leaves were placed in labeled paper bags, tightly closed and transferred to the laboratory. The collected samples of the aphids were identified and sorted to the stage and form and counted bi-weekly for each of the cowpea aphids, *Aphis craccivora* (Koch) and the corn leaf aphid, *Rhopalosiphum maidis* (Fitch) on each of the broad bean and maize, respectively.

Collection of Associated Predatory Spiders:

Spiders were bi-weekly collected at random from the 20 plants in the experimental location by the tree shaking and receiving the falling spiders on fine silky sieves. The

spiders on each plant sample were isolated in empty glasses, plugged and transferred to the laboratory. The collected spiders on the plant samples were kept in small glass tubes containing 70% ethyl alcohol. Locality, host plant and date of the collection were recorded by a pencil on a slip of paper attached to each specimen inside the tube for identification (Katson, 1978), sorting stages and counting. In the laboratory, the specimen was examined in a Petri dish under a stereoscopic binocular microscope.

Statistical Analysis:

The obtained results from seasonal dynamics of aphids, *Aphis craccivora*, *Rhopalosiphum maidis* and % occurrence of spiders on the broad bean and maize crop were analyzed by a statistical package of Social Science (SPSS), version 20 for windows.

RESULTS

The cowpea aphid, *Aphis craccivora* and corn leaf aphid, *Rhopalosiphum maidis* are common pests of the broad bean (*Vicia fabae*) and maize (*Zea mays*) which are considered two economically important crops for their use as food and fodder for man and his domestic animals in Egypt. The seasonal dynamics and abundance of each and total life stages of the two aphid species and associated spiders were investigated on their host crops at Qaha station of research, Qalubyia governorate, Egypt for two successive years, 2017 and 2018.

I.1. Seasonal Dynamics of *Aphis Craccivora* During the Broad Bean Seasons 2017 and 2018:

Infestation of the broad bean crop with *A. craccivora* started with the lowest numbers in the second week of January of each year and its monthly level gradually increased to reach peaks in March or March and February (**Fig. 1 a, b**). Two peaks of 141 and 156 aphids/40 plants appeared in February and March which represented 33.6 and 37.2% ($P<0.05$) of the total collected life stages (419 aphids) in the broad bean season 2017 (**Fig.1a**). However, only one peak of 211 aphids/40 plants was recorded in March 2018 which represented 38.5% ($P<0.05$) of the total collected life stages in the season of 2018 (548 aphids). Peaks in the two years were followed by a decrease ($P<0.05$) in the number and percent abundance of aphids in April at the end of the season to reach 81 and 118 aphids per 40 plants which represented 19.3 and 21.5% ($P<0.05$) of the total number of all life stages collected in the broad bean season in 2017 and 2018, respectively. Similarly, the monthly collected number and percent abundance of immatures gradually increased to reach two peaks of 105 and 115 aphids/40 plants in February and March which represented 33.5 and36.7% ($P<0.05$) of the total immatures collected in 2017 (313 aphids) and one peak of 118 aphids in March which represented 35.75% ($P<0.05$) of the total collected immatures in 2018 (330 aphids).

In both years, infestation with immatures started earlier (2nd week of January) than adults (4th week of January) on the plant. Also, immatures were the most prevalent life stage in each month throughout the broad bean season and represented 71.6 - 85.37% and 60.17 – 95.3% of the total collected life stages in each month of 2017 and 2018, respectively (Fig.1 a, b). The total collected number of immatures (313 and 330 aphids) constituted 74.7 and 60.22% of the total number of all life stages collected during the broad bean season in each 2017 and 2018 (419 and 548 aphids). On the other hand, the winged (alate) adult females were the least abundant life stage (34 and 89 aphids) constituting 8.11 and 16.22% of the total collected life stages in the whole season of 2017 and 2018. The winged females started appearing relatively late, in the 4th and 2nd weeks of January and February following the infestation with immatures and unwinged females in 2017 and 2018, respectively (Fig. 1 a, b). Throughout the broad bean season, winged females

represented 3.7 – 10.89 and 0 – 20.85% of the total life stages collected in each month of 2017 and 2018, respectively (Fig.1 a, b). However, the monthly collected number of winged females gradually increased to reach in March one peak of 50 and 49.43% of the total collected winged females in the broad bean season of 2017 and 2018, respectively. In 2017, the alate females disappeared during some weeks of the last month of the season before harvest. The unwinged (apterous) females appeared on the broad beans in the fourth week of January followed that of immatures in each season and constituted 17.18 and 23.54% of the total collected life stages in 2017 and 2018, respectively. Furthermore, the unwinged females represented 9.76 – 24.69% and 4.65 – 23.73% of the total life stages collected in each month of the broad bean season during 2017 and 2018, respectively (Fig. 1 a, b). However, the infestation level of apterous females gradually increased in each month to reach two similar peaks in February and March of each of 2017 (33.3%) and 2018 (about 38.5%). No adult males or eggs of *A. craccivora* were collected on the broad bean throughout the period of study. Generally, the total collected number of each life stage (immature, winged and unwinged females) of *A. craccivora* infesting the broad bean was higher in 2018 (330, 89 and 129) than in 2017 (313, 34 and 72).

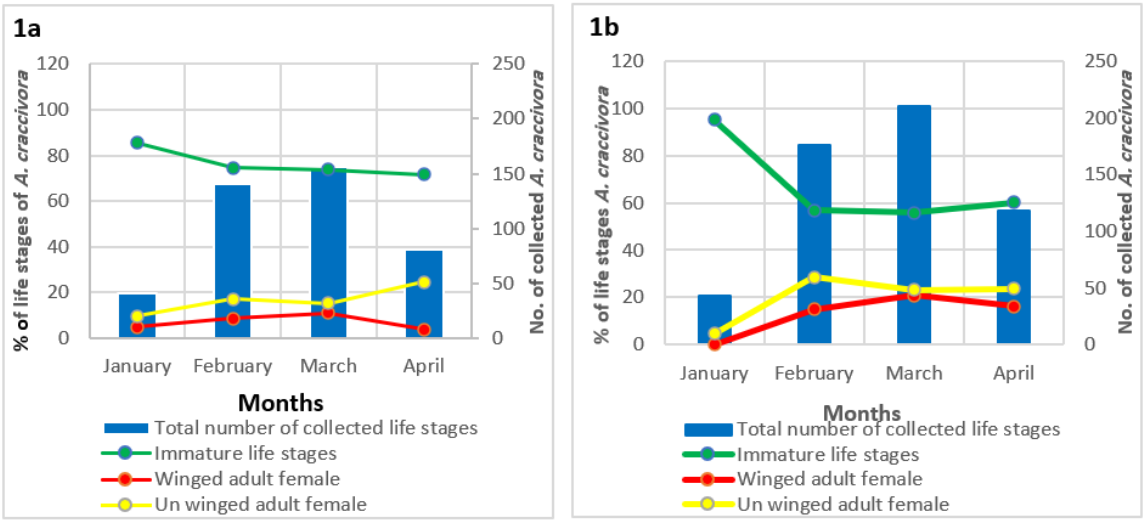

Fig.1: Seasonal dynamics of *Aphis craccivora* and prevalence of life stages collected on the broad bean crop at Qaha station 1a. 2017, 1b. 2018

I.2. Seasonal dynamics of *Rhopalosiphum maidis* during the maize seasons, 2017 and 2018

Infestation of the maize crop with *R. maidis*, started with the lowest numbers in the second and fourth week of June 2017 and May 2018, respectively. The monthly level of infestation gradually increased to reach a peak of 100 and 161 aphids /40 plants in August of each 2017 and 2018 which represented 42.7 and 41.8% ($P<0.05$) of the total collected life stages of 234 and 385 aphids, respectively (Fig. 2 a, b). Infestation with *R. maidis* decreased in September to 22.2 and 20% ($P<0.05$) of the total number of all life stages in the maize season in 2017 and 2018. Similarly, infestation with each life stage (immature, winged & unwinged female) started with the lowest level, then gradually increased to reach a peak ($P<0.05$) in August of 40.9, 61.3 & 38.2 % and 37.71, 65.78 & 42.34% of the total number collected of each stage during the maize season in 2017 and 2018, respectively. The peak was followed by a decrease in infestation level in September of each year.

Immatures and unwinged adult females started appearance in the second week of June followed by the winged females in the second week of July 2017 (Fig. 2a). However, immatures appeared the earliest in the 4th week of May followed by the unwinged females in the second week of June and winged females in the second week of July 2018 (Fig. 2b).

The winged females disappeared during some weeks of the last month of the maize season in both years. Immatures were the most prevalent life stage, constituting 54.27 and 61.29% of the total number of all life stages collected on maize in 2017 and 2018, respectively. Also, in each month they represented 50 – 63.16% and 55.28 – 100% of the monthly collected life stages in the maize season in 2017 and 2018, respectively (Fig. 2 a, b). On the other hand, the winged adult females were the least abundant constituting 13.25 and 9.87% of the total number of all life stages collected in 2017 and 2018 and represented 0 – 19 % and 0 - 15.35% of the monthly collected life stages in 2017 and 2018, respectively. The unwinged females showed an intermediate prevalence of 29 – 40.38% and 0 – 31.17% of monthly collected life stages and constituted 32.48 and 28.83% of total life stages collected in maize season 2017 and 2018, respectively. No adult males or eggs were collected on maize throughout the period of study. Generally, the total collected number of each life stage (immatures, winged and unwinged females) of *R. maidis* infested maize was higher in 2018 (236, 38 and 111 aphids) than in 2017 (127, 31 and 76 aphids).

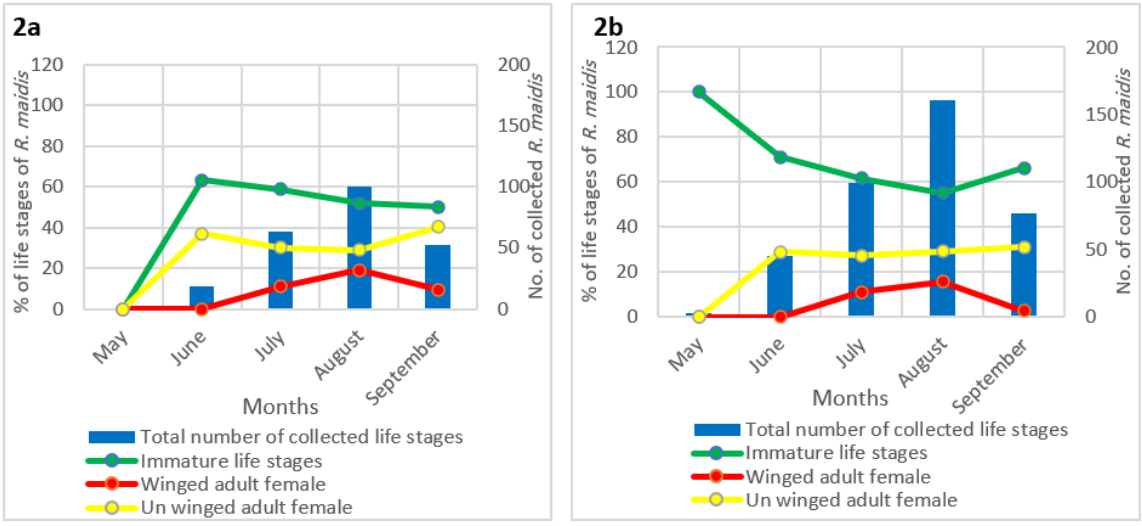

Fig. 2: Seasonal dynamics of *Rhopalosiphum maidis* and prevalence of life stages collected on maize crop at Qaha station 2a.2017, 2b. 2018.

II.1. Spider Families Associated with *A. Craccivora* And *R. Maidis* on Broad Bean and Maize Crops:

One thousand four hundred and eighty-six spiders belonging to 10 families of the order Araneae were associated with the two aphids, *A. craccivora* and *R. maidis* on broad bean (778 spiders) and maize (708 spiders) crops during the two years of study (**Table 1**). Philodromidae was the most abundant family constituting 25.64% of the total collected spiders (1486 spiders) followed by ($P<0.05$) Salticidae (19.04%), Theridiidae (18.37%) and Thomisidae (17.83%), then ($P<0.05$) Lycosidae (7.20%) followed by ($P<0.05$). Cheiracanthiidae and Araneidae (3.7%), Linyphiidae (2.35%), then ($P<0.05$) Dictynidae (1.35%) and Aglenidae (0.81%). The numbers of the collected spiders and the percent occurrence of each family varied on each of the two studied crops and hence the association with the two aphids in 2017 and 2018 (Table1). The aforementioned 10 families were associated with *A. craccivora* on the broad beans in both years. However, two families, Dictynidae and Aglenidae were absent as associates with the corn leaf aphid *R. maidis* in both years.

On broad beans and associated with *A. craccivora*, Philodromidae showed the highest incidence of occurrence during the two years (26.35%), followed by ($P<0.05$) Theridiidae (19.67%), Thomisidae and Salticidae (17.22%), then ($P<0.05$) Lycosidae (7.32%) followed by ($P<0.05$) Cheiracanthiidae (3.86%), Araneidae (2.96%) and

Dictynidae (2.57%), then (P<0.05) Aglenidae (1.54%) and Linyphiidae (1.28%). On maize and associated with *R. maidis*, Philodromidae had the highest incidence of occurrence (24.86%) followed by (P<0.05) Salticidae (21.05%) then (P<0.05) Thomisidae (18.5%) and Theridiidae (16.95%) followed by (P<0.05) Lycosidae (7.1%) then (P<0.05) Araneidae (4.52%), Cheiracanthiidae and Linyphiidae (3.53%).

Table 1: The collected number (No.) and percent abundance (%) of the spider families and species associated with *A. craccivora* and *R. maidis* on the broad bean and maize crops, respectively, during the 2017 and 2018 seasons.

Spider family No. (%)	Species	On broad bean			On maize		
		2017 No. (%)	2018 No. (%)	Total No. (%)	2017 No. (%)	2018 No. (%)	Total No. (%)
Dictynidae 20 (1.35%)	*Dictyna innocens*	6 (1.68%)	14 (3.32%)	20 (2.57%)	-	-	-
Lycosidae 107 (7.20%)	*Lycosa nilotica*	8 (2.24%)	13 (3.08%)	57 (7.32%)	10 (2.89%)	8 (2.20%)	50 (7.10%)
	Paradosa iniqua	19 (5.32%)	17 (4.04%)		16 (4.62%)	16 (4.41%)	
Salticidae 283 (19.04%)	*Ballus piger*	16 (4.48%)	15 (3.56%)	134 (17.22%)	26 (7.51%)	20 (5.52%)	149 (21.05%)
	Ballus sp.	14 (3.92)	18 (4.27)		7 (2.02%)	14 (3.86%)	
	Euophrys sp	37 (10.36%)	27 (6.41%)		-	-	
	Euophrys granulata	-	-		38 (10.98%)	31 (8.56%)	
	Salticus sp	-	-		5 (1.44%)	4 (1.10%)	
	Plexippus paykulli	-	-		-	4 (1.10%)	
	Thyere imperialis	-	7 (1.66%)		-	-	
Philodromidae 381 (25.64%)	*Thanatus albini*	59 (16.53)	79 (18.76)	205 (26.35%)	62 (17.9)	56 (15.47)	176 (24.86%)
	Philodromus cinereus	32 (8.96)	35 (8.31)		25 (7.22)	33 (9.11)	
Thomisidae 265 (17.83%)	*Thomisus sp*	-	-	134 (17.22%)	5 (1.44)	4 (1.10)	131 (18.50%)
	Thomisus spinifer	-	-		22 (6.35)	29 (8.01)	
	Misumena sp	21 (5.88)	20 (4.75)		-	-	
	Misumena atrocincta	13 (3.64)	14 (3.32)		28 (8.09)	30 (8.28)	
	Synema sp.	36 (10.08)	30 (7.13)		9 (2.60)	4 (1.10)	
Theridiidae 273 (18.37%)	*Theridion egyptium*	26 (7.28)	24 (5.70)	153 (19.67%)	18 (5.20)	22 (6.07)	120 (16.95%)
	Theridion sp	-	27 (6.41)		3 (0.86)	6 (1.65)	
	Kuchiura aulica	36 (10.08)	40 (9.50)		33 (9.53)	38 (10.49)	
Linyphiidae 35 (2.35%)	*Sengletus extricatus*	7 (1.96)	3 (0.71)	10 (1.28%)	-	-	25 (3.53%)
	Mermessus denticulatus	-	-		14 (4.04)	11 (3.03)	
Cheiracanthiidae 55 (3.70%)	*Cheirachnthida inculsum*	15 (3.64)	15 (3.56)	30 (3.86%)	12 (3.46)	13 (3.59)	25 (3.53%)
Aglenidae 12 (0.81%)	*Tegenaria sp*	5 (1.40)	7 (1.66)	12 (1.54%)	-	-	-
Araneidae 55 (3.70%)	*Larinia chloris*	7 (1.96)	16 (3.8)	23 (2.96%)	-	-	32(4.52%)
	Larinia sp	-	-		13 (3.75)	19 (5.24)	
Total (10 families)	26 sp. (20 genera)	357	421	778	346	362	708

The monthly population density and percent abundance of total spiders of the collected families per 40 plants started appearing with relatively low levels in association with each of the prey aphids, *A. craccivora* and *R. maidis* (Fig. 3a, b, 4a, b). The monthly density and abundance of the spiders were 40 and 49 spiders per 40 plants in January which represented 11.2 & 11.64% of the total spiders collected on beans (357 &421 spiders) and were 35 and 34 spiders per 40 plants in May which represented 10.12 & 9.39% of the total spiders collected on maize (346 &362 spiders) on the season 2017 and 2018, respectively. Spiders' population density and percent abundance gradually increased in parallel with the increasing population of the associated prey-aphid to reach peaks (P<0.05) in March of 140

and 157 spiders which represented 39.22 and 37.29% of the total collected spiders on beans and 106 and 114 spiders in August which represented 30.64 & 31.49% of the total collected spiders on maize in 2017 and 2018, respectively. This was followed by a decrease ($P<0.05$) in the number of spiders and the associated prey-aphid in the next month of the peak in each season.

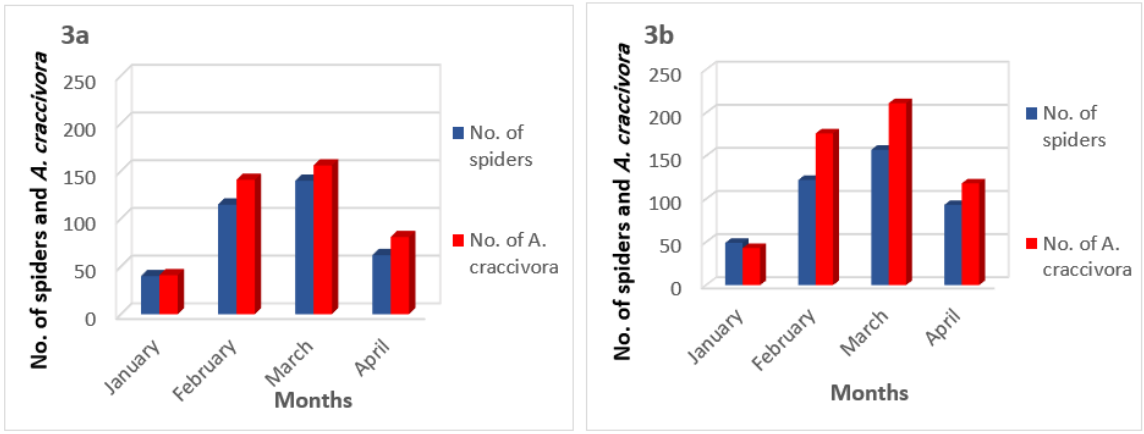

Fig. 3: Population density of spiders and their prey of *Aphis craccivora* on the broad bean crop at Qaha station, 3a. 2017, 3b. 2018.

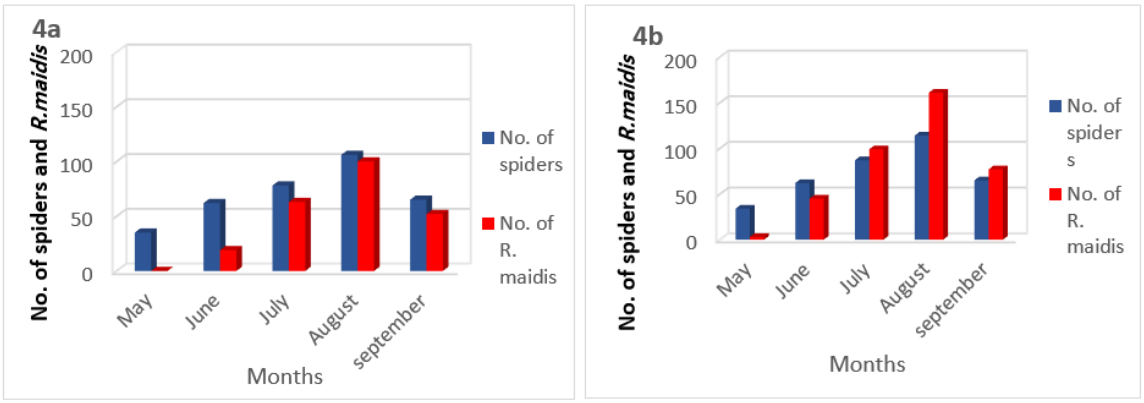

Fig. 4: Population density of spiders and their prey of *R. maidis* on maize crop at Qaha station, 4a. 2017, 4b. 2018.

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II.2. Survey and Abundance of Spider Species of The Collected Families Associated with *Aphis Craccivora* and *Rhopalosiphum Maidis* on Broad Beans and Maize:

Twenty-six spider species belonging to 20 genera and 10 families of order Araneae were associated with the aphids, *Aphis craccivora* and *Rhopalosiphum maidis* on the broad beans and maize crop, respectively at Qaha research station Qalubyia in 2017 and 2018 (Table 1). Two families, Dictynidae and Aglenidae were absent on maize. *Aphis craccivora* on faba beans (Table 1) was associated with 15 genera and 17 species of spiders in 2017 and 16 genera and 19 species in 2018 where *Thyere imperialis* (Salticidae) and *Theridion* sp. (Theridiidae) were added. *Rhopalosiphum maidis* on maize (Table 1) was associated with 15 genera and 18 species in 2017 and 16 genera and 19 species in 2018 where *Plexippus paykulli* (Salticidae) was added.

About 50% of the collected spider genera and species were common associates of the two aphid species and found on each of the broad beans and maize crops in one or both years of study (Table 1). *Thanatus albini* (Philodromidae) followed by *Kushiura aulica* (Threridiidae) were the most abundant common spider species associated with both aphid species on the two crops. *Thanatus albini* associated with *A. craccivora* constituted

16.53 and 18.76 % and *R. maidis* constituted 17.9 and 15.47% of the total spiders collected on the plant host of each aphid species in 2017 and 2018, respectively (Table 1). On the other hand, *Euophrys granulata* (Salticidae) and *Thomisus spinifer* (Thomisidae) were the most abundant specific spider species (Table 1) associated only with *R. maidis* constituting 10.98 & 8.56% and 6.35 & 8.01% of the total collected spiders on maize in 2017 & 2018, respectively. Also, *Euophrys sp*. (Salticidae) and *Misumena sp.* (Thomisidae) were the most abundant specific spider species associated only with *A. craccivora* and constituted 10.36 & 6.41% and 5.88 & 4.75% of the total collected spiders on the broad bean in 2017 & 2018, respectively.

DISCUSSION

Ecological studies revealed that infestation with *A. craccivora* on the broad bean and *R. maidis* on maize crop started with relatively low levels at the beginning of the season of the crop in winter (January) and in summer or late spring (June and May) respectively, in 2017 and 2018. The monthly collected numbers and percent abundance of each and total life stage (s) of *A. craccivora* and *R. maidis* were gradually increased to reach peaks in March (or March and February) and August of the broad bean and maize season, respectively. The peaks of the monthly infestation in each year were followed by a decrease in the number and percent abundance of aphids in the last month of the season of the host plant (April and September). The results of the present study conform to those of Ismail *et al.* (1993), El-Heneidy *et al.* (1998), El-Defrawi et al. (2000) and Abo-zaed (2008). In the present work, peaks were reached when mild and warm mean temperatures of 20.02-22.5˚C and 31.1- 31.3˚C were meteorologically recorded in March and August, respectively. Apparently, these temperatures were suitable for the increase of the population of each of *A. craccivora* and *R. maidis*, respectively. The occurrence of a second peak on the broad bean in February 2017 for *A. craccivora* might be referred to the relatively higher temperatures and relative humidity in February 2017 (15.8˚C &72 RH%) than in 2018 (13.7˚C & 64 RH%). These results are consistent with the findings of Kuroli *et al.* (1988) who attributed the rapid population increase of *A. craccivora* and *A. fabae* on field beans (*Vicia fabae*) to the increase in temperature during a period of 40 days in the year 1986.

Generally, the annually collected total number of each and total life stage (s) of *A. craccivora* and *R. maidis* infested the broad bean and maize crops, respectively, were higher in 2018 than in 2017 and on the broad bean than maize in each year of the present study. The observed increase might have been a result of changes in climatic factors where the monthly temperature and relative humidity were mostly higher in the 2018 maize season of *R. maidis* than in 2017 but interchanged between corresponding months of the two years in the broad bean season of *A. craccivora*. Saleh *et al.* (2009) reported that temperature and relative humidity play an important role in the population changes of *A. craccivora* on the broad bean crop. However, Ali et al. (2013) recorded a highly positive significant correlation between the number of *A. craccivora* on cowpea and both temperature and relative humidity but not on broad beans in Khattara district, Sharkia. Also, the relatively warmer temperatures recorded in some years positively influenced the population development of *R. maidis* in cereals (Barta and Cagan, 2005). Furthermore, Sahito *et al.* (2012) found that the population density of *R. maidis* on maize was positively and significantly correlated with increasing temperature but was negatively correlated to the relative humidity. Biotic factors as parasitoids and predators (El- Heneidy and Abdel-samad, 2001), host plant variety, cultivar and growth stage (Attia *et al.*, 1986; Ismail *et al.*, 1993 and Abdel-Samad & Ahmed, 2006) and different agricultural practices as planting date, intercropping (El-Heneidy *et al.*, 1998; Awadalla *et al.*, 2014 and Abdullah &Fouad,

2016) may contribute to the observed changes in aphid populations. In the present study, the continuous parallel increase or decrease of population densities of each of the two aphid species and its associated spiders pointed to a close relationship between them and most probably to the dependence of spiders on the aphid as prey. This suggestion conforms to findings of a highly significant positive correlation between population densities of the cowpea aphid infestation with that of associated spiders, on Lucerne (Tambe & Kadam, 2015).

In the present study, immatures were the most prevalent life stage in each aphid species and their appearance on the host plant preceded that of adult unwinged (apterous) and winged (alate) females. Immatures showed the highest number and percent abundance of the total monthly and annually collected life stages of each aphid species, which agreed with the findings of Saleh *et al.* (1973) in *A. craccivora* on broad beans in upper Egypt and Darwish (1989) in *R. maidis* on maize in Menofya. On the other hand, the winged females of each of *A. craccivora* and *R. maidis* in the present study were the least abundant life stage and had the lowest number and prevalence throughout the two years of study. The winged females mostly appeared in the latest life stage on the host plant and disappeared during some weeks in the last month of the season. This early disappearance of winged females at the preharvest time of each crop may point to their probable migration. Alate forms of aphids are called migrants and are known to migrate to other suitable plants or crops to complete the life cycle during a process of alternation of generation (Chapman, 1969). Therefore, the alate (winged) females distribute the infestation with aphids and probably infection with the disease to other plants causing the highest damage in the young and flowering crop plants (El-Heneidy &Abbas, 1984 and Attia *et al.,* 1986) which are more susceptible to infestation and its harmful effects. El-Defrawi et al., (2000) found that the alate form of *A. craccivora* was significantly and positively correlated with the incidence of faba bean necrotic virus in Egypt during 1995-1997. In the present work, no adult males or eggs of *A. craccivora* and *R. maidis* were collected during the period of study as many aphid species are viviparous and reproduce parthenogenetically which may continue indefinitely without the intervention of a sexual generation where conditions are continuously favorable as in tropics (Chapman, 1969).

Spiders are considered to be one of the most important predatory groups which can be used as biological control agents for several insects and other important agricultural pests (Toft, 1995, 2005; El-Naggar *et al.,* 1999; El- Erksousy, 2000; El- Erksousy and Fawzy, 2001 and Swaminathan *et al.,* 2015).

In the present study 26 species belonging to 20 genera and 10 families of the order Araneae were identified following Katson (1978) and were associated with *A. craccivora* and *R. maidis* on the broad bean and maize crops in Qaha research station, Qalubyia governorate during 2017 and 2018. The identity and numbers of the collected species and genera of spiders varied in the different seasons of the host plant with a slight increase in their totals in 2018 than in 2017 on each crop. About 50% of the spider species and genera collected in the studied site were common associates with the two aphids on their host plants in one, such as *Theridion sp*., or both years of study such as *Thanatus albini* and *Kuchiura aulica*. Other spiders were specific associates only with one aphid species on its host plant in the site of studies such as *Thomisus spinifer*, *Euophrys granulata* and *Plexippus paykulli* on maize and *Euophrys sp*., *Misumena sp*. and *Thyere imperealis* on the broad bean.

During the period of study, Philodromidae and *Thanatus albini* were the most abundant family and species associated with *A. craccivora* and *R. maidis* on the broad bean and maize crop, respectively which conform to findings of Hendawy and El-Mezayyen (2003) and Abo-zaed (2008). Philodromidae represented 25.64% of the total spiders

collected in the two years of the present study (1486 spiders) followed by Salticidae (19.04%), Theridiidae (18.37%) and Thomisidae (17.83%) then Lycosidae (7.20%) followed by Cheiracanthiidae and Araneidae (3.70%), Linyphiidae (2.35%), then Dictynidae (1.35%) and Aglenidae (0.80%). However, the last two families were not collected in association with *R. maidis* on maize during the period of study. Most of these families were recorded in different governorates, localities and plants including vegetables, fruits, ornamentals and field crops in Egypt (El- Hennawy, 1992; Ghabbour *et al.,* 1999; Hussein *et al.,* 1998; El- Erksousy, 2000; Abo-zaed, 2008 and Abo-zaed *et al.,* 2018).

The monthly total spiders of the collected families in the present work and most of each of these families and species according to Ibraheem (2021), started appearing with relatively low numbers on the broad bean and maize in winter (January) and late spring (May), respectively in 2017 and 2018. In parallel with the associated aphid species, the monthly collected number of spiders gradually increased to reach the maximum on the broad bean and maize at the relatively mild and warm temperature in March and August then both decreased in April and September, respectively in each year. Li & Jackson (1996) found that spiders live in warmer climates and their rate of growth, development and life history traits were affected by a change in temperature.

In a comparison of spiders collected in association with *A. craccivora* on broad beans and *R. maidis* on maize, the total monthly and the annual number of spiders collected on each crop was generally higher in 2018 than in 2017 and on broad beans than maize in each year. Qu *et al.* (1986) reported that spiders of order Araneae are closely correlated with the crop, occurrence of insect pests, farming practice, chemical application and climatic factors. The relatively higher population densities of the spiders collected on the broad bean than on maize might be attributed to the known low quality of *R. maidis* as prey for spiders and other predators (Toft, 2005 and Swaminathan *et al.,* 2015). Also, spiders were found to feed well on the major broad bean small insect pests such as the aphids, *Aphis fabae, Aphis craccivora*, *Myzus persicae*, etc. (El-Heneidy et al. 1998 and Abo-zaed, 2008) and other alternative suitable preys as leaf miners, *Liriomyza trifolii*, *Liriomyza congesta*, *Lyriomyza spp*. (Abdel-Samad & Ahmed 2006).

In the present study, however, the spiders which were collected on the broad bean crop did not include species such as *Thomisus spinifer* which was collected only on maize associated with *R. maidis* at the site of the study. In a laboratory study performed by Ibrahim et al (2021), *Th. Spinifer* refused to feed on *A. craccivora* but was efficiently fed on *R. maidis*. On the other hand, *Thanatus albinis* which was collected on each of the broad bean and maize crops and associated with *A. craccivora* and *R. maidis*, respectively, was efficiently fed on each of the two prey- aphid species but with lower consumption of *R. maidis* which is considered as a low-quality food for spiders (Toft, 1995; 2005). These findings may point to the promising role and importance of the conservation of the naturally associated enemies for use as biocontrol agents.

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ARABIC SUMMARY

التذبذبات الموسمية للمنّ والعناكب المصاحبة على محصولين حقليين في محافظة القليوبية، مصر

منال حسيني محمد [2] ، نوال محمود شنبكي[1] ، آمال إبراهيم أبوزيد[2] ، محمد حسن العرقسوسي[2] ، نادية حلمي أحمد[1] ،آيات يسري[1]

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يعتبر منّ اللوبيا*آفيس كراسيفورا* ومنّ الذرة*روبالوسيفم مايبدس* من الآفات الشائعة على محصولي الفول البلدي والذرة على التوالي والتي تعتبر من المحاصيل الإقتصادية الهامة كغذاء للإنسان ودوابه في مصر. وقد أجريت الدراسة الحالية في محطة بحوث قها بمحافظة القليوبية على مدار سنتين متتاليتين بدأت فيهما الإصابة بالأطوار المختلفة والمجمعة من المنّ على كل من محصولي الفول البلدي والذرة بمستوي منخفض من الأعداد ونسبتها المئوية في الشتاء في شهر يناير وبداية الصيف في شهر مايو (أو يونيو) على التوالي. ثم ارتفع مستوي إصابة الفول بـ*الآفيس كراسيفورا* تدريجيا ليصل الي ذروتين في شهر فبراير ومارس 2017 وذروة واحده في شهر مارس 2018. كذلك ارتفع مستوي إصابة الذرة *بروبالوسيفم مايبدس* ليصل إلى الذروة في شهر أغسطس من كل عام. وقد تبع كل ذروة للإصابة بالمنّ انخفاض ملحوظ في مستويات الإصابة بكل من نوعي المنّ خلال الشهر الأخير من الموسم الزراعي للمحصول. وأوضحت النتائج ان الأطوار غير البالغة هي السائدة بين الاطوار المجمعة في كل شهر وفي كل موسم زراعي كما سادت نسبة الإناث البالغة غير المجنحة على الإناث المجنحة في كل من نوعي المنّ. وكان العدد الكلي لما تم جمعه من كل من أطوار *الآفيس كراسيفورا وروبالوسيفم مايبدس* أعلي في 2018 عنه في 2017 لكل من محصول الفول البلدي والذرة.

تم جمع 26 نوع من العناكب المصاحبة لنوعي المنّ تنتمي الي 20 جنس و10 عائلات من رتبة آراني من على محصولي الفول البلدي والذرة في محطة بحوث قها بمحافظة القليوبية بمصر على مدار سنتين متتاليتين 2017 و2018. وقد مثّل ما يقرب من 50% من الأنواع المجمعة عناكب مشتركة مصاحبة لكل من نوعي المنّ وتم جمعها من على كل من المحصولين. وعامة بدأ ظهور العناكب من العائلات المصاحبة لكل من نوعي المنّ على الفول البلدي والذرة في شهر يناير ومايو على التوالي بأعداد قليلة نسبيا زادت تدريجيا بموازاة الزيادة في مستوي الإصابة بالمنّ المصاحب ليصلا إلى الذروة معا في شهر مارس وأغسطس تم ينخفض كلاهما عند نهاية موسم المحصول في إبريل وسبتمبر على التوالي في كل عام من الدراسة.