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Effect of biotic and abiotic factors on *Rhopalosiphum maidis* (Hemiptera: Aphididae) populations in corn fields at Sohag Governorate, Egypt.

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Abstract:

Abundance and fluctuation of *Rhopalosiphum maids* (Fitch) (Hemiptera: Aphididae) and its predatory insects was studied on both sorghum (*Sorghum bicolor* L.), maize (*Zea mays* L.) and their intercropping of both crops related weather factor through the two plantation dates of 15th June and 15th July for the two successive seasons of 2019 and 2020, respectively. Regression and correlation analysis between the aphid and predator densities were carried out. Nine predacious species were collected from corn fields, these species included: Four coleopterous, i.e. *Coccinella undecimpunctata*. (L.) , *Scymnus pallidivestis* Mulsant, *Stethorus gilvifrons* Mulsant (Coccinellidae) and *Paederus alfierii* Koch (Staphylinidae), two hemipterous *Orius albidipennis* (Reuter) and *O. laevigatus* Fieber (Anthocoridae), dipteran syrphid hover flies, *Xanthogramma aegyptium* Wied. and *Sphaerophoria flavicauda* Zett. (Syrphidae) and Neuropteran *Chrysoperla carnea* (Stephens) (Chrysopidae).

Introduction

Sorghum plants *Sorghum bicolor* L. is an important cereal crop worldwide that is widely cultivated for food, fiber, forage, ethanol, and sugar production (Andy, 2007 and Liu *et al.* , 2009). In Egypt, more than 70% of cultivated area with sorghum is in Upper Egypt, i.e. Assiut, Sohag and Fayoum Governorates, (FAO, 2012). Furthermore, maize (*Zea mays* L.) is one of the principal cereal crops. Egypt represents the third place for production at the level of the African continent (Abd El-Fatah *et al.* , 2015). It is the most important source of food for livestock and poultry. It is also used for human food alone or mixed with wheat flour for bread making. It is a major component in several industries such as corn oil and starch (Nagarjuna *et al*., 2015). The abundance of pests in maize, sorghum plants and the intercropping between them at earlier and late plantations were studied by many authors such as Daware *et al*. (2004) and Maluleke *et al*. (2005).

Piercing sucking insect pests especially aphids are considered as one of the most serious pest infesting sorghum crops, aphids affect cereal by direct feeding on plants, and or by transmitting virus (El-Gepaly, 2007 and Youssef, 2013). Populations of aphids, *Rhopalosiphum maids* (Fitch) (Hemiptera: Aphididae) were significantly affected by temperature and relative humidity (Farag *et al*.,

1992). Pfannenstiel and Yeargan (2002) and Musser *et al*. (2012) mentioned the predators collected in the different corn fields. Predators were present in association with both aphids the dominant foliar-feeding insects on sorghum, *R. maidis* and *S. graminum* and their numbers oscillated during the season in Texas, predators did not suppress increase in numbers of *S. graminum* in late July and August (Archer *et al*., 1990). Several studies dealt with the susceptibility of corn to different insect pests (El-Mandarawy *et al*. , 2000; Muhammad *et al*. , 2010 and Babu *et al*. , 2017).

Therefore, the present work is conducted to monitor aphids, *R. maids* inhabiting corn field in Sohag Governorate, Egypt and their population dynamics in relation to weather factors.

Materials and methods

The population fluctuation of *R. maids* on maize (*Z. maize*), sorghum (*S. bicolor*) and the intercropping of both crops were recorded while other species of pests have been neglected due to their occurrence by few numbers. An area of half feddan was divided into 9 plots cultivated at Shandaweel Research Station, Sohag Governorate, Egypt, during the summer seasons 2019 and 2020. Maize variety "Single Hybrid 10 (S.H. 10)" and Sorghum variety "Dorado" and them intercropping was planted in two plantations; the first plantation date on 15th June and the second one on 15th July throughout both seasons. Each tested cultivar was represented by three replicates which were arranged in a randomized complete block design. The experimental area was kept free from any pesticide treatments.

1. Estimation of aphid numbers:

To estimate the infestation of *R. maids* individuals, samples of ten plants /plot from each variety were randomly picked at weekly intervals started after two weeks plant age until the end of this experiment. aphids infested plants were counted and collected in a bag, then transferred to the laboratory in the same day to identify the species. The daily mean of minimum, maximum temperatures and relative humidity %, were obtained from the meteorological records of Central Laboratory for Agriculture Climate, Agriculture Research Center at Dokki, Egypt.

2. Natural enemies:

Insect predators were counted by either direct counts from ten randomly chosen plants /plot or yellow sticky cards were placed in the fields to attract the predators. Predators were collected and preserved for identification in tubes containing 70% ethyl alcohol.
Identification of these species carried out by Dr. Ayman Mohyieldeen (Department of Taxonomy, Plant Protection Research Institute, ARC, Giza, Egypt).

3. Statistical analysis:

Statistical analyses were performed using ANOVA and mean values were separated by the least significant difference (L.S.D.) procedure (Snedecor and Cochran, 1980) at P = 5%. To find the differences between seasonal mean numbers of tested pest on investigated maize and sorghum varieties

Results and discussion

1.Population dynamics of *Rhopalosiphum maids* on corn fields population*:*

Fluctuations in the population density of *R. maidis* inhibiting maize, sorghum and the intercropping of both crops sown in two different dates during two successive seasons 2019 and 2020 at two different planting dates 1st plantation on 15th June and 2nd plantation on 15th July, respectively illustrated in (Figure 1).

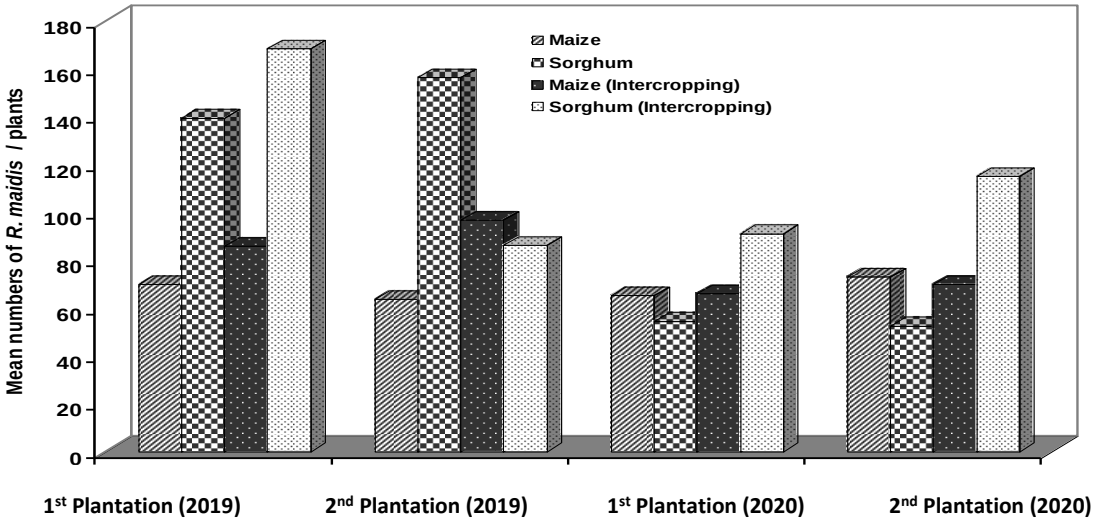

Figure (1): Mean number of *Rhopalosiphum maids* / plant from maize, sorghum and the intercropping plots on two planted dates (15th June and 15th July) in the seasons of 2019 and 2020, at Sohag Governorate.

On the 1st plantation at the season of 2019, for the sole plots, the occurrence of *R. maidis* began from the 2nd week of July. In sole plots, the mean numbers of aphids increased gradually reaching its peak of 231.67 insects/maize plant on 22nd August and 492.33 insects/sorghum plant on 29th August and decreased to reach its minimum 56.33 insects/maize plant and 147.67 insects/sorghum plants on 3rd October. For the intercropping plots, the peaks of aphids reached to 252 insects/ plant on 19th September in maize and 544.67 insects/plant on 29th August in sorghum (Figure 2).

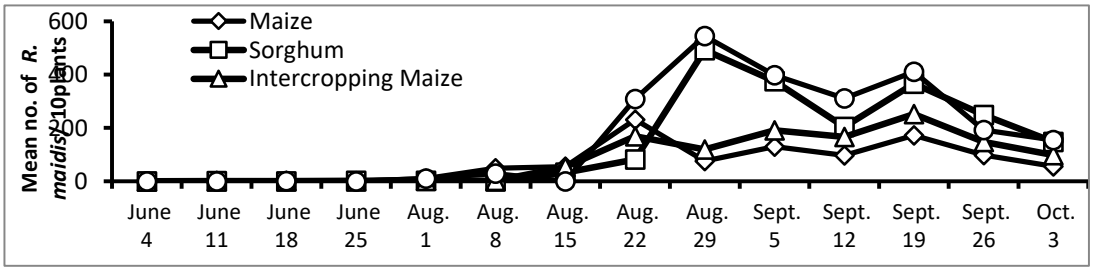

Figure (2): Fluctuation of *Rhopalosiphum maids* collected from maize, sorghum and the intercropping of both crops on Sohag Governorate during 2019 season and 1st plantation 15th June.

While in the second plantation, *R. maidis* started to appear on 8th August and 15th August for sole plots of maize and sorghum, respectively. Also, in the intercropping plots it began for both on 22nd August, at season of 2019. The numbers of insects reached its maximum on 3rd October in sole plots (188.00 and 156.67 insects/ plant of maize and sorghum, respectively) and on 12th September (205.33 insects/ plant) and on 19th September (271.33 insects/ plant) in the intercropping maize and sorghum plots, respectively (Figure 3).

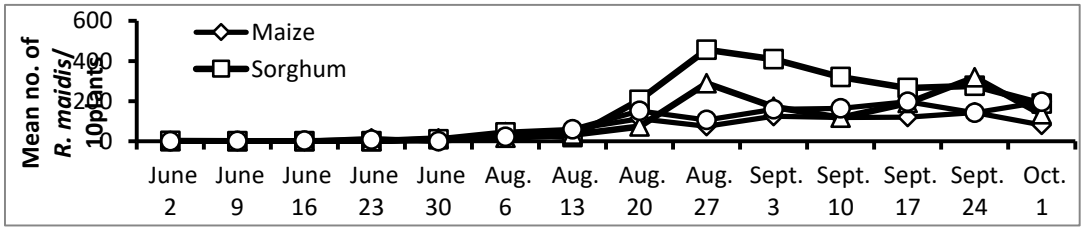

Figure (3): Fluctuation of *Rhopalosiphum maids* collected from maize, sorghum and the intercropping of both crops on Sohag governorate during 2019 season and 2nd plantation 15th July.

The mean numbers of *R. maidis* increased in the intercropped of both crops than those of the monoculture plots of the same plant, during the 1st and 2nd plantation at season 2019 (Figure 4)

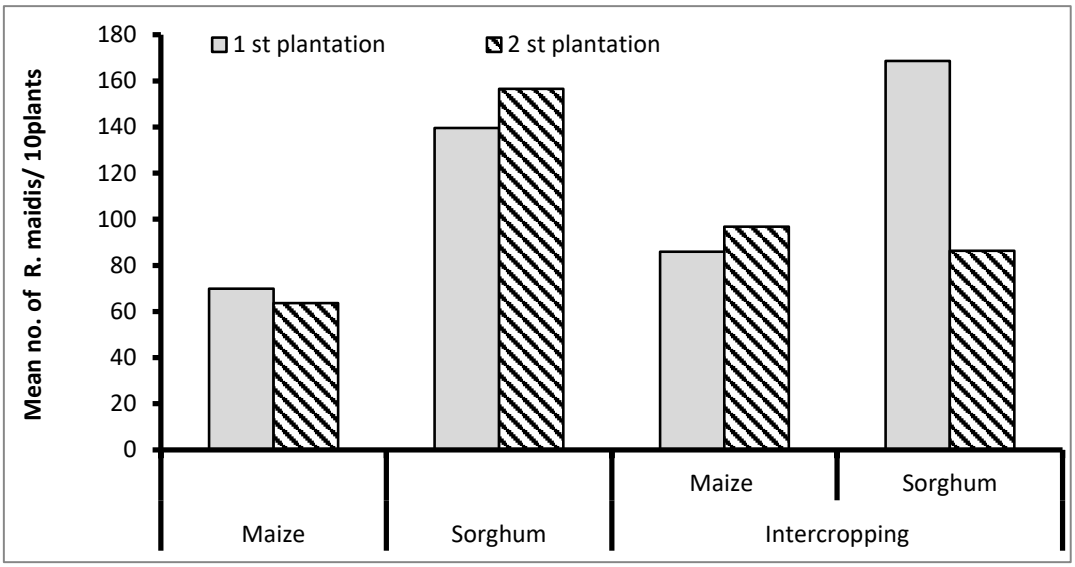

Figure (4): Mean of population fluctuation of *Rhopalosiphum maids* throughout the 1st and 2nd plantation (15th July and 15th June) through the season 2019 on Sohag Governorate.

Meanwhile, 1st plantation at the season of 2020, the aphid occurred from 23rd July to early October in sole maize plots, intercropping maize plots and sole sorghum plots, but in the intercropping sorghum plots it appeared from 9th July to early October. Aphids increased gradually reaching their climax of 143 individuals/plant on 24th September and then decreased to be 80.33 individuals/plant in early October in sole maize plots. In addition, aphids peaked on 27th August, 24th September and 17th September (456, 317.67 and 197 individuals/plant, respectively) in the monoculture sorghum and the intercropping of both crops, respectively (Figure 5).

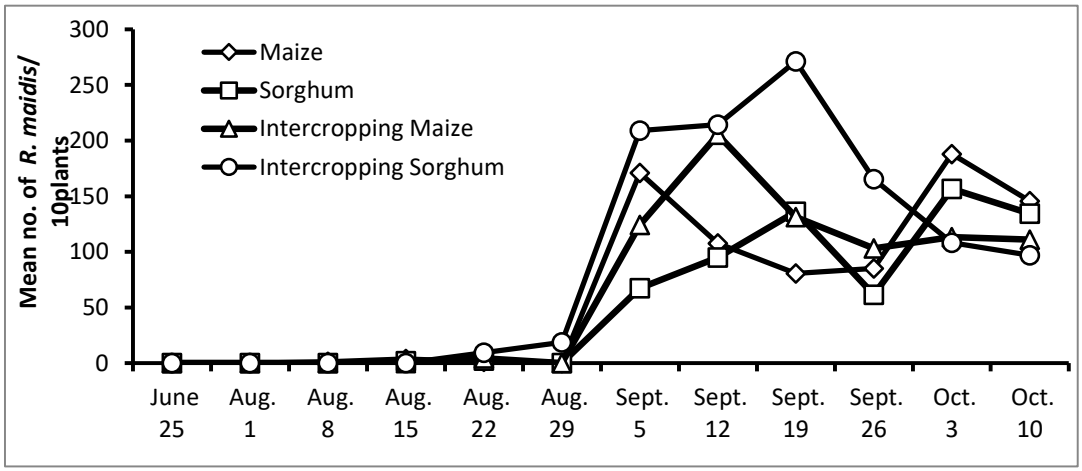

Figure (5): Fluctuation of *Rhopalosiphum maids* collected from maize, sorghum and the intercropping of both crops on Sohag Governorate during 2020 season and 1st plantation 15th June.

In 2020 at 2nd plantation, aphids began to appear on 6th August for the sole and intercropped systems. It maximized on 24th September (182.33

insects/ plant) in sole maize, on 10th September (158.00 insects/ plant) in the sole sorghum plots and on 3rd September (268.33 and 216.67 insects/ plant) on 10th September for the intercropped of both crops respectively, (Figure 6).

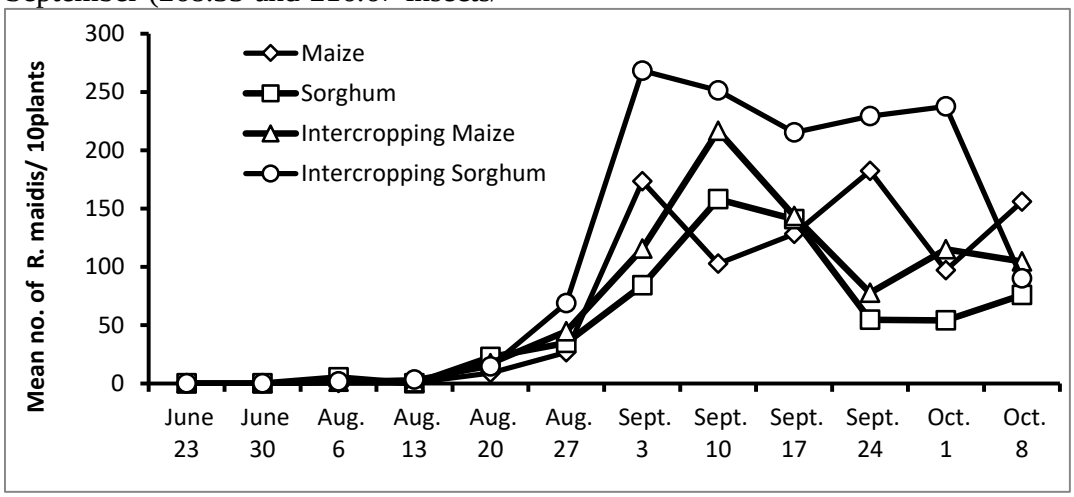

Figure (6): Fluctuation of *Rhopalosiphum maids* collected from maize, sorghum and the intercropping of both crops on Sohag Governorate during 2020 season and 2nd plantation 15th July.

The mean numbers of *R. maidis* increased in the intercropped plots than those of the monoculture plots of the same plant, during the 1st and 2nd plantation of the season 2020 (Figure 7).

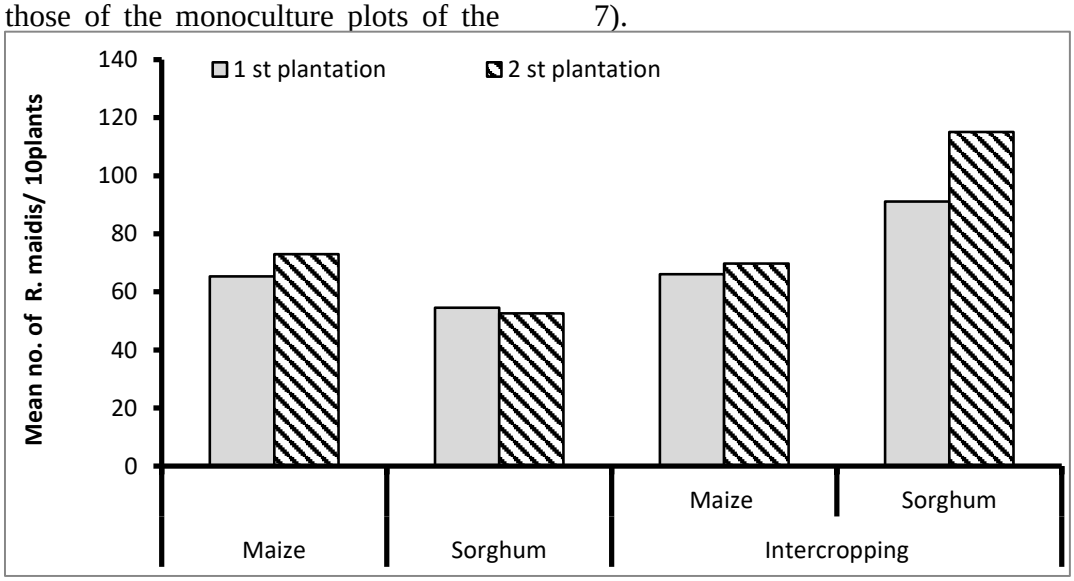

Figure (7): Mean of population fluctuation of *Rhopalosiphum maids* throughout the 1st and 2nd plantation (15th July and 15th June) of the season 2020 on Sohag Governorate.

These results agree mostly with those of Archer *et al*. (1990) who found that the highest densities of the aphid (about 200 aphids / plant) occurred on sorghum planted on first of May or in June. Borade *et al*. (1993) noticed that the least percentage of infected leaves (15.3%) was on the sorghum sown in the last week of September**.** Ibrahim *et al*. (1995) observed that the corn leaf aphid, *R. maidis* was reduced to 21 aphids/leaf in 2: 2 maize: cowpea intercrop as compared to 34 aphids/leaf on sole maize. Gad-Elrab (1997) indicated that there was significantly more infestation by *R. maidis* when sorghum intercropped with soybean than on sorghum grown alone. Kuroli

(2002) found that the average number of aphids was 24.99 per plant. *R. padi* and *M. dirhodum* were the most dominant species.

2. Effect of abiotic factors (Maximum, minimum temperatures and relative humidity) on the abundance of *Rhopalosiphum maids*:

Simple correlation coefficients presented in Table (1) showed variable relationships between weather factors and *R. maidis* density on maize, sorghum and their intercropping plantations during 2019 and 2020 seasons. The partial regression analysis in terms of regression (b) and explained values (E.V. %) are also summarized in Table (1). Regression values showed that the increasing of minimum night and daily maximum temperatures was almost decreased the aphid numbers, however, the increase of R.H. % showed a positive or negative reduction in the aphid density.

Table (1): Simple correlation and partial regression coefficient of three weather factors on the population density of *Rhopalosiphum maids* through tow plantation dates in 2019 and 2020 seasons, at Sohag Governorate.

Seasons	Plantations	Factors		Maize			Sorghum			Intercropping Maize			Intercropping Sorghum		
				R	b	E.V.%	R	b	E.V.%	r	b	E.V.%	r	B	E.V.%
2019	1st plantation	Temperature	Max.	-0.394	-9.159	39.63	-0.223	-6.777	25.40	-0.358	-10.950	49.16	-0.337	-19.447	31.04
			Min.	-0.380	-15.480		-0.335	-17.558		*-0.557	-29.537		-0.280	-30.050	
		Mean RH.%		0.444	14.870		0.345	41.639		0.371	13.828		0.449	43.997	
	2nd plantation	Temperature	Max.	0.069	-5509.000	66.67	-0.060	6.818	69.32	-0.151	3.468	25.87	-0.209	-1.185	16.58
			Min.	*-0.566	-11048.00		*-0.758	-23.053		-0.483	-20.572		-0.399	-18.940	
		Mean RH.%		-0.359	-1038.830		-0.479	-1.070		-0.169	12.641		-0.156	6.670	
2020	1st plantation	Temperature	Max.	-0.319	-5.883	65.41	-0.345	-13.419	54.64	-0.149	-1.166	54.12	-0.238	-7.541	78.78
			Min.	*-0.753	-22.595		*-0.647	-66.897		*-0.707	-48.634		*-0.855	-37.091	
		Mean RH.%		-0.128	-1.356		0.080	15.552		-0.025	10.861		-0.260	-5.560	
	2nd plantation	Temperature	Max.	-0.373	8.834	70.48	*-0.696	-10.079	65.97	*-0.709	-11.440	71.92	-0.465	0.069	62.07
			Min.	*-0.808	-42.847		*-0.660	-13.072		*-0.739	-23.217		*-0.742	39.629	
		Mean R. H.%		-0.167	0.550		-0.011	17.712		-0.094	14.292		-0.029	31.688	

r= Simple correlation **b= Partial regression coefficient** **E.V.%= Explained variance**

Results of *R. maidis* occurrence harmony with Ahmed (1996) who observed that *R. maidis* started early July and continued up to late September. Sorghum plantation on 10th June showed the greatest population of *R. maidis*. Early plantation on 20th May received the lowest population for pests. Kuroli (2002) observed that the population of the aphids first peaked in July. In September, the number of aphids began to increase, resulting in a second population peak in October. Finally, Hanafy (2005) stated that *R. maidis* attacking sorghum in Upper Egypt, began to build up its population at late of July and early August, then, it decreased gradually till the end of the growing season. This may be due to the lower temperature at the beginning of September and because of the maturity of maize plants that become unsuitable for aphid feeding.

3. Effect of biotic factors (Predacious insects) on the abundance of *Rhopalosiphum maids*:

3.1. Predacious insect species:

Data presented in Table (2) summarize the number of predators collected from maize, sorghum and their intercropping of both crops at the 1st and 2nd plantation date of the two seasons 2019 and 2020. Nine predacious species were collected during experimental period. These species included: Four coleopterous, i.e. *Coccinella undecimpunctata* (L.) , *Scymnus pallidivestis* Mulsant, *Stethorus gilvifrons* Mulsant (Coccinellidae) and *Paederus alfierii* Koch (Staphylinidae), two hemipterous *Orius albidipennis* (Reuter) and *O. laevigatus* Fieber (Anthocoridae), dipteran syrphid hover flies, *Xanthogramma aegyptium* Wied. and *Sphaerophoria flavicauda* Zett. (Syrphidae) and Neuropteran *Chrysoperla carnea* (Stephens) (Chrysopidae). The linear regression coefficient of *R. maidis* population and each of the collected predators from maize, sorghum and intercropping of both crops were summarized in the two plantations and seasons are shown in (Tables 2).

Population density of *R. maidis* inhibiting maize, sorghum and the intercropping of both crops sown in two different dates during two successive seasons 2019 and 2020 at two planting dates, on 15th June and 15th July showed that, The mean numbers of *R. maidis* increased in the intercropped of both crops than those of the monoculture plots of the same plant, during the 1st and 2nd plantation at the seasons 2019 and 2020. Regression values showed that the increasing of minimum night and daily maximum temperatures was almost decreased the aphid numbers, however, the increase of R.H. % showed a positive or negative reduction in the aphid density.

Nine predaceous species were collected during experimental period. These species included: Four coleopterous, i.e. *C. undecimpunctata*, *S. pallidivestis*, *S. gilvifrons* and *P. alfierii* , two hemipterous *O. albidipennis* and *O. laevigatus* , dipteran syrphid hover flies, *X. aegyptium* and *S. flavicauda* and Neuropteran *C. carnea* .

Table (2): Linear regression coefficient of the different predator species on the population density of aphids, *Rhopalosiphum maids* infesting maize, sorghum and the intercropping of both crops on the 1st and 2nd plantation dates in of 2019 and 2020 seasons, at Sohag Governorate.

Plantations	Predator Species	Maize		Sorghum		Intercropping Plots	
		r	b	R	b	R	b
Seasons 2019							
1st plantation	***Coccinella undecimpunctata***	0.505	0.010	0.672	0.010	0.671	0.006
	***Scymnus* spp.**	0.397	0.010	0.406	0.004	0.267	0.004
	***Orius* spp.**	0.534	0.054	0.561	0.017	0.698	0.032
	Syrphids	0.466	0.019	0.562	0.018	0.557	0.012
	Paederus alfierii	0.212	0.002	0.440	0.002	0.115	0.000
	Chrysoperla carnea	0.438	0.008	0.509	0.004	0.606	0.005
	Total No.	**0.549**	**0.102**	**0.629**	**0.056**	**0.667**	**0.064**
2nd plantation	***Coccinella undecimpunctata***	0.685	0.015	0.411	0.016	0.909	0.019
	***Scymnus* spp.**	0.289	0.013	0.371	0.013	0.575	0.021
	***Orius* spp.**	0.546	0.054	0.649	0.041	0.951	0.068
	Syrphids	0.400	0.007	0.892	0.084	0.917	0.029
	Paederus alfierii	0.613	0.006	0.912	0.010	0.613	0.002
	Chrysoperla carnea	0.301	0.002	0.002	0.000	0.111	0.001
	Total No.	**0.416**	**0.073**	**0.559**	**0.120**	**0.964**	**0.141**
Seasons 2020							
1st plantation	***Coccinella undecimpunctata***	*0.674	0.016	*0.920	0.008	*0.795	0.011
	***Scymnus* spp.**	*0.551	0.017	*0.551	0.006	*0.673	0.016
	***Orius* spp.**	*0.858	0.114	*0.612	0.023	*0.779	0.069
	Syrphids	0.490	0.017	0.484	0.019	*0.650	0.033
	Paederus alfierii	0.291	0.003	0.291	0.001	0.376	0.002
	Chrysoperla carnea	*0.692	0.022	*0.627	0.009	*0.780	0.027
	Total No.	***0.861**	**0.188**	***0.705**	**0.067**	***0.790**	**0.147**
2nd plantation	***Coccinella undecimpunctata***	*0.773	0.014	*0.751	0.027	*0.921	0.015
	***Scymnus* spp.**	*0.726	0.040	0.510	0.027	0.538	0.023
	***Orius* spp.**	*0.783	0.092	*0.886	0.058	*0.951	0.066
	Syrphids	0.410	0.006	*0.847	0.120	*0.828	0.032
	Paederus alfierii	*0.577	0.004	*0.793	0.009	*0.811	0.005
	Chrysoperla carnea	0.485	0.006	0.403	0.013	0.489	0.005
	Total No.	***0.837**	**0.159**	***0.938**	**0.253**	***0.854**	**0.130**
*** Significant effect**							

References

Abd El-Fatah, H.Y.; Mohamed, E.A.; Hassan, M.B. and Mohamed, K.A. (2015): An economic analysis for maize market in Egypt. Middle East J. Agric. Res. , 4: 873-878.

Andy, C. (2007): Managing cover crops profitably, 3rd ed. sustainable agriculture network, Beltsville, MD. P. 106-111.

Archer, T.L.; Losada, J.V. ; Bynum, E.D. and Ves Losada, J.C. (1990): Influence of planting date on abundance of foliage-feeding insects and mites associated with sorghum. J. Agric. Entomol., 7(3): 221-232.

Babu, S.R.; Meena, P.K. and Dudwal, R. (2017): Population dynamics of major defoliators (semiloopers and tobacco caterpillar) in soybean crop. Legume Research, 40 (1): 183-186.

Borade, B.V.; Pokharkar, R.N. ; Salunkhe, G.N. and Gandhale, D.N. (1993): Effects of dates of sowing on leaf sugary malady on rabi sorghum. Journal of Maharashtra Agricultural Universities, 18(1): 124-125.

Daware, D.G.; Giri, A.N. and Awaz, H.B. (2004): Effect of different intercrops in cotton on the incidence of cotton bollworms. Journal of Maharashtra Agricultural Univ., 29(2): 229-231.

El-Gepaly, H.M.K.H. (2007): Studies on some natural enemies of certain pests infesting sorghum and corn plants in Sohag Governorate. M.Sc. Thesis, Fac. Agric., Minia University .

El-Mandarawy, M.; Abdel Samae, S.A. and El-Naggar, M.A.Z. (2000): Efficacy of *Bacillus thuringiensis* alone or in combination with chemical insecticides on *Sesamia cretica* Led. and its associated natural enemies in maize field. Egypt. J. Zool. 35: 135-149.

FAO (2012): Statistical yearbook. World Food and Agriculture. ISSN: 2225-7373. (www.fao.org/publications). pp. 289.

Farag, A.I.; Abdelfattah, M.I.; Abdelrahim, M.M. and EL-Naggar, M.A.Z. (1992): Seasonal fluctuations of certain insect pests infesting maize in relation to some weather factors. Bull. Ent. Soc. Egypt., 70: 71-80.

Gad-Elrab, M.l.E. (1997): Entomological studies on Soybean, Maize and Sorghum under different intercropping systems in Upper Egypt. Ph.D. Thesis. Fac. of Agric. Minia University.

Hanafy, H.A.F. (2005): Evaluation of some pesticide alternatives on two key pests of Maize and Sorghum. M. Sc. Thesis. Fac. of Agric. Assiut University.

Ibrahim, I.L.; Ali, M.A.; El-Khouly, A.S. and Naga, S.A. (1995): Population census of Aphidophagous insects under different intercropping systems of maize and cowpea. Bull. Ent. Soc. Egypt., 73: 177-184.

Kuroli, G. (2002): Aphid flight and change in abundance of maize pests. Acta Agronomica Ovariensis, 44(1): 57-68.

Liu, G.S.; Zhou, Q.Y. ; Song, S.Q. ; Jing, H.C. ; Gu, W.B. ; Li, X.F. and Su, M. (2009): Research advances into germplasm resources and molecular biology of the energy plant sweet sorghum. Chin. Bull. Bot., 44(3): 253–261.

Maluleke, M.H.; Addo-Bediako, A. and Ayisi, K.K. (2005): Influence of Maize/Lablab Intercropping on Lepidopterous Stem Borer Infestation in Maize, Journal of Economic Entomology, 98(2): 384–388.

Muhammad, A.Z.; Muhammad, A.S.; Muhammad, A.R. ; Hamza, A.; Hayat, A. and Khan, A. (2010): Effect of temperature and relative humidity on population dynamics of some insect pests of maize. Pak. J. life Soc. Sci., 8(1):16:18.

Musser, F.R.; Nyrop, J.P. and. Shelton, A.M (2004): Survey of predators and sampling method comparison in sweet corn. J. Econ. Entomol., 97(1): 136-144.

Nagarjuna, B.; Manjunath, M. and Latha, M. (2015): Studies on varietal screening of maize hybrids against stem borer, *Sesamia inferens* (Walker). Journal of Eco-friendly Agriculture, 10(1): 64-66.

Pfannenstiel, R.S. and Yeargan, K.V. (2002): Identification and diel activity patterns of predators attacking *Helicoverpa zea* (Lepidoptera: Noctuidae) eggs in soybean and sweet corn. Environ. Entomol., 31(2): 232-241.

Snedecor, G.W. and Cochran, W.G. (1980): Statistical methods, 2nd ed. The Iowa State University Press, Ames, Iowa.

Youssef, M.A.M. (2013): Ecological studies on certain insects associated with sorghum crop in Upper Egypt. M.Sc. Thesis, Fac. Agric., Minia University.