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SOME FACTORS AFFECTING CEREAL APHID POPULATIONS (HOMOPTERA: APHIDIDAE) INFESTING WHEAT PLANTS, ASSIUT, EGYPT

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The present investigations were oriented to elucidate the effect of some factors (biotic and abiotic) on the population of cereal aphid species infesting wheat plants at Assiut. Data obtained indicated that aphids appeared on wheat plants during the first half of January when the plants were in the tillering stage. The population attained a peak of abundance during last week of February when the plants were in the flowering stage, correlated with plant age 77 days. The disappearance of the aphids from the field was recorded during the end of March when the plants were in the ripening stage. The multiple regression analysis show that the eight selected variables (plant age, max. and min. temperature, max. and min. relative humidity, effective temperatures (day-degrees), predators and parasitoids) were together responsible for about 82% of the aphid populations during wheat growing season. Plant age seemed to be responsible for about 30.61 and 29.15% of the variability in the infestation with cereal aphid complex during 2014 and 2015, respectively. Plant age came in the first order with a relative efficiency of the total efficiency (8 variables). Natural enemies (parasitoids and predators) seemed to be responsible for about 17 and 8% during 2014 and 14.26 and 9.06% during 2015, season of the total efficiency. Rating sort of co-efficient of determination indicated that biotic factors came in the two and three degrees for 2014 and 2015 growing seasons. It was found that maximum air temperatures were found to be responsible for about 7.85 and 8.72% during 2014 and 2015 growing seasons of the variability of cereal aphids infesting wheat plants. The minimum relative humidity was found to be in the lowest degree.

Key words: Factors, cereal aphids, wheat plants, Egypt.

INTRODUCTION

In Egypt, wheat occupies an important belt among the cultivated area during the winter season. Cereal aphids are a serious problem in wheat growing (Yadev 2003). Several authors studied the population dynamics of these pests and their role in yield reduction (Shahzad *et al*. 2013 and Ahmed *et al*. 2015). In Egypt, Abdel-Rahman and Ali (2003) indicated that temperature ranged from 17º to 20ºC and R.H. ranged from 45 – 55% are the most favorable conditions for development and multiplication of

cereal aphids in the field. Ali and Darwish (1990) suggested that the maximum population levels of these pests occurred in wheat field within about 75 days from the beginning of the year.

The present work was carried out to clarify the correlation between cereal aphid populations on wheat plants and some factors between which autocorrelations. Also, the present work may give an accurate data might be applied in an Integrated Pest Management (IPM) of wheat plantations in Assiut, Upper Egypt.

MATERIALS AND METHODS

The present studies were undertaken at the experimental farm of Assiut University throughout 2013-2014 and 2014-2015 wheat growing seasons. An area of ca. one feddan was cultivated with wheat variety (Sids 1) normally at 15-November in all cultivated seasons. Regular conventional agricultural practices were normally performed and no insecticides were used during the study period. Aphid numbers (all forms) and the associated natural enemies (predators and parasitoids, (mummies)) were recorded visually on 200 randomly selected seedlings or main tillers, later in the season, when the aphid numbers increased on the plants, the number of examined tillers were reduced to 100 tillers. Four replicates of visual sample were taken weekly from the beginning of January, when the migration of aphids onto the wheat crop, at the stage of tillering or early stem-elongation (ZGS 23-30) from over wintering sites began, and continued through the time when aphid populations declined to low or undetectable levels. Population densities of aphids (No. aphids/tiller) were counted and recorded. Growth stages of wheat were determined according to Zadoks *et al.* (1974). Threshold of development of the cereal aphids (*Schizaphis graminum* (Rondani) and *Rhopalosiphum padi* L.) was 12ºC according to (Hashem *et al*. 2017). Accumulative effective temperature (day-degrees) for the development of cereal aphid populations was calculated according to Madubunyi and Koechler (1974).

Temperature (maximum, minimum) and relative humidity (maximum and minimum), within the inspected periods, were the selected weather factors. Records were obtained from the Meteorological station located (500 m. away from the study site) at the experimental farm of Assiut University. Data were subjected to simple, partial, and multiple correlation by mean of the Advanced Statistical Analysis Package $(ASAP)^{R}$.

RESULTS

1- Aphid species recorded infesting wheat plants:

Survey studies through 2013-2014 and 2014-2015 wheat growing seasons, revealed the presence of four species of cereal aphids(Homoptera: Aphididae) infesting wheat plants. These species were: the oat bird-cherry aphid, *Rhopalosiphum padi* L.; the corn leaf aphid, *Rhopalosiphum maidis* (Fitch); the greenbug, *Schizaphis graminum* (Rondani) and the English gran aphid, *Sitobion avenae* (Fab). Aptera and nymphs of these species were commonly intermixed together at the same location on the wheat plants. Figure (1) showed that *R. padi* and *S. graminum* seems to be the most important cereal aphids infesting wheat plants, as indicated by the highest dominance degrees (%). Meanwhile, the *R. maidis* and *S. avenae* which had low values of dominance is expected to be of little economic importance as they may cause little damage to wheat crop in Upper Egypt.

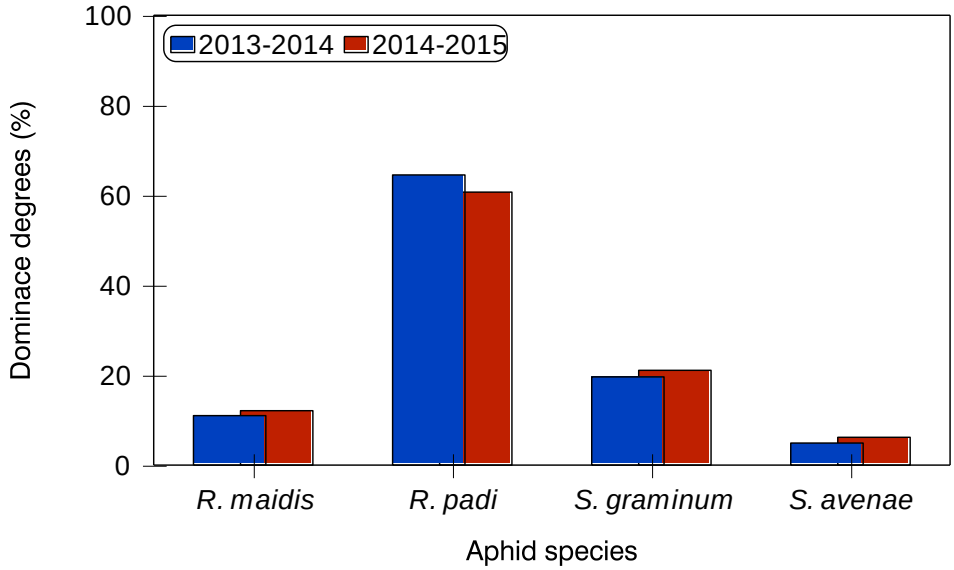


Figure (1): Percentages of cereal aphid species recorded on wheat plants.

2- Natural enemies:

2.1- Predators:

The following predators were found in association with cereal aphids during the study period (2013-2015):

Chrysoperlla carnea Steph, (Chrysopidae: Neuroptera); *Coccinella undecimpunctata* L. (Coccinellidae: Coleoptera); *Nabis* spp.

(Nabidae: Hemiptera); *Orius* spp. (Anthocoridae: Hemiptera); *Paederus alfierii* (Koch) (Staphilinidae: Coleoptera); *Scymnus* spp. (Coccinellidae: Coleoptera); *Syrphus corollae* Fab. (Syrphidae: Diptera) and some unidentified species of true spiders.

It is clear that predators are presented by seven species belonging to five orders as follow: (Coleoptera (three), Hemiptera (two), Neuroptera (one) and Diptera (one). It is obvious that order Coleoptera is presented by fairly good number of species. These predators groups are reported inhabiting wheat plants associated with cereal aphids.

2.2- Parasitoids:

Three species of primary parasitoid species were identified belong to family Aphidiidae: *Aphidius colemani* Viereck; *Aphidius ervi* (Haliday); *Diaeretiella rapae* (McIntosh), and three hyperparasitoid species belong to family Aphelinidae: *Alloxysta* sp; *Pachyneuron* sp, and *Phaenoglyphis* sp

3- Population studies:

2013-2014 Season:

Data in Figure 2 summarize the changes in the population of cereal aphids on wheat plants during 2013-2014 season. Data show that aphid began to appear in the field in relatively low numbers (2.10 individuals / tiller) during the first half of January when the plants were in the tillering stage. This period coincided with a maximum temperature of 21.00^{o}C, a minimum temperature of 7.28^{o}C, a maximum RH of 66.86% and a minimum RH of 12.71%. Thereafter, the population density of the pest fluctuated in scarcely numbers to attain the peak (73.92 aphids / tiller) during the third week of February when the plants were in the middle of booting stage and beginning of flowering. The recorded weather factors in this period were 28.14^{o}C and 9.28^{o}C for max. and min. temperatures and 73.71% and 8.71% for max. and min. RH., respectively. Then the number of cereal aphids vanished during the end of March.

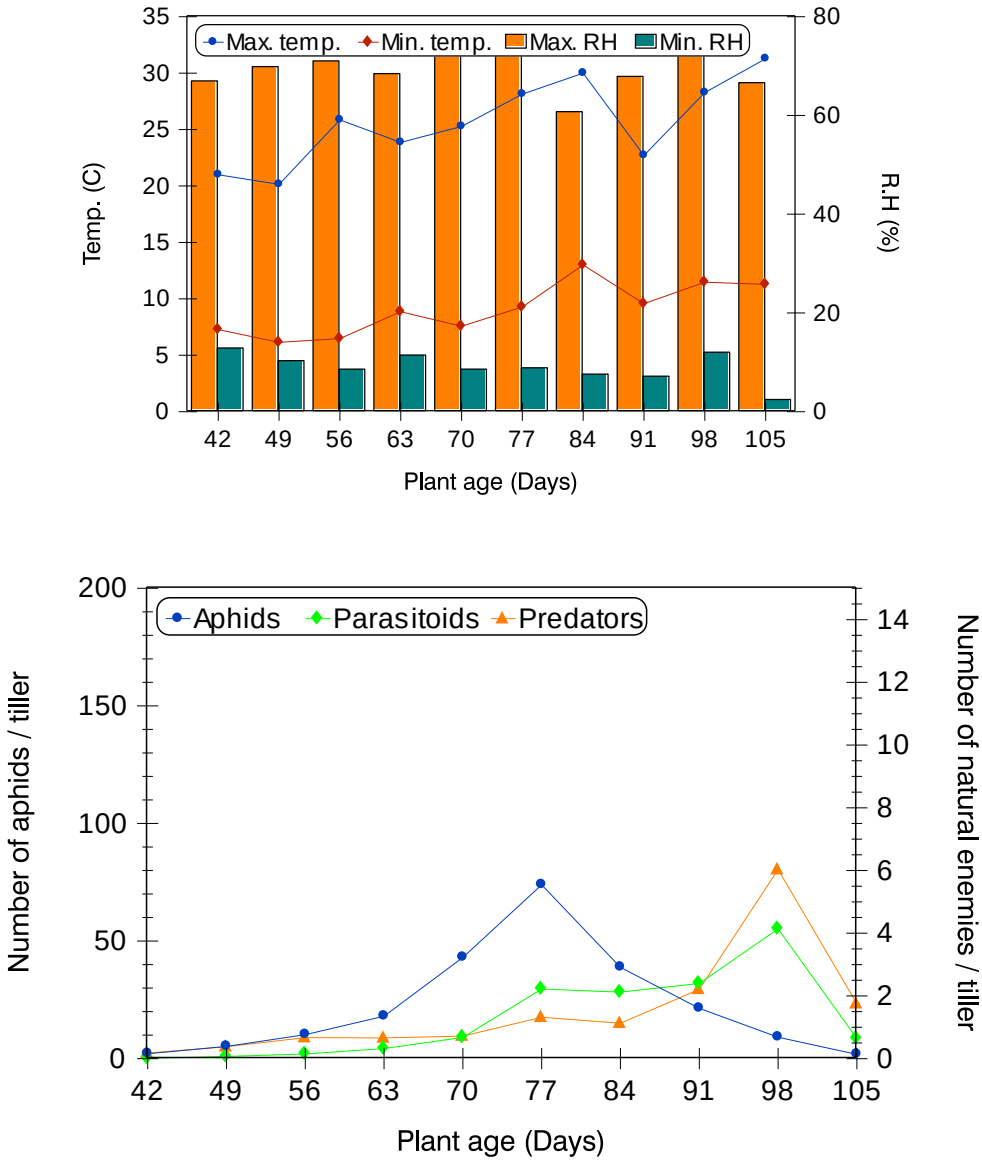


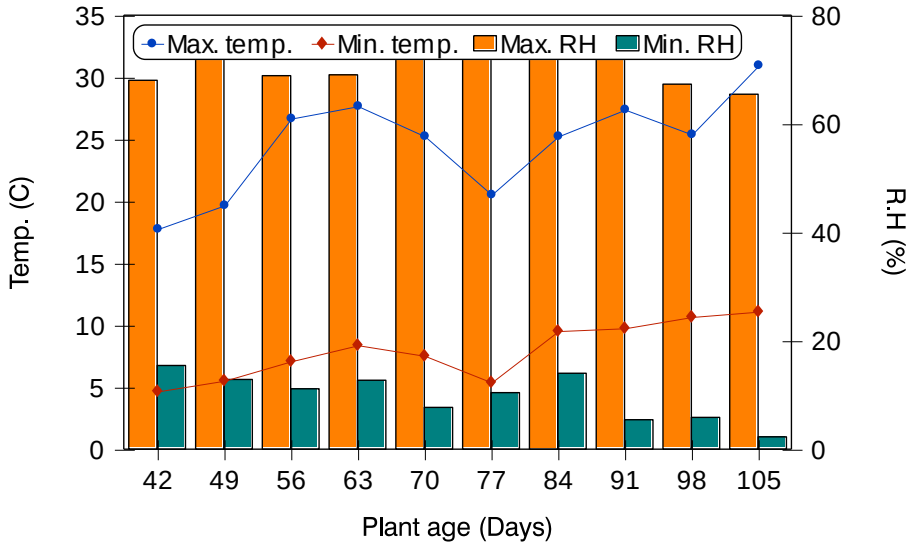
Figure (2): Population of cereal aphid complex and their natural enemies in relation to certain weather factors in a wheat field during 2013-2014.

2014-2015 season:

Data in Figure 3 show the population of cereal aphids infesting wheat plants during 2014-2015 season.

Population levels and trend were nearly similar as in 2014 season. The pest had one distinct peak during the pest activity. Aphids were first appeared in scarcely numbers during the second week of January when the plants were in the tillering stage. Then, the number increased gradually forming the peak of 177.80 individuals / tiller during the second half of February (booting stage). The recorded max., min. temperatures were 20.57^{o}C; 5.43^{o}C and the max., min. RH were 72.00% and 10.43%, respectively. A decline in the population was observed during the end of March (ripening stage). A lowest level (20 individuals / tiller) was recorded during the fourth week of March (ripening stage). The recorded max., min. temperatures were 31^{o}C, 11.14^{o}C and the max., min. RH were 65.43%, 2.28%, respectively.

The obtained data revealed that the population density of cereal aphids comparatively higher in 2015 season than in 2014 season. The number of aphids during 2015 was nearly two times as much of 2014 season. Generally, the population of the pest began to appear on wheat plants from the beginning of January and developed progressively up to the end of March with distinct peak during the third week of February.



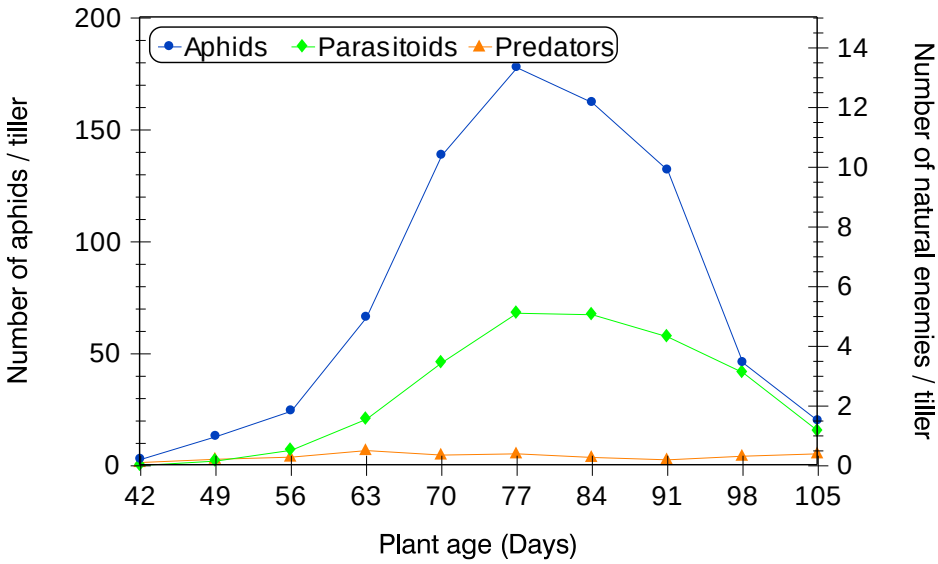


Figure (3): Population of cereal aphid complex and their natural enemies in relation to certain weather factors in a wheat field during 2014-2015.

3- Some factors affecting the population of cereal aphids

The relationship between aphids infestation and some variables was presented in Tables (1 and 2). The studied variables were plant age, natural enemies (predators and parasitoids) and effective temperature (DD) as biotic factors as well as some abiotic factors (air temperatures and relative humidity).

Generally, regardless of the growing seasons data showed that the infestation of wheat by cereal aphids appeared with few numbers during first half of January when the plant age reached about two months. It recorded 2.10 and 2.80 individuals / tiller during 2014 and 2015, respectively. In this time wheat plants were in the tillering stage, temperature ranged from 4.71 to 21.00 ºC and relative humidity ranged from 12.71 to 68.00% (Figures 2 and 3). Parasitoids and predators recorded during this phase 0.18 and 0.01 / tiller during 2014 and 0.11 and 0.01 / tiller during 2015, respectively.

The initial records of the pest were correlated with few numbers of predators and parasitoids. The data revealed also that the population of cereal aphids increased markedly with the progress of wheat plant growth toward vegetative growth and the beginning of flowering. The maximum population of aphids occurred when plants were in the beginning of booting stage. In this point plant age was about 10 weeks.

This period (the end of February and the beginning of March) however, coincided with a maximum temperature ranged from 20.57 to 28.14ºC, maximum RH% ranged from 72.00 to 73.71%. These conditions seem to be the favorable range for the reproduction and multiplication of cereal aphids. However, the rapid increase in this period might be related to suitability of the plants. The data however showed a decline in the pest's population from middle of March where it recorded minimum numbers at the end of March. This period coincided with middle of ripening stage of wheat. The prevailing maximum temperature during March ranged from 22.71 to 31.28ºC, the maximum relative humidity ranged from 60.57 to 74.14%; however the number of predators and parasitoids also increased to high level. However, the eventual decline of cereal aphids population later in the growing season results from a combination of rapid drop in the suitability of the wheat plants and the action of natural enemies of aphids.

3.1- Biotic factors:

3.1.1- Plant age:

Data in Tables 1 and 2 showed that plant age has a coefficient of determination of about 30.61% and 29.15 out of 82.92% and 80.87 of the total efficiency (8 variables). This evidence indicated that about 29.88% of the variability of the infestation of wheat by cereal aphids was due to plant age, regardless of the growing seasons. Tables showed also that the rating sort of the plant age came in number one.

3.1.2- Natural enemies:

Data in Tables 1 and 2 showed that parasitoids and predators seemed to be responsible for about 15.72% and 8.52% out of about 82% of the total efficiency (8 variables). Multi-regression analysis indicated that predators and parasitoids came in the rating sort in number two and three.

3.1.3-Effective temperatures:

Data in Tables1 and 2 showed that the accumulative day-degrees seemed to be responsible for about 6.12% of the population of cereal aphids and came in the rating sort in number six.

3.2- Abiotic factors:

3.2.1- Air temperature and humidity

It was found that the effects of maximum and minimum temperatures on the infestation of wheat plants by cereal aphids have a coefficient of determination of about 8% and 7% out of 82% of the total efficiency (8

variables). This evidence indicated that 8% and 7% of the variability of the infestation was due to maximum and minimum temperature. The rating sort of the maximum and minimum temperature came in number four and five (Tables1 and 2). The maximum and minimum relative humidity was found to be responsible for about 7.01% and 0.32% of the variability of number of cereal aphids infesting wheat during 2013-2014 season and 1.68 and 3.92 during 2014-2015 season, respectively. This evidence seamed to be logic as cereal aphids usually on the underside of leaves and stems, on which they feed and develop, far from the effect of relative humidity in microclimate.

Table (1): Multi-factors affecting fluctuation of cereal aphids infesting wheat plants through 2013-2014 growing seasons.

Factors			Simple correlation	Relative efficiency	Rating
Biotic	Plant age (days)		0.59	30.61	1
	Parasitoids		0.80	17.18	2
	Predators		0.76	7.98	3
	Effective temperatures		0.47	6.12	6
Abiotic	Temp. (ºC)	Max.	0.60	7.85	4
		Min.	0.43	5.22	7
	R.H. (%)	Max.	0.55	7.01	5
		Min	0.70	0.32	8
Co-efficient of determination			82.29		

Table (2): Multi-factors affecting fluctuation of cereal aphids infesting wheat plants through 2014-2015 growing seasons.

Factors			Simple correlation	Relative efficiency	Rating
Biotic	Plant age (days)		0.26	29.15	1
	Parasitoids		0.49	14.26	2
	Predators		0.69	9.06	3
	Effective temperatures		0.78	6.12	6
Abiotic	Temp. (ºC)	Max.	0.15	8.72	4
		Min.	0.35	7.96	5
	R.H. (%)	Max.	0.25	1.68	8
		Min	0.01	3.92	7
Co-efficient of determination			80.87		

DISCUSSION

The present research was designed to evaluate the aphid populations on wheat. Data were recorded from the start of January till the end of March at Assiut, Egypt. Many research workers have been studied the population of cereal aphids on wheat crop (Abd-El-Magid *et al*. 2007, and Ahmad *et al*. 2016). Published information reveals that aphids are serious pests of wheat crop (Sattar 2000 and Helmi and Rashwan 2013). In the present study, the increase in population was gradual from vegetative growth stage (sowing till end of February) to inflorescence (Reproductive stage). Similar results were also observed by (Hussein1993) who concluded that aphid's population on wheat crop was lower during the months of January and February whoever; it increased till mid of March. According to him a maximum abundance of each aphid species occurred at the beginning of flowering period or booting stage (Mid March), after which the population fell rapidly (Mid April). These results are inline with the findings of the current research. (Rustamani *et al*., 1999) and (Ali

and Ali 2015) observed that the infestation of aphids appeared during the 3rd week of February on all wheat varieties. The increase in population was gradual during vegetative growth stage, but the aphids multiplied rapidly during the reproductive stage. (Aheer *et al*., 2007) found that aphid populations decreased when maximum temperature and minimum temperature reached to the optimum limits i.e., 24.30°C and 9.57°C. Our results supports this statement as aphids population was low at the start of March (temperature <20ºC) and end of March (temperature > 24ºC). It was also noted that the attack of aphids was maximum during the mid February to the beginning of March when the temperature was in the aphids favoring range. Temperature and humidity plays an important role in the population build up of aphids. Both the physical and biological factors are much vital causing the variations in the densities of aphid populations (Naeem, 1996). Findings of (Aslam *et al*., 2005; Aheer *et al*., 2008) that, fluctuation in temperature starts to enhance their population was in accordance to above mentioned results. Declined Rh% improves helpful in the process of population growth. Reason may be the continuous change in climatic conditions. Changes in quality and quantity of the food occur in plant and its growth stages, strongly affect the distribution and speed of development of insects (Hinz and Daeber, 1976). Also, the present results are in consist with those of (Abdel-Rahman *et al*., 2001 and Salem, 2007) who found that the reduction of cereal aphid populations later in season may be attributed to plant growth stage. Plant maturity seemed to be the most important factors causing drastic reduction in aphid infestation. (Abdel-Rahman 1997) attributed the decline in aphid population following the peak to the senescence of the host plant. It was also found that natural enemies play an important role in natural regulation of aphid populations in wheat fields (Abdel-Rahman *et al*., 2001). In addition, Kring and Gilstrap, 1983, stated that the rapid decline in greenbug densities by late summer is primarily due to the high rates of predators and parasitoids. Also, the present results are in general agreement with those of (Abdel-Samad and Gomma, 2004 and Levie *et al*., 2005) who concluded that the natural enemies of cereal aphids affect aphid numbers particularly at the time of their higher population level.

CONCLUSIONS

It was concluded that aphid's population was lower at the start of January in all seasons. The aphids population increased from the first of January to the beginning of March and decreased after that. Aphid dynamics were largely dependent on temperature and relative humidity; however aphid population was not significantly correlated with relative

humidity. The use of indiscriminate insecticides and pesticides caused more mortality to wheat insects, they might have adverse effect on natural enemies and due to decrease in the population of natural enemies ,the aphids population will reach to the economic threshold level and cause serious damage to the wheat crop. So, we must use insecticides in appropriate time with consideration of wheat plant age and the presence of natural enemies.

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بعض العوامل المؤثرة علي تعداد حشرات مّن النجيليات (Homoptera: Aphididae) التي تصيب نباتات القمح بأسيوط

أجريت هذة الدراسة بهدف معرفة تأثير بعض العوامل سواء الحيوية او الغير حيوية على تعداد حشرات مّن النجليليات التي تصيب نباتات القمح بأسيوط. إتضح من الدراسة أن حشرات المّن تبدأ في ظهورها علي نباتات القمح إعتباراً من النصف الأول من شهر يناير حيث تكون النباتات في مرحلة التفريع. يأخذ بعد ذلك تعداد حشرات المّن في الزيادة حتى تصل إلى مرحلة أعلى كثافة عددية مع الأسبوع الأخير من شهر فبراير، حيث تكون النباتات فى مرحلة التزهير ويكون عمر النبات في هذة المرحلة ٧٧ يوماً من بداية الزراعة. يأخذ تعداد حشرات المّن بعد هذة المرحلة في الإنخفاض إلى أقل كثافة عددية مع نهاية شهر مارس، وفى هذه المرحلة تكون معظم النباتات في بداية مرحلة الطور اللبنى أو تكوين الحبوب. أُستخدم تحليل الإنحدار المتعدد لمعرفة تأثير ثمانية متغيرات وهى عمر النبات، حرارة الهواء العظمى والصغرى، والرطوبة النسبية العظمى والصغرى والحرارة الفعالة بالإضافة إلى المفترسات والطفيليات. إتضح من هذة الدراسة أن هذة العوامل المدروسة تؤثر بنسبة ٨٢% على تعداد حشرات المّن على محصول القمح. أوضحت الدراسة أيضا أن عمر النبات كان من أهم العوامل يلى في ذلك الأعداء الحيوية بما فيها المفترسات والطفيليات. أوضحت الدراسة أن الحرارة العظمى كانت مؤثرة تقريباً بنسبة ٨% من العوامل المدروسة والمؤثرة على التعداد، في حين كانت الرطوبة النسبية الصغرى أقل العوامل المدروسة والمؤثرة على تعداد حشرات مّن النجيليات التي تصيب نباتات القمح بأسيوط.