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Population Ecology of Aphids and Their Associated Predators on Wheat Crops in Najaf, Iraq

Ragab M. E.[1]; Ghanim A. A.[1*]; A. R. Ahmed[1]; H. A. S. Mohamed[2] and A. B. Al-Tamimy[1]

[1]Econ. Entomol. Dept., Fac. of Agric., Mansoura Univ., Egypt.
[2] Dept. of Plant protection- College of Agriculture – University of Baghdad

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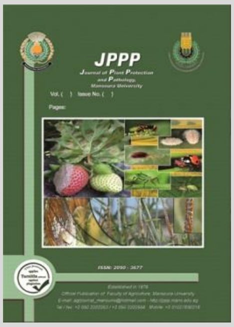

ABSTRACT

This study was conducted to assess the population density of certain aphid species and their key insect predators on wheat crops in Najaf, Iraq. The study employed two sampling methods: direct counting and sweep net collection. The findings indicate that *Schizaphis graminum* (29.37%) and *Rhopalosiphum padi* (28.52%) were the most abundant aphid species, followed by *Sitobion avenae* (23.6%) and *Diuraphis noxia* (18.5%). Regarding aphid predators, *Coccinella undecimpunctata* constituted 48.82% of the total percentage of predator species, while *Chrysoperla carnea* accounted for 44.09%, and syrphid larvae represented 7.09%. Correlation analysis revealed a significant negative relationship between aphid populations and temperature, whereas relative humidity exhibited a significant positive correlation with *R. padi* and *D. noxia* only. Wind speed showed variable effects on different aphid species. Furthermore, a significant positive correlations were observed between aphid predators and their aphid prey densities, with *C. undecimpunctata* showed a significant positive correlation with *S. graminum* (0.8٩ ****) and *C. carnea* with *R. padi* .These findings highlight the intricate interactions between aphids, their natural predators, and environmental factors. Understanding these relationships can aid in developing integrated pest management strategies to enhance wheat protection in the region.

Keywords: Environmental factors; aphids; wheat; sampling

INTRODUCTION

Bread wheat (*Triticum aestivum L.*) constitutes a significant component of the daily diet in Iraq. According to the Iraqi Central Statistical Organization (Iraqi CSO, 2019), winter wheat is the country's primary crop, contributing approximately 70% of total cereal production. Wheat Sown in mid-November, the crop is harvested between mid-April and late May (DEAT, 2019). In 2019, wheat production in Iraq was projected to increase by 10.34% across all wheat-growing regions (USDA FAS, 2019). The sustainability of wheat production is increasingly threatened by climate change. Significant shifts in global climate patterns are expected to impact wheat yields both directly and indirectly, particularly by influencing wheat–pest interactions. Between 1880 and 2012, the average global temperature across land and ocean surfaces rose by 0.85°C, with projections indicating a further increase of 0.2°C per decade (Pachauri *et al.*, 2014). Climate change is not limited to temperature variations alone; other climatic factors, such as relative humidity, wind speed, and additional environmental variables, must also be considered. These factors can significantly influence both crop productivity and the dynamics of insect pests, along with their associated natural predators (Bajwa *et al.*, 2020 and Asiry, 2022). There are more than 100 species of arthropod pests that attack wheat, most of which are occasional or inhabit limited areas of wheat production, with only a few species of major economic importance (Hatchett *et al.*, 1987 and El-Heneidy and Edly, 2012).

Although many insect pests attack wheat, severe damage is caused by aphids. Aphids cause yield losses either directly (35-40%) by sucking the sap of the plants or indirectly (20-80%) by transmitting viral and fungal diseases (Aslam *et al.*, 2005). Population density of aphids also depends on the abiotic factors (Aheer *et al.,* 2007, Aheer *et al.,* 2007 and Wains *et al.*, 2008). During (February-March) aphid population increases, at the same time biocontrol agents as coccinellids also increase as natural check on this pest (El-Heneidy *et al.,* 2004 Khan *et al.*, 2011).

Wheat aphids are globally distributed (Shah *et al.*, 2006). Theyreported that *Rhopalosiphum padi* L., *Sitobion avenae* Fabricius, *Duraphis noxia* (Mordvilko) and *Schizaphis graminum* (Rondani) are among the major wheat aphids species.

Several studies suggested that aphid predators, including adult and larval stages of the ladybird (*Coccinella undecimpunctata*), larval stages of the syrphid(???????) and chrysopid (*Chrysoperla carnea*) predators may play a significant role in the natural regulation of aphid populations (Freier and Triltsch, 1996; Elliott *et al.*, 2000). However, other researchers challenged this assertion, arguing that aphid predators are not sufficiently effective in controlling aphid populations (Dixon, 2000).

This study aims to 1) assess the population density of aphid species infesting wheat crops in the Najaf region of Iraq, 2) determine their prevalence and impact on wheat production, 3) enumerate the key insect predators associated with aphids and examine the relationship between aphid population densities and their predator species, 4) determine the correlation coefficients either between population densities of aphid species and their predator species or between certain weather factors(i.e. temperature, relative humidity, and wind speed) and populations of aphids and predators. These information will contribute toward increasing our understanding regarding the development of effective biological control strategies and sustainable agricultural practices.

* **Corresponding author.**
E-mail address: ghanim@mans.edu.eg

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MATERIAL AND METHODS

The present study carried out at Agriculture Research Institute (ARI) Najaf Government (30.418°, 45.41°)(Fig 1), Iraq during the cropping season 2023-2024. Wheat (Ebaa 99 cultivar) was planted during the 2nd week of November with applying regular agronomic procedures and appropriate fertilizers applications. Data of the population density of aphid species and their associated predators started after two weeks of wheat plantation and continued till the harvest date. Samples were taken weekly by two methods as follows:

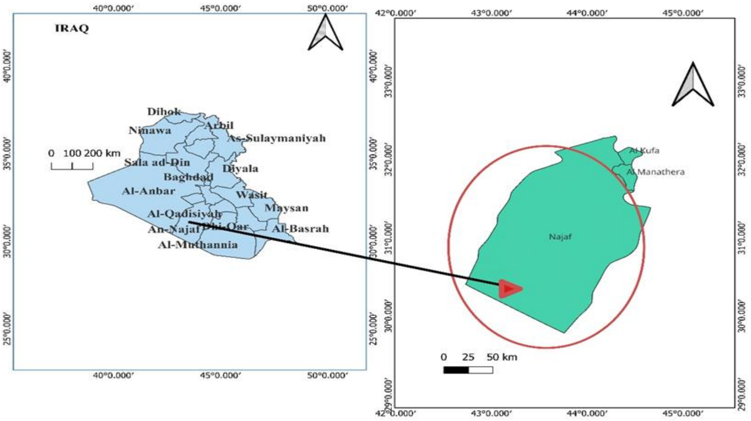

Fig. 1. Map for the Study Area of Wheat in Najaf, Iraq

1- Visual observation

Hundred wheat plants, chosen at random in the same experimental region, were marked and subjected to weekly observations to identify potential infestations and to collect aphid species associated with the plants. Each collection was made at 9 a.m.

2- Sweep net method

The sample was represented by fifty double strokes of the sweep net in each direction of the five directions of the study area. Thus, 250 double strokes were performed. The gathered insects were placed in a plastic bag and promptly sedated with each other before being transferred to the laboratory. Insects were identified in the laboratory at the species level, counted and recorded.

Influence of certain weather factors on aphid populations:

Daily temperature and relative humidity data for the 2023 growing season was obtained from the Iraqi Meteorological Department, located in the Najaf Governorate. The weekly averages of the three weather variables (Temperature, relative humidity and wind speed) from the beginning of sampling dates were used to determine the partial correlation coefficients between these whether factors, the population densities of insect species, and their predators. Furthermore, the correlation between aphid and predator populations was also determined.

Statistical analysis

All statistical analyses were performed using GraphPad Prism (version [9.4.1], GraphPad Software, San Diego, CA, USA). Correlations between aphid populations and predator populations as well as between those organisms and certain weather factors (Temperature; Relative Humidity and wind speed) were determined using a one-tailed Pearson correlation test, and Pearson's correlation coefficient (r) was reported with a 95% confidence interval. The significance level of $p < 0.05$ was considered statistically significant. Graphs were generated using GraphPad Prism.

RESULTS AND DISCUSSION

The data presented in Fig (٢) indicate that *R. padi* first appeared at the beginning of the season, with its population gradually increasing until it reached its peak on February 7. Following this peak, the population began to decline, eventually reaching zero by early April and remaining at that level until the harvest. As for the species *S. graminum*, it first appeared in early December and reached its highest population density of 48 individuals/tiller in mid-February. Subsequently, its population declined toward the end of the season. The last species to appear was *S. avenae*, which first emerged in late December and reached its peak in mid-December 42 individuals/tiller. Its population then declined toward the end of the season but never completely disappeared. As for the species *D. noxia*, it first appeared in the end of November and reached its highest population density of 31 individuals/tiller in mid-January. Subsequently, its population declined toward the end of the season.

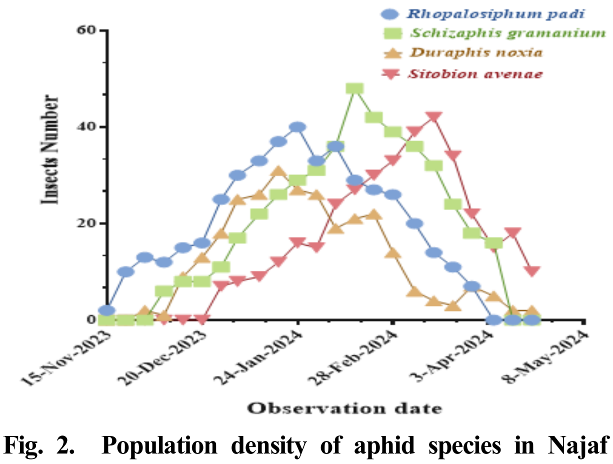

Fig. 2. Population density of aphid species in Najaf Governorate during the 2023 season.

The results illustrated in Fig (٣) show that the aphidophagous predators first appeared at the beginning of December, with their population gradually increasing until reached its peak on February. Following this peak, the highest population was for *C. undecimpunctata* began to decline, eventually reaching zero by early April and remaining at that level until the harvest. The highest population was for *C. undecimpunctata* While the lowest population was for Syrphid larvae.

The results in consistence with those of El-Hag *et al.* (1996), who investigated aphid species in wheat and barley fields in central Saudi Arabia from 1994 to 1995. Furthermore, El-Hag and El-Meleigi (1991) indicated that *S. graminum* and *R. padi* were the most common aphid pests infesting wheat crops in Central Saudi Arabia (Gassim Region). In Egypt, Slman (2006) reported a high abundance of *R. padi*, followed by *S. graminum*, *R. maidis*, and *S. avenae* in wheat crops.

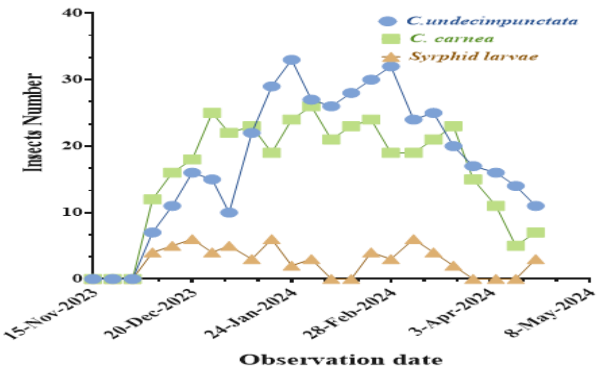

Fig. 3. Abundance of aphidophagus predators in Najaf Governorate during the 2023 season.

Table (1) presents the population density of aphids and their predators affecting wheat crops in the Najaf region of Iraq during 2023. Among the aphid species, *S. graminum* recorded the highest total count (4490 individuals, 29.37%), followed closely by *R. padi* (4360 individuals, 28.52%), *S. avenae* population (3610 individuals, 23.6%), while *D. noxia* had the lowest population (2830 individuals, 18.5 %)

Regarding the predator species, *C. undecimpunctata* was the most abundant (4130 individuals, 48.82%), followed by *C. carnea* (3730 individuals, 44.09%), whereas Syrphid larvae constituted a significantly smaller proportion of the natural enemies recorded (60 individuals, 7.09%).

Table (2) present the correlation coefficients between populations of various aphid species and their associated predators as well as between these insect species and certain climatic variables (temperature, relative humidity, and wind speed). The results indicated a significant negative correlation between *R. padi* and temperature , meaning that there were inverse relation between temperature and aphid population resulting in higher temperatures significantly reducing their population. However, its population is positively correlated, in a significant way) with relative humidity, meaning that humid conditions leading their populations to increase. Wind speed, however, does not appear to have any impact.

Similarly, *S. graminum* also has a significant negative correlation with temperature, but not with relative humidity or wind speed . *Duraphis noxia* is significantly correlated in a positive trent with temperature and humidity, but not with wind speed.

In contrast, *S. avenae* did not respond to either temperature or relative humidity, but it responded positively to wind speed, suggesting that its dispersal may be influenced by wind currents.

Table 1. Populations of aphids and their predators in wheat field of Najaf region of Iraq during 2023 growing season.

	Rhopalosiphum padi	Schizaphis gramanium	Duraphis noxia	Sitobion avenae	C. undecimpunctata	C. carnea	Syrphid larvae
Total Number	4360	4490	2830	3610	4130	3730	600
%	28.52	29.37	18.5	23.6	48.82	44.09	7.09

Table 2. Correlation coefficients between populations of various aphid species and certain weather factors of 2023 season.

	Temperature	Relative humidity	Wind speed
Rhopalosiphum padi	-0.83****	0.58**	-0.13ns
Schizaphis gramanium	-0.59**	0.22ns	0.17ns
Duraphis noxia	-0.65***	0.56**	-0.15ns
Sitobion avenae	-0.15ns	-0.23ns	0.44*
C. undecimpunctata	-0.48**	0.11ns	0.24ns
C. carnea	-0.65***	0.32ns	0.09ns
Syrphid larvae	-0.43*	0.09ns	-0.04ns

Table (3) shows the correlation coefficients between populations of different aphid species and their major predator species.

Table 3. Correlation coefficient between populations of various aphid species and certain aphidophagus predators.

	C. undecimpunctata	C. carnea	Syrphid larvae
Rhopalosiphum padi	0.66***	0.74****	0.34ns
Schizaphis gramanium	0.88****	0.76****	0.16ns
Duraphis noxia	0.66***	0.74****	0.34ns
Sitobion avenae	0.71****	0.49**	0.03ns

The data demonstrated that all predator species (R. padi and C. undecimpunctata and C. carnea) had significant positive correlations with their aphid populations, indicating that these predator species seem to be density-dependent mortality factors. However, the correlation between Syrphid larvae (0.34ns) is not significant, which indicates a weak or predator-prey relation, i.e. density independent mortality factor.

The same relationships and their significance for predator species are reported on S. graminum, D. noxia and S. avenae.

These results are in agreement with those of Chakravarty and Gautam (2004) showing that temperature was the most important abiotic factor affecting aphid populations. As well, a significant positive correlations were observed between aphid populations and their predator populations. (Elliott *et al.* 2000 and El-Heneidy *et al.* 2003).

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كثافة التعداد لحشرات المن والمفترسات المرتبطة بها على محصول القمح في النجف، العراق وتفاعلاتها مع بعض العوامل البيئية

محمد السيد رجب[1] ، عبد البديع عبدالحميد غانم[1] ،أحمد راشد أحمد[1] ، حسام الدين صالح محمد[2] وعلي باسم صالح التميمى [1]

[1]قسم الحشرات الاقتصادية، كلية الزراعة، جامعة المنصورة، مصر
[2]قسم وقاية النبات، كلية الزراعة، جامعة بغداد ،العراق

الملخص

تم إجراء هذه الدراسة لدراسة تعداد بعض أنواع المن والمفترسات الحشرية الرئيسية المرتبطة بها على محصول القمح في مدينة النجف، العراق. تم استخدام طريقتين لجمع العينات: العد المباشر وشبكة الجمع. أظهرت النتائج أن *Schizaphis graminum* (29.37%) و*Rhopalosiphum padi* (28.52%) كانتا أكثر أنواع المن انتشارًا، تليهما *Sitobion avenae* (23.6%) و*Diuraphis noxia* (18.5%). وبالنسبة لمفترسات المن، شكّلت *Coccinella undecimpunctata* نسبة ٤٨,٨٢% من إجمالي المفترسات، بينما بلغت نسبة *Chrysoperla carnea* 44.09%، وبلغت نسبة يرقات السرفيس ٧,٠٩%. أظهرت تحليلات الارتباط وجود علاقة سلبية معنوية بين تعداد المن ودرجة الحرارة، خاصةً بالنسبة لـ *R. padi* (-0.8261 ***) و *S. graminum* (-0.5874 *) و *D. noxia* (-0.6454 *). في المقابل، كان للرطوبة النسبية ارتباط إيجابي مع *R. padi* (0.5771 **) و *D. noxia* (0.5600 **)، بينما أظهرت سرعة الرياح تأثيرات متباينة على الأنواع المختلفة من المن. علاوة على ذلك، تم تسجيل ارتباط إيجابي قوي بين مفترسات المن وتعداد فرائسها، حيث أظهرت *C. undecimpunctata* أعلى ارتباط مع *S. graminum* (0.8849 ****)، بينما سجلت *C. carnea* ارتباطًا قويًا مع *R. padi* (0.7371 ****). تُبرز هذه النتائج التفاعلات المعقدة بين أنواع المن والمفترسات الطبيعية والعوامل البيئية. يمكن أن يساعد فهم هذه العلاقات في تطوير استراتيجيات متكاملة لإدارة الآفات بهدف تعزيز حماية محصول القمح في المنطقة.