Research Journal of Agricultural Science, 57 (3), 2025; ISSN: 2668-926X

http://doi.org/10.59463/RJAS.2025.3.46

ECOLOGICAL MANAGEMENT OF APHID POPULATIONS IN WHEAT CROPS

Alexandra-Renate ROȘCA, Radu ANCA, Delia Gabriela JURCHITA, Ana Maria VIRTEIU, Ioana GROZEA

University of Life Sciences" King Mihai I" from Timisoara, Romania

Corresponding author: ioanagrozea@usab-tm.ro; anamaria.badea@gmail.com

Abstract. *The present study aimed to evaluate the population levels and interactions between cereal aphids (Schizaphis graminum and Sitobion avenae) and their natural coccinellid predators in a winter wheat crop. Weekly observations were conducted from 10 April to 22 May in six 1 m² sampling plots, three located at the field margins and three within the interior. Aphids and coccinellids were collected using a sweep net, and all individuals were counted and identified in the laboratory. Population densities (individuals/m²) and the rate of aphid decline between successive sampling dates were calculated, together with the estimated predation potential of coccinellids based on a feeding rate of 400 aphids per adult per week. Results showed a rapid increase in aphid populations until early May, followed by a gradual decrease correlated with the rise in coccinellid abundance. Mean aphid densities ranged from 350 to 590 individuals/m², while coccinellid densities varied between 4 and 7 individuals/m². The aphid-to-coccinellid ratio ranged from 58 to 109 aphids per predator, depending on location. Estimated weekly aphid consumption reached up to 2,500 individuals/m², indicating that coccinellids exerted a measurable regulatory pressure on aphid populations. The study demonstrates the importance of natural predation in the biological control of cereal aphids and highlights the potential of coccinellids as effective biocontrol agents in wheat agroecosystems. Encouraging ecological farming practices that conserve predator populations can significantly enhance the sustainability of integrated pest management programs in cereals.*

Keywords*: Cereal aphids, Schizaphis graminum, Sitobion avenae, Coccinellidae, biological control, wheat agroecosystem, predator-prey dynamics, population density*

INTRODUCTION

Aphids (Aphididae: Hemiptera) are among the most important pest groups affecting cereal crops, due to their direct impact on both yield and quality of wheat (*Triticum aestivum* L.). These phytophagous insects feed by piercing and sucking plant sap, which causes chlorosis of leaves, reduced photosynthetic activity, and decreased growth and grain formation capacity. In addition, they excrete sugary substances (honeydew) that promote the development of sooty mold, further interfering with plant respiration and photosynthesis (GROZEA, 2015; AHMAD ET AL., 2016; LIU ET AL., 2020).

Among the aphid species associated with wheat, *Schizaphis graminum* (Rondani, commonly known as the greenbug and *Sitobion avenae* (Fabricius), the grain aphid, are considered the most frequent and economically significant, owing to their rapid reproduction and ability to transmit viruses (BÜHLER AND SCHWEIGER, 2024). In favorable climatic conditions, these species can cause substantial yield losses (PALAGESIU ET AL., 2001; HU ET AL., 2020).

According to K-State Research and Extension (2023), the economic injury levels for *S. graminum* vary depending on the growth stage of wheat: from approximately 25 aphids per plant at early stages to over 1000 individuals per plant at later stages of development. Exceeding these thresholds can lead to visible reductions in plant density (ZHANG ET AL., 2022) and vigor (POEHLING ET AL., 2027).

http://doi.org/10.59463/RJAS.2025.3.46

In the current context of sustainable agriculture, reducing dependence on chemical insecticides is a major objective, and biological control is becoming a key component of modern integrated pest management (IPM) strategies (SINGH AND SINGH, 2016). Among the most efficient natural enemies of aphids are coccinellids (Coleoptera: Coccinellidae), generalist predators that feed on aphids in all developmental stages (CANEPARI., 2005; HULLÉ ET ALL., 2020). Studies by HODEK AND EVANS (2012) demonstrated that both adults and larvae of *Coccinella septempunctata* and *Hippodamia variegata* can significantly decrease aphid population density in wheat fields.

The ecological importance of these predators is enhanced by agricultural practices that support their presence (GROZEA ET AL., 2008). Maintaining field margins with natural vegetation, avoiding insecticide treatments during predator activity periods, and providing refuge zones along field edges can all increase the effectiveness of biological control. According to LANDIS ET AL. (2020), habitat management aimed at supporting natural enemies represents one of the most effective strategies for maintaining ecological balance in agroecosystems.

Therefore, the present study aims to analyze the population dynamics of *Schizaphis graminum* and *Sitobion avenae* in wheat crops and to assess the role of coccinellids in their natural regulation, with the objective of developing practical recommendations for the sustainable implementation of biological control within modern agricultural systems..

MATERIAL AND METHODS

Experimental design

The study was conducted in a wheat crop (*Triticum aestivum* L.) from Ghilad (Timis County) (Figure 1), with the objective of evaluating the population levels of aphids and their coccinellid predators in order to assess the natural control potential of the latter.

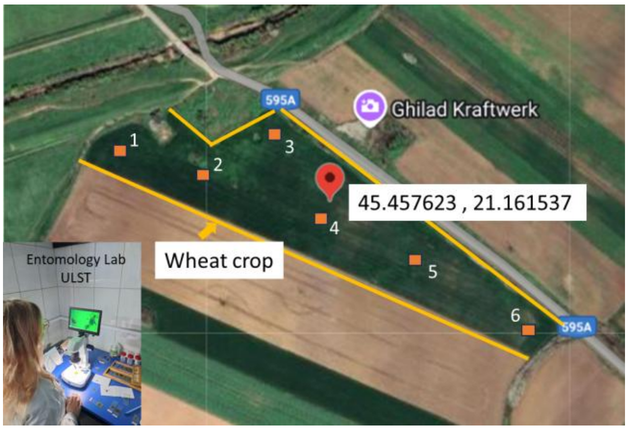

Figure 1. The experimental plot with designated observation points and the Entomology Laboratory where the aphid samples were analyzed

http://doi.org/10.59463/RJAS.2025.3.46

The experimental field (45.457623, 21.161537) was divided into six observation points: three located near the outer edge of the field and three towards the interior, to capture potential spatial differences in insect population density (Figure 1).

Within each point, a plot of 1 m² of wheat plants was marked and isolated using wooden stakes and twine, ensuring repeated sampling from the same area throughout the study period. The plant density per analyzed point ranged between 290 and 370 plants.

Sampling procedure

Aphids and coccinellids were collected using a standard sweep-net method. Sweeps were performed weekly during the main vegetation period of wheat, between 20 April and 22 May, when aphid and predator activity typically reach their peak.

The collected material was transferred to labelled containers and taken to Entomology Laboratory for sorting and identification (Figure 1). Aphids were identified to species level using specialized taxonomic keys. Among the identified aphids, two dominant species (those with the highest frequency) were considered as target species for analysis. All coccinellid species encountered were recorded, but for the quantitative assessment, individuals were grouped together, as the focus was on their overall predatory impact rather than species-specific differences.

Population density and rate of decline calculations

The mean population density of aphids and coccinellids per square meter was calculated for each sampling point and date according to the formula:

$$D = \frac{N}{A}$$

where: D = population density (individuals/m²)
N = number of individuals counted
A = sampled area (m²)

The rate of aphid decrease between two successive observations was calculated to estimate temporal population reduction, using the formula:

$$Rd = \frac{Dt - Dt+1}{Dt} \times 100$$

where:
Rd = rate of decrease of aphids (%)
Dt = aphid density at time t
D{t+1} = aphid density at the following observation

Data processing and statistical analysis

Data were processed using basic descriptive statistics (mean, standard deviation, and range).

Mean population densities of aphids and coccinellids were calculated for each observation point, and the aphid-to-coccinellid ratio was determined to evaluate the balance between pest and predator populations.

RESULTS AND DISCUSSIONS

Throughout the monitoring period (20 April - 22 May), both aphid and coccinellid populations exhibited clear temporal fluctuations across all observation points (Figure 2).

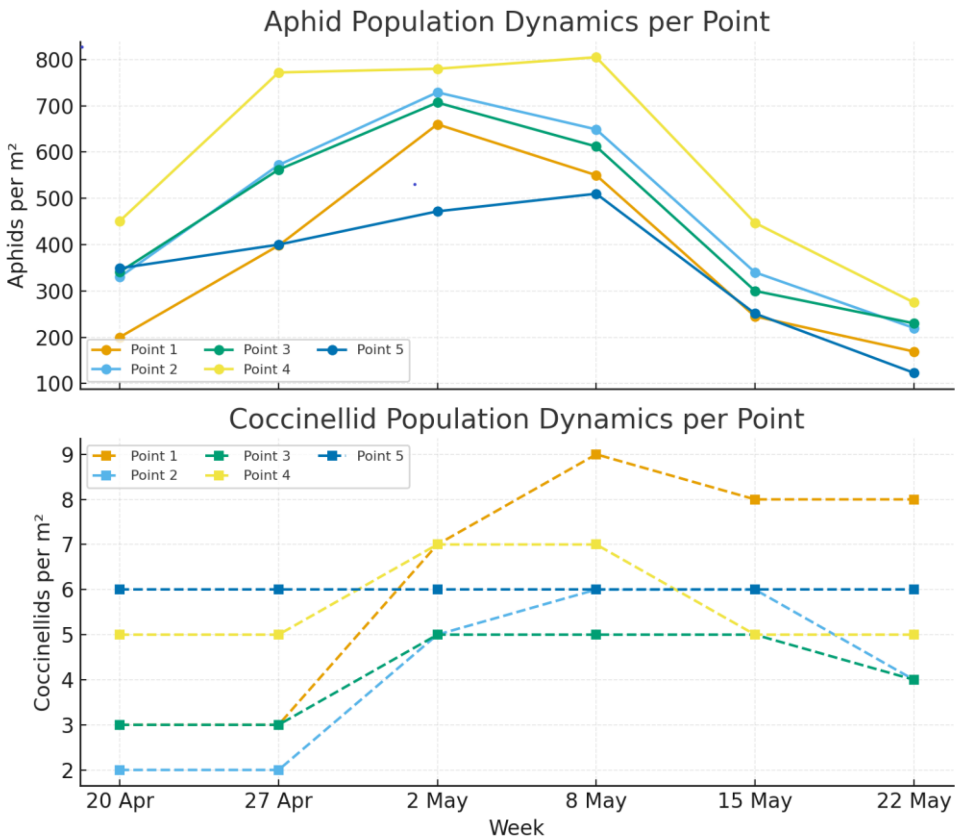

Figure 2. Population dynamics of aphids and coccinellids per point (P1-P5)

Aphid density increased steadily from mid-April, reaching its peak during the first half of May (2-8 May), followed by a pronounced decline towards the end of the observation period (15-22 May).

Conversely, coccinellid populations showed a delayed increase, with the highest densities recorded between 8 and 15 May, coinciding with the peak abundance of aphids.

The population dynamics observed suggest a strong trophic relationship between the two groups, where predator abundance responds to prey availability.

This synchrony indicates that coccinellids played an active role in reducing aphid numbers in the later stages of wheat vegetation.

Research Journal of Agricultural Science, 57 (3), 2025; ISSN: 2668-926X
http://doi.org/10.59463/RJAS.2025.3.46

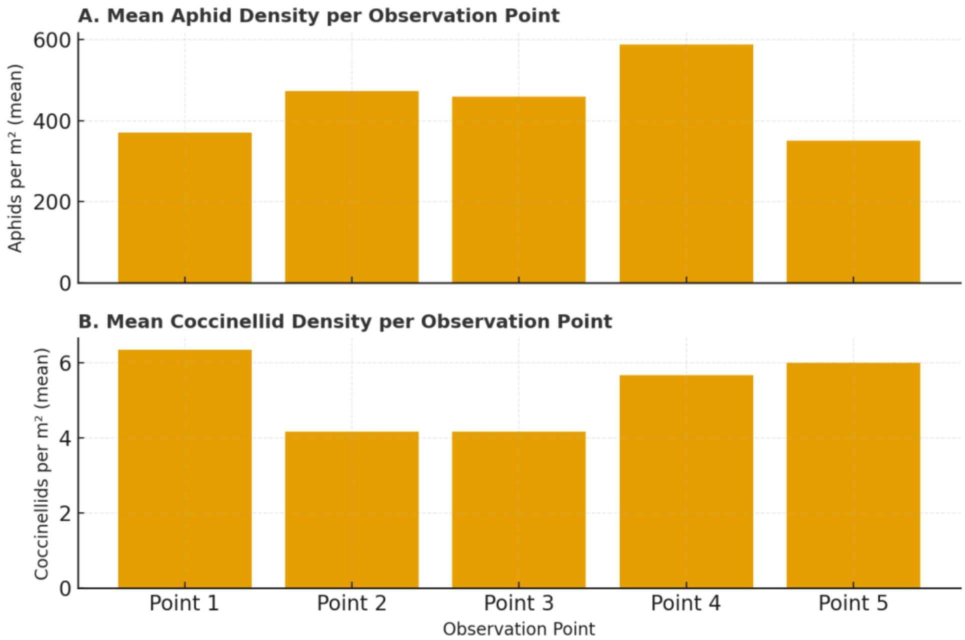

Figure 3. Mean population density of aphids (A) and coccinellids (B) per observation point (P1-P5)

Figure 4. Aphid populations at various developmental stages (1, 2, 4) and coccinellid larvae (3)

In the monitored wheat crop, two aphid species were identified with significant frequency: *Sitobion avenae* (the English grain aphid) and *Schizaphis graminum* (the greenbug aphid) (Figure 4).

Both alate (winged) and apterous (wingless) forms were observed, as well as immature stages forming extremely dense colonies with a high number of individuals (Figure 4).

http://doi.org/10.59463/RJAS.2025.3.46

This condition is particularly harmful to the plants due to the intensive sap extraction occurring over a relatively small leaf surface.

Among the coccinellid species recorded, *Coccinella septempunctata*, *Harmonia axyridis*, and *Hippodamia variegata* were the most frequent, as adults and larvae (Figure 4).

However, a detailed species-level analysis for both aphids and coccinellids was not considered relevant to the scope of this study.

Therefore, the assessment was conducted at the category level, aphids as pests and coccinellids as their natural predators or biological control agents.

Table 1 presents the mean population densities of aphids and coccinellids and the resulting aphid-to-coccinellid ratios across the five observation points.

The mean aphid density ranged from 350.8 to 588.3 individuals/m² (Figure 3), while coccinellid densities varied between 4.2 and 6.3 individuals/m².

The corresponding mean ratios ranged between 58.5 and 109.2 aphids per one coccinellid, reflecting spatial differences in the predator-prey balance.

Lower ratios (about of 59 aphids per coccinellid) were recorded at Points 1 and 5, suggesting higher relative predator presence and potential for effective natural control.

Higher ratios (above 100 aphids per coccinellid) observed at Points 2-4 indicate zones of greater aphid pressure or delayed predator response.

The estimated weekly aphid consumption, calculated from the mean coccinellid densities and an average feeding rate of 400 aphids per predator per week, ranged between 1,680 and 2,520 aphids/m², supporting the role of coccinellids in reducing aphid populations during May.

Table 1

Summary of mean population parameters for aphids and coccinellids across the five observation points

Observation Point	Mean aphids (ind./m²)	Mean Coccinellids (ind./m²)	Aphids per Coccinellid (mean ratio*)	Estimated aphids consumed/week
1	370.3	6.3	58.8	2,520
2	473.3	4.8	98.6	1,920
3	458.7	4.2	109.2	1,680
4	588.3	5.7	103.2	2,280
5	350.8	6.0	58.5	2,400

*Mean Ratio represent the mean number of aphids per one coccinellid, calculated based on the mean densities recorded per observation point

CONCLUSIONS

The present study highlights the population dynamics and ecological interactions between aphids (*Schizaphis graminum* and *Sitobion avenae*) and their natural coccinellid predators in wheat crops.

The results demonstrated a clear temporal overlap between the peaks of aphid and coccinellid populations, suggesting a predator response closely linked to prey abundance.

Mean aphid densities varied between 350 and 590 individuals/m², while coccinellid densities ranged from 4 to 7 individuals/m².

Despite the numerical dominance of aphids, the estimated feeding capacity of coccinellids (1,700-2,500 aphids consumed per week per m²) indicates that these predators exerted a significant regulatory effect, contributing to the natural decline of aphid populations in May.

Spatial differences among observation points revealed that lower aphid-to-coccinellid ratios (about 60:1) were associated with a more stable predator-prey balance, whereas higher ratios (>100:1) reflected localized outbreaks of aphids.

These findings confirm the key role of coccinellids as effective biological control agents in cereal agroecosystems.

To enhance their regulatory potential, agricultural practices that conserve or promote coccinellid populations, such as reduced pesticide use, maintenance of refuge habitats, and diversified crop margins, should be encouraged.

Such ecologically based management strategies can support sustainable pest control and maintain the ecological balance in wheat production systems.

ACKNOWLEDGEMENT

We thank the owner of the cereal lot who allowed us access throughout the observation period. The detailed studies were carried out in the Entomology Laboratory of ULST.This laboratory was equipped and modernized through the project PRV/47/PRV_P6/OP4/RSO4.2/PRV_A32: 329137, entitled "Modernization of the educational infrastructure of USVT-P1", financed by AM_PRV - Agency for Regional Development West (ADR West), PRV/6.1.D/1 Universities.

BIBLIOGRAPHY

AHMAD, T., MUHAMMAD, W.H., JAMIL, M., IQBAL, J., 2016 – Population dynamics of aphids (Hemiptera: Aphididae) on wheat varieties (*Triticum aestivum* L.) as affected by abiotic conditions in Bahawalpur, Pakistan. Pakistan Journal of Zoology, 48, (4), 991–997, Pakistan.

BÜHLER, A., SCHWEIGER, R., 2024 – Previous infestation by conspecifics leads to a transient increase of the performance of *Sitobion avenae* aphids on wheat leaves. Ecological Entomology, https://doi.org/10.1111/een.13316, United Kingdom.

CANEPARI, C., 2005 - Familia Coccinellidae. In: Fauna Europaea. Available online at: http www.faunaeur.org., Italy.

GROZEA, I., 2015 – Entomologie generala, Editura Eurobit, 155 p.

GROZEA, I., CARABET, A., CHIRITA, R., BADEA, A.M., 2008 – Natural enemies in control of invasive species Diabrotica virgifera Virgifera from maize crops. Communication in agricultural and applied biological science, 73, 3, 201-508, Romania.

HODEK, I., EVANS, E.W., 2012 – Ecology and behaviour of the ladybird beetles (Coccinellidae). Wiley-Blackwell, Chichester, 532 p., United Kingdom.

HU, Z., SU, D., LI, D., TONG, Z., ZHANG, C., ZHANG, G. ET AL., 2020 – Diversity of secondary endosymbionts among different geographical populations of the grain aphid, *Sitobion avenae* (Fabricius) (Hemiptera: Aphididae) in China. Entomologia Generalis, 40, 253–262, Germany.

HULLÉ, M., CHAUBET, B., TURPEAU, E., SIMON, J.-C., 2020 – Encyclop'Aphid: a website on aphids and their natural enemies. Entomologia Generalis, 40, 97–101, Germany.

K-STATE RESEARCH AND EXTENSION, 2023 – Greenbug and other cereal aphid thresholds in wheat. Kansas State University Extension Bulletin, Manhattan, Kansas, 12 p., USA.

LANDIS, D.A., WRATTEN, S.D., GURR, G.M., 2020 – Habitat management to enhance natural enemies in agricultural landscapes. Annual Review of Entomology, 65, 247-266, USA.

LIU, F.-H., KANG, Z.-W., TAN, X.-L., FAN, Y.-L., TIAN, H.-G., LOI, T.-X., 2020 – Physiology and defense responses of wheat to the infestation of different cereal aphids. Journal of Integrative Agriculture, 19, 1464–1474, China.

PĂLĂGEȘIU, I, SÂNEA, N, PETANEC, D., GROZEA, I., 2000 – Ghid practic de Entomologie agricolă şi horticolă, Mirton, Timişoara.

POEHLING, H.M., THIEME, T., HEIMBACH, U., 2017 – IPM case studies: Grain. In: Aphids as Crop Pests (eds. Van Emden, H.F. & Harrington, R.), CABI, pp. 545–556, United Kingdom.

SINGH, R., SINGH, G., 2016 – Aphids and Their Biocontrol. In: Ecofriendly Pest Management for Food Security (Ed. Omkar), Academic Press, pp. 63–108, United Kingdom.

ZHANG, K.-X., LI, H.-Y., QUANDAHOR, P., GOU, Y.-P., LI, C.-C., ZHANG, Q.-Y., HAQ, I.U., MA, Y., LIU, C.-Z., 2022 – Responses of six wheat cultivars (*Triticum aestivum*) to wheat aphid (*Sitobion avenae*) infestation. Insects, 13, 508, https://doi.org/10.3390/insects13060508, Switzerland.