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THE INFLUENCE OF CLIMATIC CONDITIONS IN 2023 ON APHID INFESTATION IN VEGETABLE CROPS AT VRDS BACĂU

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KEYWORDS

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ABSTRACT

Climate change, through its influence on temperature, humidity and rainfall, favors the spread and activity of many aphid species, leading to increased infestation risks for vegetable crops worldwide. In 2023, aphid species were monitored at the Vegetable Research and Development Station of Bacău (VRDS Bacău). Six aphid species were identified in the vegetable crops in the conventional agriculture experimental field. However, only four species - *Aphis fabae, Aphis gossypii, Myzus persicae* and *Brevicoryne brassicae* - exceeded the economic damage threshold. The degree of attack (DA%) of these species was influenced by climatic factors, in particular fluctuations in temperature, relative humidity and precipitation. In May and June, moderate temperatures and high humidity levels favored aphid activity, with maximum DA% observed for *A. fabae* and *M. persicae*. During summer, *A. gossypii* became more predominant, while *B. brassicae* showed maximum activity in the fall months. The data highlight the importance of climate monitoring in integrated pest management, allowing control strategies to be adapted to seasonal conditions and increasing the effectiveness of pest control measures. This study provides valuable information for optimizing pest management practices in vegetable crops under varying climatic conditions.

INTRODUCTION

Climatic conditions significantly impact the aphid population dynamics and their interactions with host plants to a large extent. Temperature plays a vital role, with higher temperatures generally leading to increased aphid abundance (Neupane and Subedi, 2020; Dampc *et al.*, 2021). However, excessive heat can negatively impact aphid biology, reducing reproduction and longevity (Dampc *et al.*, 2021). Humidity and rainfall also affect aphid populations, although their impact may be lower (Neupane and Subedi, 2020). Urban environments create unique conditions that may favor aphid development, with species diversity varying across urban landscapes (Mackoś-Iwaszko, Lubiarz and Karczmarz, 2015). Plant varieties exhibit different levels of resistance to aphid, which also indicates the important role of variety selection in pest management strategies (Wains *et al.*, 2023). Climate change-induced temperature increases not only affect aphids directly, but also influence them indirectly by altering host plant quality and defense mechanisms (Dampc *et al.*, 2021). Understanding these complex interactions is crucial for developing effective aphid control strategies in the context of changing climatic conditions.
Climatic conditions in Romania show significant variability, influenced by both geographical features and ongoing climate change. In recent decades, Romania has seen a remarkable increase in average temperature, coupled with fluctuating changes in precipitation patterns. This climatic evolution has profound implications for agriculture and water resources, influencing both agricultural practices and production quality. Mean temperatures in Romania have increased by more than 1.5°C over the last three decades, with a more pronounced increase of 0.61°C in the last ten years, according to recent research (Ciornei *et al.*, 2023). This warming trend is particularly evident in the north-eastern regions of the country, where the average air temperature increased by 1.70°C between 1971 and 2020, generating more days with extreme temperatures (Filimon *et al.*, 2024). Such changes lead to an increase in

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extreme weather events, such as heat waves and droughts, which negatively affect crops and agricultural productivity. Rainfall patterns have become increasingly erratic, influencing agricultural practices and water resource management (Filimon *et al.*, 2024). Variations in rainfall amount and distribution affect both crop yield and crop quality, including vegetable production, which is sensitive to climate change (Filimon *et al.*, 2024).
Aphids are major agricultural pests in Romania, affecting many crops, including vegetables. Species such as *Myzus persicae* and *Aphis gossypii* can cause significant damage, not only by feeding directly on plant leaves, but also by transmitting viruses that affect crop yield and quality. *M. persicae*, for example, is a particularly dangerous species for solanaceous crops, acting as a vector for viruses that severely affect these plants (Chiriloaie-Palade *et al.*, 2020; Bărăscu *et al.*, 2021). Long-term monitoring studies in potato crops have revealed fluctuations in the abundance and species composition of aphid species, indicating a complex dynamic that requires adapted control methods (Bărăscu *et al.*, 2021). In vegetable crops, ecological control methods are increasingly used to meet the requirements of sustainable and healthy agriculture. Thus, natural enemies, such as insect predators of the families Coccinellidae (ladybirds) and Syrphidae (hoverflies), play an important role in reducing aphid populations (Chiriloaie-Palade *et al.*, 2020; Grozea *et al.*, 2023). These predators can help to reduce aphid pressure on vegetable crops by providing a natural and effective alternative to chemical pesticides.
This study aims to evaluate the influence of climatic conditions during 2023 on the degree of aphid infestation in vegetable crops at the Vegetable Research and Development Station of Bacău (VRDS Bacău). The objective was to study aphid population dynamics in the context of the climatic conditions that occurred in 2023 and to identify correlations between various climatic factors - air temperature, relative humidity, precipitation, leaf humidity and wind speed - and the degree of attack (DA%) of aphid species in different vegetable crops, such as beans, tomatoes, cabbage, eggplant and others.

MATERIALS AND METHODS

The research was carried out in 2023 on the experimental field for conventional agriculture at the VRDS Bacău. The biological material analyzed included a wide range of vegetable crops cultivated at the station, such as peppers, tomatoes, eggplants, lovage, cucumber, parsley, cabbage and other species of interest for local agriculture. Observations were made at 10-day intervals during the survey, the aphid species present in each crop were identified and recorded. To follow population variations and infestation levels, the degree of attack (DA%) was calculated. This data provided a detailed insight into peak periods of aphid activity and facilitated a better understanding of the degree of infestation in relation to weather conditions. Meteorological data were collected using the iMetos 3.3 weather station, a device that constantly recorded important climatic parameters for the period May-December 2023. These parameters included air temperature, relative humidity, precipitation, leaf humidity, and wind speed. All these variables were analyzed to determine how climatic conditions influence aphid infestation. Meteorological data were essential to highlight the correlations between climatic parameters and aphid activity, providing valuable information that can contribute to the development of effective pest management strategies under conventional farming conditions.

RESULTS AND DISCUSSION

In 2023, at VRDS Bacău, several aphid species associated with various vegetable crops and wild plants were identified (Table 1).

Table 1. Aphid species identified in various vegetable crops at VRDS Bacău in 2023

Nr. crt.	Aphid species	Associated cultures
1	Black bean aphid (*Aphis fabae*)	Common bean (*Phaseolus vulgaris*)
		Lovage (*Levisticum officinale*)
		Parsley (*Petroselinum crispum*)
		Spinach (*Spinacia oleracea*)
		Muskweed (*Myagrum perfoliatum*)
		Creeping thistle (*Cirsium arvense*)
		Sun spurge (*Euphorbia helioscopia*)
2	Cotton aphid (*Aphis gossypii*)	Cucumber (*Cucumis sativus*)
		Tomato (*Solanum lycopersicum*)
		Squash (*Cucurbita maxima*)
3	Cabbage aphid (*Brevicoryne brassicae*)	Cabbage (*Brassica oleracea*)
4	Potato aphid (*Macrosiphum euphorbiae*)	Eggplant (*Solanum melongena*)
		Tomato (*Solanum lycopersicum*)

Nr. crt.	Aphid species	Associated cultures
5	Green peach aphid (*Myzus persicae*)	Pepper (*Capsicum annuum*)
		Eggplant (*Solanum melongena*)
		Tomato (*Solanum lycopersicum*)
6	Corn leaf aphid (*Rhopalosiphum maidis*)	Maize (*Zea mays*)

These data (Table 1) indicate a significant diversity of aphid species associated with different vegetable crops, with each species having certain preferred host plants. This specific association between aphids and crops highlights the importance of monitoring each crop according to the predominant pests and the need to implement targeted control strategies to minimize damage and protect crop yield at VRDS Bacău.

Figure 1. Climate conditions in 2023 from VRDS Bacău
a) air temperature b) relative humidity c) precipitation, leaf humidity d) wind speed

At VRDS Bacău in 2023, climatological data covering an extended period from the beginning of May to December were collected and analyzed (figure 1). These climatological data have been collected using the iMetos 3.3 weather station and provide a detailed picture of seasonal climate variations and their potential impact on vegetable crops and pests.

- **Air temperature** varied significantly throughout the year, with a gradual increase from May (averages of around 12-19°C) to the summer months (July-August), when average maximum values of up to 24.62°C and peaks of over 33°C in August were recorded. Temperatures started dropping from September, reaching average values of 11-15°C in October and dropping below freezing in December. Research indicates that temperature variations correlate with aphid population peaks, with optimal temperature ranges promoting higher densities (Zamani *et al.*, 2006; Jovičić *et al.*, 2022).
- **Relative humidity** showed considerable fluctuations, being lower in the summer months (47-73% in June-August) and increasing in the fall and winter, with high average values in November and December, reaching highs of over 99%. This suggests higher ambient humidity in the cold season, conditions that may influence the level of aphid infestation and the spread of fungal diseases. Higher relative humidity, particularly in the morning and evening, shows a positive correlation with aphid populations. Conversely, maximum temperature exhibits a negative correlation with aphid numbers (Pathipati et al., 2020; Mandal et al., 2018).
- **Rainfall** varied significantly, with a peak in July (69.6 mm) and other wetter periods in September and October. These variations in rainfall influenced soil moisture and leaf humidity, which are essential factors for crop and pest development. During periods of relative drought (e.g. early August), plants were exposed to water stress, which can weaken their resistance to pest attacks (Ximénez-Embún *et al.*, 2017).

- **Leaf humidity**, measured in minutes during each observation period, was also high in the fall months, with highs of over 400 minutes in some decades in November. This suggests that during those periods the leaves had an extended period of wetness, favoring the development of molds and other diseases (Nguyen, Gilbert and Rolandi, 2023).
- **Wind speed** showed higher values in the spring and early summer months, with peaks of 10.11 m/s in June. In cooler periods, wind speed decreased slightly, with lower average values, but with some peaks in November, which could have influenced pest dispersal (Antolínez *et al.*, 2022).

In 2023, at VRDS Bacău, six aphid species were identified in vegetable crops (table 1.), four of them exceeded the economic damage threshold: *A. fabae*, *A. gossypii*, *M. persicae* and *B. brassicae*. The degree of attack (DA%) (figure 2.) varied throughout the year, influenced by climatic conditions, in particular temperature, relative humidity and rainfall.

- ***A. fabae*** had a low attack in early May, but by the third decade of the month, as the average temperature increased to 19.18°C, the DA% reached 5.61%. The peak attack of this species occurred in early June, with a DA% of 12.66%, when temperatures remained around 19-21°C and relative humidity was moderate. After this period, the attack gradually decreased, reaching very low values in the summer and fall months. Peak infestation typically occurs in early summer, with aphid density varying annually. Infestation severity is influenced by meteorological factors, with temperature and relative humidity positively correlated to aphid abundance (Almogdad, Lavrukaitė and Semaškienė, 2024). Climate change has advanced *A. fabae* arrival dates by approximately 10 days over 62 years, with earlier arrivals in warmer years (Baker, Venugopal and Lamp, 2015).
- ***A. gossypii*** showed moderate attack in the second half of June, reaching a maximum of 10.26% during this period. These increases are correlated with high relative humidity (73.51%) and average temperatures of about 19°C. Also, in the third decade of July, the DA% for this species reached a significant level of 10.5%, a period characterized by maximum temperatures above 30°C and high relative humidity, suggesting a sensitivity of the species to heat and humidity conditions. Liu et al. (2023) found that *A. gossypii* can adapt to warmer temperatures through the upregulation of heat shock protein 70 and cathepsin B genes. Another study by Liu et al. (2021) demonstrated that *A. gossypii* showed better survival and fecundity at higher temperatures compared to other aphid species.
- ***M. persicae*** was active over an extended period, with a peak in DA% in the second decade of June (17%) and high values in the third decade of June (11%). The intense activity of this species is associated with wetter and warmer periods, with leaf humidity being high in these decades. In July and August, DA% decreased significantly, indicating a lower preference for extremely high temperatures. The literature reported that temperature plays a crucial role in aphid flight activity and population development (Tolba, 2020; Luquet *et al.*, 2023). The peak activity typically occurs in spring and early summer, with studies reporting highest numbers in February (Tolba, 2020) and April-June (Ramadan, Bayoumy and Afifi, 2022).

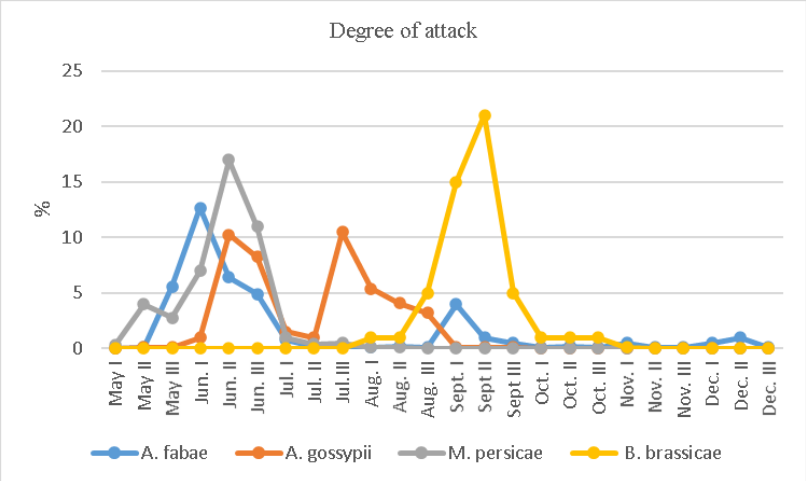

Figure 2. Degree of attack (DA%) of aphid species with economic importance in vegetable crops at VRDS Bacău, influenced by climatic conditions in 2023

- ***B. brassicae*** peaked later in the season, with an increase in DA% in early September, peaking at 21% in the second decade of the month. This coincides with more moderate temperatures (around 18°C) and very high relative humidity of over 73%. The activity of this species in the fall suggests greater sensitivity to low temperatures and high humidity. The research in the field suggests that aphid's development is optimal

between 15-25°C, with peak fertility at 20°C (Soh *et al.*, 2018). Population dynamics show seasonal variations, with highest numbers observed in late autumn to early spring when temperatures are moderate (10-25°C) and relative humidity is high (38-92%) (Maurya and Sharma, 2016; Yadav and Agrawal, 2018).

CONCLUSION

The year 2023 was marked by significant variations in weather conditions. Temperatures and humidity showed fluctuations that directly influenced growing conditions and crop health. Precipitation was uneven, with dry spells and heavy rains influencing leaf wetness. Wind speed was generally low, suggesting relatively calm conditions for vegetable crops. These climatic variables are key to understanding the impact on pest infestation and appropriate crop management.

Aphis fabae - Present in crops from May through December, indicating that the species can be a problem throughout the vegetable growing season, with a continuous presence and requiring long-term management.

The data collected in 2023 are important for planning and implementing pest management strategies in vegetable crops at VRDS Bacău to reduce pest damage from this species in the coming years.

In order to obtain a complete and robust understanding of the impact of these climatic variables on the degree of infestation of aphids and other pests, long-term studies are needed. Such studies would allow the identification of clear trends and long-term correlations, contributing to the development of effective agricultural management and plant protection strategies.

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REFERENCES

1. Almogdad M., Lavrukaitė K., Semaškienė R. *Temporal Analysis of the Relationship between Black Bean Aphid (Aphis fabae) Infestation and Meteorological Conditions in Faba Bean (Vicia faba).* Agronomy, 2024, 14 (6): 1182.
2. Antolínez C.A., Marini X., Stelinski L.L., Rivera M.J. *Wind speed and direction drive assisted dispersal of Asian citrus psyllid.* Environmental Entomology, 2022, 51 (2): 305-312.
3. Baker M.B., Venugopal P.D., Lamp W.O. *Climate change and phenology: Empoasca fabae (Hemiptera: Cicadellidae) migration and severity of impact. PLoS One*, 2015, 10 (5): e0124915.
4. Bărăscu N. Donescu D., Donescu V., Urdă C. *Monitoring of aphids species in the potato crop from "Țara Bârsei*". Romanian Agricultural Research, 2022, 39: 489-496.
5. Chiriloaie-Palade A., Radulea M., Lămureanu G., Mocanu S. I., & Iamandei M. *Study regarding the aphidofagous fauna structure in the peach orchards from Constanta county in 2020*. *Romanian Journal for Plant Protection*, 2020, 13: 110-114.
6. Ciornei L., Udrea L., Munteanu P., Simion P.S., Petcu V. *The effects of climate change. trends regarding the evolution of temperature in Romania*. Annals of "Valahia" University of Târgoviște. Agriculture, 2023, 15 (2): 50-57.
7. Dampc J., Mołoń M., Durak T., Durak R. *Changes in aphid—plant interactions under increased temperature.* Biology, 10 (6): 480.
8. Filimon R.M., Bunea C.I., Filimon R.V., Bora F.D., Damian D. *Long-term evolution of the climatic factors and its influence on grape quality in Northeastern Romania*. Horticulturae, 2024, 10 (7): 705.
9. Grozea I., Chis C., Grozea A., Stef R., Virteiu A.M. *Control of Phytophagous aphids in urban green spaces through environmentally friendly ways.* International Multidisciplinary Scientific GeoConference: SGEM, 2023, 23 (6.2): 93-100.
10. Jovičić I.S., Vujadinović M.P., Vuković A.J., Radonjić A.B., Petrović-Obradović O.T. *Effects of temperature on Acyrthosiphon pisum and Therioaphis trifolii (Hemiptera: Aphididae) abundance in alfalfa crops: A case study in northern Serbia*. Journal of Agricultural Sciences, 2022, 67 (3): 269-283.
11. Liu J., Liu Y., Li Q., Lu Y. *Heat shock protein 70 and Cathepsin B genes are involved in the thermal tolerance of Aphis gossypii.* Pest Management Science, 2023, 79 (6): 2075-2086.
12. Liu J., Wang C., Desneux N., Lu Y. *Impact of temperature on survival rate, fecundity, and feeding behavior of two aphids, Aphis gossypii and Acyrthosiphon gossypii, when reared on cotton.* Insects, 2021, 12(6): 565.
13. Luquet M., Poggi S., Buchard C., Plantegenest M., Tricault Y. *Predicting the seasonal flight activity of Myzus persicae, the main aphid vector of Virus Yellows in sugar beet*. Pest Management Science, 2023, 79 (11): 4508-4520.
14. Mackoś-Iwaszko E., Lubiarz M., Karczmarz K. *The impact of urban conditions on the occurrence of aphids on Acer platanoides L.* Acta Scientiarum Polonorum-hortorum Cultus, 2015, 14: 189-207.
15. Maurya V., Sharma K. *Seasonal incidence of Brevicoryne brassicae and Plutella xylostella on Brassica oleracea in Rohtak District.* Annals of Plant Protection Sciences, 2016, 24 (2): 319-323.
16. Neupane S., Subedi S. *climatic factors affecting the population dynamics of lentil aphid in Inner Terai Region of Nepal*. SAARC Journal of Agriculture, 2020, 17: 155-164.

17. Nguyen B.H., Gilbert G.S., Rolandi M. *A bio-mimetic leaf wetness sensor from replica molding of leaves.* Advanced Sensor Research, 2023, 2 (6): 202370014.
18. Ramadan M.M., Bayoumy M., Afifi M. *Ecological studies on the Peach green aphid, Myzus persicae and its natural enemies.* Journal of Plant Protection and Pathology, 2022, 13 (1): 29-35.
19. Soh B.S.B., Kekeunou S., Nanga Nanga S., Dongmo M., Rachid H. *Effect of temperature on the biological parameters of the cabbage aphid Brevicoryne brassicae.* Ecology and Evolution, 2018, 8 (23): 11819-11832.
20. Tolba E.F. *Population gluctuation of the green peach aphid, Myzus persicae (SULZ.) (Homoptera: Aphididae) infesting canola plants at Assiut Area.* Journal of Plant Protection and Pathology, 2020, 11 (1): 15-18.
21. Wains M.S., Javaid M.M., Afzal M.B.S., Ali H.A., Sarfraz M., Banazeer A., Aslam M.N. *Surveillance and evaluation of climatic factors on varietal screening against aphid population in wheat.* Pakistan Journal of Biotechnology, 2023, 20 (2): 371-375.
22. Ximénez-Embún M.G., Glas J.J., Ortego F., Alba J.M., Castañera P., Kant M.R. *Drought stress promotes the colonization success of a herbivorous mite that manipulates plant defenses*. Experimental and Applied Acarology, 2017, 73: 297-315.
23. Yadav N., Agrawal N.: *Seasonal abundance of Brevicoryne brassicae and their predators under different field of cabbage in relation to weather parameters*. Journal of Entomology and Zoology Studies, 2018, 6: 1098-1101.
24. Zamani A., Talebi A., Fathipour Y., Baniameri V. *Temperature-dependent functional response of two aphid parasitoids, Aphidius colemani and Aphidius matricariae (Hymenoptera: Aphidiidae), on the cotton aphid*. Journal of Pest Science, 2006, 79: 183-188.