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INFLUENCE OF IRRIGATION ON APHID INFESTATION IN MAIZE

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Abstract. *Maize (Zea mays L.) is a crucial crop for both Ukraine and the global agricultural sector, serving as a key staple and export commodity. Ukraine ranks among the top ten maize producers worldwide, with annual production reaching 27–35 million tons and exports of 20–25 million tons. Irrigation significantly enhances maize yield, potentially increasing productivity from 6.8–7.0 tons per hectare to 12–15 tons per hectare. Given the importance of maize for food security, economic stability, and international trade, understanding factors that influence its productivity is essential. One of the major challenges in the Steppe, Forest-Steppe, and Polissia regions of Ukraine is the irregular water regime, which limits the full utilization of soil potential. Effective irrigation management not only improves water use efficiency and soil health but also promotes the proliferation of beneficial organisms, contributing to increased crop resilience.*

This study, conducted from 2020 to 2023 in the Kyiv region, investigated the development and population dynamics of aphids (Aphididae spp.) on irrigated and non-irrigated maize, alongside the role of natural predators in regulating aphid abundance. Experimental plots of 50 m² were established using a randomized design with four replications. The maize hybrid P9074 (FAO 330) was grown under controlled irrigation with water-jet sprinklers, while control plots relied on natural precipitation. Meteorological data, including air temperature, precipitation, and the Selyaninov hydrothermal coefficient (SHC), were recorded to assess their impact on aphid population density.

Results indicated that aphid infestation was higher on irrigated plots, particularly during the tassel emergence and flowering stages. Average infestation in irrigated areas reached 47.8 % during maize ripening, compared to 42.8 % in non-irrigated fields. A moderate negative correlation was found between precipitation and aphid infestation (r = -0.34), while a weak positive correlation existed with air temperature (r = 0.19). Irrigation was found to modify the microclimate significantly, reducing air temperature by 2.4–6.1 °C and increasing humidity to 78–100 %, depending on timing and water volume, with nocturnal irrigation producing the most gradual changes.

In addition, irrigation enhanced the abundance of natural aphid predators. Populations of Coccinellidae and Chrysopidae were 2.2 and 1.7 times higher, respectively, in irrigated fields compared to non-irrigated plots. Key predator species, including Chrysopa carnea Steph., played a critical role in controlling aphid populations, demonstrating that irrigation can indirectly support biocontrol mechanisms.

Overall, the study highlights that irrigation not only increases maize productivity but also influences aphid population dynamics and predator activity. These findings emphasise the importance of integrated water and pest management strategies to optimise crop yields and strengthen the ecological resilience of maize agroecosystems in Ukraine.

Keywords*: aphid, irrigation, maize, agrocenosis, predator*

Relevance of the research. Maize is a staple foodstuff which has been cultivated for thousands of years, and it is also very important crop for Ukraine. Country is one of the top 10 global producers and is a leader in exports. It produces 27–35 million tons annually and exports 20–25 million tons [1]. The estimated yield is from 6.8 to 7 tons per hectare with drip irrigation it can be from 12 to 15 tons per hectare [2]. This highlights its importance for domestic food security, the national economy, and global grain markets [3].

The impact of stress on maize production is a matter of significant concern, with the potential for deleterious consequences on food security. The predominant constraint on maize productivity in the Steppe and Forest-Steppe regions of Ukraine, and more recently in the Polissia region, is the unfavourable water regime of the soil, which hinders the realisation of the agricultural potential of these territories [4]. The implementation of irrigation enhances soil health through optimised water utilisation, mitigated erosion, and facilitated proliferation of beneficial microbes and thereby promoting increased crop yields [5].

Analysis of recent research and publications. Gebretsadik K.G. et al. [6] have stated that aphids are considered to be highly destructive agricultural pests, characterised by complex life cycles and phenotypic variability, facilitating their adaptation to diverse climates and host plants.

A study undertaken by Mahmoud H. et al. [7] established that aphids appeared at the middle of July and reached their highest number in the III decade of August – I decade of September, when the maize plants were at ripening stage. From the second week of September, the number of aphids started to go down.

For most species of aphids, the optimal temperature for development is in the range of 20–25 °C, while a temperature close to 30 °C is lethal [8]. Kuroli G. and Lantos Z. [9] recorded changes in the number of aphids and where they were located on maize crops from July to late October. Based on the results of 20 years, 52.3 % of the change in the number of maize-colonizing aphids is explained by the temperature, precipitation and relative humidity, as seen from the determination coefficient.

As demonstrated by Sana B. et al. [10], biotic factors, including but not limited to crowding, host plant quality, natural enemies (e.g., ladybirds, lacewings) have been shown to influence aphid survival and behaviour. It is noteworthy that natural predators of aphids exhibit reduced effectiveness in areas characterised by diminished biodiversity and augmented agricultural intensification [6].

It is imperative to implement meticulous irrigation management techniques to ensure a balanced equilibrium between plant health and pest control. Also, timely pest and disease control is crucial for maize, which is vulnerable to numerous insect pests affecting both aboveground and underground plant parts [11].

Corn leaf aphid (CLA; Rhopalosiphum maidis) is an economically important pest of maize and several other monocot crops [12, 13]. In addition to crop damage, CLA acts as a vector for viruses that cause devastating diseases in maize.

The present study aimed to investigate the effect of biotic and abiotic factors on the most important insect pests of maize. Consequently, constant monitoring of aphid population density in maize crops will allow us to study the impact of irrigation on the characteristics of aphid colonization of crops. The study of the formation of the species composition of aphids and their density in irrigated conditions in order to clarify the timing of protective measures on corn crops is relevant.

Material and methods. The study was carried out from 2020 to 2023 in Kyiv region, Ukraine (50.289959° N and 31.157489° E). The characteristics of aphid colonies under various management conditions of maize hybrid P9074 (FAO 330) cultivated were examined. The variant of the experiment involved studying the number of aphids present under irrigation conditions (control of the variant – natural moistening of the area). The experimental plots were of a size of 50 m², with dimensions of 10.4 m × 4.8 m. The experiment was conducted using a randomised design with four replications.

The irrigation of the plots was facilitated by a watering system comprising a water-jet rain gun. The sprinkler head, in consideration, has a water spray radius of 20–35 m and adjustable water jet pressure. The provision of water to the site was enabled by the implementation of a motor pump, which was connected to a fire hose. Water was collected from a network of water-filled canals situated in close proximity to the experimental plots. Irrigation was carried out by sprinkling in the morning, afternoon, and night hours at different watering rates from June to July.

The climatic characteristic of the research area is the presence of substantial heat and variable moisture levels [14]. The lowest average monthly temperature recorded in January was −8.7 °C, while the highest was −3.2 °C.

The lowest average monthly temperature recorded in July was 14.0 °C, while the highest was 25.4 °C. During the period of vegetation growth, the total precipitation was 429 mm, with 225 mm occurring during the summer months. The mean annual relative air humidity is 76 %, with a range of 64 to 88 % per month.

The Chernozem, which has undergone podsolisation and developed on a layer of loess rock, characterises the soil of the experimental plots. The proportion of physical clay in the layer of 0–25 cm is 27.1 %, in 25–50 cm is 26.2 %, and in 50–100 cm is 24.6 %. The soil organic matter content in the 0–50 cm is 2.35 %. The salinity degree in the plots is not saline, as the salt content does not exceed 0.064 %. The sodium content of a one-metre layer of soil is shown to be less than 0.04 % of the total absorbed cation content, thus indicating that the soil is non-saline.

The Selyaninov hydrothermal coefficient (SHC) was calculated using the formula:

$$\mathrm{SHC} = R \times 10 / \Sigma t, \qquad (1)$$

where R – the sum of precipitation in mm over the growing season (April – September) with temperatures above +10 °C;

Σt – the sum of temperatures in degrees Celsius (°C) over the same period.

The aphid colonies were monitored from mid-June, in conjunction with observations of the development of stem butterflies in maize during the phase of maize growth and development, which corresponded to the onset of tassel emergence. Observations were conducted on a daily basis for tassels, stems, leaves, cobs, and cob legs for the presence of aphids until the phase of full ripeness of maize. The onset of plant infestation and subsequent colony formation was observed at a plant infestation level of 10 %, with an aphid population of 150 individuals per 10 plants [15]. The degree of aphid infestation was determined by visual inspection of 100 plants on a 9–point scale.

The surveys were conducted by inspecting 10 crop plants in 10 random locations of the plots under irrigation, as well as non-irrigated. During the observation, two lines on each plot with the configuration of the route are analogous to the letter X were traversed.

The degree of threat to maize plants determined through the coefficient of aphid infestation by the formula:

$$K = a \times b, \qquad 100\ (2)$$

where K – the coefficient of aphid infestation;

a – the proportion of plants infested with aphids;

b – the average score of plant infestation.

Observations of beneficial entomofauna on phytophagous insects in maize fields were conducted daily, encompassing the enumeration of their adult and larval populations in conjunction with the quantification of aphid colonies on maize plants. After the enumeration process, the arithmetic mean of the number of entomophages per 100 aphid colonies was calculated.

The statistical significance of an analysis of variance (ANOVA) was conducted using SPSS 19.0 software.

Results and discussion.

Meteorological conditions during the experiment

In the study area of the Kyiv region, the following aphid species were identified as the primary cause of damage to maize plants: the common cereal aphid (*Schizaphis graminum* Rond.) and the bird cherry aphid (*Rhopalosiphum padi* L.). The number of aphids exhibited a complex and fluctuating dynamic.

A comparison of the weather conditions experienced during the research period in Kyiv region with the proportion of damaged plants indicates that the number of aphid colonies is at its maximum in years characterised by a significant increase in summer air temperatures, provided that there is sufficient moderate moisture,

1. Scale for assessing the degree of maize colonisation by aphids

The 9 score	The degree of colonisation	Occupied by colonies of the leaf surface, % and signs of the pest presence
1	initial	single individuals, <5, leaves without visible changes
2–3	weak	5–25, the presence of reddish-light yellow dots covering up to 5 % of the surface
4–5	average	26–50, pale yellow or reddish spots with purple margins covering 6–30 % of leaf surface
6–7	strong	51–75, the plant has a discoloured sheath, a corrugated and twisted plate of the upper leaf
8–9	very strong	76–100, plant withers, dries up

particularly during the period of intensive plant growth (tassel emergence). The findings of the study by Carena M. and Glogoza Ph. [16] also indicate that climatic conditions have a significant effect on the rate of colony development and the amount of grain yield reduction.

A thorough examination of the meteorological conditions during the study period reveals that the aggregate of active temperatures in 2020 and 2022 exceeded the long-term average by approximately 180 °C, while in 2023, it approached 240 °C. The 2021–2023 growing season was marked by sufficient moisture levels (SHC was 1.23–1.58), in contrast to the 2020 season where the SHC was recorded at 0.78, indicating notably arid conditions during the growing period (Table 2).

The substantial quantity of precipitation, devoid of substantial rainfall, resulted in a considerable proliferation of aphids. Conversely, arid conditions curtailed their population, concomitantly expediting the progression of plants through the phenophases of crop development. Another analysis by Csorba A.B. et al. [17] demonstrates a strong correlation between increases in the population sizes of corn leaf aphids and climate change, thereby indicating a potential link between environmental shifts and the observed increase in the prevalence and distribution of the aforementioned pests.

Features of aphid settlement in different conditions

A comparative analysis was conducted on the infestation levels of maize plants cultivated under irrigated conditions and without irrigation. The results of this analysis revealed that the former group exhibited a significantly higher incidence of aphids compared to the latter. Consequently, during the period spanning from 2020 to 2023, specifically in the phase of tassel emergence and flowering, which transpired in late June and early July, the pest infestation on irrigated crops exhibited an average prevalence of 25.0 %, accompanied by an average infestation score of 1.48. Concurrently, the infestation rate was recorded at 0.38. In the plots without irrigation, the average population of plant pests in the tassel emergence-flowering phase of maize was 18.0 %, with an average population score of 1.38. The population coefficient was 0.26 (Table 3).

Thereafter, an increase in the population density of cereal aphids in maize was observed. A study conducted during the waxy ripeness phase of maize revealed that the aphid population of crop plants in irrigated areas exhibited an average of 47.8 %, with an average population score of 2.78. Concurrently, the population coefficient 1.35 was determined. In contrast, on maize without irrigation, the pest infestation of plants averaged 42.8 %, with an average infestation score of 2.75, and an infestation rate of 1.2.

The effect of temperature and humidity on aphid reproduction

The substantial presence of pests on maize under irrigation can be attributed to the creation of optimal conditions for the reproduction of the phytophage, particularly concerning air

2. Meteorological conditions of the growing season

Indicator (average)	2020	2021	2022	2023	Long-term
Sum of active temperature (SAT) of IV–IX months, °C	3005.1	2833.1	3007.1	3063.6	2825.0
Sum of effective temperature, (>10°C) (SET) of IV–IX months, °C	1415.1	1363.1	1257.7	1463.6	1300.0
Sum of precipitation for IV–IX months, mm	235.4	371.8	476.6	375.4	343.0
SHC	0.78	1.31	1.58	1.23	1.21

3. Colonisation of maize plants by aphids

Year	Populated plants, %	score	Irrigation coefficient of colonisation	Populated plants, %	Score	Non-irrigation coefficient of colonisation
tassel emergence-flowering phase						
2020	27.0	1.4	0.38	18.0	1.4	0.25
2021	20.0	1.4	0.28	12.0	1.2	0.14
2022	31.0	1.8	0.56	25.0	1.7	0.43
2023	22.0	1.3	0.29	17.0	1.2	0.20
waxy grain ripeness						
2020	60,	3.0	1.80	51.0	3.0	1.53
2021	38.0	2.6	0.99	32.0	2.5	0.80
2022	54.0	3.0	1.62	52.0	3.0	1.56
2023	39.0	2.5	0.98	36.0	2.5	0.90

temperature and humidity, as well as the plant's condition. As Tali M.K. et al. [18] noted, the mean aphid population exhibited a significant positive correlation with mean atmospheric temperature. Also, the pivotal role of relative air humidity in the proliferation and reproduction of aphids on maize. Favourable conditions for the intensive reproduction of these phytophages on plants are created when a percentage exceeding 60 % [19].

Concurrently, it is imperative to acknowledge that the irrigation of maize engenders pronounced fluctuations in air temperature and relative humidity. These fluctuations exert a deleterious effect on the reproduction and development of numerous species of aphids. The study in Kyiv region of the watering rate on changes in the microclimate of the experimental plot indicates that the minimum rate of 2 m³ per hectare does not affect changes in air temperature. However, the rate of two times has been shown to lead to a short-term decrease in air temperature (1 hour) by 0.9 °C and an increase in air humidity by 17.0 %. Based on irrigation data, including time of day and irrigation water discharge rate, as well as weather data, an analysis of the impact of irrigation on changes in microclimate in maize was conducted.

Irrigation in the morning hours

The irrigation at a rate of 50 m^3/ha in the morning (8–12 a.m.), the air temperature decreased by 2.4 °C from 16.7 °C to 14.3 °C, and the air humidity increased by 51.9 % from 48.0 % to 99.9 %. Over the next 3 hours, the air temperature increased by 5.7 °C from 14.3 °C to 20.0 °C, and the air humidity increased by 48 % from 99.9 % to 51.9 %.

The norm of irrigation of 110 m^3/ha in period 10–11 a.m. the average air temperature increased from 17.2 °C to 21.6 °C, and the air humidity decreased from 52.0 % to 36.5 %.

Consequently, the implementation of irrigation during the morning hours, contingent on the output rate, results in a short-term decline in temperature and an augmentation in air humidity. After the cessation of irrigation, an augmentation in temperature and a diminution in air humidity to reference values for days without irrigation were observed over the ensuing hours.

Irrigation during the day.

At a rate of 100 m^3/ha from 1–3 p.m. the average air temperature decreased from 27.8 °C to 25.1 °C, the air humidity increased from 63.4 % to 67.4 %, and over the next 2 hours it dropped to 58.4 %.

An 8-hour irrigation cycle with an irrigation rate of 252 m^3/ha conducted in the morning and afternoon resulted in a decline in air temperature from 17.2 °C to 16.1 °C, accompanied by an augmentation in air humidity from 84.4 % to 99.9 %. Over the subsequent five-hour period, the air temperature increased from 16.1 °C to 20.8 °C, while the air humidity gradually decreased from 99.9 % to 73.2 %.

The irrigation at a rate of 450 m^3/ha from 11 a.m. to 1 p.m. resulted in a decline in air temperature of 6.1 °C and an increase in air humidity of 35.5 %. Subsequent to the cessation of watering, a rise in air temperature from 23.3 °C to 33.6 °C was observed, accompanied by a precipitous decline in air humidity from 80.8 % to 30.1 %.

The watering with rate of 150 m^3/ha in the afternoon (3–6 p.m.) the air temperature decreased by 4.5 °C in the first hour from 31.8 °C to 27.3 °C, and by 16.3 °C in the next three hours. At the same time, air humidity increased by 64.3 % from 33.8 % to 98.1 %. Two hours after the end of irrigation cycle, the air temperature increased by 2.0 °C from 16.3 °C to 18.3 °C, and the air humidity decreased by 24.6 % from 98.1 % to 73.5 %.

Therefore, during periods of high air temperatures (29.3 C – 33.6 C), the short-term irrigation with high rate of irrigation results in immediate, though transient, alterations to the microclimate of the agrocenosis. This option has a detrimental effect on the number of maize phytophages, especially aphids. The population of these insects can be significantly reduced through the process of defoliation, whereby the maize leaves are removed.

Irrigation at night hours.

During 4 hours of sprinkling with 30 m^3/ha at night (11 p.m – 1 a.m.) the air temperature decreased by 6.5 °C from 23.7 °C to 17.2 °C, the air humidity increased by 53.3 % to 99.9 % and remained at this level for 10 hours after the start of irrigation.

The irrigation with rate of 300 m^3/ha in period of 6–9 p.m. the average air temperature decreased by 5.4 °C from 22.8 °C to 17.4 °C, the air humidity increased from 89.9 % to 99.9 %, remaining at the same level for the next 9 hours.

The irrigation of 150 m^3/ha over 8 hours at night (8 p.m. – 3 a.m.) resulted in a decrease in air temperature by 3.9 °C and an increase in air humidity by 24.7 % from 75.2 % to 99.9 %. After 7 hours, the air temperature increased by 4.4 °C, and the air humidity decreased by 25.8 % from 99.9 % to 74.2 %. The rate of irrigation of 150m^3/ha was poured from 11–12 p.m. based on this the average air temperature decreased by 0.9 °C from 17.3 °C to 16.4 °C, and the air humidity increased from 88.3 % to 99.8 %, remaining at the same level for the next 9 hours.

At an irrigation rate of 300 m^3/ha with irrigating from 1 to 4 a.m. the average air temperature decreased by 4.5 °C from 22.8 °C to 18.3 °C, the air humidity increased from 87.1 % to 99.9 %, remaining at the same level for the next 9 hours.

It was determined that the irrigation during the evening and night-time, even under lower rate of irrigation, can result in a substantial increase in air humidity, reaching a level of 99.9 % over an extended period. The air temperature in maize agrocenoses after irrigation decreased by an average of 4.3 °C (0.9 °C –6.5 °C).

Furthermore, an investigation into the impact of weather conditions, specifically air temperature and precipitation, during the period of June to September, revealed an inverse proportional relationship between precipitation and the coefficient of aphid infestation of maize plants (r = -0.34) and a weak direct relationship between air temperature and the coefficient of aphid infestation of maize plants (r = 0.19) (Table 4).

Irrigation effects on aphids and predators in maize.

It was observed that the incidence of aphids on maize occurred at approximately the same time during the research period. The winged settlers were first observed on the plants in early June. The presence of phytophage colonies was identified in the initial and subsequent decades of July, with a marked increase in the number of pests during the late July to mid-August period.

During the last decade of August and the first decade of September, elevated air temperatures induced accelerated maturation of the cobs and consequent release of moisture to the maize, thereby resulting in the occurrence of black layer on the maize kernel. As previously stated, the appearance of a black spot on the base of the kernel is indicative of the plant's inability to receive nutrients from the plant, thus leading to the death of the plant itself. Concurrently, the leaves of the crop rapidly desiccated from the base to the apex. Aphid colonies were relocated to the upper green leaves of maize in order to continue feeding on them. The presence of a black layer on the maize kernel in late August suggests that the crop yield is no longer affected by aphids.

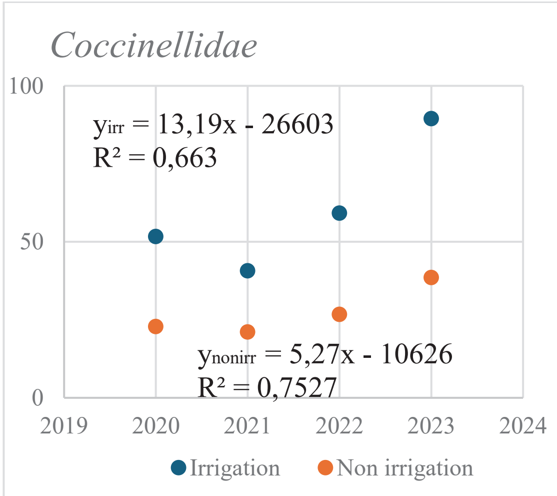
The irrigation in maize cultivation has been demonstrated to result in a substantial augmentation in the abundance and ecological significance of entomophages, concurrently enhancing the resistance and compensatory capacity of the plants themselves. It was determined that this action serves to mitigate the adverse effects of aphid infestation. The study revealed that representatives of the order Coleoptera, specifically the seven-point ladybird (*Coccinella septempunctata* L.), the variable ladybird (*Hippodamia (Adonia) variegata* Gz.) and the five-point ladybird (*Coccinella quinquepunctata* L.), exhibited remarkable efficacy in the regulation of aphids at all stages of their development. During the period of tassel emergence, a greater number of entomophagous insects was found under irrigation conditions. The mean number of representatives of Coccinellidae averaged 40.8–89.6 individuals per 100 aphid colonies, which was 2.2 times higher than in conditions without irrigation (Figure 1).

The presence of the fourteen-spotted ladybird (*Calvia quatuordecimguttata* L.), the fourteen-spotted propylea (*Propylea quatuordecimpunctata* L.), the Asian harmony (*Harmonia axyridis* Pall.) and the two-spotted ladybird (*Adalia bipunctata* L.) was also confirmed in Kyiv region. In some research, as Carena & Glogoza (2004) have previously indicated, the utilisation of natural predators to control the corn leaf aphid has been demonstrated to be an effective strategy, in addition to the employment of biochemical and physical barriers [16].

In July, the highest density of predators from the family Chrysopidae (larvae and adults) was observed, and these predators were found to be actively destroying aphids. Observations revealed a greater number of these predators at the stage of tassel formation on maize under irrigation.

4. Influence of weather conditions on aphid infestation in maize

Indicator	2020	2021	2022	2023	Average
the relationship between precipitation and					
% of plants infested with aphids	−0.18	−0.08	−0.26	−0.55	−0.27
score	−0.38	−0.06	−0.28	−0.23	−0.24
coefficient of colonisation	−0.42	−0.12	−0.30	−0.51	−0.34
the relationship between air temperature and					
% of plants infested with aphids	0.04	−0.02	0.23	0.40	0.16
score	0.06	0.23	0.28	0.29	0.22
coefficient of colonisation	−0.03	0.12	0.28	0.37	0.19



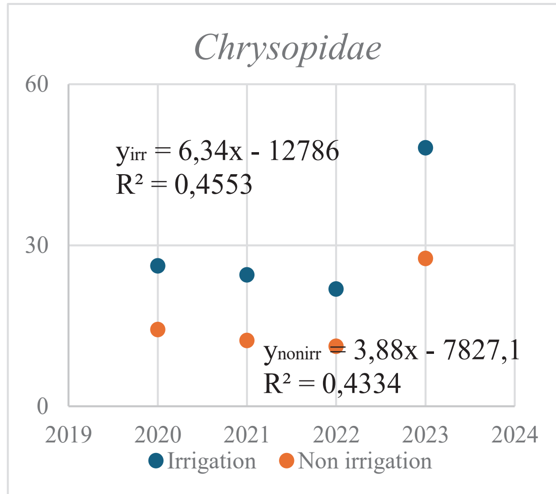


Fig. 1. The number of entomophages on maize under different conditions

The mean number of Chrysopidae representatives was found between 15.9 and 48.2 specimens per 100 aphid colonies, which was 1.7 times higher than the mean number observed in conditions without irrigation. This phenomenon can be attributed to the increased density of the aphid population in irrigated maize fields. The most prevalent species among the entomophages was the common goldeneye (*Chrysopa carnea* Steph.).

Furthermore, the presence of flies belonging to the family Syrphidae (*Diptera: Syrphidae*) was detected, including the bandaged syrphus (*Syrphus ribesii* L.), the marmalade fly (*Episyrphus balteatus* De Geer) and the decorated syrphus (*Sphaerophoria scripta* L.). The impact of predatory gall midges (*Diptera: Cecidomyiidae*), specifically *Aphidoletes aphidimyza* Rond., on the population dynamics of aphids was examined. The results indicated that these insects had minimal impact on aphid abundance due to their low population density. The presence of certain species of predatory insects was found to be random, presumably due to the proximity of other agrocenoses to maize. The presence of a sufficient food source in irrigated conditions attracted entomophages and contributed to their survival and propagation.

Conclusions. In the research area of Kyiv region, the following aphid species were observed to be predominantly responsible for the colonisation and damage to maize plants: the common corn aphid (*Schizaphis graminum* Rond.) and the cherry aphid (*Rhopalosiphum padi* L.).

The implementation of irrigation has been demonstrated to effect alterations in the microclimate of maize, with a decline in air temperature ranging from 2.4 °C to 6.1 °C, contingent on the prevailing conditions and the quantity of water employed. Concurrently, the humidity level has been shown to increase to 78–100 %. It has been demonstrated that nocturnal irrigation is the most gradual method of altering temperature and humidity. During the process of maize ripening in irrigated areas, the average aphid infestation was recorded to be 47.8 %, with an infestation score of 2.78 and a coefficient of 1.35. In non-irrigated maize, the infestation rate averaged 42.8 %, with an average score of 2.75 and a coefficient of 1.2.

The study established a moderate negative correlation between precipitation and the aphid infestation coefficient ($r = -0.34$) and a weak positive correlation between air temperature and infestation ($r = 0.19$).

The increased aphid density in irrigated maize fields resulted in a 2.2-fold higher mean number of Coccinellidae and a 1.7-fold higher mean number of Chrysopidae compared to non-irrigated conditions. The findings demonstrate that irrigation supports greater predator abundance, particularly of key species like *Chrysopa carnea* Steph., thereby enhancing natural aphid control in maize agroecosystems.

Conflicts of interest: the authors declare no conflict of interest.

Use of artificial intelligence: the authors confirm that they did not use artificial intelligence technologies during the creation of this work.

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ВПЛИВ ЗРОШЕННЯ НА ЗАСЕЛЕННЯ КУКУРУДЗИ ПОПЕЛИЦЕЮ

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Анотація. *Кукурудза (Zea mays L.) є важливою культурою для аграрного сектора як України, так і для світу, оскільки є основним товаром для експорту. Україна входить до десятки найбільших виробників кукурудзи в світі з річним виробництвом 27–35 мільйонів тон та експортом 20–25 мільйонів тон. Зрошення значно підвищує врожайність кукурудзи, потенційно збільшуючи врожайність з 6,8–7,0 т/га до 12–15 т/га. Враховуючи важливість кукурудзи для продовольчої безпеки, економічної стабільності та міжнародної торгівлі, розуміння факторів, які впливають на її продуктивність, має важливе значення. Однією з основних проблем Степу, Лісостепу та Полісся України є нерівномірний водний режим, що обмежує повне використання потенціалу родючості ґрунту. Ефективне управління зрошенням не тільки покращує ефективність використання води, але й сприяє розмноженню корисних організмів, поліпшуючи здоров'я екосистеми ґрунту та сприяючи підвищенню стійкості врожаю сільськогосподарських культур.*

У цьому дослідженні, яке проводилося з 2020 по 2023 рік у Київській області, вивчався розвиток та динаміка популяцій попелиць (Aphididae spp.) на зрошуваних та незрошуваних посівах кукурудзи, а також роль природних хижаків у регулюванні чисельності попелиць. Експериментальні ділянки площею 50 м² були створені за допомогою рандомізованого дизайну за чотирьох кратного повторення. Гібрид кукурудзи P9074 (ФАО 330) вирощували в умовах контрольованого зрошення, тоді як контрольні ділянки закладалися за природного – у вигляді опадів. Для оцінки впливу на щільність популяції попелиці реєстрували метеорологічні дані, включаючи температуру повітря, опади та гідротермічний коефіцієнт.

Результати показали, що заселення попелицею рослин кукурудзи було вищим на зрошуваних ділянках, особливо у фенофазу викидання волоті та цвітіння. Середня заселеність на зрошуваних площах досягла 47,8 % під час дозрівання кукурудзи порівняно з 42,8 % на незрошуваних полях. Помірну негативну кореляцію виявлено між сумою опадів і заселенням попелицями (r = −0,34), а слабку позитивну між температурою повітря і заселенням попелицями (r = 0,19). Було відмічено, що зрошення суттєво змінює мікроклімат, знижуючи температуру повітря на 2,4–6,1 °С і підвищуючи вологість до 78–100 %, залежно від часу проведення цього агроприйому та об'єму використаної води. При цьому полив у вечірні та нічні години найбільш плавно впливав на зміну температури і відносної вологості повітря.

Крім того, зрошення збільшувало чисельність природних хижаків попелиці. Щільність популяції представників родин Coccinellidae та Chrysopidae була в 2,2 та 1,7 рази відповідно вищою на зрошуваних полях, порівняно з незрошуваними ділянками. Ключові види хижаків, у тому числі Chrysopa carnea Steph., відіграли вирішальну роль у контролі популяцій попелиці. Це вказує на те, що зрошення може опосередковано підтримувати механізми біоконтролю.

Загалом дослідження підкреслює, що зрошення не тільки підвищує продуктивність кукурудзи, але також впливає на динаміку популяції попелиці та активність хижаків. Ці результати висвітлюють важливість інтеграції зрошення посівів культури із стратегією боротьби зі шкідниками для посилення екологічної стійкості агроекосистем кукурудзи та оптимізації її врожайності в Україні.

Ключові слова: *попелиця, зрошення, кукурудза, агроценоз, ентомофаг*