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IMPACT OF WEED INFESTATION ON PROJECTIVE SOIL COVER CHANGES DURING THE SUNFLOWER VEGETATION PERIOD

Weed infestation is one of the key factors influencing the formation of plant cover in agroecosystems. In the context of sunflower cultivation, projective soil cover varies depending on the intensity of weed competition, especially during critical periods of vegetation.

Purpose. To determine the effect of varying levels of weed competition on the dynamics of projective cover in sunflower crops throughout the growing season.

Methods. Field experimentation, laboratory-analytical methods, and statistical analysis.

Results. An increase in the duration of weed competition led to a consistent reduction in plant biometric parameters (height, leaf area), projective crop cover, and yield. The highest yield was recorded under full-season weed control, which served as the benchmark for evaluating other treatments. Even short-term weed competition caused a notable yield reduction. Extending the weed-free period improved growth indicators but did not fully compensate for productivity losses. The first month of vegetation was identified as the critical competition period. Limiting weed infestation during the first 30–45 days after emergence significantly improved plant growth, leaf area development, and projective soil cover. The most effective projective cover and biomass accumulation were observed when weed competition was entirely eliminated during this early phase—crucial for ensuring full crop development. Weed spread in later stages had a less pronounced impact on plant morphology but impeded harvesting and increased the risk of secondary field infestation. In contrast, prolonged weed competition suppressed crop development, reduced leaf area, and decreased yield.

Conclusions. The findings confirm the importance of weed control during critical biomass formation periods to support the soil-protective function of crops and ensure stable production. The proposed approaches can be used to improve sunflower cultivation technologies, taking into account environmental conditions.

KEYWORDS: *sunflower, weed infestation, competition, projective cover, biometric indicator, yield*

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Introduction

One of the key conditions for the effective cultivation of agricultural crops is the control of weed infestation in agrocenoses, particularly in industrial crops such as sunflower. Weeds not only reduce yields by competing for moisture, light, and nutrients but also alter the spatial structure of the phytocenosis, especially its projective cover. This indicator serves as a marker of crop stand condition and allows for the assessment of competitive interactions between crops and weeds. Furthermore, the dynamics of projective cover throughout the growing season can reflect the effectiveness of agronomic weed control measures and indicate the agroecological balance within the phytocoenosis.

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Despite a considerable body of research on weed management in agroecosystems, the relationship between weed infestation levels and changes in the projective cover of sunflower during the growing season remains insufficiently explored. This underscores the need for further investigation into the spatial structure of agrocenoses under weed pressure, with the aim of optimizing sunflower cultivation technologies and improving their agroecological efficiency.

The problem of weed infestation in sunflower crops remains relevant both in Ukraine and internationally. Weeds not only reduce yields but also negatively affect the morphological traits of crops. International studies emphasize the importance of identifying critical periods for effective weed control. For instance, E. Stefanic et al. found that the duration of this critical period in sunflower varies depending on weed density and environmental conditions; failure to manage it appropriately can result in significant yield losses [1]. In a study by J. Peña-Barragán et al., multispectral aerial imagery was used to analyse the relationship between sunflower yield, terrain elevation, and weed infestation. The findings indicated that higher yields were recorded in areas with lower elevation and lower weed density [2].

It is worth noting that Ukrainian research has also increasingly adopted unmanned aerial vehicles (UAVs) to monitor weed infestation in sunflower fields. For example, A. B. Achasov et al. demonstrated the effectiveness of UAVs in assessing weed pressure and crop condition, enabling timely responses to agrocenosis changes [3]. Furthermore, a study conducted in the Steppe zone of Ukraine revealed a substantial negative impact of the quarantine weed Ambrosia artemisiifolia on sunflower yield: at a density of 5 plants/m², yield losses reached 0.41 t/ha, increasing to 1.09 t/ha at 10 plants/m² [4].

Purpose: to determine the effect of varying levels of weed competition on the dynamics of projective cover in sunflower crops throughout the growing season.

Methodology

The study was conducted from 2021 to 2023 on the experimental field of the Department of Agriculture and Herbology named after O. M. Mozheiko.

The soil at the experimental site is classified as typical heavy loam Chernozem developed on loess-like loam, with the following agrochemical characteristics: a salt extract pH ranging from 6.4 to 7.0 and a humus content of approximately 5% in the arable layer.

The research was carried out within a crop rotation that included the following sequence:

1. Fallow
2. Winter wheat
3. Safflower + corn
4. Winter rye
5. Sunflower

The sunflower hybrid used in the study was Cruiser LG59580. Each treatment was replicated three times. The total plot area for sowing was 30 m^2, while the accounting (sampling) plot measured 10 m^2. Weed infestation was assessed on 1.0 m^2 subplots at the beginning of the growing season and prior to harvest using the quantitative-weight method with three replications.

The experimental design included the following treatments:

1. Weed-free throughout the entire growing season (weed-free control)
2. Weeds removed during the first 15 days after sunflower emergence
3. Weeds removed during the first 30 days after emergence
4. Weeds removed during the first 45 days after emergence
5. Weeds present during the first 15 days after emergence, then left unmanaged
6. Weeds present during the first 30 days after emergence, then left unmanaged
7. Weeds present during the first 45 days after emergence, then left unmanaged
8. Continuous weed competition throughout the growing season (weedy control)

To simulate different intensities of weed competition, manual weeding was used. This method allowed for the creation of both temporarily weed-free conditions and continuous weed presence at specific crop development stages.

Projective cover was visually assessed using a grid frame 1 cm^2 in size on permanent monitoring plots at the stages of 2–3 pairs of true leaves and at budding. Assessments were conducted separately for sunflower plants and weeds, allowing for the analysis of competitive interactions and structural changes in vegetation cover throughout the season.

All collected data were analyzed using analysis of variance (ANOVA) with a standard statistical software package. The results were interpreted based on mean values, standard deviations, and the significance of differences at $p \leq 0.05$.

Results and Discussion

The results of the study show that the duration of weed competition significantly affects the condition of sunflower crops, in particular, the weediness of the agrocenosis and biometric indicators of the crop. Sunflower weediness depending on the period of weed competition (average values of the number of weeds at the time of emergence and before harvesting for the period 2021-2024) is given in Table 1.

The lowest number of weeds at harvest was recorded in the treatments with a weed-free period of 45 days—5 plants/m², with perennial weeds accounting for only 1 plant/m². This indicates the effectiveness of limiting competition specifically during the first 4–6 weeks of crop development. In contrast, under conditions of continuous weed competition (treatment 8), the number of annual weeds at harvest reached 27 plants/m², which is 2.7 times higher than in the 15-day weed-free treatment and 5.4 times higher than in the 45-day weed-free treatment. This confirms the strong regenerative ability of weeds to restore their biomass following early-season hand weeding.

Table 1

Weed infestation of sunflower depending on the period of weed competition (average for 2021–2024)

Variants	Number of weeds, pcs/m²			
	For the time of germination		Before harvesting	
	1	2	1	2
Weed-free throughout the entire growing season (weed-free control)	–	–	–	–
Weeds removed during the first 15 days after sunflower emergence	–	–	16	3
Weeds removed during the first 30 days after emergence	–	–	10	1
Weeds removed during the first 45 days after emergence	–	–	5	1
Weeds present during the first 15 days after emergence, then left unmanaged	11	–	–	–
Weeds present during the first 30 days after emergence, then left unmanaged	13	–	–	–
Weeds present during the first 45 days after emergence, then left unmanaged	12	–	–	–
Continuous weed competition throughout the growing season (weedy control)	11	–	27	2

Note: 1 – annual weeds; 2 – perennial weeds

As the duration of weed competition increased, a clear trend of decreasing sunflower biometric indicators was observed (Table 2). The plant height in the weed-free control treatment (treatment 1) reached 166.6 cm, while under full-season weed competition (treatment 8), it decreased to 134.0 cm. A similar trend was observed for leaf area: the maximum value was recorded in treatment 1, and the minimum in treatment 8. The difference between these two extremes was 54.1%, indicating a high degree of suppression of the crop's photosynthetic apparatus due to weed pressure.

It is noteworthy that the 30-day weed-free treatment resulted in nearly the same plant height – 164.4 cm – as the full weed-free control, and the leaf area was only 12% lower than the maximum recorded value. This suggests that the first 30 days after crop emergence are critical for the development of a viable leaf canopy in sunflower.

Similar findings have been reported in international studies [4, 5], which emphasize the importance of preventing weed competition during the early growth stages of the crop to minimize yield losses.

Projective cover is an important indicator characterizing the degree of soil surface shading by the plant canopy. This parameter closely relates to the development of phytomass of both crops and weeds, as well as determining the microclimatic conditions within the agrocenosis – such as temperature regime, moisture conservation, photosynthetic intensity, and soil erosion resistance.

Table 2

Effect of weed infestation on sunflower biometric indicators under different durations of competitive interaction (average for 2021–2024)

Variants	Plant height, cm	Leaf area, cm^2
Weed-free throughout the entire growing season (weed-free control)	166.6	6368
Weeds removed during the first 15 days after sunflower emergence	159.3	4586
Weeds removed during the first 30 days after emergence	164.4	5590
Weeds removed during the first 45 days after emergence	164.2	5947
Weeds present during the first 15 days after emergence, then left unmanaged	156.7	4482
Weeds present during the first 30 days after emergence, then left unmanaged	150.6	4096
Weeds present during the first 45 days after emergence, then left unmanaged	143.5	3184
Continuous weed competition throughout the growing season (weedy control)	134.0	2924

In this study, changes in projective cover were directly correlated with weed infestation and the duration of competitive interactions. Treatments with complete weed control (variant 1) or weed suppression for 30–45 days after emergence (variants 3 and 4) developed full projective cover due to a well-developed leaf area of sunflower plants (5590–6368 cm^2). This ensured uniform and dense soil shading, positively influencing moisture retention, reducing temperature fluctuations in the rhizosphere, and inhibiting weed regrowth.

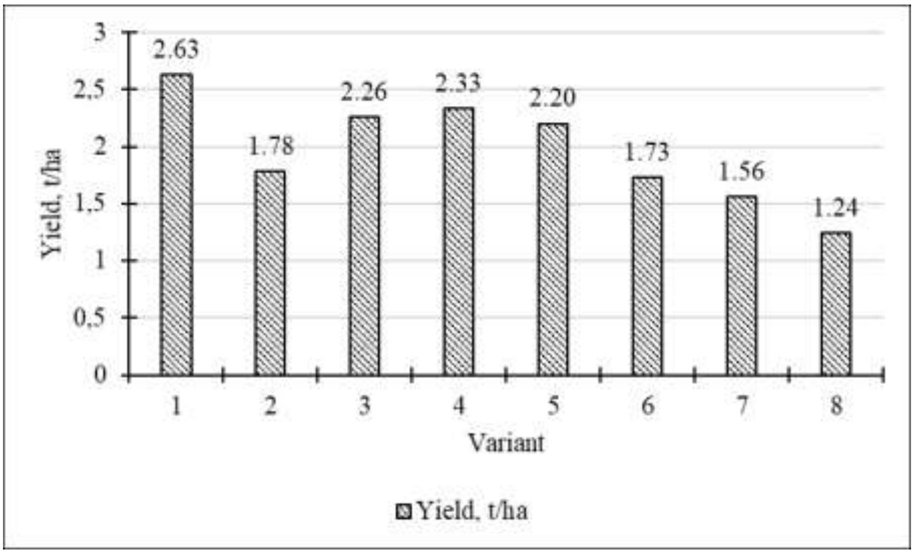
Conversely, in treatments with early or prolonged weed competition (variants 5–8), projective cover at early stages was primarily formed by weeds. For instance, treatments with competition lasting 15–30 days (variants 5 and 6) exhibited rapid initial soil coverage by weeds; however, after their removal, the cover did not fully recover due to weakened sunflower growth (leaf area 4096–4482 cm^2), contributing to a secondary weed infestation wave before harvest.

Previous studies also indicate that the effectiveness of projective cover formation depends on both the sunflower growth stage and weed presence. Specifically, complete absence of weeds during early vegetation stages resulted in better leaf coverage and reduced secondary weed infestation [6, 7]. Projective cover significantly influences the soil microclimate, including temperature and humidity, which affects weed growth [8]. Similar findings were reported under Central Ukrainian conditions, where partial weed suppression during the first 30 days post-emergence promoted crop recovery of projective cover [9].

The lowest projective cover was observed under constant weed competition (variant 8), with the smallest sunflower leaf area (2924 cm^2) and high weed density (27 annual and 2 perennial plants/m^2). This resulted in unstable, fragmented soil cover throughout the season, causing moisture fluctuations, surface overheating, intensified micro-erosion, and substantial yield reduction to 1.24 t/ha. During weed presence (particularly in variants 5–8), a significant soil area was covered by weed biomass. Average weed densities of 11–13 plants/m^2 in the first 15–45 days, especially without weeding, suggest that projective cover during this period was predominantly weed-derived.

Considering weed morphology (e.g., broadleaf species such as *Chenopodium album* and *Polygonum lapathifolium*), under medium to high infestation, weeds contributed 35–60% to temporary projective cover, partially providing soil protection by reducing runoff, insolation, and evaporation. However, such cover is temporally unstable. Due to interspecies competition, weeds were either suppressed (variants 5–6) or proliferated excessively (variant 8), creating shading that disrupted crop development. By canopy closure (approximately days 45–60), weeds either disappeared or remained as a low but dense understory, impeding full projective cover formation by sunflower. Consequently, the highest ecological efficiency of projective cover was in treatments with early weed suppression (up to 30–45 days), where sunflower rapidly covered the soil, conserving moisture and suppressing further weed waves. Prolonged weed pressure led to unstable, fragmented cover insufficient for agroecosystem protection.

The highest yield (2.63 t/ha) was achieved with complete weed control, serving as the benchmark (Fig. 1). Limiting weed competition to 15 days reduced yield to 1.78 t/ha (67.7% of control). Extending the weed-free period to 30 and 45 days resulted in higher yields – 2.26 and 2.33 t/ha (85.9–88.6% of control), confirming the first month of vegetation as the critical competition period. Similar trends were found where crops grew with weed pressure for 15, 30, and 45 days: 15-day competition slightly reduced yield (2.20 t/ha), but 30-day and 45-day competition lowered yields more substantially (1.73 and 1.56 t/ha respectively), reflecting growth suppression. The lowest yield (1.24 t/ha, 47.1% of control) occurred under constant weed competition, where pre-harvest weed density was highest (27 annual and 2 perennial plants/m^2), indicating a stable and aggressive weed community.



Variant:1 – Weed-free throughout the entire growing season (weed-free control);
2 – Weeds removed during the first 15 days after sunflower emergence;
3 – Weeds removed during the first 30 days after emergence;
4 – Weeds removed during the first 45 days after emergence;
5 – Weeds present during the first 15 days after emergence, then left unmanaged;
6 – Weeds present during the first 30 days after emergence, then left unmanaged;
7 – Weeds present during the first 45 days after emergence, then left unmanaged;
8 – Continuous weed competition throughout the growing season (weedy control).

Fig. 1 – Effect of weed infestation on sunflower yield, t/ha (2021–2024)

Yield reduction is closely associated with a decrease in leaf area to 2924 cm^2 (in variant 8) and plant height to 134.0 cm. This indicates limitations in photosynthesis processes and the assimilative capacity of the crop.

Similar conclusions were presented in the work of T. D. Israel et al. [5], who reported a direct influence of weed infestation levels on leaf area index and final yield of oilseed crops. Comparable trends were observed in other studies. Specifically, B. J. Johnson [10] found that the maximum sunflower yield is achieved in the absence of weeds during the first 4–6 weeks after sowing. In the study by L. M. Alcântara et al. [11], it was noted that competition from weeds such as Urochloa decumbens and Panicum maximum negatively affects early sunflower development by reducing leaf area and plant height. Furthermore, research demonstrated that effective weed management during the first 30–45 days after emergence is critical for ensuring optimal sunflower growth and achieving high yields. This aligns with findings by M. Sattin and A. Berti [12], who emphasized the importance of weed control within the first 25–40 days after emergence to prevent significant yield losses.

Weed infestation in crops is influenced by a complex of factors, among which crop rotation and preceding crop play a decisive role [13, 14, 15], as well as the primary tillage system [16, 17, 18], nutrient regime [19], and others.

Conclusions

The formation of a stable projective cover requires effective weed control for at least the first 30–45 days after emergence. It is during this period that the structural foundation of sunflower phytomass is established, which ensures soil coverage, suppression of subsequent weed waves, and agroecological stability of the crop stand. Projective soil cover in sunflower crops is an important indicator of the effectiveness of weed control and the overall condition of the agrocenosis. Treatments with complete weed control or with weed suppression for 30–45 days after emergence developed dense projective cover due to a well-developed leaf area of sunflower. This provided uniform soil shading, contributed to moisture retention, and inhibited weed regrowth.

The duration of weed competition significantly affects the formation of projective soil cover during sunflower vegetation. The best leaf area and projective cover indices were observed in treatments with weed limitation during the first 30–45 days after emergence. Prolonged weed competition reduces biometric parameters of sunflower (plant height, leaf area) and leads to significant yield decline, confirming the importance of timely weed control during the formation of the crop's main biomass. The obtained data can be used to improve sunflower weed management systems, taking into account the specific features of projective soil cover, which will ensure increased productivity and soil fertility preservation. The results of the study underscore the necessity of implementing weed control measures during the initial stages of sunflower development, using techniques aligned with the technological requirements of crop management. This strategy maintains crop productivity, promotes the formation of effective projective cover, and enhances the agrocenosis's capacity for soil protection.

Conflict of Interest

The authors declare no conflict of interest regarding the publication of this manuscript. Furthermore, the authors have fully adhered to ethical norms, including avoiding plagiarism, data falsification, and duplicate publication.

***Authors contribution*:** authors have contributed equally to this work.

The work does not use artificial intelligence resources.

Reference

1. Stefanic, E., Rasic, S., Lucic, P., Zimmer, D., Mijic, A., Antunovic, S., Japundzic-Palenkic, B., Lukacevic, M., Zima, D., & Stefanic, I. (2023). The critical period of weed control influences sunflower (Helianthus annuus L.) yield, yield components but not oil content. *Agronomy*, 13(8), 2008. https://doi.org/10.3390/agronomy13082008
2. Pena-Barragán, J. M., López-Granados, F., Jurado-Expósito, M., & García-Torres, L. (2010). Sunflower yield related to multi-temporal aerial photography, land elevation and weed infestation. *Precision agriculture*, *11*, 568–585. https://doi.org/10.1007/s11119-009-9149-6
3. Achasov, A. B., Sedov, A.O., & Achasova, A.O. (2016). Assessment of a contamination of crops of sunflower by means of unmanned aerial vehicles. *Man and environment. Issues of neoecology*, (26), 69–74. https://doi.org/10.26565/1992-4224-2016-26-08 (in Ukrainian)
4. Gavrilyuk, Y., Aksyonov, I., Matsay, N., Beseda, A., & Aksyonova, I. (2023). Dissemination of the quarantine weeds of the genus Ambrosia in the steppe zone of Ukraine. *Acta agriculturae Slovenica*, *119*(2), 1-9. https://doi.org/10.14720/aas.2023.119.2.2492
5. Israel, T. D., Bates, G. E., Mueller, T. C., Waller, J. C., & Rhodes Jr, G. N. (2016). Effects of Aminocyclopyrachlor Plus Metsulfuron on tall fescue yield, forage quality, and ergot alkaloid concentration. *Weed Technology*, *30*(1), 171-180. https://doi.org/10.1614/WT-D-15-00122.1
6. Polyakov, O. I., Nikitenko, O. V., & Karaputa, S. K. (2015). *Effect of sowing dates and crop management practices on weed infestation and yield of the sunflower hybrid Region*. Scientific and Technical Bulletin of the Institute of Oilseed Crops of NAAS of Ukraine, (22), 140–148. (in Ukrainian)
7. Shrestha A., Hembree K.J., Va, N. (2007). Growth stage influences level of resistance in glyphosate-resistant horseweed. *California Agriculture*, *61*, 67–70. http://dx.doi.org/10.3733/ca.v061n02p67
8. Osipitan, O. A., Dille, A., Assefa, Y., Radicetti, E., Ayeni, A., Knezevic, S. Z. (2019). Impact of cover crop management on level of weed suppression: a meta-analysis. *Crop Science*, *59*(3), 833–842. https://doi.org/10.2135/cropsci2018.09.0589

9. Tkalich, Yu. I. (2018). Assessment of the biological and economic effectiveness of herbicides in sunflower crops. *Scientific and Technical Bulletin of the Institute of Oilseed Crops of NAAS of Ukraine*, (26), 98–107. https://doi.org/10.36710/ioc-2018-26-11 (in Ukrainian).
10. Johnson B. J. (1971). Effect of weed competition on sunflowers. *Weed Science*. *19*(4). 378–380. https://doi.org/10.1017/S0043174500049183
11. Alcântara, L. M. da S., Lisboa, L. A. M., Storti, S. M. M., Lima, A. E. da S., Crispim, N. P. de O., Silva, G. G. da, & Cardoso, A. dos S. (2018). Initial Development of Sunflower (Helianthus annuus L.) under Weed Competition with Different Species of Grasses. *Journal of Experimental Agriculture International*, *29*(2), 1–11. https://doi.org/10.9734/JEAI/2019/45613
12. Sattin M., Berti A. (2001). Parameters for weed-crop competition. *Food and Agriculture Organization of the United Nations.* Retrieved from https://www.fao.org/4/y5031e/y5031e04.htm
13. Shevchenko, M. S., Shevchenko, O. M., & Parlikokoshko, M. S. (2010). Factors of weed control in crops and productivity of maize hybrids. *Bulletin of the Institute of Grain Farming*, (38), 25–29 (in Ukrainian)
14. Voitovyk, M. (2023). Weed infestation in sunflower agrocenoses under short-rotation crop rotations. *Foothill and Mountain Agriculture and Animal Husbandry*, (74)1, 8–21. https://doi.org/10.32636/01308521.2023-(74)-1-1 (in Ukrainian)
15. Borovyk, S. O., & Budionnyi, V. Yu. (2024). Potential weed infestation of winter rye depending on predecessors and tillage methods. Agrarian Innovations, (23), 26–31. https://doi.org/10.32848/agrar.innov.2024.23.4 (in Ukrainian)
16. Hutianskyi, R. A., Popov, S. I., Kostromitin, V. M., Kuzmenko, N. V., & Hlubokyi, O. M. (2021). Influence of primary tillage and fertilization on weed infestation in sunflower crops. Bulletin of Agricultural Science of the Black Sea Region, (1), 60–68. https://doi.org/10.31521/2313-092X/2021-1(109) (in Ukrainian)
17. Masyk, I., Lutsyk, R., Ustymenko, V., Lytvynenko, S., & Nedbailo, V. (2022). Weed infestation in sunflower crops under different pre-sowing tillage systems in the conditions of the Left-Bank Forest-Steppe of Ukraine. Proceedings of the III International Scientific and Theoretical Conference «Science of XXI century: development, main theories and achievements» (December 2, 2022; Helsinki, Finland), 52–53. https://doi.org/10.36074/scientia-02.12.2022 (in Ukrainian)
18. Laslo, O. (2023). Impact of deep and shallow primary tillage methods on potential and actual weed infestation in sunflower crops. SWorldJournal, (21-02), 15–21. https://doi.org/10.30888/2663-5712.2023-21-02-011 (in Ukrainian)
19. Tkachuk, O. P., & Bondaruk, N. V. (2024). Weed infestation in sunflower crops depending on fertilization. *Agrarian Innovations*, (27), 113–118. https://doi.org/10.32848/agrar.innov.2024.27.16 (in Ukrainian)

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ВПЛИВ ЗАБУР'ЯНЕНОСТІ НА ЗМІНУ ПРОЕКТИВНОГО ПОКРИТТЯ ҐРУНТУ ПРОТЯГОМ ВЕГЕТАЦІЙНОГО ПЕРІОДУ СОНЯШНИКУ

Забур'яненість є одним із ключових факторів, що впливають на формування рослинного покриву в агроценозі. У контексті вирощування соняшнику проективне покриття ґрунту змінюється залежно від інтенсивності конкуренції з боку бур'янів, особливо в критичні періоди вегетації.

Мета. Визначити вплив різного рівня конкуренції бур'янів на динаміку проективного покриття посівів соняшнику протягом вегетаційного періоду

Методи. Польові, лабораторно-аналітичні, статистичні.

Результати. Зі зростанням тривалості конкуренції з боку бур'янів спостерігалося систематичне зниження біометричних показників рослин (висоти, площі листкової поверхні), проективного покриття культури, а також урожайності. Найвищу врожайність забезпечив повний контроль забур'яненості протягом усього вегетаційного періоду, який використано як еталон для порівняння. За короткотривалого

обмеження конкуренції бур'янів урожайність суттєво знижувалася. Подовження періоду чистоти посівів сприяло покращенню показників, проте повністю не компенсувало втрати. Вирішальне значення першого місяця вегетації як критичного періоду конкуренції з бур'янами. Встановлено, що обмеження забур'яненості протягом перших 30–45 днів після сходів сприяє кращому росту рослин, формуванню листкової поверхні та підвищенню проективного покриття ґрунту. Найефективніше формування проективного покриття й біомаси соняшника забезпечується за відсутності конкуренції з боку бур'янів упродовж перших 30–45 днів після появи сходів. Цей період можна вважати критичним для забезпечення повноцінного розвитку культури. Подальше поширення бур'янів на пізніших етапах має менш виражений вплив на морфологічні характеристики, але істотно ускладнює збирання врожаю та сприяє вторинному засміченню поля. Натомість тривала конкуренція з боку бур'янів пригнічує розвиток культури, знижує площу листків і врожайність.

Висновки. Отримані результати підтверджують важливість контролю забур'яненості у критичні періоди формування біомаси для забезпечення ґрунтозахисної функції посівів та стабільного виробництва. Запропоновані підходи можуть бути використані для удосконалення технологій вирощування соняшнику з урахуванням екологічних чинників.

КЛЮЧОВІ СЛОВА: *соняшник, забур'яненість, конкуренція, проективне покриття, біометричний показник, урожайність*

Конфлікт інтересів

Автори заявляють, що конфлікту інтересів щодо публікації цього рукопису немає. Крім того, автори повністю дотримувались етичних норм, включаючи плагіат, фальсифікацію даних та подвійну публікацію.

Внесок авторів: всі автори зробили рівний внесок у цю роботу/

В роботі не використано ресурс штучного інтелекту.

Список використаної літератури

1. Stefanic, E., Rasic, S., Lucic, P., et al. The critical period of weed control influences sunflower (Helianthus annuus L.) yield, yield components but not oil content. *Agronomy*. 2023. 13(8). 2008. https://doi.org/10.3390/agronomy13082008
2. Pena-Barragán J. M., López-Granados F., Jurado-Expósito M., García-Torres L. Sunflower yield related to multi-temporal aerial photography, land elevation and weed infestation. *Precision Agriculture.* 2010. Vol. 11 P. 568–585. https://doi.org/10.1007/s11119-009-9149-6
3. Ачасов А. Б., Седов А. О., Ачасова А. О. Оцінка забур'яненості посівів соняшника за допомогою безпілотних літальних апаратів. *Людина та довкілля. Проблеми неоекології.* 2016. № 3–4(26). С. 69–74. https://doi.org/10.26565/1992-4224-2016-26-08
4. Gavrilyuk Y., Aksyonov I., Matsay N., Beseda A., Aksyonova I. Dissemination of the quarantine weeds of the genus Ambrosia in the steppe zone of Ukraine. *Acta agriculturae Slovenica*. 2023. Vol. *119*(2). P. 1-9. https://doi.org/10.14720/aas.2023.119.2.2492
5. Israel T. D., Bates G. E., Mueller T. C., Waller J. C., Rhodes Jr, G. N. Effects of aminocyclopyrachlor plus metsulfuron on tall fescue yield, forage quality, and ergot alkaloid concentration. *Weed Technology*. 2016. Vol. 30(3). P. 171–180. https://doi.org/10.1614/WT-D-15-00122.1
6. Поляков О. І., Нікітенко О. В., Карапута С. К. Вплив строків сівби та агроприйомів по догляду за рослинами на забур'яненість посівів соняшнику гібриду Регіон та його врожайність. *Науково-технічний бюлетень Інституту олійних культур НААН*. 2015. № 22. С. 140–148.
7. Shrestha A., Hembree K.J., Va, N. Growth stage influences level of resistance in glyphosate-resistant horseweed. *California Agriculture*. 2007. Vol. 61. P. 67–70. http://dx.doi.org/10.3733/ca.v061n02p67
8. Osipitan O. A., Dille A., Assefa Y., et al. Impact of cover crop management on level of weed suppression: a meta-analysis. *Crop Science*. 2019. Vol. 59(3). P. 833–842. https://doi.org/10.2135/cropsci2018.09.0589
9. Ткаліч Ю. І. Оцінка біологічної та господарської ефективності гербіцидів в посівах соняшнику. *Науково-технічний бюлетень Інституту олійних культур НААН*. 2018. № 26. С. 98–107. https://doi.org/10.36710/ioc-2018-26-11
10. Johnson B. J.Effect of weed competition on sunflowers. *Weed Science.* 1971. Vol. 19(4). P. 378–380. https://doi.org/10.1017/S0043174500049183
11. Alcântara L. M. da S., Lisboa L. A. M., Storti S. M. M, et al. Initial development of sunflower (Helianthus annuus L.) under weed competition with different species of grasses. *Journal of Experimental Agriculture International.* 2018. Vol. 29(2). P. 1–11. https://doi.org/10.9734/JEAI/2019/45613
12. Sattin M., Berti A. Parameters for weed-crop competition. Food and Agriculture Organization of the United Nations. 2001. URL: https://www.fao.org/4/y5031e/y5031e04.htm

13. Шевченко М. С., Шевченко О. М., Парлікокошко М. С. (2010). Фактори контролювання забур'яненості посівів і продуктивність гібридів кукурудзи. *Бюлетень Інституту зернового господарства*. 2010. Вип. 38. С. 25–29.
14. Войтовик М. Забур'яненість агроценозів соняшнику в короткоротаційних сівозмінах. *Передгірне та гірське землеробство і тваринництво*. 2023. Вип. 74 (1). С. 8–21. https://doi.org/10.32636/01308521.2023-(74)-1-1
15. Боровик С. О., Будьонний В. Ю. Потенційна забур'яненість жита озимого залежно від попередників та способів обробітку грунту. *Аграрні інновації*. 2024. Вип. 23. С. 26–31. https://doi.org/10.32848/agrar.innov.2024.23.4
16. Гутянський Р. А. , Попов С. І., Костромітін В. М., Кузменко Н. И., Глибокий О.М. Вплив основного обробітку ґрунту та удобрення на забур'яненість посівів соняшнику. *Вісник аграрної науки Причорномор'я.* 2021. Вип. 1 С. 60–68. https://doi.org/10.31521/2313-092X/2021-1(109)
17. Масик І., Луцик Р., Устименко В., Литвиненко С., Недбайло В. Забур'яненість посівів соняшнику за використання різних систем передпосівного обробітку грунту в умовах Лівобережного Лісостепу України. *Collection of scientific papers «SCIENTIA»*. 2022. С. 52–53. https://doi.org/10.36074/scientia-02.12.2022
18. Ласло О.О. Вплив способів різноглибинного основного обробітку ґрунту на потенційну і актуальну забур'яненість посіві соняшника. *SWorldJournal*. 2023. Вип. 21, № 2. С. 15–21. https://doi.org/10.30888/2663-5712.2023-21-02-011
19. Ткачук О. П., Бондарук Н. В. Забур'яненість посівів соняшнику залежно від удобрення. *Аграрні інновації*. 2024. Вип. 27. С. 113–118. https://doi.org/10.32848/agrar.innov.2024.27.16

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