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Effects of different herbicide treatments on *Solidago canadensis* L.

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Purpose. The study aimed to evaluate the impact of various herbicide treatments on *Solidago canadensis* L. and develop recommendations for its long-term management. **Methods.** Three chemical control schemes were assessed in 2021–2025: Lintur 70 WG (triasulfuron + dicamba), Roundup Max (glyphosate), and Dianate BASF (dicamba). Treatments were applied using a handheld sprayer during the active vegetative growth phase at a temperature of +20–23 °C and relative humidity of 65–70%. The herbicides' effectiveness was evaluated comprehensively by determining the suppression of the aboveground part, the number of viable shoots, and the ability to regenerate. Statistical analysis was performed using ANOVA with the $LSD_{0.05}$ criterion in Statistica 13.0 and Microsoft Excel 2019. **Results.** The results show that all the herbicides tested have a clear suppressive effect on *Solidago canadensis* L., although their effectiveness varies considerably depending on the active ingredients and how long they remain effective for. Overall, Lintur 70 WG exhibited the greatest effectiveness, providing rapid and progressive suppression of plant growth, reaching 91.8 ± 3.5% by 42 days after treatment, along with the greatest biomass suppression (86.8 ± 2.7%) and the strongest decrease in shoot density (~90% to 3 shoots/m^2), indicates the minimal regeneration ability of the plant. Dianate BASF exhibited moderate but less stable control, with final suppression of 79.3 ± 3.5% and biomass suppression of 69.3 ± 2.6%. The reduction in shoot density (~71% to 6 shoots/m^2) suggests partial recovery potential of the species after treatment. Roundup Max demonstrated moderately high yet less sustainable performance, reaching 84.7 ± 3.5% suppression and 57.2 ± 2.4% biomass suppression, with the weakest reduction in shoot density (~63% to 9 shoots/m^2), indicating the highest regeneration potential among the tested variants. **Conclusions.** These findings confirm that multicomponent herbicides with different modes of action are the most effective way to sustainably control *S. canadensis*, as they ensure rapid biomass suppression and minimal regeneration. The study highlights the importance of considering the physiological responses of plants when predicting the duration of herbicide effectiveness against invasive species. These results could inform the development of chemical management strategies for invasive weeds in Ukrainian agroecosystems and natural habitats.

Keywords: *weed suppression; biomass; shoot density; plant regeneration; invasive species control; chemical plant protection.*

Introduction

In a global context, invasive plant species are recognized as one of the main causes of ecosystem degradation. This leads to reduced biodiversity, an imbalance in the ecosystem and a decline in land productivity. Among them, *Solidago canadensis* L. is considered one of the most aggressive and widespread invasive species in Europe, particularly in the forest-steppe zone of Ukraine [1, 2]. This species is characterized by high ecological plasticity, rapid vegetative propagation, and the ability to form dense monodominant stands, which suppress native vegetation, alter the structure of plant communities, and significantly reduce forage productivity of pastures [3, 4].

The spread of *S. canadensis* in agricultural landscapes is also associated with negative economic consequences, including decreased crop yields, competition for water and nutrients, and deterioration of soil conditions [5]. Despite numerous studies addressing the biology and distribution of this species, effective methods for its long-term control remain insufficiently developed, especially under specific agroecological conditions of Ukraine.

Chemical control using herbicides is currently one of the most widely applied methods for managing invasive weeds. However, the effectiveness of herbicide treatments depends not only on the choice of active substances but also on the biological characteristics of the target species, its growth stage, and its physiological response to stress factors [4]. In particular, invasive species such as *S. canadensis* often demonstrate high regenerative capacity, which reduces the long-term efficiency of control measures [6].

Current research largely focuses on visual assessments of weed suppression, while the physiological responses of plants to herbicide

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application – including changes in photosynthetic activity, stress resistance and recovery potential – receive insufficient attention [7]. This creates a knowledge gap regarding the mechanisms underlying the effectiveness of herbicide action, thereby limiting the development of scientifically grounded control strategies.

Recent studies have shown that different herbicides exert significantly varying effects on the physiological processes of weeds. For instance, acetolactate synthase (ALS) inhibitors, such as triasulfuron, disrupt amino acid and protein synthesis, thereby reducing shoot growth and photosynthetic activity [8]. Herbicides based on synthetic auxins, such as dicamba, cause hormonal imbalance, tissue necrosis, and deformation of growth points [9, 10]. Meanwhile, glyphosate-based products affect metabolic pathways and inhibit the EPSP synthase enzyme, but their ability to fully control perennial weeds with well-developed root systems is generally limited [11].

Many studies emphasize that the initial suppression of above-ground plant parts by herbicides does not guarantee long-term control, given the substantial potential for regeneration from roots and rhizomes [12]. Deep root tissues often serve as the main source of recovery, necessitating consideration of systemic herbicide action when predicting effectiveness [13]. In addition to chemical control, modern approaches investigate the use of bioherbicides capable of inducing oxidative stress in weeds, which further suppresses both root and shoot tissues without leaving high chemical residues in the soil [14].

Physiological studies also indicate that invasive species such as *S. canadensis* can exhibit specific adaptive responses, allowing partial restoration of key physiological parameters, including photosynthetic efficiency, antioxidant enzyme activity, and hormonal balance, following herbicide exposure. These responses can depend on the plant's ontogenetic stage, environmental conditions, and the type of herbicidal stress [15].

Other authors have highlighted changes in root system structure and respiration under the influence of herbicides with different modes of action. These changes may serve as indicators of long-term plant tolerance or sensitivity [16]. Furthermore, research shows that invasive plants may respond differently to herbicides depending on the state of their physiological processes prior to exposure, such as flavonoid metabolism, which plays an important role in stress adaptation [17].

It is noteworthy that most contemporary studies focus on describing the general effects of herbicides on weed growth and biomass, while the physiological mechanisms underlying these changes are only partially addressed. Nevertheless, there is a growing understanding of the need to integrate physiological parameters – such as photosynthetic activity, gas exchange rates, antioxidant system activity, and metabolic activity – into a comprehensive assessment of herbicide treatment effectiveness [18].

Thus, a review of the current literature indicates that, although recent research has increasingly focused on weed responses to chemical control, there is still insufficient data on the physiological mechanisms of *S. canadensis* response to different herbicides, particularly regarding photosynthesis disruption, hormonal regulation, antioxidant activity, and the link between these processes and regeneration capacity.

The aim of this study was to evaluate the effects of different herbicide treatments on *Solidago canadensis* L., focusing on their impact on plant growth, shoot density, biomass suppression, and regeneration dynamics, in order to develop scientifically grounded recommendations for effective and long-term control of this invasive species.

Materials and methods

Studies assessing the effectiveness of the chemical control of *Solidago canadensis* L. were conducted from 2021 to 2025 in the Forest-Steppe zone of Ukraine, at a stationary experimental field in Dubliany in the Lviv district (formerly the Zhovkva district) of the Lviv region, Ukraine (49.8962° N, 24.0849° E). The studies were carried out on the same plot throughout the entire period, which ensured the comparability of the results obtained. The soils of the experimental plot were gray forest medium loam, with a humus content of 2.6%, pH of the salt extract – 6.1. The area of the accounting plot was 125 m^2. The experiment was set up in three replications, the placement of variants was by the method of complete randomization. Each treatment option was represented by three separate plots (replications). A control treatment (untreated plots without herbicide application) was also included in the experimental design. Preliminary surveys of shoot density, plant growth, and phenological development were conducted on the control plots as well, providing a baseline for comparison with treated variants (Fig.1).

A preliminary survey of plants was conducted on each plot, recording the number of individuals per 1 m^2 and determining their pheno-

Fig. 1. General view of the experimental design and herbicide effects on *Solidago canadensis* L.:
(a) control plot without treatment, characterized by dense and vigorous plant growth; (b) experimental field with randomized plot arrangement and marked replications; (c) severe phytotoxic effect resulting in complete desiccation of shoots; (d) moderate phytotoxic response with partial damage to plant tissues

logical stages prior to herbicide application. The plants were in the active vegetative growth phase during the treatments, with heights ranging from 30 to 50 cm, which ensured maximum efficacy of systemic herbicides. The study compared three herbicide treatment schemes (Table 1).

The choice of herbicides for the study is due to their widespread use in the practice of controlling dicotyledonous weeds, in particular invasive species, as well as different mechanisms of action, which allows for a comprehensive assessment of the effectiveness of chemical control of *S. canadensis*. The experiment used preparations based on active ingredients with systemic action.

The research was conducted on the same stationary site throughout the entire period (2021–2025); no transition to new, previously untreated sites was carried out.

The plants were treated using a backpack sprayer under air temperatures of +20…23 °C, relative humidity of 65–70%, and wind speeds up to 2 m/s. The working solution was prepared and applied at a rate of 300 L/ha. Visual assessment of plant suppression was conducted on days 7, 14, 28, and 42 after treatment using the EWRC scale, while shoot density

Table 1

Herbicide protection schemes for the control of *Solidago canadensis* L.

Variant	Herbicide	Consumption rate, kg/ha or l/ha	Active ingredient(s)	Active ingredient content	Mode of action
I	Control (without herbicide application)				
II	Lintur 70 WG, Syngenta	0.3 kg/ha	Triasulfuron Dicamba (sodium salt)	41 g/kg 659 g/kg	ALS inhibitor (triasulfuron) + synthetic auxin (dicamba)
III	Dianate, BASF	1.5 l/ha	Dicamba	480 g/l	Synthetic auxin causing hormonal imbalance
IV	Roundup Max, Monsanto/Bayer	4.0 l/ha	Glyphosate (potassium salt)	551 g/l (equiv. 450 g/l)	EPSPS inhibitor blocking aromatic amino acid synthesis

Source: compiled by the authors.

was determined through direct counting on 1 × 1 m quadrats.

Shoot density reduction (%) was calculated as the ratio of the number of newly emerged viable shoots at 60 days after treatment to the initial number of shoots before treatment, expressed as a percentage:

$$\text{Shoot density reduction (\%)} = \frac{N_c - N_t}{N_c} \times 100$$

where: N_c – number of shoots in the control (untreated), shoots/m²; N_t – number of shoots after treatment, shoots/m².

Aboveground biomass of *Solidago canadensis* L. was assessed by harvesting all shoots within 1 × 1 m quadrats. Plant material was collected at 7, 14, 28, and 42 days after herbicide application. Fresh biomass was weighed immediately after harvesting using a laboratory balance with an accuracy of ± 0.1 g. Biomass suppression (%) was calculated in relation to the untreated control using the formula:

$$\text{Biomass suppression (\%)} = [(B_0 - B_1) / B_0] \times 100$$

where: B_0 – mean biomass in control plots; B_1 – biomass in treated plots at each observation date.

Statistical analysis of the results was performed using analysis of variance (ANOVA) with the $LSD_{0.05}$ criterion to identify significant differences among treatments. Data collection and analysis were carried out using Statistica 13.0 and Microsoft Excel 2019, enabling comparative analysis of means, standard deviations, and the construction of graphical dependencies with error bars for visual representation. This comprehensive approach allowed assessment not only of suppression of above- and belowground biomass but also of regeneration potential, which are key indicators of the effectiveness of chemical control of the invasive species.

Research results

As a result of the studies, it was found that all three options for herbicide protection demonstrated a suppressive effect on *Solidago canadensis* L., however, the degree of effectiveness of the herbicides differed significantly both in terms of the speed of action and the duration of the phytotoxic effect.

The analysis indicates that all three herbicides exerted a suppressive effect on *S. canadensis*, but their intensity and dynamics differed significantly. In particular, on average for 2021–2025 the highest efficacy was observed in treatment II – Lintur 70 WG, which combines triasulfuron and dicamba. By day 7 after application, plant suppression reached 63.5%, increasing to 78.7% by day 14, indicating a rapid accumulation of phytotoxic effects. By day 28, efficiency reached 84.3%, and by day 42 it remained high at 91.8%, confirming the stable and long-lasting action of the herbicide with minimal potential for plant regeneration.

Treatment III – Dianate BASF, containing only dicamba, showed a moderate level of effectiveness. Suppression was 47.8% on day 7, rising to 69.6% by day 14, and 74.1% by day 28. By day 42, efficacy increased to 79.3%, indicating a gradual, less radical control of the weed. Partial plant regeneration was possible, as the herbicide's effect was not sufficiently deep at the root system level.

Treatment IV – Roundup Max, containing glyphosate, exhibited moderately high efficacy. Initial suppression on day 7 was 52.1%, increasing to 73.4% by day 14, 82.6% by day 28, and 84.7% by day 42. The dynamics show a more gradual increase in phytotoxic effect compared to Lintur 70 WG; however, the herbicide only provides partial stabilization of suppression and does not fully prevent long-term plant regeneration (Table 2).

During the conducted observations, a cumulative effect of herbicide application was recorded. In particular, the most pronounced long-

Table 2

Dynamics of herbicides effectiveness against *Solidago canadensis* L., % of suppressed plants (average for 2021–2025)

Variant	Herbicide	Herbicides effectiveness, %			
		7 days	14 days	28 days	42 days
II	Lintur 70 WG	63,5 ± 2,3	78,7 ± 3,1	84,3 ± 2,8	91,8 ± 3,5
III	Dianate BASF	47,8 ± 2,3	69,6 ± 3,1	74,1 ± 2,8	79,3 ± 3,5
IV	Roundup Max	52,1 ± 2,3	73,4 ± 3,1	82,6 ± 2,8	84,7 ± 3,5

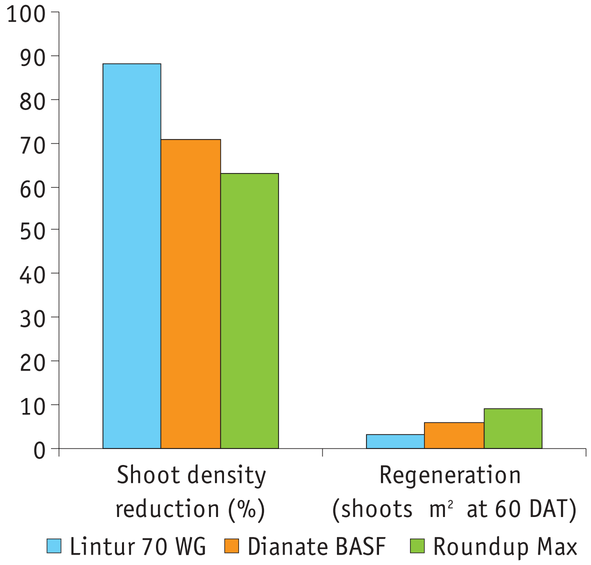
Source: compiled by the authors.

term effect was observed in the Lintur 70 WG treatment, which was manifested in a reduction of shoot density and inhibition of population recovery in subsequent years.

The study demonstrated that Lintur 70 WG exhibited the highest effectiveness in controlling growth. Following its application, shoot density decreased by nearly 90%, and only 3 shoots/m^2 were recorded at the final assessment, indicating very low regeneration potential.

Dianate (BASF) showed moderate efficacy, reducing shoot density by 71%, with approximately 6 shoots/m^2 remaining, indicating partial population recovery.

The lowest effectiveness was observed with Roundup Max, which reduced shoot density by 63%, with approximately 9 shoots/m^2 remaining. This indicates the highest regeneration potential among the tested treatments (Fig. 2).



Source: compiled by the authors.

Fig. 2. Dynamics of shoot density reduction and regeneration of *Solidago canadensis* L. under herbicide treatments

Analysis of biomass suppression dynamics of *S. canadensis* reveals clear differences in the effectiveness of the three applied herbicides over 42 days following treatment. Lintur 70 WG proved to be the most effective: within one week of application, plant biomass was suppressioned by 43.5% relative to the control, and by day 42 suppression reached 86.8%. This trend indicates a rapid and sustained phytotoxic effect that increased over time, resulting in strong population control and minimal regeneration potential.

In the case of Roundup Max, biomass suppression progressed more gradually: by day 7 biomass decreased by 32.1%, reaching 57.2% by day 42. This pattern suggests a relatively slow mode of action, indicating a higher potential for population recovery over time.

Dianate (BASF) showed an intermediate outcome, with biomass suppression of 37.8% on day 7 and 69.3% on day 42. Although this effect was stronger than that of Roundup Max, it remained less effective compared to Lintur 70 WG. Gradual suppression was observed, indicating moderate regeneration potential in the presence of dense perennial root systems of *S. canadensis* (Table 3).

The obtained results confirm that the effectiveness of herbicide control of *Solidago canadensis* L. strongly depends on the active ingredients, their combinations, and the mechanism of action, which is consistent with previous studies on invasive plant management. In particular, the highest efficacy of Lintur 70 WG observed in this study can be explained by the synergistic interaction of triasulfuron (ALS inhibitor) and dicamba (synthetic auxin), which ensures both rapid growth disruption and long-term suppression of regenerative capacity. Similar conclusions were reported by D. Poljuha et al. [20], who emphasized that the control of *S. canadensis* requires multi-target approaches due to its high ecological plasticity and adaptive potential.

The moderate but less stable performance of glyphosate (Roundup Max) aligns with the findings of X. Ye et al. [23], who demonstrated that *S. canadensis* may exhibit variable sensitivity to glyphosate compared to native species, with a tendency toward partial recovery under certain environmental conditions. In the present study, the observed regrowth after initial suppression further supports the idea that glyphosate alone may not provide sufficient long-term

Table 3

Dynamics of *Solidago canadensis* L. biomass suppression after the herbicides treatment

Variant	Herbicide	The percent of biomass suppression			
		7 days	14 days	28 days	42 days
II	Lintur 70 WG	43.5 ±2.1	65.7 ±2.5	79.3 ±2.3	86.8 ±2.7
III	Roundup Max	32.1 ±1.8	49.6 ±2.2	54.1 ±2.1	57.2 ±2.4
IV	Dianate BASF	37.8 ±2.0	53.4 ±2.3	62.6 ±2.4	69.3 ±2.6

Source: compiled by the authors.

control of perennial invasive populations, particularly due to limited impact on underground regenerative structures.

The comparatively lower effectiveness of dicamba-only treatment (Dianat BASF) corresponds with the broader understanding that single-mechanism herbicides often fail to ensure sustainable suppression of invasive clonal species. This is also supported by Baranets et al. [19], who highlight that effective mitigation of *S. canadensis* invasion is significantly improved when chemical treatments are combined with biological or ecological agents, such as endophytes or natural substances, enhancing overall stress pressure on the plant system.

Additionally, Shuvar et al. [12] emphasize that the spread of invasive plant species results in long-term biodiversity loss. This underlines the importance of achieving stable population control, as well as short-term suppression. In this context, the present results clearly demonstrate that Lintur 70 WG provides the most reliable strategy for reducing both biomass and shoot density, thereby limiting the regenerative potential of the species more effectively than single-component formulations.

Overall, the comparison with previous studies confirms that integrated and multi-mechanism approaches are essential for effective management of *S. canadensis*. While chemical control remains a key tool, its efficiency increases significantly when herbicides with different modes of action are combined or supplemented with additional control strategies, as highlighted in recent literature.

Conclusion

These results confirm that Lintur 70 WG provides the most stable and radical control of *S. canadensis*, whereas Roundup Max and Dianate BASF leave a considerable potential for population recovery, particularly over an extended period after treatment. The superiority of Lintur 70 WG can be attributed to the synergistic action of its active ingredients, which combine different mechanisms of phytotoxicity and ensure both rapid initial suppression and prolonged inhibition of regenerative processes. In contrast, the single-mechanism formulations demonstrate weaker persistence of effect, allowing partial regrowth of the species due to its high regenerative capacity and perennial root system.

The findings also emphasise that aboveground suppression alone is insufficient for the long-term management of *S. canadensis*. Successful control depends on limiting underground regenerative structures and preventing the re-establishment of shoot density during subsequent growth periods. This is particularly important in the context of invasive species that exhibit strong clonal propagation and high ecological plasticity.

Future research should therefore focus on optimizing the combination of active ingredients and application rates, as well as the timing of herbicide application, to enhance overall efficacy while minimising environmental risks. Additionally, investigating integrated management approaches, such as repeated treatments over multi-year cycles and integrating chemical control with mechanical or ecological methods, is advisable to achieve more sustainable suppression of invasive populations and reduce the long-term soil seed bank and vegetative regeneration potential.

References

1. Havryliuk, O., Hovorukha, V., Bida, I., Gladka, G., Tymoshenko, A., Kyrylov, S., Mariychuk, R., & Tashyrev, O. (2023). Anaerobic degradation of the invasive weed *Solidago canadensis* L. (goldenrod) and copper immobilization by a community of sulfate-reducing and methane-producing bacteria. *Plants*, *12*, Article 198. https://doi.org/10.3390/plants12010198
2. Yavorska, H., & Vorobets, N. (2025). Evaluation of antifungal activity of "green" *Solidago canadensis* extracts. *The Journal of V. N. Karazin Kharkiv National University. Series Biology*, *45*, 115–123. https://doi.org/10.26565/2075-5457-2025-45-8
3. Bakacsy, L., Kardos, L. V., Szepesi, Á., Nagy, K. N., Vasas, A., & Feigl, G. (2024). Investigation of the allelopathic effect of two invasive plant species in rhizotron system. *Life*, *14*(4), Article 475. https://doi.org/10.3390/life14040475
4. Bang, A., Cuthbert, R. N., Haubrock, P. J., Fernandez, R. D., Moodley, D., Diagne, C., Turbelin, A. J., Renault, D., Dalu, T., & Courchamp, F. (2022). Massive economic costs of biological invasions despite widespread knowledge gaps: A dual setback for India. *Biological Invasions*, *24*(7), 2017–2039. https://doi.org/10.1007/s10530-022-02780-z

5. Dakhil, M. A., El-Keblawy, A., El-Sheikh, M. A., Halmy, M. W. A., Ksiksi, T., & Hassan, W. A. (2021). Global invasion risk assessment of *Prosopis juliflora* at biome level: Does soil matter? *Biology, 10*(3), Article 203. https://doi.org/10.3390/biology10030203
6. García-Mozo, H. (2024). Assessment of the diversity, abundance and range of invasive alien plant species in Córdoba, a Mediterranean urban area. *Diversity*, *16*(12), Article 777. https://doi.org/10.3390/d16120777
7. Khan, A. M., Li, Q., Saqib, Z., Khan, N., Habib, T., Khalid, N., Majeed, M., & Tariq, A. (2022). MaxEnt modelling and impact of climate change on habitat suitability variations of economically important chilgoza pine (*Pinus gerardiana* Wall.) in South Asia. *Forests*, *13*(5), Article 715. https://doi.org/10.3390/f13050715
8. Lipińska, H., Lipiński, W., Shuvar, I., Korpita, H., & Shuvar, A. (2023). Invasive species of plants and their threat to biodiversity. *Plant and Soil Science*, *14*(1), 51–66. https://doi.org/10.31548/plant1.2023.51
9. Nagabhushan Arun, M., Mahender Kumar, R., Sreedevi, B., Padmavathi, G., Revathi, P., Pathak, N., Srinivas, D., & Venkatanna, B. (2023). The rising threat of invasive alien plant species in agriculture. *IntechOpen*. https://doi.org/10.5772/intechopen.106742
10. Rai, P. K., & Singh, J. S. (2020). Invasive alien plant species: Their impact on environment, ecosystem services and human health. *Ecological Indicators*, *111*, Article 106020. https://doi.org/10.1016/j.ecolind.2019.106020
11. Rashid, I., Haq, S. M., Lembrechts, J. J., Khuroo, A. A., Pauchard, A., & Dukes, J. S. (2021). Railways redistribute plant species in mountain landscapes. *Journal of Applied Ecology*, *58*(9), 1967–1980. https://doi.org/10.1111/1365-2664.13961
12. Shuvar, I., Korpita, H., Balkovskyi, V., Shuvar, A., & Kropyvnytskyi, R. (2021). *Asclepias syriaca* L. is a threat to biodiversity and agriculture of Ukraine. *BIO Web of Conferences*, *36*, Article 07010. https://doi.org/10.1051/bioconf/20213607010
13. Słowiński, K., Grygierzec, B., Synowiec, A., Tabor, S., & Araniti, F. (2022). Preliminary study of control and biochemical characteristics of giant hogweed (*Heracleum sosnowskyi* Manden.) treated with microwaves. *Agronomy*, *12*(6), Article 1335. https://doi.org/10.3390/agronomy12061335
14. Sužiedelytė Visockienė, J., Tumelienė, E., & Maliene, V. (2020). Identification of *Heracleum sosnowskyi*-invaded land using earth remote sensing data. *Sustainability*, *12*(3), Article 759. https://doi.org/10.3390/su12030759
15. Tiwari, S., Mishra, S. N., Kumar, D., Kumar, B., Vaidya, S. N., Ghosh, B. G., Rahaman, S. M., Khatun, M., Garai, S., & Kumar, A. (2022). Modelling the potential risk zone of *Lantana camara* invasion and response to climate change in eastern India. *Ecological Processes*, *11*(1), Article 1–13. https://doi.org/10.1186/s13717-021-00354-w
16. Zhu, X., Li, W., Shao, H., & Tang, S. (2022). Effects of extracts from various parts of invasive *Solidago* species on the germination and growth of native grassland plant species. *Chemical Biodiversity*, *19*(10), Article e202200728. https://doi.org/10.1002/cbdv.202200728
17. Anas, M., Huang, Z. Y., Xiong, H., Imran, M., Yan, M. T., Javed, Q., Ren, G. Q., Qi, S. S., Li, J., Dai, Z. C., & Du, D. L. (2025). Response of invasive *Solidago canadensis* to foliar application of natural herbicide and glyphosate. *Journal of Environmental Management*, *394*, Article 127522. https://doi.org/10.1016/j.jenvman.2025.127522
18. Szabó, A.-K., Bálint, J., Molnár, A., Aszalos, S. E., Fora, C. G., Loxdale, H. D., & Balog, A. (2022). Associational susceptibility of crop plants caused by the invasive weed Canadian goldenrod, *Solidago canadensis*, via local aphid species. *Frontiers in Ecology and Evolution*, *10*, Article 1080599. https://doi.org/10.3389/fevo.2022.1080599
19. Baranets, M., Bień-Kostycz, P., Turnau, K., Kalaji, H., & White, J. (2025). Mitigation of *Solidago canadensis* invasion using natural substances and selected endophytes. *Research Square*. https://doi.org/10.21203/rs.3.rs-7665103/v1
20. Poljuha, D., Sladonja, B., Božac, M., Šola, I., Damijanić, D., & Weber, T. (2024). The invasive alien plant *Solidago canadensis*: Phytochemical composition, ecosystem service potential, and application in bioeconomy. *Plants*, *13*(13), Article 1745. https://doi.org/10.3390/plants13131745
21. Shuvar, I., Korpita, H., Shuvar, A., Shuvar, B., & Kropyvnytskyi, R. (2021). Invasive plant species and the consequences of its prevalence in biodiversity. *BIO Web of Conferences*, *31*, Article 00024. https://doi.org/10.1051/bioconf/20213100024
22. Visockienė, J. S., Tumelienė, E., & Maliene, V. (2020). Identification of *Heracleum sosnowskyi*-invaded land using earth remote sensing data. *Sustainability*, *12*, Article 759. https://doi.org/10.3390/su12030759
23. Ye, X., Gu, C., Meng, J., & Wu, M. (2025). Differences in the response of invasive *Solidago canadensis* and native *Imperata cylindrica* to glyphosate. *Plants*, *14*(17), Article 2640. https://doi.org/10.3390/plants14172640

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Мета. Оцінити вплив різних гербіцидних обробок на *Solidago canadensis* L. та розробити рекомендації для його ефективного довгострокового контролю. **Методи**. У процесі досліджень застосовували три схеми хімічного контролю: гербіциди Лінтур (триасульфурон + дикамба), Раундап Макс (гліфосат) і Діанат (дикамба). Ефективність гербіцидів оцінювали комплексно: визначали пригнічення надземної частини, кількість життєздатних пагонів і можливість регенерації. Статистичну обробку проводили методом дисперсійного аналізу (ANOVA) з критерієм НІР$_{0.05}$ за допомогою програм Statistica 13.0 та Microsoft Excel 2019. **Результати.** Всі протестовані гербіциди мали чіткий супресивний вплив на *S. canadensis*. Утім, залежно від активних інгредієнтів та тривалості дії, їхня ефективність значно варіювала. Загалом, найвищою та найстабільнішою вона була в Lintur 70 WG, який забезпечував швидке та прогресивно посилюване пригнічення росту рослин, що досягало 91,8 ± 3,5% через 42 дні після обробки, разом із максимальним зниженням біомаси (86,8 ± 2,7%) та щільності пагонів (~90% до 3 пагонів/м^2). Це свідчить про мінімальну регенеративну здатність. Dianate BASF продемонстрував помірний, але менш стабільний контроль із кінцевим пригніченням, що становило 79,3 ± 3,5%, та зниженням біомаси на рівні 69,3 ± 2,6%. Зменшення щільності пагонів (~71% до 6 пагонів/м^2) вказує на частковий потенціал відновлення виду після обробки. Roundup Max характеризувався помірно високою, але менш стійкою продуктивністю, досягаючи пригнічення на 84,7 ± 3,5% та скорочення біомаси на 57,2 ± 2,4%, з найслабшим зниженням щільності пагонів (~63%

до 9 пагонів/м^2). Це свідчить про максимальний потенціал регенерації серед протестованих варіантів. **Висновки.** Отримані дані підтверджують, що для стійкого контролю *S. canadensis* найефективнішими є мультикомпонентні гербіциди з різними механізмами дії, які забезпечують швидке пригнічення біомаси та мінімальну регенерацію. Результати можуть бути використані для розробляння стратегій хімічного управління інвазійними бур’янами в агроекосистемах та природних угіддях України.

Ключові слова: *пригнічення бур’янів; біомаса; щільність пагонів; регенерація рослин; контроль інвазійних видів; хімічний захист рослин.*

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