UDC: 633.854.78:632.954
DOI: 10.56407/bs.agrarian/1.2025.20

Ukrainian Black Sea Region Agrarian Science
Vol. 29, No. 1

Express Gold herbicide effectiveness based on application methods in sunflower crops

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Abstract. One of the main challenges in sunflower cultivation is weed infestation, which significantly affects crop yield. This study aimed to determine the effectiveness of the Express Gold herbicide under different application methods and rates in sunflower crops. The Suomi sunflower hybrid, adapted to the ExpressSun technology, was selected for the research. Various application rates and methods of Express Gold herbicide were examined, including ground spraying and drone application, with an assessment of their effectiveness. The experiments were conducted in the research field of LLC Ahross+, with trials carried out in 2022, 2023, and 2024. The experiment involved two application methods (ground and drone), three herbicide doses (half, optimal, and maximum), and four working solution application rates. A control plot (without the application of a post-emergence herbicide) was included for comparison. The two-year average results indicated that the herbicide performed effectively at both the half and optimal application rates across all plots. When applied at a rate of 20 g/ha, the herbicide demonstrated higher efficacy compared to treatments with working solution application rates of 50 L/ha and 100 L/ha. As the herbicide dose and working solution volume increased, no further differences were observed in herbicidal performance across plots, with comparable effectiveness at both 50 L/ha and 200 L/ha. It was established that drone application maintained a consistently high treatment quality, regardless of the herbicide dose applied per hectare

Keywords: adjuvant; low-volume spraying; drone; biometric indicators; yield

INTRODUCTION

In modern agriculture, the rational use of energy resources and the need to minimise pesticide load on the environment have become increasingly urgent issues. Farmers are actively seeking alternative approaches to crop protection applications, particularly methods such as low-volume spraying and drone technology. These approaches not only enhance production efficiency but also contribute to maintaining ecological balance. In sunflower cultivation under a system that does not involve soil-applied herbicides, weed infestation presents a significant challenge. However, the scientific literature provides limited coverage of alternative crop

Article's History:
Received: 17.12.2024
Revised: 06.03.2025
Accepted: 27.03.2025

Suggested Citation:
Kozechko, V., & Ivanchenko, O. (2025). Express Gold herbicide effectiveness based on application methods in sunflower crops. *Ukrainian Black Sea Region Agrarian Science*, 29(1), 20-29. doi: 10.56407/bs.agrarian/1.2025.20.

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protection methods in such conditions. This highlights the need for research into plant responses to varying doses of plant protection products (PPPs) and different working solution application rates.

The effectiveness of chemical treatment depends on the degree of coverage of the target surface with the working solution. Improved results can be achieved by increasing droplet density in plants. High treatment efficiency is attained through both the use of modern formulations and the optimisation of application technologies. Yu.I. Tkalich *et al.* (2022) investigated the effectiveness of adjuvants in combination with the herbicide tribenuron-methyl in sunflower crops. Their findings indicated that the addition of adjuvants improved the uniformity of herbicide coverage on plant surfaces, thereby enhancing weed control efficacy. Furthermore, the authors emphasised that the rational use of adjuvants allows for a reduction in herbicide consumption, mitigating its environmental impact. The study concluded that optimising herbicide and adjuvant dosing according to weather conditions and the growth stage of sunflower is advisable.

M. Radchenko *et al.* (2022) analysed the effectiveness of herbicide mixtures containing flumioxazin and fluorochloridone in sunflower crops. Their study demonstrated that the use of combined formulations enables more effective control of a broad spectrum of weeds while reducing the risk of resistance development. The authors highlighted that the correct selection of application rates and spraying techniques is crucial for achieving high herbicidal effectiveness. Additionally, they examined the impact of these formulations on sunflower yield, concluding that adherence to manufacturer recommendations is essential to prevent phytotoxicity. These findings indicate that the effectiveness of herbicides and their combinations with adjuvants depends on multiple factors, including product selection, application method, dosage, weather conditions, and crop growth stage. Further research in this area will contribute to improving sunflower crop protection efficacy and enhancing the environmental safety of agronomic practices.

The findings of A.W. Howell *et al.* (2023) and A. Panfilova *et al.* (2024) confirmed that ultra-low-volume spraying in aerial applications using unmanned aerial vehicles (UAVs) enhanced treatment efficiency, reduced costs by minimising the number of refills and water consumption, and ensured high biological effectiveness through precise distribution of the working solution. However, this method also has certain drawbacks, including a high risk of solution drift and rapid evaporation. O.O. Ivashchenko *et al.* (2018) stated that weeds exhibit high seed productivity, meaning that even a small number of surviving weed plants can produce a substantial amount of viable seeds, replenishing the soil seed bank. Although sunflower is relatively more weed-tolerant than most other row crops, yield losses due to weed infestation remain significant.

Studies by S. Okrushko (2010) and K. Siva Sankar & D. Subramanyam (2011) have shown that if sunflower crops are infested with weeds during the early stages of development, significant yield losses can be expected. The more advanced the sunflower growth stage, the lower its sensitivity to weed competition. This finding reinforces the importance of post-emergence herbicide applications. A review of the literature reveals inconsistent conclusions regarding the effects of different herbicides in sunflower cultivation, highlighting the need for further research under field conditions. According to G. Delchev *et al.* (2022), numerous new production systems, including ExpressSun, have emerged, covering up to 25-30% of the sunflower-growing area in different years. However, despite their widespread adoption, these new systems have yet to undergo thorough field validation and require adaptation to various soil and climatic conditions.

Unmanned aerial vehicles (UAVs) are increasingly used in agriculture for the application of fertilisers and crop protection products. As noted by J. Martinez-Guanter *et al.* (2020) and M.L. Shulyak & S.P. Sokolik (2024), UAV technology enhances application precision and efficiency, reduces agrochemical use, and contributes to environmental protection. This approach optimises agricultural processes by preventing excessive fertiliser and pesticide application, which is beneficial from both an environmental and economic perspective.

The findings of S. Kaya & Z. Goraj (2020) and C. Hiremath *et al.* (2024) highlighted the advantages of UAV technology in terms of time efficiency for herbicide application, reducing the required time by up to 99% compared with conventional spraying methods. The use of agricultural drones also significantly decreased water and labour requirements. Notably, drone-based herbicide spraying demonstrated the potential to reduce herbicide dosage by 30%, emphasising its role in minimising herbicide use.

This study aimed to determine the effectiveness of Express Gold herbicide in sunflower crops under different application methods and rates.

Research objectives:

- to determine the feasibility of using alternative herbicide application methods in sunflower crops;
- to analyse the impact of working solution rates and application methods on herbicide efficacy;
- to evaluate the influence of herbicide dosage and the use of different adjuvants on grain yield formation.

MATERIALS AND METHODS

Field experiments were conducted on the commercial farmland of LLC Ahross+ in the Dnipro District of Dnipropetrovsk Region from 2022 to 2024. During this period, trials were established, and observations were carried out to examine the effects of two application methods (trailed boom sprayer and UAV), three herbicide doses of Express Gold (20, 30, 40 g/ha), various working solution rates (7, 50, 100, 150, 200 L/ha), and two adjuvants (Trend and Esterlip) on sunflower growth, development, and yield compared with the control.

The cultivation technology for the Suomi sunflower hybrid followed the standard agronomic practices for the northern Steppe zone of Ukraine. The preceding crop was maize. Primary tillage involved mouldboard ploughing to a depth of 25-27 cm using a Lemken Diamant 11 reversible plough (Lemken, Germany). Once the soil reached physical maturity, a Solomiya harrow (Haleshchyna Mashzavod, Ukraine) was used to level the soil surface and aid moisture retention. Before sowing, the soil was cultivated to a depth of 5-6 cm with a Kompaktomat pre-sowing unit (Farmet, Czech Republic) to create an optimal seedbed for uniform and efficient sunflower germination. Sowing was carried out using a Horsch Maestro precision seeding system (Horsch, Germany) with a seeding rate of 55,000 plants/ha, a row spacing of 70.0 cm, and a sowing depth of 4.0 cm, with simultaneous application of $N_{20}P_{20}$ mineral fertiliser. Plant protection products were applied using an Amazone Badilli trailed boom sprayer (Amazonen-Werke H. Dreyer SE & Co. KG, Germany) and an Agras t30 drone (DJI, China). Yield measurements and observations in the experimental plots were conducted using generally accepted methods and recommendations from the Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine. The research was carried out following the ethical standards outlined in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973) and the Convention on Biological Diversity (1992). The plots were arranged in a systematic design with three replications. Each plot had a sowing area of 0.4 ha (40×100 m) and a measurement area of 0.24 ha (30×80 m). The total sowing area was 11.0 ha.

According to the results of agrochemical soil surveys (2020-2023), the arable soil of the farm contained an average of 3.0-3.9% humus, 8.0-9.2 mg/100 g of hydrolysable nitrogen, 6.68.1 mg/100 g of available phosphorus, 9.2-13.7 mg/100 g of exchangeable potassium, a pH of 5.5 in saline solution, 6.5 in aqueous solution, a hydrolytic acidity of 0.99 mEq/100 g, and a cation exchange saturation of 97%. The Express Gold herbicide was applied at doses of 20, 30, and 40 grams, with the addition of adjuvants Trend and Esterlip to compare their efficacy. Working solution rates were 50, 100, 150, and 200 L/ha using the trailed boom sprayer, and 7 L/ha using the drone (Table 1).

Table 1. *Experimental design for determining the efficacy of the protective herbicide using different applications*

Working solution rate, L/ha (A)	Herbicide dose (B)	Adjuvant (C)
Control		
7	20 30 40	Trend
50	20 30 40	Trend
50	20 30 40	Esterlip
100	20 30 40	Trend
100	20 30 40	Esterlip
150	20 30 40	Trend
150	20 30 40	Esterlip

Table 1, Continued

Working solution rate, L/ha (A)	Herbicide dose (B)	Adjuvant (C)
Control		
200	20	Trend
	30	
	40	
200	20	Esterlip
	30	
	40	

Source: *developed by the authors*

Yield assessments were conducted by direct combining at the full seed maturity stage of the sunflowers. The measurement area was 0.24 ha. Seed weight from each plot was measured using electronic portable platform scales. Yields were calculated to 100% purity and 8% seed moisture content of the sunflower seeds. Plant height and leaf area were determined at the full flowering stage of the crop.

RESULTS AND DISCUSSION

Table 2 presents the results of leaf area assessment at the full flowering stage, based on the working solution rates, herbicide doses, and the use of adjuvants. Analysis showed that the control treatment (without herbicide or adjuvant application) had an average leaf area of 29.19 thousand m^2/ha over the three years of research. This value was used as the baseline for comparing results.

Table 2. *Leaf area during the full flowering stage based on the factors studied, thousand m^2/ha*

Working solution rate, L/ha (A)	Herbicide dose (B)	Adjuvant (C)	Years				
			2022	2023	2024	Average	+/-
Control			27.55	36.81	23.22	29.19	-
7	20	Trend	36.35	39.64	30.40	35.46	6.27
	30		35.42	37.40	29.13	33.98	4.79
	40		33.24	35.90	27.66	32.27	3.07
50	20	Trend	34.78	34.90	27.87	32.52	3.32
	30		37.80	36.94	29.90	34.88	5.69
	40		36.88	33.27	28.06	32.74	3.54
50	20	Esterlip	28.65	42.55	28.48	33.23	4.03
	30		28.95	56.33	34.11	39.80	10.60
	40		29.72	40.32	28.02	32.69	3.49
100	20	Trend	38.90	49.10	35.20	41.07	11.87
	30		30.96	42.64	29.44	34.35	5.15
	40		32.11	45.29	30.96	36.12	6.93
100	20	Esterlip	41.67	56.50	39.27	45.81	16.62
	30		35.90	63.53	39.77	46.40	17.21
	40		42.06	44.16	34.49	40.24	11.04
150	20	Trend	33.76	49.01	33.11	38.63	9.43
	30		34.46	42.99	30.98	36.14	6.95
	40		36.75	37.04	29.52	34.44	5.24
150	20	Esterlip	39.47	45.94	34.16	39.86	10.66
	30		40.86	47.33	35.28	41.16	11.96
	40		37.00	44.21	32.48	37.90	8.70
200	20	Trend	38.20	43.53	32.69	38.14	8.95
	30		42.11	31.11	29.29	34.17	4.98
	40		34.91	42.85	31.10	36.29	7.09
200	20	Esterlip	36.82	42.49	31.72	37.01	7.82
	30		34.16	40.55	29.88	34.86	5.67
	40		39.81	33.90	29.48	34.40	5.20

Source: *developed by the authors*

The application of a working solution rate of up to 7 L/ha with the use of a drone showed that the average leaf area increased based on the herbicide dose. The maximum value in this group was achieved with a dose of 20 g/ha using the Trend adjuvant, which amounted to 35.46 thousand m²/ha, 6.27 thousand m²/ha higher than the control. Increasing the working solution rate to 50 L/ha resulted in improved leaf area in all the experimental variants. When applying the herbicide at a dose of 30 g/ha with the addition of the Trend adjuvant, the value reached 34.88 thousand m²/ha, exceeding the control by 5.69 thousand m²/ha. The use of the Esterlip adjuvant in the same variant yielded an even higher result – 39.80 thousand m²/ha (+10.60 thousand m²/ha compared to the control).

The largest increases in leaf area were observed with a working solution rate of 100 L/ha. In the variant with a herbicide dose of 30 g/ha and the Esterlip adjuvant, the average value was 46.40 thousand m²/ha, which was 17.21 thousand m²/ha higher than the control. A similar trend was observed with the use of the Trend adjuvant, where the leaf area reached 41.07 thousand m²/ha (+11.87 thousand m²/ha). When the working solution rate was increased to 150-200 L/ha, the leaf area values slightly decreased but remained higher than the control. Specifically, with a rate of 150 L/ha, a dose of 30 g/ha, and the Esterlip adjuvant, the average value was 41.16 thousand m²/ha (+11.96 thousand m²/ha compared to the control). At a rate of 200 L/ha, the maximum leaf area was achieved in the variant with the Trend adjuvant (38.14 thousand m²/ha), which exceeded the control by 8.95 thousand m²/ha. It was established that the control variant, without the use of herbicides or adjuvants had an average plant height of 124 cm over three years of observation (Table 3).

Table 3. *Plant height at the full flowering stage based on the investigated factors, cm*

Working solution rate, L/ha (A)	Herbicide dose (B)	Adjuvant (C)	Years 2022	2023	2024	Average	+/-
Control			116	149	106	124	-
7	20	Trend	130	167	119	139	15
	30		129	158	115	134	10
	40		130	162	117	136	13
50	20	Trend	142	158	120	140	16
	30		138	163	120	140	17
	40		128	158	114	133	10
50	20	Esterlip	129	160	116	135	11
	30		123	162	114	133	9
	40		135	144	112	130	7
100	20	Trend	141	174	126	147	23
	30		128	170	119	139	15
	40		127	159	114	133	10
100	20	Esterlip	136	156	117	136	13
	30		135	163	119	139	15
	40		145	153	119	139	15
150	20	Trend	130	158	115	134	11
	30		142	153	118	138	14
	40		134	156	116	135	12
150	20	Esterlip	139	153	117	136	13
	30		127	159	114	133	10
	40		134	167	120	140	17
200	20	Trend	128	163	116	136	12
	30		130	165	118	138	14
	40		125	161	114	133	10
200	20	Esterlip	130	162	117	136	13
	30		127	160	115	134	10
	40		130	160	116	135	12

Source: *developed by the authors*

The application of a working solution rate of up to 7 L/ha using a drone contributed to an increase in plant height compared to the control. With a herbicide dose of 20 g/ha and the Trend adjuvant, the average height was 139 cm, which exceeded the control by 15 cm. In the variants with doses of 30 and 40 g/ha, the plant height was 134 cm and 136 cm, respectively, which was 1,013 cm higher than the control. The application of a working solution rate of 50 L/ha further promoted an increase in plant height. The highest values were recorded with a herbicide dose of 30 g/ha and the Trend adjuvant, where the average height was 140 cm (+17 cm compared to the control). The use of the Esterlip adjuvant in the same variant yielded a slightly lower result of 133 cm (+9 cm compared to the control).

At a working solution rate of 100 L/ha, the highest plant height values were recorded. In the variant with a herbicide dose of 20 g/ha and the Trend adjuvant, the average height reached 147 cm, which was 23 cm higher than the control. Other variants with the use of this adjuvant also demonstrated consistently high results (139-147 cm), exceeding the control by 15-23 cm. Increasing the working solution rate to 150 and 200 L/ha was associated with a slight reduction in effectiveness. At a rate of 150 L/ha, a herbicide dose of 30 g/ha, and the use of the Esterlip adjuvant, the average height was 140 cm, which exceeded the control by 17 cm. At a rate of 200 L/ha, the maximum value (138 cm) was recorded in the variant with the Trend adjuvant at a dose of 30 g/ha (+14 cm compared to the control). It was established that the control variant, without the use of herbicides and adjuvants, resulted in the lowest yield, averaging 1.80 t/ha over the three years (Table 4).

Table 4. *Sunflower seed yield based on the investigated factors, t/ha*

Working solution rate, L/ha (A)	Herbicide dose (B)	Adjuvant (C)	Years				
			2022	2023	2024	Average	+/-
	Control		1.65	2.37	1.37	1.80	-
7	20	Trend	2.64	3.39	2.05	2.69	0.90
	30		2.69	3.29	2.03	2.67	0.88
	40		2.61	3.28	2.00	2.63	0.84
50	20	Trend	2.30	3.39	1.93	2.54	0.75
	30		2.24	3.26	1.87	2.46	0.66
	40		2.06	3.04	1.73	2.28	0.48
50	20	Esterlip	1.73	3.28	1.70	2.24	0.44
	30		2.06	3.22	1.80	2.36	0.56
	40		2.30	3.02	1.81	2.38	0.58
100	20	Trend	2.26	3.41	1.93	2.53	0.74
	30		2.17	3.31	1.86	2.45	0.65
	40		2.20	2.97	1.76	2.31	0.51
100	20	Esterlip	2.07	3.40	1.86	2.44	0.65
	30		2.51	3.13	1.92	2.52	0.72
	40		2.41	2.80	1.77	2.33	0.53
150	20	Trend	2.71	3.30	2.04	2.68	0.89
	30		2.73	3.31	2.05	2.70	0.90
	40		2.16	2.95	1.74	2.28	0.49
150	20	Esterlip	2.29	3.38	1.93	2.53	0.74
	30		2.56	3.30	1.99	2.62	0.82
	40		2.55	3.01	1.89	2.48	0.69
200	20	Trend	2.71	3.27	2.03	2.67	0.88
	30		2.57	3.27	1.99	2.61	0.81
	40		2.93	3.01	2.02	2.65	0.86
200	20	Esterlip	2.57	3.26	1.98	2.60	0.81
	30		2.46	3.13	1.90	2.50	0.70
	40		2.49	2.95	1.85	2.43	0.63

Source: *developed by the authors*

The application of a working solution rate of 7 L/ha in combination with the herbicide and Trend adjuvant significantly increased yield. The maximum value in this group was achieved with a herbicide dose of 20 g/ha, where the average yield was 2.69 t/ha, exceeding the control by 0.90 t/ha. Other herbicide doses (30 and 40 g/ha) resulted in only slight reductions in yield – 2.67 and 2.63 t/ha, respectively (+0.88 and +0.84 t/ha compared to the control). At a working solution rate of 50 L/ha, yield decreased slightly compared to variants with lower rates, especially at a dose of 40 g/ha, where the average yield was 2.28 t/ha (+0.48 t/ha compared to the control). In variants with the Esterlip adjuvant, yields ranged from 2.24 to 2.38 t/ha (+0.44-0.58 t/ha compared to the control). Increasing the working solution rate to 100 L/ha positively impacted yield. The highest results were achieved with a herbicide dose of 30 g/ha combined with Trend, resulting in 2.53 t/ha (+0.74 t/ha compared to the control). However, using Esterlip in the same variant yielded slightly lower results – 2.44 t/ha (+0.65 t/ha compared to the control).

The highest yield values were recorded with a working solution rate of 150 L/ha. With a herbicide dose of 30 g/ha combined with Trend adjuvant, the average yield was 2.70 t/ha, exceeding the control by 0.90 t/ha. The use of Esterlip provided slightly lower results – 2.62 t/ha (+0.82 t/ha compared to the control). The working solution rate of 200 L/ha showed consistently high results. With a herbicide dose of 40 g/ha and Trend adjuvant, the average yield was 2.65 t/ha (+0.86 t/ha compared to the control). The use of Esterlip in the same variant resulted in a similar yield – 2.60 t/ha (+0.81 t/ha compared to the control). Weeds are an important biotic constraint for sunflower production, and the application of herbicides can provide effective weed control in this crop. The reduction in sunflower seed yield in the control group compared to all the other plots where herbicide was applied ranged from 20-33%. According to R.H. Wanjari *et al.* (2001), competition from weeds can reduce sunflower yield by up to 81%, depending on weed density, timing and duration of competition, and the weed spectrum. In the study by M. Jursík *et al.* (2020), competition from weeds reduced sunflower yield by nearly 40%.

An analysis of the literature reveals conflicting conclusions regarding the effects of various herbicides on sunflower cultivation. Some authors prefer soil-applied herbicides, such as E. Pannacci *et al.* (2007), E. Nádasy *et al.* (2008), and O. Kilinc *et al.* (2011), used active substances like linuron, flurochloridone, oxyfluorfen, pendimethalin, prosulfocarb, biphenox, aclonifen, flumioxazin, and lenacil in combination with acetamide herbicides (acetochlor, dimethenamid, petoxamid, metolachlor, flufenacet, propisochlor) for pre-emergence control of broadleaf weeds in sunflowers. It is well-known that the effectiveness of soil-applied herbicides is significantly influenced by soil moisture. In their study, M. Jursík *et al.* (2015) demonstrated that in dry conditions, the effectiveness of soil-applied herbicides generally decreases. However, intense rainfall following the application of these herbicides can cause crop damage. This effect is particularly important for sunflowers, as the selectivity of most herbicides depends on the placement of the herbicide layer on the soil surface and the distribution of seeds in the soil profile. Sandy soils, with lower adsorption capacity, are at greater risk of herbicide leaching after heavy rainfall or irrigation, which increases the risk of crop damage.

However, most researchers believe that to obtain weed-free sunflower crops, it is necessary to apply both soil-applied and post-emergence herbicides. In particular, I. Mostoviak *et al.* (2024) demonstrated the negative impact of weed vegetation on sunflower yield formation, which manifested in a reduction in seed productivity as the number of weeds in the crops increased. The lowest weed infestation in sunflower agrocenoses (1.5 plants/m^2) at harvest was observed in the variant with the application of soil herbicide (Oscar Premium, suspension emulsion, 3.75 L/ha) and a tank mix of post-emergence herbicides (Challenge, suspension concentrate, 1.0 L/ha + Heliantex, suspension concentrate, 0.045 L/ha + surfactant Vivolt, 0.25 L/ha) at the BBCH 14 growth stage. The highest yield of the studied crop was also recorded in this variant of the experiment – 4.13 t/ha, which was 2.58 t/ha higher than the control variant.

Numerous studies have been conducted regarding the effectiveness of using CLEARFIELD herbicides on IMI-resistant sunflower hybrids. In particular, M. Pfenning *et al.* (2008) demonstrated that the application of CLEARFIELD herbicides provides exceptional post-emergence and soil activity for controlling a wide range of weeds found in regions where sunflowers are grown. They noted that one of the main advantages of the CLEARFIELD system for sunflowers is the post-emergence control of a broad spectrum of weeds with imazamox, and pointed out that, depending on local needs, a soil-applied herbicide such as pendimethalin complements the residual activity of imazamox very well. S. Jocić *et al.* (2008) extensively studied the effect of tribenuron-methyl on broadleaf weeds in the crops of imidazolinone-resistant sunflower hybrids. They found that the development of hybrids resistant to tribenuron-methyl enabled the use of a wider range of herbicides for sunflowers, provided more effective chemical control of harmful vegetation, and made it economically advantageous to control certain annual and perennial broadleaf weeds post-emergence in sunflower crops, including troublesome species such as common ragweed, lamb's quarters, redroot pigweed, rag sumpweed, creeping thistle, and others.

CONCLUSIONS

Complete control and the death of broadleaf weeds in the investigated sunflower plots were achieved by drone application at a herbicide dose of 30 g/ha of Express Gold, as well as by spraying in the plot group with application rates of 50, 100, and 150 L/ha using herbicide doses of 30 and 40 g/ha at the 5-6 leaf stage of the sunflowers. At application rates of 150 and 200 L/ha with a herbicide dose of 20 g/ha, deformation of the weed growth point and cessation of growth were observed; complete death occurred only in weeds at the initial stage of vegetation. The highest sunflower yield was recorded when applying half the recommended dose of Express Gold herbicide (20 g/ha) via drone, amounting to 2.69 t/ha, indicating a reduction in pesticide load on the crop. The herbicide's effect on the weeds was lethal due to the fine droplets and maximum leaf surface coverage.

The best results across all aspects (leaf area, plant height, yield) were observed with application rates of 100-150 L/ha, herbicide doses of 20-30 g/ha, and the addition of the Trend adjuvant. These combinations ensured optimal coverage of the working solution, an increase in the plants' assimilatory surface, and, consequently, maximum yield. The yield in the control plot was 1.80 t/ha, the lowest among all the experimental plots, indicating that weed infestation had a greater negative impact on sunflower yield than increased pesticide load on the crop. Therefore, the optimal method of herbicide application involves using medium rates of working solution and herbicide doses, with drone application being a promising approach, though it requires further detailed and careful study.

Given the current labour outflow from Ukraine due to martial law and the need for intellectual agricultural production, it is expected that the use of agricultural UAVs will further unlock the production potential. Therefore, research and development in the use of agricultural unmanned equipment are promising, representing a crucial step in implementing the technological modernisation of smart agriculture. This will enable the timely intellectual transformation of agriculture in today's context.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

None.

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Ефективність гербіциду «Експрес Голд» залежно від способів застосування в посівах соняшнику

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Анотація. Однією з головних проблем на посівах соняшнику є забур'яненість, яка має значний вплив на урожайність культури. Метою роботи було встановити ефективність застосування гербіциду «Експрес Голд» при різних методах та нормах внесення на посівах соняшнику. Для дослідження було обрано гібрид соняшнику Суомі під технологію ExpressSun. У ході досліджень вивчалися різні норми та методи внесення гербіциду «Експрес Голд», зокрема наземне обприскування та використання дронів, а також оцінювалась ефективність їх застосування. Експериментальні роботи проводилися на дослідному полі ТОВ «Агросс+», дослідження закладались і здійснювались у 2022, 2023 та 2024 роках. В експерименті використано два методи (наземне та дрон), три дози препарату (половинна, оптимальна, максимальна) та чотири норми впливу робочої рідини. Для порівняння також було включено контрольну ділянку (без застосування страхового гербіциду). Усереднене за два роки дослідження показало, що гербіцид спрацював половинною і оптимальною нормами максимально якісно на всіх ділянках. У варіанті застосування гербіциду з нормою 20 г/га ефективність була вищою ніж при обробці з нормами виливу робочої рідини 50 л/га та 100 л/га. Коли підвищувалась доза гербіциду і норма виливу робочого розчину, то на тих ділянках уже не було видно різниці між кількістю робочого розчину на гектар: гербіцид однаково якісно спрацював і при 50 л/га і на 200 л/га. Встановлено, що при використанні методу внесення дроном, незалежно від досліджуваної дози гербіциду на 1 га, якість обробки залишалася високою

Ключові слова: прилипач; малооб'ємне обприскування; дрон; біометричні показники; урожайність