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RESPONSE OF SUNFLOWER HYBRIDS TO WEEDS

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Sunflower is the main crop for the agricultural sector of Ukraine, which provides significant foreign exchange revenues to the state budget. The problem of its cultivation is the weediness of crops. The aim of the work was to establish the response of sunflower hybrids resistant to herbicides from the sulfonylurea group to weeds. The methodology included the establishment and conduct of experiments with two new zoned Ravelin and Phenomen sunflower hybrids on two growing backgrounds (with weeds; without weeds) in the fields of the Yuriev Plant Production Institute of the NAAS of Ukraine in 2021, 2023. It was established that in the conditions of the Eastern Forest-Steppe of Ukraine, the main weeds in the crops of the studied hybrids were *Echinochloa crus-galli*, *Chenopodium album* and *Amaranthus retroflexus*. The indices of the total number (r = –0.744), raw mass (r = –0.627) and air-dry mass (r = –0.791) of weeds in hybrid crops had a statistically significant negative relationship with their biological yield. The presence of weeds in crops of Ravelin and Phenomen hybrids extended their growing season by 3 days and 5 days, respectively. Against a background of weedy crops of Ravelin and Phenomen hybrids, compared to crops, without weeds lower values were formed for the following indices: height of cultivated plants by 16.1% and 10.6%, respectively; diameter of the middle part of the stem by 32.9% and 39.0%; diameter of calathide by 35.9% and 38.2%; mass of seeds from the calathide by 82.0% and 80.3%; the number of seeds in the calathide by 89.0% and 63.7%; the 1,000-kernel weight by 8.0% and 14.1%; the mass of hybrid plants by 72.6% and 82.0%; biological yield by 150.4% and 97.9%; fat content in seeds by 0.20% and 0.29%; the oil yield per hectare by 174.1% and 118.0%. Thus, the Phenomen hybrid had higher competitiveness against weeds, and the Ravelin hybrid had higher biological yield and oil content. The results obtained are recommended for introduction in production practice to increase the efficiency of growing sulfonylurea-resistant sunflower hybrids.

Keywords: sunflower, hybrids, weediness, biometric and productive indicators, plant mass, biological yield, fat content and oil collection

Introduction. Sunflower is an annual plant (*Helianthus annuus* L.), which is used in the diet, for oil, for obtaining dyes, for medical purposes and as an ornamental plant (Jocic et al., 2015). Ukraine occupies a leading position in the global sunflower market, acting not only as one of the largest producers of its seeds, but also as a global leader in the export of its processed products. The high concentration of processing capacities has led to the formation of an export model focused mainly on products with high added value, which allows us to consider our country as an important processing hub in the global oilseed complex. Export of sunflower seed processing products, in particular oil and cake, provides significant foreign exchange revenues to the state budget, contributes to the growth of employment and the formation of tax revenues,

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and also increases the resilience of the agricultural sector of the economy to price and logistical challenges (Stepasiuk, 2026).

Sunflower cultivation is accompanied by a significant problem associated with weed control. An effective way to solve this problem is to use new hybrids in combination with appropriate herbicides. However, for specific soil and climatic conditions, it is worth selecting sunflower varieties and hybrids and appropriate technologies for their cultivation (Hrytsev, 2015). Therefore, scientific research into the reaction of new sunflower hybrids to weed vegetation in crops is a relevant topic for scientists and agricultural producers.

The diversity of species and the frequency of occurrence of weeds in sunflower crops varies depending on the natural soil and climatic conditions. The following weeds are most often found in sunflower crops (Republic of Croatia): *Polygonum persicaria* L., *Polygonum lapathifolium* L., *Ambrosia artemisiifolia* L., *Chenopodium polyspermum* L., *Amaranthus retroflexus* L., *Solanum nigrum* L. emend Miller, *Abutilon theophrasti* Medik, *Datura stramonium* L., *Xanthium strumarium* L., *Convolvulus arvensis* L., *Cirsium arvense* (L.) Scop., *Echinochloa crus-galli* (L.) Pb., *Setaria glauca* (L.) Pb., *Setaria viridis* (L.) Pb., *Digitaria sanguinalis* (L.) Scop., *Panicum* spp. and *Sorghum halepense* (L.) Pers. (Mijić et al., 2022). In Ukraine, weed infestation of sunflower crops can vary from region to region. In sunflower agrocenoses in Vinnytsia region, the species composition of segetal weed vegetation includes: *S. glauca*, *Chenopodium album* L., *Capsella bursa-pastoris* (L.) Medik., *A. retroflexus*, *C. arvensis* (Tkachuk & Bondaruk, 2024). In Odessa region, the species composition of weeds in sunflower crops is represented by: *S. glauca*, *C. album*, *Amaranthus blitoides* S. Wats., *A. retroflexus*, *X. strumarium*, *C. arvensis* (Hrytsev, 2015), *C. arvense*, *Sonchus arvensis* L., *Ambrosia trifida* L., *E. crus-galli* (Kurtiev & Domaratskyi, 2025). For the Kyiv region, the main contaminants of sunflower crops are *C. arvense*, *C. arvensis*, *E. crus-galli*, *A. retroflexus*, *C. album* (Babenko, 2017). In addition, in recent years, a parasitic weed, *Orobanche cumana* Wallr., has become widespread in sunflower crops (Tsyliuryk et al., 2018).

It has been established that seedlings of segetal vegetation appear in the period from the beginning of the growing season to the closing of rows in sunflower crops (Laslo et al., 2025). The most effective period for weed control of sunflower crops is the first 10–20 days, which leads to the smallest yield losses (7.9–12.2%). Reducing the period of joint vegetation of the crop with weed plants from 60 to 10 days led to the preservation of yield at the level of 1.97–3.03 t/ha, losses amounted from 40.1 to 7.9% depending on the number of days. Studies show that even a small delay in protecting sunflower crops from weeds can cause significant yield loss (Zadorozhnyi & Chernelivska, 2025).

The sunflower weed protection system involves the mandatory use of herbicides (Shevchenko et al., 2025). Optimal herbicide protection allows the crop to realize its full potential, increases seed productivity and quality (Tarasiuk & Bezvikonnyi, 2025). At present, farmers use three technologies for growing sunflower based on the use of herbicides such as classical, Clearfield and Express Sun. Each of them has its positive and negative sides. Classical technology is the most expensive and requires high costs, the use of soil herbicides and mechanical inter-row cultivation. Clearfield technology (“clean field”) has its advantages over classical technology, as it involves less costs, but requires hybrids that are created specifically for such crop protection conditions. The second component of this technology is the preparation Eurolighting (active ingredient – imazamox, 33 g/l + imazapyr, 15 g/l), which, when

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applied to the soil, creates a protective layer from germinating weeds until the sunflower is harvested. The advantages of this technology are the destruction of all types of weeds with one treatment for the entire growing season of crops. But there are also negative aspects such as the fight against sunflower windfall in the crops of the next crop and restrictions on sowing of subsequent crops. Express Sun technology is based on the systemic herbicide Express (active ingredient – tribenuron-methyl, 750 g/ha), which is applied to vegetative plants (2–8 pairs of true leaves of sunflower, can be applied in two stages). Its main advantage over Clearfield technology is the absence of restrictions on sowing the next crop (Tymchyshyn & Rudavska, 2022) and more effective control of *A. retroflexus* (Mykhalska & Schwartau, 2022).

The Express Sun technology is supported by the results of a study on the use of biostimulants to eliminate the acute phytotoxic effect of sunflower hybrids created using Clearfield and Express Sun technologies, caused by the use of herbicides based on imazamox and tribenuron-methyl (Neshev et al., 2022). But *Descurainia Sophia* L. has developed a high level of resistance to tribenuron-methyl (Deng et al., 2017; Xu et al., 2020). At the same time, both post-emergence herbicides that inhibit acetolactate synthase (imazamox and tribenuron-methyl) when used in hybrid crops carrying the resistance gene to these herbicides are able to effectively suppress the noxious weed *A. artemisiifolia* (Reisinger et al., 2013).

Hybrids are imported from abroad for the above technologies, and modern varieties and hybrids of Ukrainian selection are also being developed (Tymchyshyn & Rudavska, 2022). In particular, in Ukraine, the resistance of created hybrids to sulfonylurea herbicides is being assessed (Ilchenko et al., 2023). Research is actively being conducted with hybrids for Express Sun (or SUMO) technology. In foreign SUZUKA, LG59580, ES AROMATIC SU, P64LE25 hybrids, using Express Sun herbicide protection technology, the formation of plant height, calathide diameter, fat content and yield was studied (Kostyna et al., 2024).

Adaptation of protection systems to the genetic properties of hybrids and growing conditions is most significant for achieving maximum yield and stable agricultural production. The use of specialized herbicides allows not only to reduce crop losses, but also to reduce the pesticide load on the agroecosystem, which is important for ecology (Kryvulko, 2025).

All of the above necessitates conducting scientific research to determine the harmfulness of weeds in crops of new zoned sunflower hybrids in the conditions of the Eastern Forest-Steppe of Ukraine. The main goal of the investigation is to establish the reaction of sunflower hybrids resistant to herbicides from the sulfonylurea group to weeds. The task of the investigation is to determine the impact of weediness of crops on the duration of growing season, biometric and productive indices, plant mass, biological yield and fat content in the seeds of Ravelin and Phenomen. sunflower hybrids.

Materials and Methods. The experimental part of the study was conducted in the experimental fields of the third scientific crop rotation of the Yuriev Plant Production Institute of the NAAS of Ukraine (Kharkiv district, Kharkiv region of Ukraine) in 2021, 2023, in accordance with existing methods and techniques (Tkachyk et al., 2016; Kyienko et al., 2016). The soil is a typical medium-humus, slightly leached black soil. The forecrop was grain crops.

Two hybrids of linoleic sunflower, oil-bearing Ravelin and Phenomen, which are resistant to herbicides from the sulfonylurea group (originator was the Yuriev Plant Production Institute of the NAAS of Ukraine), were studied; two cultivation

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backgrounds (with weeds was control, natural weediness of crops (factor A); without weeds were systematic manual weeding of crops (factor B). The placement of plots was randomized. The plot area was 33.6 m^2. Experiments were replicated four times.

The experiment was established and conducted annually against the background of two pre-sowing cultivations without the use of herbicides and fertilizers. Before sowing, the seeds of both hybrids were treated with a tank mixture of the preparations Barion, ES (active agent: metalaxyl-m, 350 g/l) with rate of 3.0 l/t + Exor, FS (active agent: thiamethoxam, 600 g/l) with rate of 6.0 l/t. Sowing was carried out on 05/26/2021 and 05/22/2023, row spacing was 70 cm. Before closing the rows of cultivated plants, one intercropping tillage was carried out.

Phenological observations were carried out taking into account the beginning of the stage (10% of all hybrid plants in the plot) and full onset (75% of plants). Weeds in hybrid crops were counted before harvesting (at the end of the weed vegetation) by species and quantitative-weight methods. Weediness per 1 m^2 of field was determined by applying a frame measuring 0.5 m^2 (0.70 × 0.71 m) along the largest diagonal in four places of each plot. Weeds were removed with roots, counting by species and weighing their raw and air-dried mass by groups. At the stage of hybrid maturation, in the plots where weeds had already been removed, 40 sunflower plants were selected (10 plants in a row in four replicates) and the height of the plants from the soil surface to the point of attachment of the calathide with a ruler was determined, diameter of the middle part of the stem and calathide with a measuring tape was determined. After the onset of full ripeness, the selected 40 sunflower hybrid plants were removed, cleaned of soil, labeled, dried and their air-dry biomass was determined. Calathides were cut from hybrid plants, threshed by hand, and after cleaning the seeds were weighed and the average weight and number of seeds per calathide were calculated. From the seeds obtained from each replicate, the 1,000-kernel weight by taking 2 average samples in a row with a number of 500 seeds in each of them was determined, weighed separately and brought to the 1,000-kernel weight. The biological yield of sunflower seeds was determined in each replicate by multiplying the plant density per 1 ha (pcs.) by the average seed weight per plant in grams (converted to 10% moisture) and dividing by 1,000,000 to convert to t/ha. The seed quality was determined using generally accepted methods in accordance with DSTU ISO6492:2003. Statistical processing of the experimental results was carried out using Excel.

Weather conditions in 2023 were more favorable for growing hybrids than in 2021. The average daily air temperature for May–October in 2021 and 2023 was 18.1 °C and 18.2 °C, respectively (the average multi-year value is 16.7 °C), and the total amount of precipitation was 193 mm, or 37.3% less than the climatic norm, and 387 mm, or 25.6% more than the norm (the average multi-year value is 308 mm).

Results and Discussion. Pre-harvest counts showed that in 2021 and 2023, weeds in the Ravelin hybrid crops were represented by 14 species and 12 species, respectively, and in the Phenomen hybrid by 14 species and 11 species. In 2021 annual cereal weeds in the crops of both hybrids included *E. crus-galli*, *S. glauca, S. viridis*, and in 2023 included *E. crus-galli*, *S. glauca*. In 2021, *C. album*, *A. retroflexus*, *Fallopia convolvulus* (L.) A. Love, *Stachys annua* L., *Sonchus oleraceus* L., *Melandrium album* (Mill.) Garcke, *Viola arvensis* Murr., *A. artemisiifolia*, *Portulaca oleracea* L., from dicotyledonous annual in Ravelin hybrid crops were detected, and *C. album*, *A. retroflexus*, *A. blitoides*, *F. convolvulus*, *S. annua*, *S. nigrum*, *S. oleraceus*, *A. artemisiifolia*, *P. oleracea* were in the Phenomen hybrid crops. In 2023, the dicotyledonous annual species in hybrid Ravelin crops were represented by

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C. album, *A. retroflexus*, *F. convolvulus*, *S. annua*, *V. arvensis*, *A. artemisiifolia*, *P. oleracea*, *Thlaspi arvense* L., and *C. album*, *A. retroflexus*, *P. lapathifolium*, *A. blitoides*, *F. convolvulus*, *A. artemisiifolia*, *P. oleracea* were in the hybrid Phenomen crops. During the research years, the dicotyledonous perennial weeds *C. arvense* і *C. arvensis* in the crops of both hybrids were found.

In 2021, annual cereal species were most commonly found in the Ravelin and Phenomen hybrids (72.0% and 52.0% of the total number of weeds, respectively), and in 2023, dicotyledonous annual (75.5% and 53.6%) (Table 1). On average for 2021 and 2023, the main weeds in the Ravelin and Phenomen hybrids were *E. crus-galli* (65.5% and 47.7% of the total number of weeds, respectively), *C. album* (14.4% and 21.1%) and *A. retroflexus* (11.4% and 20.3%).

Table 1

Number of weeds in crops of sulfonylurea-resistant sunflower hybrids before harvest, pcs./m^2

Hybrid	Background	Annual cereals	Dicotyledons annual	Dicotyledonous perennials	Total amount
2021					
Ravelin	with weeds	435.5	143.7	25.4	604.6
Phenomen	with weeds	239.5	204.4	17.1	461.0
LSD_{05}		357.5	62.5	27.9	395.7
2023					
Ravelin	with weeds	14.0	44.7	0.5	59.2
Phenomen	with weeds	12.3	18.5	3.7	34.5
LSD_{05}		6.3	41.4	9.8	35.1
average for 2021, 2023					
Ravelin	with weeds	224.8	94.2	13.0	332.0
Phenomen	with weeds	125.9	111.5	10.4	247.8
Correlation coefficient (r) with biological yield		–0.722*	–0.486	–0.786*	–0.744*

Notes: * the index is reliable. High values of LSD_{05} are the result of uneven distribution of weed species in sunflower hybrid crops.
Source: developed by the author.

It was found that during the years of research, the total number, raw and air-dry mass of weeds in Ravelin hybrid crops were mostly higher, within the experimental error, than in crops of the Phenomen hybrid (Table 2). Another study also noted differences in weed formation in crops of different sunflower hybrids (Kryvulko, 2025).

The mass of weeds has a stronger effect on the reduction of sunflower yield than their number. It has been established that there is an inverse linear relationship between the weediness of crops and seed yield, the degree of which increases with the increase in weediness of crops, especially their mass. Correlation between the mass of weeds and sunflower seed yield was (r = –0.83); correlation between the number of weeds and sunflower seed yield was (r = –0.68) (Babenko, 2017).

In our study, a negative relationship between the most of weediness indicators in the crops of both hybrids and their biological yield was also established. A statistically significant negative relationship with biological yield was observed for the number of annual cereals (r = –0.722), perennial dicotyledons (r = –0.786) and all weeds (r = –0.744), as well as the raw mass of perennial dicotyledons (r = –0.820), raw mass of all weeds (r = –0.627) and their air-dry mass (r = –0.791).

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Table 2

Weed mass in crops of sulfonylurea-resistant sunflower hybrids before harvest, g/m^2

Hybrid	Background	Raw mass				Air-dry mass
		annual cereals	dicotyledonous annual	dicotyledonous perennials	total amount	total amount
2021						
Ravelin	with weeds	398.8	152.7	318.2	869.7	443.2
Phenomen	with weeds	321.0	316.4	257.9	895.3	420.1
LSD_{05}		366.2	92.7	456.1	387.6	94.5
2023						
Ravelin	with weeds	395.0	409.5	0.9	805.4	267.0
Phenomen	with weeds	192.9	203.9	8.0	404.8	132.1
LSD_{05}		264.2	536.9	21.6	508.9	195.3
average for 2021, 2023						
Ravelin	with weeds	396.9	281.2	159.6	837.7	355.2
Phenomen	with weeds	257.0	260.2	133.0	650.2	276.2
Correlation coefficient (r) with biological yield		–0.236	0.460	–0.820*	–0.627*	–0.791*

Notes: * the index is reliable. High values of LSD_{05} are the result of uneven distribution of weed species in sunflower hybrid crops.
Source: developed by the author.

It was found that on average in 2021 and 2023, the presence of weeds in of hybrids Ravelin and Phenomen crops (with weeds) extended the growing season (full germination–full maturity) of these hybrids by 3 days and 5 days, respectively, compared to crops free of weeds (without weeds).

The most important morphological characteristics of sunflower, which determine the formation of its productivity, are the height of the stem, the length of the root system, the calathide diameter, and the size of leaf surface. The values of these indices indicate the level of influence of the genotype under different conditions of crop cultivation, and reflect the state of plant development (Mazur & Matusevych, 2023). According to the results of our research, weeds in the Ravelin and Phenomen hybrid crops negatively affected the biometric indices of these hybrids. When grown with weeds, compared to growing without weeds, the plant height of the Ravelin and Phenomen hybrids were mostly statistically significantly lower by 38.1 cm and 28.2 cm in 2021 and by 7.3 cm and 2.4 cm in 2023, respectively; the diameter of the middle part of the stem by 0.65 cm and 0.71 cm in 2021 and by 0.28 cm and 0.40 cm in 2023; the calathide diameter by 6.8 cm and 5.2 cm less in 2021 and by 2.5 cm and 4.3 cm less in 2023. On average for 2021, 2023, when grown with weeds, compared to growing without weeds, the height of plants of the Ravelin and Phenomen hybrids was by 16.1 % and 10.6 % less, respectively, the diameter of the middle part of the stem by 32.9 % and 39.0 % less, the calathide diameter by 35.9 % and 38.2 % less (Table 3).

Weediness of crops of both hybrids also negatively affected their productivity indices. Thus, the mass of seeds from the calathide of hybrids Ravelin and Phenomen on a background with weeds, compared to a background without weeds, statistically significantly decreased by 25.9 g and 17.2 g in 2021 and by 18.5 g and 21.2 g in 2023, respectively; the number of seeds in the calathide by 561.1 pcs. and 438.0 pcs. in 2021 and 353.7 pcs., and 354.0 pcs. in 2023; the 1,000-kernel weight by 8.6 g and 4.7 g in 2021. At the same time, in 2023, the 1,000-kernel weight in the Ravelin hybrid on a

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background with weeds, compared to a background without weeds, increased by 1.0 g (within the experimental error), and in the Phenomen hybrid this index statistically significantly decreased by 5.5 g. On average for 2021, 2023, the mass of seeds from calathide of Ravelin and Phenomen hybrids when grown with weeds, compared to growing without weeds, decreased by 82.0% and 80.3%, respectively; the number of seeds in the calathide by 89.0% and 63.7%; the 1,000-kernel weight by 8.0% and 14.1% (Table 4). Our results confirm that weed control in sunflower crops contributes to an increase in seed weight (Tarasiuk & Bezvikonnyi, 2025).

Table 3

Biometric indices of sulfonylurea-resistant sunflower hybrids at the ripening stage depending on the cultivation background

Hybrid (A)	Background (B)	Plant height, cm	Diameter, cm	
			middle part of the stem	calathide
2021				
Ravelin	with weeds	116.9	0.74	6.7
	without weeds	155.0	1.39	13.5
Phenomen	with weeds	114.5	0.85	7.5
	without weeds	142.7	1.56	12.7
LSD_{05} for factor A		14.1	0.14	1.3
LSD_{05} for factor B		14.1	0.14	1.3
LSD_{05} for factor AB		20.0	0.20	1.8
2023				
Ravelin	with weeds	165.1	2.13	19.6
	without weeds	172.4	2.41	22.1
Phenomen	with weeds	173.3	1.97	17.1
	without weeds	175.7	2.37	21.4
LSD_{05} for factor A		5.4	0.18	1.7
LSD_{05} for factor B		5.4	0.18	1.7
LSD_{05} for factor AB		7.6	0.25	
average for 2021, 2023				
Ravelin	with weeds	141.0	1.43	13.1
	without weeds	163.7	1.90	17.8
Phenomen	with weeds	143.9	1.41	12.3
	without weeds	159.2	1.96	17.0
Correlation coefficient (r) with biological yield		0.659*	0.639*	0.672*

Notes: * the index is reliable.
Source: developed by the author.

Sunflower yield as the main indicator of the agronomic experiment most convincingly reflects the effects of the factors being studied (Mynkina, 2021). The presence of weeds in the crops of Ravelin and Phenomen hybrids negatively affected the mass indicators of cultivated plants and, in general, the level of biological productivity of these hybrids (Table 5). Thus, the mass of plants of Ravelin and Phenomen hybrids on a background with weeds, compared to clean crops from weeds (without weeds), statistically significantly decreased by 482.5 g/m^2 and 369.7 g/m^2 in 2021 and by 512.5 g/m^2 and 703.0 g/m^2 in 2023, respectively; biological yield by 2.32 t/ha and 1.62 t/ha in 2021 and by 1.27 t/ha and 1.15 t/ha in 2023. On average for 2021, 2023, the mass of plants of the Ravelin and Phenomen hybrids when grown with

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weeds, compared to growing without weeds, decreased by 72.6% and 82.0%, respectively; biological yield by 150.4% and 97.9%.

Table 4

Productivity and plant mass of sulfonylurea-resistant sunflower hybrids depending on the growing background

Hybrid (A)	Background (B)	Mass of seeds from the calathide, g	Number of seeds in the calathide, pcs.	1,000-kernel weight, g	Plant mass, g/m^2
2021					
Ravelin	with weeds	7.3	203.5	35.2	186.5
	without weeds	33.2	764.6	43.8	669.0
Phenomen	with weeds	11.0	328.9	32.1	208.3
	without weeds	28.2	766.9	36.8	578.0
LSD_{05} for factor A		4.6	125.3	3.9	81.7
LSD_{05} for factor B		4.6	125.3	3.9	81.7
LSD_{05} for factor AB		6.5	177.2	5.5	115.5
2023					
Ravelin	with weeds	47.2	823.9	56.7	1183.8
	without weeds	65.7	1177.6	55.7	1696.3
Phenomen	with weeds	36.8	913.5	40.2	1100.0
	without weeds	58.0	1267.5	45.7	1803.0
LSD_{05} for factor A		11.4	167.4	4.0	259.3
LSD_{05} for factor B		11.4	167.4	4.0	259.3
LSD_{05} for factor AB		16.2	236.7	5.7	366.7
average for 2021, 2023					
Ravelin	with weeds	27.2	513.7	46.0	685.1
	without weeds	49.5	971.1	49.7	1182.6
Phenomen	with weeds	23.9	621.2	36.1	654.1
	without weeds	43.1	1017.2	41.2	1190.5
Correlation coefficient (r) with biological yield		0.743*	0.824*	0.479*	0.660*

Notes: * the index is reliable.
Source: developed by the author.

The yield structure and plant mass indicators of the studied hybrids were closely related to the level of their biological yield. Thus, the linear correlation coefficient (r) between the mass of seeds from the calathide and biological yield was statistically significant at 0.743, the number of seeds in the calathide and biological yield at 0.824, the 1,000-kernel weight and biological yield at 0.479, and the mass of plants and biological yield at 0.660.

The qualitative indicators of sunflower seeds depend on the duration of competition with weeds. The longer the period of competition for life factors, the lower the fat content in the seeds and the oil yield per hectare, and vice versa (Babenko, 2017). The genotype also has a significant impact on the oil component (Önemli & Tetik, 2023). According to the results of our investigations, weed infestation in crops of the Ravelin and Phenomen hybrids had different effects on the fat content in the seeds during the years of research. Thus, in 2021, the fat content in the seeds of the Ravelin and Phenomen hybrids on a background with weeds, compared to a background without weeds, increased by 0.71% and 1.35%, respectively, and in 2023, on the contrary, it decreased by 1.11% and 1.93%, respectively. Changes in the fat

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content of seeds of the Phenomenon hybrid were statistically significant annually. On average for 2021, 2023, the fat content of seeds of sunflower hybrids Ravelin and Phenomen on a background with weeds, compared to a background without weeds, decreased by 0.20% and 0.29%, respectively. No statistically significant relationship was found between biological yield and fat content.

Table 5

Biological yield, fat content and oil yield from seeds of sulfonylurea-resistant sunflower hybrids depending on the growing background

Hybrid (A)	Background (B)	Biological yield, t/ha	Fat content, %	Oil yield, t/ha
2021				
Ravelin	with weeds	0.69	52.78	0.309
	without weeds	3.01	52.07	1.345
Phenomen	with weeds	1.02	53.34	0.427
	without weeds	2.64	51.99	1.170
LSD_{05} for factor A		0.46	1.20	0.208
LSD_{05} for factor B		0.46	1.20	0.208
LSD_{05} for factor AB		0.65	1.70	0.295
2023				
Ravelin	with weeds	1.68	38.87	0.539
	without weeds	2.95	39.98	0.979
Phenomen	with weeds	1.79	36.49	0.539
	without weeds	2.94	38.42	0.937
LSD_{05} for factor A		0.45	1.66	0.151
LSD_{05} for factor B		0.45	1.66	0.151
LSD_{05} for factor AB		0.64	2.34	0.214
average for 2021, 2023				
Ravelin	with weeds	1.19	45.83	0.424
	without weeds	2.98	46.03	1.162
Phenomen	with weeds	1.41	44.92	0.483
	without weeds	2.79	45.21	1.053
Correlation coefficient (r) with biological yield		–	–0.186	0.926*

Notes: * the index is reliable.
Source: developed by the author.

Weeds in the crops of the studied sunflower hybrids had a negative impact on the oil yield from the seeds of these hybrids. Thus, the oil yield from the seeds of the Ravelin and Phenomen hybrids on a background with weeds, compared to clean crops from weeds (without weeds), statistically significantly decreased, respectively, by 1.036 t/ha and 0.743 t/ha in 2021 and by 0.440 t/ha and 0.398 t/ha in 2023. On average for 2021, 2023, the oil yield from the seeds of the Ravelin and Phenomen hybrids on a background with weeds, compared to a background without weeds, decreased by 174.1 % and 118.0 %, respectively. There was a statistically significant high positive relationship (r = 0.926) between biological yield and oil yield per hectare.

Conclusions. The conducted studies confirm that weeds in sunflower crops worsen the efficiency of growing this crop. It was found that in the conditions of the Eastern Forest-Steppe of Ukraine, the presence of weeds in crops of Ravelin and Phenomen hybrids extended their growing season by 3 days and 5 days, respectively.

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In weeded crops of Ravelin and Phenomen hybrids, compared with clean crops from weeds, indices of the height of cultivated plants were formed, respectively, by 16.1% and 10.6% less; diameter of the middle part of the stem by 32.9% and 39.0% less; calathide diameter by 35.9% and 38.2% less; mass of seeds from the calathide by 82.0% and 80.3% less; number of seeds in the calathide by 89.0% and 63.7% less; the 1,000-kernel weight by 8.0% and 14.1% less; mass of hybrid plants by 72.6% and 82.0% less; biological yield by 150.4% and 97.9% less; fat content in seeds by 0.20% and 0.29% less; oil yield per hectare by 174.1% and 118.0% less. In general, the Phenomen hybrid demonstrated higher competitiveness against weeds, and the Ravelin hybrid demonstrated higher biological yield and oil content. In the future, it is advisable to investigate the effectiveness of various herbicides against individual species and groups of weeds in these hybrid crops.

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РЕАКЦІЯ ГІБРИДІВ СОНЯШНИКУ НА БУР'ЯНИ

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Соняшник є основною культурою для аграрного сектору України, що забезпечує суттєві валютні надходження до бюджету держави. Проблемою при його вирощуванні є забур'яненість посівів. Мета роботи – встановити реакцію гібридів соняшнику, стійких до гербіцидів з групи сульфонілсечовин, на бур'яни. Методологія включала закладання та проведення дослідів із двома новими районованими гібридами соняшнику Равелін і Феномен на двох фонах вирощування (з бур'янами; без бур'янів) на полях Інституту рослинництва ім. В.Я. Юр'єва НААН України в 2021, 2023 рр. Встановлено, що в умовах Східного Лісостепу України основними бур'янами в посівах досліджуваних гібридів були *Echinochloa crus-galli*, *Chenopodium album* і *Amaranthus retroflexus*. Показники загальної кількості (r = –0,744), сирої (r = –0,627) та повітряно-сухої маси (r = –0,791) бур'янів у посівах гібридів мали статистично достовірний від'ємний зв'язок з їх біологічною врожайністю. Присутність бур'янів у посівах гібридів Равелін і Феномен подовжувала їх вегетаційний період відповідно на 3 доби і 5 діб. На фоні забур'янених посівів гібридів Равелін і Феномен, порівняно з чистими посівами, формувались менші значення за показниками: висота культурних рослин відповідно на 16,1% і 10,6%; діаметр середньої частини стебла – на 32,9% і 39,0%; діаметр кошика – на 35,9% і 38,2%; маса насіння з кошика – на 82,0% і 80,3%; кількість насіння в кошику – на 89,0% і 63,7%; маса 1000 насінин – на 8,0% і 14,1%; маса рослин гібридів – на 72,6% і 82,0%; біологічна врожайність – на 150,4% і 97,9%; вміст жиру в насінні – на 0,20% і 0,29%; збір олії з гектара – на 174,1% і 118,0%. Отже, гібрид Феномен мав вищу

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конкурентоспроможність щодо бур'янів, а гібрид Равелін – вищу біологічну врожайність і олійність. Отримані результати рекомендуються до впровадження у виробничу практику для підвищення ефективності вирощування стійких до сульфонілсечовин гібридів соняшнику.

Ключові слова: соняшник, гібриди, забур'яненість, біометричні та продуктивні показники, маса рослин, біологічна врожайність, вміст жиру і збір олії

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