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SUNFLOWER CROP PRODUCTIVITY DEPENDING ON THE EFFECT OF DIFFERENT COMBINATIONS OF ROW SPACING AND SEED SOWING RATE

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According to the results of two years of research, the influence of different combinations of row spacing and seeding rate on the formation of seed yield and dry biomass of sunflower hybrids of different maturity groups was determined. Increasing the seeding rate from 45 to 50 thousand seeds per hectare did not ensure a significant increase in sunflower yield either in 2024 or in 2025. According to the statistical analysis based on Duncan's test, the yield at these seeding rates belonged to the same ranking group. Reducing row spacing from 70 to 45 cm contributed to obtaining higher sunflower seed yield. The influence of the seeding rate on the seed yield of both sunflower hybrids was greater in the variants with 45 cm row spacing, which indicates the interaction of these factors. In particular, on average over the years, the seed yield of the hybrid SY Diego increased by 0.61 t/ha when the seeding rate was raised from 35 to 50 thousand seeds per hectare in the variants with 45 cm row spacing, and by 0.51 t/ha in the variants with 70 cm row spacing. In the crops of the hybrid SY Flavio, in the variants with row spacing of 45 and 70 cm, the increase in seed yield when raising the seeding rate from 35 to 50 thousand seeds per hectare was 0.62 t/ha and 0.55 t/ha, respectively. The highest seed yield was observed in sunflower crops of the hybrid SY Diego in the variant combining the seeding rate of 50 thousand seeds per hectare with 45 cm row spacing – 2.40 t/ha in 2024 and 2.82 t/ha in 2025. At the same time, the seed yield of this hybrid did not differ significantly from the variant combining the seeding rate of 45 thousand seeds per hectare with 45 cm row spacing. In 2024, the difference in yield between these variants was only 0.05 t/ha, and in 2025 it was 0.07 t/ha, which is lower than the LSD_{05} value. The dry biomass yield of sunflower plants of both hybrids was the highest in the variants with the highest studied seeding rate. On average over the years and sowing methods, the dry biomass yield of sunflower hybrids SY Diego and SY Flavio at the seeding rate of 50 thousand seeds per hectare was 8.75 t/ha and 8.29 t/ha, respectively, which is 1.68 t/ha and 1.52 t/ha higher compared with the seeding rate of 35 thousand seeds per hectare. At the same time, no significant difference was found compared with the seeding rate of 45 thousand seeds per hectare. Only a statistically insignificant tendency toward higher dry biomass formation was observed.

Keywords: sunflower, hybrid, productivity potential, plant density, feeding area, seed yield, plant dry biomass

Introduction. Sunflower is an important field crop from which various products are produced, including oil, groats, and confectionery products. In the global ranking of oilseed crops, it ranks fourth after soybean, oil palm, and rapeseed (Adeleke et al., 2020; Ma'ali et al., 2024).

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Sunflower is an annual oilseed crop grown in many countries around the world on an area of approximately 27 million hectares. Annually, 45 to 57 million tons of sunflower seeds are produced. In particular, in the 2024/2025 marketing year, the global gross production of sunflower seeds exceeded 55.4 million tons, which accounts for approximately 8.0% of the global oilseed market (Lalrammawii et al., 2026).

As of today, Ukraine ranks among the top three global leaders both in terms of sown area and gross sunflower seed production. The main cultivation areas are concentrated in the steppe and forest-steppe regions. Sunflower is considered a fairly drought-resistant crop that can withstand dry conditions for an extended period. The record sunflower sowing area in Ukraine was recorded in 2021 at 6.5 million hectares. The high interest in this crop among producers is due to its high profitability, high seed value, strong demand, and the absence of issues with selling the harvested seeds (Shokalo et al., 2023).

In recent periods, a positive trend of gradual increase in sunflower seed yields in Ukraine has been observed, which is due both to improvements in cultivation techniques and the introduction of new high-yielding hybrids that are more resistant to a range of adverse factors, including drought, high temperatures, the parasitic plant *Orobanche Cumana* (sunflower broomrape), a wide spectrum of diseases, and others. At the same time, sunflower seed yields in Ukraine are significantly lower than in leading agricultural countries such as France, Serbia, Germany, Hungary, the Czech Republic, and others (Onyshchenco et al., 2023). This is caused not only by a lower amount of precipitation but also by imperfect cultivation techniques. For this reason, research on modern hybrids aimed at optimizing cultivation technology elements – particularly seeding rates and row spacing – is relevant and has practical value.

The seeding rate, in combination with the sowing method, is increasingly being considered as one of the key approaches to effectively managing the productive potential of sunflower crops (Dumych & Krupych, 2024). An incorrect choice of seeding rate is one of the reasons for low yields. When determining the seeding rate, it is necessary to take into account the morpho-biotype of the cultivated hybrids/varieties, the specifics of the applied agricultural practices, as well as the soil and climatic conditions of the region (Polyakov et al., 2022; Poorna Chandra Rao et al., 2025).

Alongside the morpho-biotype of hybrids, when choosing the sowing rate of seeds, it is important to consider moisture conditions, since sunflower is one of the most moisture-demanding crops, requiring about 150–170 mm of water to produce 1 ton of seeds. In arid regions, the sowing rate is reduced, while in more humid areas, it is increased. For example, in the southern regions of Ukraine, the recommended plant density before harvest is 35–40 thousand plants per hectare (Maliarchuk et al., 2025), and in the Forest-Steppe regions – 45–50 thousand plants per hectare (Masliiov, 2018). In studies by Shokalo & Svystun (2023) in the Poltava region, the highest sunflower seed yield was obtained at a sowing rate of 50 thousand plants per hectare. In areas with sufficient rainfall and under irrigation, the recommended plant density before harvest for early- and mid-maturing hybrids is 70–80 thousand plants per hectare, and for ultra-early hybrids – up to 100 thousand plants per hectare (Chigrin et al., 2024).

In areas with sufficient moisture, the highest sunflower seed yields are usually achieved at a plant density of 70–75 thousand plants per hectare at the time of harvest, although this reduces both the number of seeds per head and the weight of 1,000 seeds (Maliarchuk et al., 2025). In the Right-Bank Forest-Steppe of Ukraine, researchers Pinkovskyi H. & Tanchyk (2021) recommend sowing sunflower seeds at a rate of 60 thousand plants per hectare.

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In Canada, the highest sunflower seed yield is also achieved by increasing plant density up to 75 thousand plants/ha, although individual plant productivity decreases under these conditions (May et al., 2018). In Uzbekistan, the highest seed yield and oil harvest per hectare from sunflower crops of different maturity groups are obtained at a seeding rate of 60 thousand seeds/ha (Yuldasheva, 2025). In Kazakhstan, in the arid steppe zones, sunflower hybrids produce the highest seed yield at a seeding rate of 57 thousand seeds/ha, while in the less arid areas of the northern Steppe, the optimum seeding rate is 65 thousand seeds/ha (Gordeyeva, 2024).

In addition to the standard seeding rate, the width of the rows has a significant impact on the level of competitive interaction among plants in sunflower crops. It has been proven that different sunflower hybrids and varieties respond differently both to planting density and to the distance between plant rows (Baghdadi, 2014; Dumych, 2024). Generally, late-maturing sunflower hybrids and varieties are recommended to be sown with wider row spacing and a lower seeding rate (Grabovskyi, 2019).

The question of choosing the optimal row spacing for sunflower sowing continues to be a subject of scientific discussion. Some researchers emphasize the advisability of using narrow rows (15–30 cm), arguing that this configuration promotes higher productivity of individual plants and positively affects the overall yield of the crops (Masliiov, 2018). At the same time, other studies highlight the effectiveness of wide-row sowing with row spacing from 70 to 90 cm, noting that it can also ensure high seed yield (Ibrahim, 2023). In particular, researcher Borysenko (2023) points out the advantage of wide-row sowing with 70 cm spacing, which, under the conditions of the Right-Bank Forest-Steppe of Ukraine, and at seed sowing rates ranging from 50 to 90 thousand seeds per hectare, provided higher plant productivity and sunflower seed yield compared to sowing with 45 cm row spacing.

In our opinion, a more reasonable statement is as follows: the effectiveness of a sowing method is determined by a number of factors, among which the key ones are soil moisture content and the forecasted amount of precipitation during the growing season, the morpho-biotype of the hybrids being cultivated, the nutrition system, and the seeding rate. Based on this, for some conditions, the most suitable sunflower sowing methods will involve row spacing in the range of 70 to 90 cm, while for others, row spacing of 50, 45, 30, or even 15 cm may be preferable.

In the eastern part of Sudan, the possibility of sowing sunflower using a narrow-row method with 10 cm row spacing was studied. However, both in terms of plant productivity and seed yield, it performed worse than the wide-row sowing method with 30 cm row spacing. The sowing variant with 20 cm row spacing also showed poorer results compared to the 30 cm spacing (Ibrahim et al., 2023).

The nutrient supply area of plants significantly affects the growth and development of their root systems, as well as their ability to make optimal use of abiotic factors. In sparsely planted crops, plants receive more light; however, the overall consumption of solar energy by the crops decreases (Gavrilyuk 2023). In such crops, the maturation of flower heads slows down, the risk of weed infestation increases, and the efficiency of water and nutrient use decreases. It is important to ensure an even distribution of plants across the nutrient supply area and their synchronous growth and development, since uneven plant distribution leads to considerable differentiation in plant size, and the maturation of large and small flower heads occurs unevenly. This complicates harvesting and results in increased seed losses during collection (Chigrin, 2024).

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Despite numerous studies aimed at determining the optimal plant spacing and pattern for sunflower, the issue remains relevant. This is due both to global climate changes and the emergence of new high-yielding hybrids and varieties, which are characterized by specific morpho-biotypes and, therefore, respond differently to cultivation practices, particularly to seeding rates and sowing methods. Even within a single soil-climatic zone, recommendations regarding the optimal seeding rate and sowing method can vary significantly.

Based on this, the aim of the conducted research was to determine the effect of different combinations of seeding rate and sowing method on the seed yield of new, high-yielding sunflower hybrids of various maturity groups.

Materials and Methods. The research was conducted during 2024–2025 at the «Hryha» farm, located in the Poltava region (Left-Bank Forest-Steppe). The sunflower cultivation technology, with the exception of the elements selected for study, was generally accepted for the area where the research was carried out.

A three-factor field experiment was established using the split-plot design with three replications. The main plots consisted of two sunflower hybrids (Factor A) – SY Diego (mid-season) and SY Flavio (early-mid-season); the subplots were two row spacing variants (Factor B) – 45 cm and 70 cm; and the sub-subplots were four seeding rate variants (Factor C) – 35, 40, 45, and 50 thousand seeds per hectare. The area of the sub-subplot for sowing was 168 m², and for harvesting it was 84 m². The experiment setup and yield assessment were conducted according to generally accepted methods (Rozhkov, 2016). Analysis of variance (ANOVA) of the seed yield results was performed using Microsoft Excel based on standard procedures.

The weather conditions during the research years differed significantly from the climatic norm in terms of both temperature regime and precipitation amount and distribution. The weather in 2024 was unfavorable for sunflower, both in terms of temperature (during the third decade of June and the first and second decades of July, daytime air temperatures reached 35.0 ºC) and precipitation (the amount of rainfall in the summer months was significantly lower than the climatic norm), which negatively affected the formation of yield components and the biological seed yield of sunflower. In 2025, both the temperature regime and the amount and distribution of precipitation were conducive to normal growth and development of sunflower.

Since the weather conditions were quite variable, this was clearly reflected in the growth, development of plants, and sunflower seed yields. At the same time, it provided an opportunity to more objectively compare the agronomic efficiency of the options selected for the study.

Results and Discussion. The studied options for row spacing and seeding rates caused significant changes in the seed yield of the investigated sunflower hybrids. At the same time, seed yield was more strongly affected by the seeding rate, which is quite natural, since a rather wide range of seeding rates was studied.

On average, all other factors being equal, the highest sunflower seed yield in the experiment was observed in the variants with a seeding rate of 50 thousand seeds/ha – 2.31 t/ha in 2024 and 2.75 t/ha in 2025 (table 1). The yield increase compared to the lowest studied seeding rate of 35 thousand seeds/ha amounted to 0.52 and 0.63 t/ha, or 29.0% and 29.7%, respectively.

Since the seeding rates of 40 and 45 thousand plants per hectare also provided a significant increase in yield compared to the seeding rate of 35 thousand plants per hectare, we conducted a statistical analysis of the yield using a rank-based criterion in order to compare all seeding rate options and determine which one is the most effective.

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As a result of the analysis, it was established that increasing the seeding rate from 45 to 50 thousand seeds per hectare did not ensure a significant increase in sunflower seed yield in either 2024 or 2025. According to the statistical analysis based on Duncan's criterion, the yield at these seeding rates belonged to the highest – third rank group. At a seeding rate of 40 thousand seeds per hectare, the seed yield belonged to the second rank group, significantly exceeding the results at a seeding rate of 35 thousand seeds per hectare, while being noticeably lower than the yield at seeding rates of 45 and 50 thousand seeds per hectare.

Table 1

Sunflower seed yield of the hybrids SY Diego and SY Flavio depending on the combination of the studied row spacing options with the seed sowing rate, t/ha

Hybrid (factor A)	Row spacing, cm (factor B)	Seeding rate, thousand plants/ha (factor C)	Year		Average
			2024	2025	
SY Diego	45	35	1.83^{I}*	2.16^{I}	2.00
		40	2.10^{II}	2.47^{II}	2.29
		45	2.35^{III}	2.75^{III}	2.55
		50	2.40^{III}	2.82^{III}	2.61
	70	35	1.81^{I}	2.16^{I}	1.99
		40	2.07^{II}	2.42^{II}	2.25
		45	2.25^{III}	2.66^{III}	2.46
		50	2.29^{III}	2.70^{III}	2.50
SY Flavio	45	35	1.77^{I}	2.09^{I}	1.93
		40	2.02^{II}	2.36^{II}	2.19
		45	2.26^{III}	2.66^{III}	2.46
		50	2.32^{III}	2.78^{III}	2.55
	70	35	1.75^{I}	2.06^{I}	1.91
		40	1.99^{II}	2.32^{II}	2.16
		45	2.14^{III}	2.56^{III}	2.35
		50	2.22^{III}	2.69^{IV}	2.46
Average for hybrids		SY Diego	SY Diego	2.14^{I}	2.52^{I}
		SY Flavio	SY Flavio	2.06^{II}	2.44^{II}
Average across row spacing options		45	45	2.15^{I}	2.51^{I}
		70	70	2.07^{II}	2.45^{II}
Average by seeding rates		35	35	1.79^{I}	2.12^{I}
		40	40	2.05^{II}	2.39^{II}
		45	45	2.25^{III}	2.66^{III}
		50	50	2.31^{III}	2.75^{III}
LSD_{05} of the main effect of factor A			0.06	$F_f < F_t$	–
LSD_{05} of the main effect of factor B			0.06	$F_f < F_t$	
LSD_{05} of the main effect of factor C			0.08	0,13	
LSD_{05} of partial comparisons of factor A			0.07	$F_f < F_t$	
LSD_{05} of partial comparisons of factor B			0.08	$F_f < F_t$	
LSD_{05} of partial comparisons of factor C			0.11	0,16	

Notes: * – statistically homogeneous groups of seed yield according to the conducted analysis of variance using Duncan's multiple range test: I – first; II – second; III – third; IV – fourth.
Source: developed by the author

Within the studied variants of row spacing and hybrids, there was no significant difference in seed yield between the variants with a seeding rate of 45 and

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50 thousand seeds per hectare. The minimum significant increase in seed yield when raising the seeding rate from 45 to 50 thousand seeds per hectare was observed only in 2025 in the sunflower crops of the hybrid SY Flavio with 70 cm row spacing. Specifically, with the increase in seeding rate from 45 to 50 thousand seeds per hectare, the yield increased by 2.56 to 2.69 t/ha, with LSD_{05} of partial comparisons – 0.128 t/ha.

Narrowing the row spacing from 70 to 45 cm contributed to higher sunflower seed yields; however, a significant difference between these variants was observed only under the weather conditions of 2024, whereas in 2025 there was only a statistically non-significant tendency toward higher yields. Specifically, with the reduction of row spacing from 70 to 45 cm, the seed yield, on average across other factors, increased by only 0.06 t/ha, or 2.4%.

The effect of the seeding rate of both studied hybrids on their yield was more pronounced in the variants with 45 cm row spacing, indicating an interaction effect between these factors. In particular, over the two years of research, the seed yield of the sunflower hybrid SY Diego increased with a rise in seeding rate from 35 to 50 thousand seeds/ha by 0.61 t/ha in the variants with 45 cm row spacing, or by 0.51 t/ha in the variants with 70 cm row spacing, which corresponds to an increase of 25.6%. In the crops of the SY Flavio hybrid, the increase in seed yield with a seeding rate increase from 35 to 50 thousand seeds/ha was 0.62 t/ha and 0.55 t/ha for the 45 cm and 70 cm row spacing variants, respectively.

Overall, in the experiment, the highest seed yield was observed in the crops of the medium-maturing sunflower hybrid SY Diego under the combination of a seeding rate of 50 thousand seeds/ha with a row spacing of 45 cm – 2.40 t/ha in 2024 and 2.82 t/ha in 2025. At the same time, the seed yield of this hybrid did not differ significantly from the combination of a seeding rate of 45 thousand seeds/ha with a row spacing of 45 cm. In 2024, the difference in seed yield between these variants was only 0.05 t/ha (2.1%), and in 2025 – 0.07 t/ha (2.5%), which is below the LSD_{05} value.

In the experiments by Shokalo & Svystun (2023) conducted in the Poltava region, the highest sunflower seed yield was achieved at a sowing rate of 50 thousand seeds/ha, which is slightly higher than in our study. In our opinion, this may, in part, be related to the different gradation steps of the variants. Specifically, the gradation step in our stu thousand dy was 5 thousand seeds/ha, whereas in the experiments of these researchers it was 10 seeds/ha. It is quite possible that if a sowing rate of 45 thousand seeds/ha had been tested in their study, it might have shown the best result.

Alongside seed yield, we also determined the dry biomass yield of sunflower plants, based on which a significant difference was found between the studied variants of seed sowing rate and row spacing combinations.

The dry biomass yield of sunflower plants for both hybrids, like the seed yield, was highest in the variants with the highest investigated seeding rate. On average across years and sowing methods, the dry biomass yield of the sunflower hybrids SY Diego and SY Flavio at a seeding rate of 50 thousand seeds/ha was 8.75 and 8.29 t/ha, respectively, which is 1.68 t/ha and 1.52 t/ha higher compared to the seeding rate of 35 thousand seeds/ha (table 2). At the same time, no significant differences were observed compared to the seeding rate of 45 thousand seeds/ha. There was only a non-significant tendency toward higher dry biomass formation in plants.

With each subsequent increase in the seeding rate by the chosen increment of 5 thousand seeds/ha, a clear trend of decreasing gains in plant dry biomass is observed, which is, of course, due to the intensification of competitive interactions. In particular, when the seeding rate was increased from 35 to 40 thousand seeds/ha, the dry biomass

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of sunflower plants, on average across years, hybrids, and row spacing, increased by 0.77 t/ha or 11.1%; from 40 to 45 thousand seeds/ha – by 0.52 t/ha or 6.8%; and from 45 to 50 thousand seeds/ha – only by 0.31 t/ha or 3.8%.

With the exception of weather conditions, in the conducted experiment, the seeding rate had the greatest impact on the variability of sunflower plant dry biomass. Under its influence, the dry biomass of sunflower plants ranged from 6.92 to 8.52 t/ha (a difference of 1.60 t/ha or 23.1%), under the influence of row spacing – from 7.70 to 7.96 t/ha (a difference of 0.26 t/ha or 3.4%), and under the influence of hybrid morpho-biotype – from 7.63 t/ha to 8.03 t/ha (a difference of 0.40 t/ha or 5.2%).

Table 2

Yield of sunflower dry biomass of hybrids SY Diego and SY Flavio under the influence of the studied row spacing variants with seed sowing rate, t/ha

Hybrid (factor A)	Row spacing, cm (factor B)	Seeding rate, thousand plants/ha (factor C)	Year		Average
			2024	2025	
SY Diego	45	35	6.42^{I}*	7.83^{I}	7.13
		40	7.19^{II}	8.71^{II}	7.95
		45	7.75^{III}	9.53^{III}	8.64
		50	8.08^{III}	9.77^{III}	8.93
	70	35	6.27^{I}	7.72^{I}	7.00
		40	6.84^{II}	8.64^{II}	7.74
		45	7.32^{III}	9.30^{III}	8.31
		50	7.75^{IV}	9.36^{III}	8.56
SY Flavio	45	35	6.08^{I}	7.54^{I}	6.81
		40	6.82^{II}	8.35^{II}	7.59
		45	7.23^{III}	9.16^{III}	8.15
		50	7.43^{III}	9.58^{IV}	8.51
	70	35	6.02^{I}	7.43^{I}	6.73
		40	6.69^{II}	8.24^{II}	7.47
		45	6.90^{II}	8.96^{III}	7.93
		50	6.96^{II}	9.16^{III}	8.06
Average for hybrids		SY Diego	7.20^{I}	8.86^{I}	8.03
		SY Flavio	6.70^{II}	8.55^{II}	7.63
Average across row spacing options		45	7.11^{I}	8.81^{I}	7.96
		70	6.79^{II}	8.60^{I}	7.70
Average by seeding rates		35	6.20^{I}	7.63^{I}	6.92
		40	6.89^{II}	8.49^{II}	7.69
		45	7.30^{III}	9.24^{III}	8.21
		50	7.56^{IV}	9.47^{III}	8.52
LSD_{05} of the main effect of factor A			0.24	0.29	–
LSD_{05} of the main effect of factor B			0.27	*Ff* < *Ft*	
LSD_{05} of the main effect of factor C			0.31	0.36	
LSD_{05} of partial comparisons of factor A			0.26	0.32	
LSD_{05} of partial comparisons of factor B			0.30	*Ff* < *Ft*	
LSD_{05} of partial comparisons of factor C			0.33	0.38	

Notes: * – statistically homogeneous groups of seed yield according to the conducted analysis of variance using Duncan's multiple range test: I – first; II – second; III – third; IV – fourth.
Source: developed by the author

Significantly higher indicators of sunflower plant dry biomass, as well as seed yield, were observed under more favorable moisture conditions in 2025. Thus, on

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average, with other factors being equal, the dry biomass yield of sunflower plants in 2024 was 6.95 t/ha, whereas in the more favorable 2025 it reached 8.70 t/ha. The dominant role of weather conditions in the formation of sunflower plant biomass is also noted by other researchers (Ibrahim et al. 2023; Poorna Chandra Rao et al. 2025).

Like seed yield, the dry biomass of plants was more affected by the seeding rate in the variants with 70 cm row spacing, indicating an interaction effect between these factors. In particular, in the variants with 45 cm row spacing, the dry biomass yield of sunflower hybrids SY Diego and SY Flavio increased, on average over two years, by 1.80 and 1.70 t/ha, or by 25.2% and 24.9%, respectively, when the seeding rate was raised from 35 to 50 thousand seeds/ha. In contrast, in the variants with 70 cm row spacing, the increase was 1.56 and 1.33 t/ha, or 22.2% and 19.6%, respectively. The trend of a greater effect of seeding rate on the dry biomass of both sunflower hybrids in the 45 cm row spacing variants, in our opinion, may be associated with reduced competitive interaction among plants, as they are more evenly distributed across the nutrient area.

Overall, in the experiment, the highest dry biomass was produced by the mid-season sunflower hybrid SY Diego in the variants combining a seeding rate of 50 thousand seeds/ha with 45 cm row spacing – 8.08 t/ha in 2024 and 9.77 t/ha in 2025. At the same time, as mentioned above, no significant increase in this indicator compared to the seeding rate of 45 thousand seeds/ha was observed in the crops of either hybrid under these row spacing conditions.

The analysis of the proportion of seeds in the total biomass of sunflower plants revealed a tendency for it to increase with higher seeding rates. In particular, with an increase in the seeding rate from 35 to 50 thousand seeds per hectare, the share of seeds in the total dry biomass of sunflower plants, on average across hybrids and the studied row spacing variants, increased from 28.9 % to 30.6 % in 2024 and from 27.8 % to 29.0 % in 2025 (Table 3).

Table 3

Proportion of seeds in the total dry biomass of sunflower plants of the hybrids SY Chester and SY Flavio depending on the studied combinations of row spacing and seeding rate, %

Seeding rate, thousand plants/ha (factor C)	Hybrid (factor A)				Average
	SY Diego		SY Flavio		
	Row spacing, cm (factor B)				
	45	70	45	70	
2024					
35	28.5	28.8	29.1	29.1	28.9
40	29.2	30.3	29.6	29.7	29.7
45	30.3	30.7	31.3	31.0	30.8
50	29.7	29.6	31.2	31.9	30.6
Average	29.4	29.9	30.3	30.4	30.0
2025					
35	27.6	28.0	27.7	27.7	27.8
40	28.4	28.0	28.3	28.2	28.2
45	28.9	28.6	29.0	28.6	28.8
50	28.9	28.8	29.0	29.4	29.0
Average	28.5	28.4	28.5	28.5	28.5

Source: developed by the author

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The trend of increasing the proportion of seeds in the dry biomass of sunflower plants under conditions of higher seeding rates within the studied range indicates that the vegetative mass of the plant decreases more noticeably than the mass of its seeds as a result of increased competition in the crops.

The effect of the studied row spacing variants on the proportion of seeds in the dry biomass of sunflower plants was practically negligible. In particular, for the mid-season sunflower hybrid SY Diego, the seed proportion in the dry biomass of plants at row spacing variants of 45 and 70 cm averaged 29.4% and 29.9%, respectively, in 2024, and 28.5% and 28.4%, respectively, in 2025, under the standard seeding rate.

Conclusions. As a result of the conducted studies, certain patterns were identified regarding the influence of the examined seeding rate variants in combination with different row spacings on the formation of seed yield and plant dry biomass indicators in years with varying weather conditions, namely:

– the highest seed yield of both sunflower hybrids, averaged over two years, was observed in the variants combining a seeding rate of 45 thousand seeds/ha with a row spacing of 45 cm – 2.55 t/ha for the mid-ripening hybrid SY Diego and 2.46 t/ha for the early-mid-ripening hybrid SY Flavio. Increasing the seeding rate of both hybrids to 50 thousand seeds/ha did not result in a significant increase in seed yield compared to the seeding rate of 45 thousand seeds/ha;

– the highest dry biomass was produced by the SY Diego hybrid in the combination of a seeding rate of 50 thousand plants/ha with 45 cm row spacing – 8.08 and 9.77 t/ha in 2024 and 2025, respectively. At the same time, no significant increase in this parameter was observed compared to the seeding rate of 45 thousand plants/ha in the crops of both hybrids at the same row spacing;

– considering the continuous introduction of new sunflower hybrids into production, which are characterized by different morpho-biotypes and, consequently, may have varying responses to plant density and their uniformity across the growing area, research aimed at studying the optimal combinations of seed sowing rates and row spacing is relevant. In addition, changes in the moisture regime caused by global climate changes also require research in this area, since water is the key factor that must be taken into account when determining the parameters of the crop stand.

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ПРОДУКТИВНІСТЬ ПОСІВІВ СОНЯШНИКА ЗАЛЕЖНО ВІД СПОЛУЧЕННЯ РІЗНИХ ВАРІАНТІВ ШИРИНИ МІЖРЯДЬ І НОРМИ ВИСІВУ НАСІННЯ

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За результатами дворічних досліджень визначено вплив різних варіантів поєднання ширини міжрядь з нормою висіву на формування врожайності насіння та сухої біомаси гібридів соняшника різної групи стиглості. Підвищення норми висіву від 45 до 50 тис. шт./га не забезпечувало істотного росту врожайності насіння соняшника ні в 2024, ні в 2025 рр. За проведеним статистичним аналізом на основі критерію Дункана, урожайність за цих норм висіву відносилася до однієї рангової групи. Звуження міжрядь від 70 до 45 см сприяло отриманню вищої врожайності соняшника. Вплив норми висіву на врожайність обох гібридів соняшника вищим був на варіантах з міжряддями 45 см, що свідчить про взаємодію цих факторів. Так, у середньому за роками, урожайність насіння гібрида СИ Дієго з підвищенням норми висіву насіння від 35 до 50 тис. шт./га на варіантах з міжряддями 45 см зростала на 0,61 т/га, а на варіантах з міжряддями 70 см – на 0,51 т/га. На посівах гібрида СИ Флавіо на варіантах з міжряддям 45 і 70 см приріст урожайності насіння за умови підвищення норми висіву від 35 до 50 тис. шт./га становив 0,62 т/га і 0,55 т/га відповідно. Найвищу врожайність насіння відмічено на посівах гібрида СИ Дієго у варіантах сполучення норми висіву насіння 50 тис. шт./га з міжряддям 45 см – 2,40 т/га – у 2024 р. і 2,82 т/га – у 2025 р. Разом з тим, вона істотно не відрізнялася від варіанта сполучення норми висіву 45 тис. шт./га з міжряддям 45 см. У 2024 р. різниця за врожайністю між цими варіантами становила лише 0,05 т/га, а в 2025 р. – 0,07 т/га, що менше за показника $НІР_{05}$. Урожайність сухої біомаси рослин соняшника обох гібридів, найвищою була у варіантах з найвищою досліджуваною нормою висіву насіння. У середньому за роками та способами сівби, урожайність сухої біомаси гібридів соняшника СИ Дієго і СИ Флавіо за норми висіву насіння 50 тис. шт./га становила 8,75 т/га і 8,29 т/га відповідно, що на 1,68 т/га і 1,52 т/га більше порівняно з нормою висіву 35 тис. шт./га. Водночас, істотно різниці порівняно з нормою висіву насіння 45 тис. шт./га не встановлено. Мала місце лише істотно не доведена тенденція формування вищої сухої біомаси рослин.

Ключові слова: соняшник, гібрид, потенціал продуктивності, густота рослин, площа живлення, урожайність насіння, суха біомаса рослин

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