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Quality indicators of new sunflower (*Helianthus annuus* L.) varieties for high oleic and oilseed use under different growing conditions

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Purpose. To study the influence of steppe and forest-steppe climatic conditions on the yield, oil content in seeds and fatty acid composition of oil in new sunflower varieties of high oleic and oilseed use. **Methods.** The research was conducted in accordance with "Methods of qualification examination of plant varieties for their suitability for distribution in Ukraine (general part)" and "Methods of qualification examination of plant varieties for their suitability for distribution. Methods of determining quality indicators of plant production". The following methods were used in the research: laboratory, comparison, generalisation, mathematical statistics, analysis and synthesis to draw conclusions. **Results.** The fatty acid composition of the seeds of new varieties of sunflower (*Helianthus annuus* L.) of high oleic and oilseed use, grown in different soil and climatic conditions, was studied. According to the results of the analysis in the steppe zone, the variety 'LG50648' has the highest economic and value characteristics: oil content (51,0%), oleic acid (85.1%), yield (3.11 t/ha); varieties 'SULIANO' and 'MAS 908HOCP' – yield (3.40 and 3.91 t/ha) and oleic acid content (85.8 and 86.1%) regardless of the growing conditions. It was found that high oleic sunflower varieties 'MAS 908HOCP', 'LG50648', 'SULIANO' grown under steppe and forest-steppe conditions yielded higher quality oil. The maximum content of oleic acid in 2022–2023 was characteristic of the seeds of the varieties 'MAS 908HOCP' (86.1% in the steppe and 85.8% in the forest steppe) and 'SULIANO'. The highest linoleic acid content was obtained in the seeds of the oilseed use varieties 'STK104' (62.9% in the steppe and 58.5% in the forest steppe) and 'STK103' (61.2% in the forest steppe). Among the high oleic varieties, the best results were obtained with 'LG50648' (5.7% in the steppe and 5.9% in the forest steppe). **Conclusions.** Oil content of sunflower varieties and fatty acid composition are determined by varietal characteristics of sunflower and environmental conditions. Modern sunflower varieties, which are included in the State Register of Plant Varieties of Ukraine, have high yield potential and can provide a large yield of vegetable oil per unit area. Agroclimatic conditions have different effects on the gross seed yield and oil quality in the conditions of the forest steppe and steppe of Ukraine.

Keywords: *sunflower; oil content; high oleic varieties; quality indicators; husk; fatty acids.*

Introduction

Sunflower (*H. annuus*) is an oilseed crop native to North America and, along with oil palm (*Elaeis guineensis* Jacq.), soybean [*Glycine max* (L.) Merr.] and rapeseed (*Brassica napus* L.), is one of the world's most important oilseed crops grown in a wide variety of agricultural environments. The global trend towards sunflower cultivation is steadily increasing. The crop is grown on a total area of over 26 million hectares worldwide, mainly due to the high oil content of its seeds (~44%) [1, 2]. Among oilseeds, sunflower is ranked 2nd in Europe and 4th in the world [3, 4].

Sunflower oil is considered a high quality oil because it is rich in monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) [5]. Varieties with high oleic acid content are highly valued in the food industry due to the oxidative and thermal stability of the oil [6]. This extends the shelf life of vegetable oils and prevents the formation of trans fats when heated to high temperatures (e.g. frying), which is why HO (high oleic) oils are high quality cooking oils. As a result, high oleic oils are naturally stable and do not require hydrogenation [4]. However, vegetable oils rich in PUFAs are susceptible to lipid oxidation, which can result in the formation of cytotoxic and genotoxic compounds that negatively affect the nutritional value and shelf life of foods [7]. Oil quality is determined by the com-

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position of fatty acids and the levels of tocopherols, stearins, carotenoids and other compounds. At the end of the last century, new high-oleic sunflower (HO) varieties with higher levels of monounsaturated fatty acids (MUFA) were bred and commercialised [8]. In general, sunflower oil contains about 90% unsaturated fatty acids, mainly oleic acid (monounsaturated omega-9) (C18:1) and linoleic acid (polyunsaturated omega-6) (C18:2) [9–11], and up to 10% saturated fatty acids, mainly palmitic and stearic acid (C16:0 and C18:0, respectively) [1, 12–14]. Sunflower oil also contains several other fatty acids (C14:0, C16:1, C14:1, C20:0, C22:0), but these are usually found in small amounts. In the seeds of oilseed sunflower varieties, the content of oleic acid does not exceed 30% [4, 15, 16], so the main goal of sunflower breeding is to create new varieties rich in oleic acid. Oleic acid (C18:1) is synthesised from stearic acid (C18:0) and converted to linoleic acid (C18:2) by the oleate desaturase enzyme [17]. The levels of linoleic and oleic acids are influenced by both environmental conditions and plant genotype characteristics. In particular, air temperature, precipitation, soil water regime, intercepted solar radiation, etc. and the agronomic practices used can affect the kernel filling phase, thus altering both the fatty acid profile of the oil and the yield of the sunflower [14].

According to the classifier of quality indicators of botanical taxa, sunflower varieties tested for their suitability for marketing [18] have the following uses 1) oilseed – up to 50.9%, 2) high oleic – over 60%.

With climate change, sunflower, as a rainfed spring crop, may be more susceptible to direct heat stress during flowering or grain filling, as well as to variable and unpredictable drought scenarios during the growing cycle, both of which lead to significant yield loss, a decrease in oil content and a change in fatty acid composition [19, 20].

The aim of the research is to study the influence of steppe and forest-steppe climatic conditions on quality indicators, in particular yield, oil content in seeds and fatty acid composition of oil of new sunflower varieties of high oleic and oilseed use.

Materials and methods

The experimental studies were carried out during 2022–2023 on the experimental fields of the branches of the Ukrainian Institute for Plant Variety Examination (UIPVE) within the soil and climatic zones of the steppe – Kirovohrad (Novoselytsia village, Blahovishchensky district, Kirovohrad region), Odesa (Novoselyvka village, Rozdilna district, Odesa region), Dnipropetrovsk (Semenivka village, Krynychkyi district, Dnipropetrovsk region). Semenivka, Krynychanskyi district, Dnipropetrovsk region) of UIPVE branches and forest-steppe – Vinnytsia (Holubeche village, Kryzhopilsky district, Vinnytsia region), Sumy (Likarske village, Sumy district, Sumy region), Poltava (Karlivka village, Karlivskyi district, Poltava region) in accordance with the "Methodology for the qualification examination of plant varieties for their suitability for distribution in Ukraine (General part)" [21]. Eight varieties of high oleic sunflower ('MAS 908HOCP' and 'LG50648' – France, 'SULIANO' – Switzerland, 'N4H413 CL' – UK) and oilseeds ('STK102', 'STK101', 'STK104', 'STK103' – Romania), included in the State Register of Varieties Suitable for Distribution in Ukraine, were used as material for the research. Biochemical studies were carried out in the UIPVE Plant Variety Quality Indicators Laboratory according to the "Methods of qualification examination of plant varieties for suitability for distribution. Methods for determining quality indicators of plant production" [22]. The oil content of sunflower seeds was determined by the express method using an MGC 5–11 nuclear magnetic analyser (Oxford Instruments, UK).

The oil yield per hectare was calculated using the formula

$A = Y \times C \times F$,

where A – oil yield; Y – yield (c/ha) at standard moisture; C – dry matter coefficient (for sunflower K = 0.88); F – fat content in seed, % [22].

The protein content was determined using an Instalab 700 infrared analyser (DICKEY-john, USA); the fatty acid composition of the oil was determined by gas chromatography using a Shimadzu Nexis GC-2030 gas chromatograph (Shimadzu, Japan).

Sunflower was sown in 2022 in the steppe zone from 07.05.–18.05., in the forest steppe zone from 03.05.–16.05., in 2023 in the steppe zone from 03.05.–12.05. and in the forest steppe zone from 24.04.–10.05. The experiment was replicated four times, the treatments were randomly arranged and the plot size was 25 m^2. The records and observations were made according to the "Methods of examination of plant varieties of the group of technical and fodder plants for their suitability for distribution in Ukraine (VCU)" [23]. The weather conditions during the research period (2022–2023) differed from the long-term average in terms of temperature, precipitation and their distribution in individual months.

The beginning of the growing season in 2022 was characterised by low rainfall, so sunflower

was sown on dry soil. The sunflower growing season in 2023 was characterised by sufficient soil moisture in spring and cooler growing temperatures than in 2022. The average daily air temperature at all research sites exceeded climatic norms by 1–5 °C. The maximum temperature in the steppe zone was observed in August 2023, when the heat reached +37 °C. In the forest steppe zone, the maximum temperature in the same year and month was almost +35 °C.

The average annual air temperature in 2022 and 2023 in the steppe and forest steppe was 11.0–10.0 and 11.4–10.7 °C, respectively, and exceeded the long-term mean by 2.4–2.9 and 2.7–3.5 °C, respectively. Annual precipitation in 2022 and 2023 averaged 236.9 and 548.4 mm, or 56 and 101% of the annual norm, in the steppe; 462.5 and 666.3 mm, or 109 and 123%, in the forest steppe. To determine the influence of environmental conditions on productivity, oil content and fatty acid composition, the hydrothermal coefficient (HTC) was calculated.

Crops sown in spring produce the best yields when HTC = 1.0–1.6, while drought causes plant depression when HTC = 0.6 or less, or overwetting – when HTC = more than 1.6. The vegetation period of sunflower in the steppe zone in both 2022 and 2023 was characterised by very dry conditions (HTC = 0.5), slightly dry and optimal moisture conditions in the forest steppe zone (respectively HTC = 1.1; 1.3), which had a positive impact on the formation of sunflower productivity in this zone.

The statistical processing of the results of the experimental data obtained was carried out using the tools of the Excel programme. The limits of the maximum random deviations of the obtained results were determined by the Least Significant Difference (LSD) method.

Results and Discussion

The zone of cultivation and the weather and climatic conditions had a positive effect on the seed yield of all varieties, which is confirmed by an average increase in seed yield of 4.4 to 38.4% in the forest steppe zone compared to the steppe zone (Table 1).

The yield of the varieties varied from 2.29 to 3.91 t/ha depending on the direction of use and the growing zone. In the forest steppe zone, higher yields were obtained than in the steppe zone due to the longer growing season for sunflower varieties in this zone and optimal growing conditions. The most productive sunflower variety in the forest steppe zone was 'MAS 908HOCP' with a yield of 3.91 t/ha. Its yield was 44.3% higher than 'N4H413 CL' and 26.9% higher than 'LG50648'. The variety 'SULIANO' performed well in the steppe and forest steppe zones with yields of 3.40 and 3.55 t/ha.

Table 1

Yield of new sunflower varieties of high-oleic and oilseed use in different soil and climatic zones, t/ha (average for 2022–2023)

Variety	Steppe			Forest Steppe		
	2022	2023	Average	2022	2023	Average
high-oleic						
'MAS 908HOCP'	2.46	3.19	2.83	4.48	3.33	3.91
'LG50648'	2.76	3.45	3.11	2.98	3.18	3.08
'SULIANO'	3.42	3.38	3.40	3.69	3.41	3.55
'N4H413 CL'	1.66	3.35	2.51	2.76	2.65	2.71
$LSD_{0.05}$	1.3	0.2	0.7	1.3	0.6	0.9
oilseed						
'STK101'	2.18	3.18	2.68	3.59	3.05	3.32
'STK102'	2.18	2.88	2.53	3.71	2.96	3.34
'STK103'	2.22	2.35	2.29	3.61	2.73	3.17
'STK104'	1.99	3.16	2.58	3.74	2.99	3.37
$LSD_{0.05}$	0.2	0.7	0.3	0.1	0.2	0.2

When growing crops, it is important to know what elements make up the crop. This is necessary in order to influence the production process in a sensible way. It is known that the main elements of yield formation are its main structural elements: the diameter of the head, the weight of 1000 seeds, the husk content of the seeds, etc. The results of the research showed that the size of the head diameter varies according to the variety and the soil and climatic conditions of cultivation. Head diameter in the forest steppe zone was 0.7–3.7 cm larger than in the steppe for all varieties. The largest head diameter was observed in variety 'MAS 908HOCP' – 20.2 cm, which is confirmed by its highest yield – 3.91 t/ha.

The weight of 1000 seeds is a genetically determined indicator but can vary according to soil and climatic conditions. The weight of 1000 seeds of new varieties for different uses varied from 51.2 to 67.2 g depending on the growing zone (Table 2).

The highest weight of 1000 seeds was observed in the studied varieties of high oleic sunflower in both forest steppe and steppe zones, with values ranging from 61.3–67.2 g, with the exception of variety 'N4H413 CL', which had an average weight of 1000 seeds at the level of 52.7 g and 57.9 g, respectively. The lowest weight of 1000 seeds was found in the steppe zone in the varieties 'STK102' and 'STK101', with an average of 51.7 and 52.0 g, respectively.

The ratio of husk to kernel weight is important because an increase in the percentage of husk leads to a decrease in seed oil content and an increase in the unproductive part of the crop, which is confirmed by the results presented in Tables 2 and 3. In sunflower varieties 'STK102' and 'LG50648' for oilseed use, the husk content

Table 2

Structural elements of yield of sunflower varieties of high-oleic and oilseed use according to soil and climate zone (average for 2022–2023)

Variety	Head diameter, cm		Weight of 1000 seeds, g		Husk content,%	
	Steppe	Forest Steppe	Steppe	Forest Steppe	Steppe	Forest Steppe
high oleic						
'MAS 908HOCP'	16.5	20.2	66.8	67.2	27.6	26.6
'LG50648'	16.8	17.8	62.0	62.2	24.8	23.8
'SULIANO'	17.1	18.6	62.6	61.3	28.3	26.0
'N4H413 CL'	17.1	17.8	57.9	52.7	25.1	24.9
$LSD_{0.05}$	0.5	2.0	6.3	10.5	3.0	2.1
oilseed						
'STK101'	15.1	18.4	52.0	54.2	26.7	24.9
'STK102'	15.5	17.0	51.7	59.8	25.1	23.6
'STK103'	15.2	18.0	53.3	51.2	27.4	24.8
'STK104'	15.6	17.4	55.2	55.7	27.0	26.2
$LSD_{0.05}$	0.4	1.1	2.8	6.2	1.7	1.8

was the lowest in the forest steppe zone, averaging 23.6 and 23.8%, while the oil content was the highest in variety 'LG50648' – 53.3%, and all other varieties were approximately at the same level of 50.0–50.7%. For the high oleic variety 'MAS 908HOCP' the husk index in the steppe zone increased to an average of 27.6% and for 'SULIANO' – to 28.3% (Table 2), while the oil content was the lowest of these varieties at 48.1% for both varieties.

The principal quality indicators of high oleic sunflower seeds are the oil and oleic acid content. The morphological characteristics of sunflower plants, as well as the structure of their seeds and the chemical composition of their seeds, are affected not only by weather and climatic conditions, but also by the area of cultivation. The oil content of the seeds initially increases rapidly, but by approximately the 24th day after flowering, it reaches a constant level. The oil content of sunflower is determined by its varietal characteristics and the growing conditions, in particular the hydrothermal regime during seed formation. Variations in oil content have been observed according to the growing zone (Table 3).

Table 3

Oil and protein content in seeds of sunflower varieties for different use depending on soil and climate zone of cultivation, % (2022–2023)

Variety	Oil content						Protein content					
	Steppe			Forest Steppe			Steppe			Forest Steppe		
	2022	2023	X	2022	2023	X	2022	2023	X	2022	2023	X
high oleic												
'MAS 908HOCP'	49.5	46.6	48.1	50.1	50.4	50.3	14.2	17.9	16.1	15.2	13.4	14.3
'LG50648'	51.2	50.8	51.0	53.9	52.7	53.3	16.4	16.7	16.6	15.5	15.4	15.5
'SULIANO'	47.8	48.3	48.1	50.8	49.3	50.1	16.1	15.4	15.8	13.1	14.7	13.9
'N4H413 CL'	51.1	48.1	49.6	51.7	49.3	50.5	16.7	17.6	17.2	15.1	15.7	15.4
$LSD_{0.05}$	2.8	3.0	2.4	2.9	2.8	2.6	2.0	1.9	1.1	1.9	1.8	1.4
oilseed												
'STK101'	49.7	50.4	50.1	51.0	50.1	50.6	17.6	18.4	18.0	15.9	16.0	16.0
'STK102'	49.1	50.6	49.9	51.6	48.4	50.0	17.4	17.8	17.6	16.4	15.9	16.2
'STK103'	50.1	46.1	48.1	51.5	49.3	50.4	16.2	20.1	18.2	15.8	16.0	15.9
'STK104'	49.7	47.3	48.5	52.1	49.3	50.7	16.9	20.0	18.5	15.8	15.8	15.8
$LSD_{0.05}$	0.7	3.9	1.7	0.8	1.2	0.5	1.1	2.0	0.7	0.5	0.2	0.3

The data presented in Table 3 show that the oil content of sunflower seeds in the forest steppe zone was higher than in the steppe zone in both 2022 and 2023. The growing conditions in the forest steppe zone were optimal (HTC 1.3) and slightly dry (HTC 1.1), which had a positive effect on the oil content. In 2022, the varieties grown in the forest steppe zone had an oil content of 50.1–53.9%, depending on the variety. The highest oil content was recorded for the seeds of the varieties 'LG50648' and 'STK104' (53.9 and 52.1%). In 2023, the oil content of the seeds ranged from 48.4 to 52.7%, depending on the variety. The highest values were obtained for the seeds of the varieties 'LG50648' and 'STK101' (52.7 and 50.1%). It is noteworthy that the variety 'LG50648' showed the best results in all the years of testing and regardless of the soil and climatic zone compared to other varieties.

According to the classifier of quality indicators of botanical taxa whose varieties are evaluated for their suitability for distribution [18], sunflower varieties in the forest steppe zone were characterised on average by high (>50.1%) oil content, only for variety 'STK102' this indicator corresponded to (47.1–50.0%) average oil content. Seeds of the varieties 'LG50648' and 'STK101' grown in the steppe had a high oil content – 51.0 and 50.1% respectively, while the rest of the varieties had an average oil content.

In the steppe zone, the highest oil content was observed in the seeds of varieties 'LG50648' and 'STK101' (51.0 and 50.1%), in the forest steppe zone – in the seeds of varieties 'LG50648' and 'STK104' (53.3 and 50.7%). At the same time, protein accumulation was better in very dry conditions (HTC 0.5), which occurred in the steppe zone in both 2022 and 2023. Higher protein content was observed for varieties with lower oil content in seeds compared to other varieties – varieties 'STK101', 'STK103', 'STK104', for which the protein content in seeds was 18.0, 18.2, 18.5% in the steppe zone, and varieties 'STK103', 'STK101', 'STK102', for which the protein content in seeds was 15.9, 16.0, 16.2% in the forest steppe zone, respectively.

It is worth mentioning the variety 'STK101' which showed high values of oil content (50.1% in the steppe and 50.6% in the forest steppe) and protein content (18.0 and 16.0%) compared to other varieties.

Oil yield per hectare is the main indicator for characterising oilseed varieties. The values obtained for oil yield per hectare in the forest steppe zone were significantly higher than in the steppe zone, which is explained by the higher yield and oil content in this soil and climatic zone (Table 4).

Table 4

Oil yield for different sunflower varieties of high-oleic and oilseed use according to research years and soil-climate zones, t/ha (2022–2023)

Variety	Steppe			Forest Steppe		
	2022	2023	X	2022	2023	X
high-oleic						
'MAS 908HOCP'	1.07	1.31	1.20	1.98	1.48	1.73
'LG50648'	1.24	1.54	1.40	1.41	1.47	1.44
'SULIANO'	1.44	1.44	1.44	1.65	1.48	1.57
'N4H413 CL'	0.75	1.42	1.10	1.26	1.15	1.20
$LSD_{0.05}$	0.5	0.2	0.3	0.5	0.3	0.4
oilseed						
'STK102'	0.94	1.28	1.11	1.68	1.26	1.47
'STK101'	0.95	1.41	1.18	1.61	1.34	1.48
'STK104'	0.87	1.32	1.10	1.71	1.30	1.50
'STK103'	0.98	0.95	0.97	1.64	1.18	1.41
$LSD_{0.05}$	0.1	0.3	0.2	0.1	0.1	0.1

The highest average oil yields were obtained by the variety 'MAS 908HOCP' in the forest steppe zone – 1.73 t/ha, the variety 'SULIANO', regardless of the growing conditions, showed high yields – 1.44 (steppe) and 1.57 t/ha (forest steppe), it is also worth mentioning the variety 'LG50648', its yields were at the level of 1.40 (steppe) and 1.44 t/ha (forest steppe). The varieties 'STK102', 'STK101', 'STK104' of the oilseed use showed high results of oil yield per hectare on average in the forest steppe zone, their values ranged from 1.47 to 1.50 t/ha.

The forest steppe zone was characterised by optimal and slightly dry conditions, in this zone an increase in oil content in the seeds of 'LG50648' was observed – 53.3%, but the content of oleic acid decreased to 83.9% compared to other varieties of high oleic direction. Jocić et al. [25] found that most modern sunflower hybrids contain 45–50% oil in seeds. Ferfuia et al. [26] believe that high temperature increases the oleic acid content of standard sunflower varieties (low oleic). At the same time, contradictory results have been reported on the effect of temperature on oleic acid content in high oleic varieties: no effect [27] or, on the contrary, an increase in oleic acid content with increasing temperature [27, 28]. We recorded a higher content of oleic acid in high oleic varieties in the steppe in both 2022 and 2023 (Table 5), which had very dry moisture conditions, with HTC at the level of 0.6; 0.5 compared to the forest steppe, which had optimal conditions in 2022 – HTC = 1.3 and in 2023 – slightly dry growing conditions – HTC = 1.1. In oilseed varieties, the content of oleic acid in 2022 was higher in forest steppe, where there were optimal growing conditions in 2023, the highest content of oleic acid was in steppe, where growing conditions were very dry.

Table 5

The content of oleic acid in the oil of the seeds of sunflower varieties of high-oleic and oilseed use depending on the soil and climatic zone, % (2022–2023)

Variety	Steppe			Forest Steppe		
	2022	2023	X	2022	2023	X
high-oleic						
'MAS 908HOCP'	86.2	85.9	86.1	84.6	85.5	85.1
'LG50648'	86.5	83.6	85.1	83.5	84.2	83.9
'SULIANO'	84.9	84.5	84.7	86.2	85.3	85.8
'N4H413 CL'	85.9	85.6	85.8	84.8	84.4	84.6
$LSD_{0.05}$	0.9	1.4	0.8	1.5	0.8	1.1
oilseed						
'STK102'	14.0	13.9	14.0	15.7	13.7	14.7
'STK101'	13.4	12.9	13.2	17.2	13.2	15.2
'STK104'	13.0	13.0	13.0	14.6	11.2	12.9
'STK103'	12.1	14.3	13.2	13.1	10.6	11.9
$LSD_{0.05}$	1.0	0.9	0.6	2.3	2.0	2.0

We studied the fatty acid composition of sunflower oil from new varieties for different uses (Table 6). The results obtained characterise the fatty acid composition of 8 varieties of sunflower grown in different soil and climatic zones. The table shows that there are significant differences in both the qualitative and quantitative content of individual fatty acids in the oil of each variety. The analysis of the data obtained shows that in the oil from the seeds of the studied sunflower varieties, one of the polyunsaturated fatty acids is dominant in the composition of fatty acids. Thus, linoleic acid (C18:2) is dominant in oilseed sunflower varieties and oleic acid (C18:1) in high oleic sunflower varieties. The main fatty acids in sunflower oil are oleic and linoleic. Palmitic acid (C16:0) and stearic acid (C18:0) are always present among the saturated fatty acids. In addition to the above acids, small amounts of linolenic, palmitoleic and other acids are found in sunflower oil.

Table 6

Fatty acid composition of oil from high oleic and oilseed sunflower varieties according to soil and climate zone, % (average for 2022–2023)

Fatty acid	High-oleic				$LSD_{0.05}$	Oilseed				$LSD_{0.05}$
	'MAS 908HOCP'	'LG50648'	'SULIANO'	'N4H413 CL'		'STK101'	'STK102'	'STK103'	'STK104'	
Forest Steppe										
Palmitic C16:0	1.3	1.3	1.8	1.7	0.3	2.7	2.1	3.1	2.9	0.6
Stearic C18:0	0.8	1.1	1.0	1.0	0.2	1.1	1.2	1.2	1.2	0.1
Oleic C18:1	85.1	83.9	85.8	84.6	1.1	15.2	14.7	11.9	12.9	2.0
Linoleic C18:2	5.3	5.9	5.0	4.8	0.6	57.2	54.7	61.2	58.5	3.5
Steppe										
Palmitic C16:0	1.5	1.6	1.9	1.5	0.3	2.9	2.7	2.9	3.0	0.2
Stearic C18:0	0.8	1.0	0.9	1.3	0.3	1.0	1.0	0.8	0.8	0.2
Oleic C18:1	86.1	85.1	84.7	85.8	0.8	13.2	14.0	13.2	13.0	0.6
Linoleic C18:2	4.4	5.7	4.7	5.1	0.7	60.6	57.8	50.2	62.9	7.2

The content of oleic acid ranged from 11.9 to 86.1% and significant differences in this indicator were clearly observed between varieties for different uses. The highest value of oleic acid content was obtained from the seed oil of 'SULIANO' (85.8%) in the forest steppe zone and 'MAS 908HOCP' (86.1%) in the steppe zone of the high oleic direction of use, while the lowest value was obtained in varieties 'STK104', 'STK103' of oilseeds (12.9 and 11.9%) in the forest steppe zone and 'STK104' – (13.0%), 'STK101', 'STK103' – (13.2%) in the steppe zone. The increase in oleic acid content and the corresponding decrease in linoleic acid content was due to a significant and negative ratio of oleic and linoleic acid (Table 6). A significant difference between high and low oleic varieties is observed in the percentage of oleic and linoleic acids.

From the results presented in (Table 6), the highest value of linoleic acid was recorded in varieties of oilseeds, the values varied between 50.2 and 62.9% depending on the variety and growing zone, but the lower value of linoleic acid was recorded in varieties of high oleic direction of use 'N4H413 CL' (4.8%) in the forest steppe zone, in the steppe zone in varieties 'MAS 908HOCP' and 'SULIANO' 4.4 and 4.7%, respectively.

The palmitic acid (C16:0) content of the studied oilseed sunflower varieties is 1.2–1.3 times higher than that of the high oleic sunflower varieties, depending on the growing zone. On average, the palmitic acid content of the varieties studied is in the range of 1.3–3.1%. The seeds of 'STK103' from the forest steppe zone and 'STK104' from the steppe zone contained (3.1 and 3.0%) palmitic acid, which is the highest among the seeds of the varieties studied.

The average stearic acid content of the varieties studied varied between 0.8 and 1.3%, with a significant difference between the varieties.

Conclusions

Modern varieties 'MAS 908HOCP', 'LG50648', 'SULIANO' showed the highest yield and extended the range of high oleic sunflower varieties in Ukraine. 'MAS 908HOCP' is recommended for cultivation in the forest steppe zone, while the others are recommended for both soil and climate zones. High oleic sunflower varieties showed high oil content compared to oilseed varieties. The variety 'LG50648' had a high oil content with values of 51.0 and 53.3% in both steppe and forest steppe zones. The varieties 'SULIANO' and 'MAS 908HOCP' had high yields and oleic acid content regardless of the growing conditions.

Among the eight varieties studied, the average oil content was almost the same, ranging from 50.0 to 50.7% in the forest steppe zone, but the highest values were obtained in the varieties 'LG50648' (51.0% in the steppe and 53.3% in the forest steppe zone) and 'STK101' (50.0%

in the steppe). The highest protein content in the seeds was found in the varieties 'STK104' and 'STK103' (18.5 and 18.2% in the steppe zone). It is worth mentioning the variety 'STK101', which has high values of protein content in both soil and climatic zones (18.0% in the steppe and 16.0% in the forest steppe).

In terms of oil yield per hectare, the highest values were obtained with 'SULIANO' – 1.44 t/ha in the steppe and 1.57 t/ha in the forest steppe, and with 'MAS 908HOCP' – 1.73 t/ha in the forest steppe.

The maximum content of oleic acid in 2022–2023 was found in the varieties 'MAS 908HOCP' (86.1% in the steppe zone) and 'SULIANO' (85.8% in the forest steppe zone).

The highest content of linoleic acid in sunflower seed oil was obtained in the oilseed varieties 'STK104' (62.9% in the steppe and 58.5% in the forest steppe zone) and 'STK103' (61.2% in the forest steppe zone). Among the high oleic varieties, the highest results for linoleic acid content were shown by the variety 'LG50648' (5.7% in the steppe and 5.9% in the forest steppe).

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Мета. Вивчити вплив кліматичних умов Степу та Лісостепу на врожайність, жирнокислотний склад олії та її вміст у насінні нових сортів соняшнику однорічного високоолеїнового та олійного напрямів використання. **Методи.** Дослідження виконували відповідно до «Методики проведення кваліфікаційної експертизи сортів рослин на придатність до поширення в Україні (Загальна частина)» та «Методики проведення кваліфікаційної експертизи сортів рослин на придатність до поширення. Методи визначення показників якості продукції рослинництва». Використовували такі методи: лабораторний, порівняння, узагальнення, математичної статистики, аналізу та синтезу для підготовки висновків. **Результати.** Проаналізовано жирнокислотний склад насіння нових сортів соняшнику однорічного (*Helianthus annuus* L.) високоолеїнового та олійного напрямів використання, вирощених у різних ґрунтово-кліматичних умовах. Зокрема, у зоні Степу найліпші результати за господарсько-цінними ознаками продемонстрував сорт 'LG50648': вміст олії – 51,0%, олеїнової кислоти – 85,1%, урожайність – 3,11 т/га. 'SULIANO' та 'MAS 908HOCP' незалежно від умов вирощування характеризувалися високими врожаями (3,40 і 3,91 т/га) та вмістом олеїнової кислоти (85,8 і 86,1%). Олія була більш якісною у високоолеїнових сортів 'MAS 908HOCP', 'LG50648' і 'SULIANO'. Максимальний вміст олеїнової кислоти впродовж 2022–2023 рр. фіксували в насінні сортів 'MAS 908HOCP' (86,1% у Степу) та 'SULIANO' (85,8% у Лісостепу). Найвищі результати за вмістом лінолевої кислоти серед сортів олійного напряму використання продемонстрували 'STK104' (62,9% у Степу та 58,5% у Лісостепу) та 'STK103' (61,2% у Лісостепу); високоолеїнового напряму – 'LG50648' (5,7% у Степу та 5,9% у Лісостепу). **Висновки.** Олійність і жирнокислотний склад визначаються сортовими особливостями соняшнику та умовами навколишнього середовища. Сучасні сорти соняшнику, внесені до Державного Реєстру сортів рослин України, мають великий потенціал урожайності та здатні забезпечити значний збір олії з одиниці площі. Агрокліматичні умови по-різному впливають на валовий збір насіння та якість олії в умовах Лісостепу та Степу України.

Ключові слова: *соняшник однорічний; олійність; високоолеїнові сорти; показники якості; лушпиність; жирні кислоти*.

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