Original Paper

Effect of growing factors on production and fatty acid composition of sunflower achenes

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The aim of the study is to evaluate the influence of selected growing factors on the production, quality, and composition of fatty acids. The field small plot experiments were stablished on research-experimental base in Dolná Malanta in 2018 and 2019. Growing factors and experimental material used in this study were hybrids Carrera, SY Gracia, Marbelia CS and Reasun DS-5 grown by Clearfield and Clearfield Plus technology, and biostimulating preparations Florone (made from hydrolyzed plant proteins formulated with NPK) and Fertisilinn (foliar fertilizer with orthosilicic acid and micronutrients). Statistical analyzes confirmed the significant influence of the year on all monitored parameters of the experiment. For achieved yield and fatty acid content (oleic acid, palmitic acid, and stearic acid) was more favorable experimental season of 2018. Experimental year 2019 was more suitable for creation of yield-forming elements, oil content, and linoleic acid content. Used hybrids significantly affected the head diameter, weight of thousand achenes, yield, oil content, oleic, linoleic, palmitic, and stearic acids. Significant differences between hybrids were achieved mainly in qualitative parameters (oil content, linoleic, palmitic, and stearic acids). The biostimulating preparations significantly affected yield-forming elements (head diameter, weight of head, and weight of thousand achenes), yield and quality (oil content, and all fatty acid composition), from which it follows that the application of biostimulating preparations affects the main production parameters, and the quality of the oil through fatty acid content. The very strong negative relationship (r = -0.9951; P <0.01) in fatty acid composition between oleic and linoleic acid was found. In the other side very strong positive relation (r = 0.9882; P <0.01) between number of plants and number of heads was recorded.

Keywords: biostimulants, hybrids, oil content, quality, yield

1 Introduction

Continually more requirements are placed on improvement of quality human nutrition and healthy lifestyle through a high-quality, and varied diet. Sunflower (*Helianthus annuus* L.), as one of the most important edible oilseed crops, is cultivated all over the world, its achenes are rich in functional and nutritional components and are widely used in various fields of processing (Adeleke and Babalola, 2020; Bashir et al., 2015). The sunflower oil contents in oil soluble vitamins A, D, E and K. Sunflower cake and margarine are used as feedstuff for livestock (Soare and Chiurciu, 2018). The main object of sunflower cultivation is high yield and oil content of achenes.

It is well known that the fatty acid content changes according to weather conditions and genotypes. The right choice of sunflower hybrid affects not only the yield but oil content (Kaya and Katakisi, 2004). In the field of developing new varieties of sunflower, the focus is constantly on obtaining new varieties with high quality and consistently high yields (Tan et al., 2011).

In the cultivation system of some crops, it is also possible to use substances stimulating their production process. These substances affect growth and development, thus affecting the final production and quality of the grown product (Slowiński, 2008). The effect rate of biostimulants on sunflower production indicators is often limited by the specific course of weather conditions (Wanderley et al., 2007; Toyota et al., 2010). It has been proven that

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the effectiveness of biostimulants in the cultivation of sunflowers has a beneficial effect not only on vegetative growth, achene yield and oil quality, but also on the achievement of high-quality reproductive material for future generations (Rehman et al., 2018). Many studies and practical use consider positive effect of silicon (Si) on growth and development of many types of plants, mainly against biotic and abiotic stress (Savvas and Ntatsi, 2015). Liquid form as a source of Si is orthosilicic acid stabilized by choline. Influence on commercial crops is not enough known (Jurkic et al., 2013), so paths are opening for new knowledge in the commercial field.

Sunflower oil is classified in three types, standard, mid and high-oleic acid containing types (Akkaya, 2018). Oil content of sunflower achenes consists of fatty acids, mainly oleic acid, linoleic acid, palmitic acid, stearic acid, and linolenic acid (Wang et al., 2006). Standard type of sunflower oil composed of about 15% saturated and 85% unsaturated fatty acids. About 14–43% and 44–75% of the unsaturated fatty acids are oleic and linoleic acids, respectively. It has been argued that fatty acid synthesis in oilseeds can vary due to genetic, environmental, morphological, physiological, and cultural processes. Also, the same types of oils can show different fatty acid properties. A specific character is the relation between the level of oleic and linoleic acids because they relation is inverse (Izquierdo et al., 2002).

Various studies are also focused on detection the effect of different application doses of fertilizers on the oil content and composition of fatty acids of different oil crops. An interesting finding was the fact that higher nitrogen doses significantly decreased the achieved oil content in seed of observed crop. Important fatty acid (linolenic acid) was unaffected by fertilization (Škarpa & Lošák, 2008; Šípalová et al., 2011). Fertilizers and biostimulants are materials used in the experimental area, where monitoring their interaction relations can be interesting aim for the next experiments.

The aim of the study is to evaluate the influence of selected cultivation factors on the production, quality, and composition of fatty acids. It is expected that, biostimulants affect yield-forming elements, achene yield, oil content. Correlation relationships will be significant in the assessment of fatty acid composition.

2 Material and methods

2.1 *Experimental field*

The field small plot experiments were stablished at the Dolná Malanta (48° 19′ 0″ North, 18° 9′ 0″ East) research-experimental base, located approx. 5,000 m from the Slovak University of Agriculture in Nitra in growth seasons 2018 and 2019. The very warm and dry experimental area is characterized by the sum of average air temperatures (*TS* >10 °C) for the main growing season of 3,000 °C and more. The agroclimatic subregion is very dry with an irrigation indicator in the summer months (KVI–VIII = 150 mm). The soil of the experimental plots is Haplic Luvisol silt loam according to the IUSS Working Group WRB classification (IUSS WRB, 2015; Šimanský and Kováčik, 2015). The course of weather conditions of 2018 and 2019 is recorded in Figures 1 and 2.

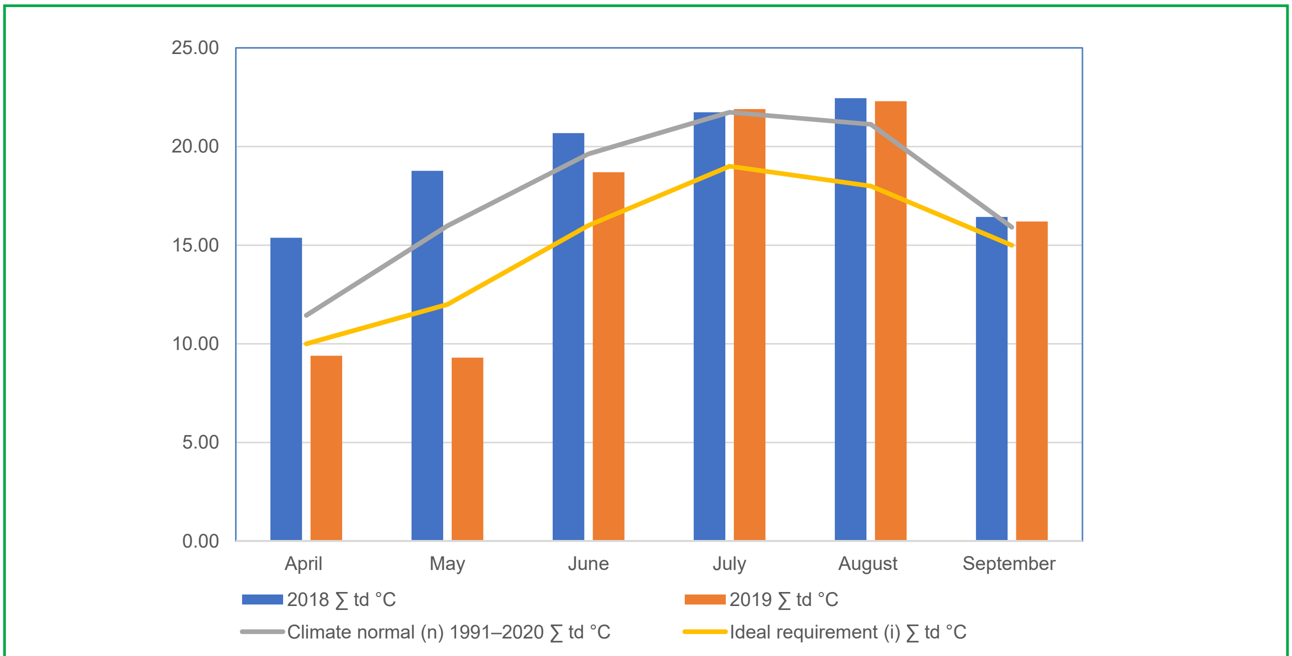

Figure 1 The course of temperature in 2018 and 2019

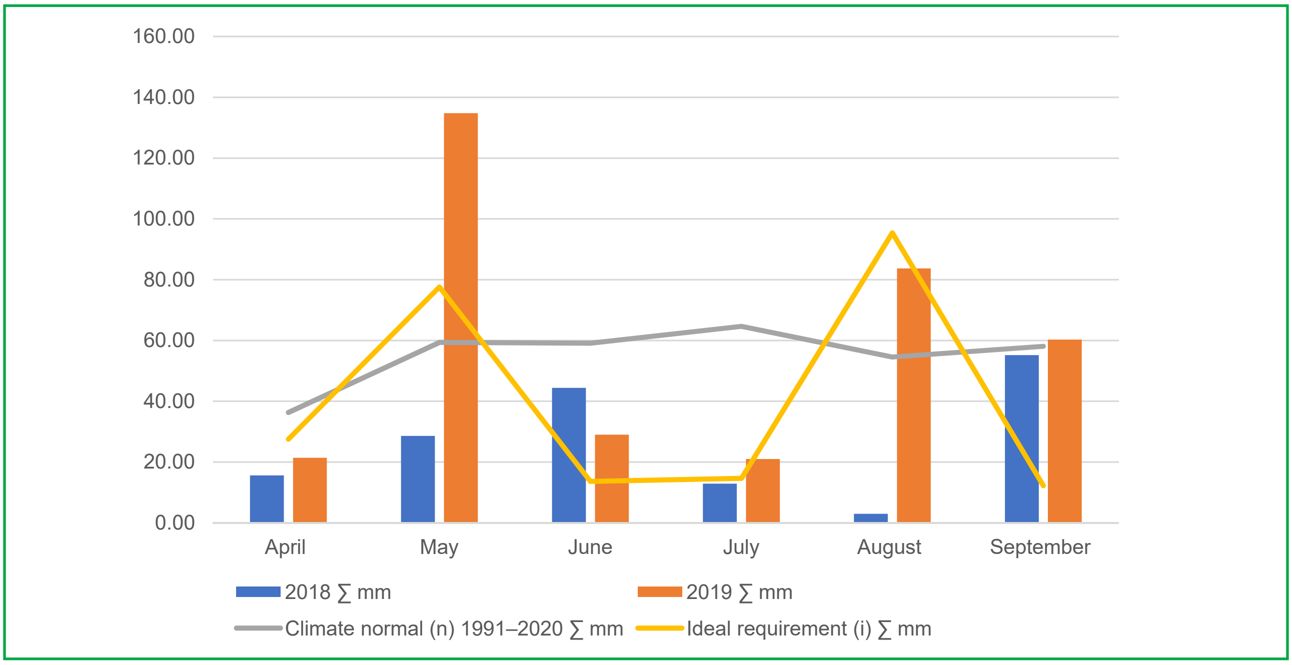

Figure 2 The course of precipitation in 2018 and 2019

2.2 Experimental material

Sunflower hybrids Carrera, SY Gracia, Marbelia CS and Reasun DS-5 (Saatbau Linz, Leonding, Austria) grown by Clearfield® and Clearfield Plus® technology were used in the experiment. Clearfield® hybrids:

- Marbelia CS (the medium-early and medium-tall hybrid is characterized by high plasticity, resistance to pathogens such as *Sclerotinia sclerotiorum*, *Peronospora halstedii*, *Phomopsis helianthi*, *Verticilium*, and *Phoma*).
- Reasun DS-5 (the medium-tall hybrid is defined by high oil production and good resistance to diseases such as *Phomopsis helianthi*, *Sclerotinia*).

Clearfield Plus® hybrids:

- Carrera CS (the medium-early type, with an oil content of 46–47%, and with inclined position of the crops, resistant to *Sclerotinia sclerotiorum* of heads, and *Peronospora halstedii*).
- SY Gracia (the medium-early hybrid, with high yields, and stabile content of oleic acid, very good resistance to stem diseases *Sclerotinia* and head diseases *Phoma*, *Verticilium*, *Alternaria*).

Basic and pre-sowing fertilization was realized on the base of agrochemical analysis results. The soil samples were taken in autumn and spring for the expected sunflower yield of 3 tons per hectare (Table 1). Application dose of NPK (Duslofert, ACHP Levice a.s., Slovakia) was 263.08 kg. Calculated dose was determined by balance method with respect to the content of nutrients in soil and usability of nutrients from soil and fertilizers. The winter wheat (*Triticum aestivum* L.) was used as a forecrop. The biostimulants Florone (made from hydrolyzed plant proteins, formulated with NPK in the amount of total N 1.0%; P in the form of P_2O_5 10.0%; K in the form of K_2O 10.0% and microelements B 0.25% and Mo 0.20%; Atlántica Agrícola Spain), and Fertisilinn (foliar fertilizer

Table 1 Agrochemical soil analysis of experimental area in 2018 and 2019

Soil analyses with methods of determination	2017/2018	2018/2019
pH/KCl (pH units) by 0.2 mol.dm^{-3} KCl	6.98	6.49
Nin (mg.kg^{-1}) as a sum of ammonium and nitrate nitrogen	18.55	14.80
NO_3^--N (mg.kg^{-1}) colorimetrically by phenol 2,4-disulfonic acid	8.80	7.80
NH_4^+-N (mg.kg^{-1}) colorimetrically by Nessler's reagent	9.75	7.00
P Mehlich III (mg.kg^{-1}) colorimetrically by Mehlich III	23.80	63.75
K Mehlich III (mg.kg^{-1}) flame photometry by Mehlich III	255.00	425.00
Mg Mehlich III (mg.kg^{-1}) AAS by Mehlich III	813.10	331.60

containing orthosilicic acid with a Si content of 2.5%; with microelements B 0.3%; Cu 1.0%; Mo 0.2%; Zn 0.6%; Innvigo Poland). The treatments with growth stages and doses of applications are given in Table 2.

Table 2 Scheme of experimental treatments

Treatment	Growth stage and dose of application
Control	without treatment
FL 15	BBCH 15 – phase 6–8 leaves; 0.2 $l.ha^{-1}$
FL 55	BBCH 55 – beginning of flowering; 0.2 $l.ha^{-1}$
FL 15,55	BBCH 15; 0.2 $l.ha^{-1}$, and BBCH 55; 0.2 $l.ha^{-1}$
FE 15	BBCH 15 – phase 6–8 leaves; 0.6 $l.ha^{-1}$
FE 55	BBCH 55 – beginning of flowering; 0.6 $l.ha^{-1}$
FE 15,55	BBCH 15; 0.6 $l.ha^{-1}$ and BBCH 55; 0.6 $l.ha^{-1}$

FL – florone; FE – fertisilin

2.3 Experimental methods

Field experiments were established according to Ernst et al. (2022). The determination methods for individual nutrients and results are listed in Table 1. Yield-forming elements were evaluated manually according to Ernst et al. (2016). The oil content in the samples of sunflower hybrid seeds (weight of sample 200g) was determined by the extraction method (%) using a Soxhlet extraction apparatus. The contents of selected fatty acids were determined by gas chromatography with a flame ionization detector (FID) expressed as a percentage of crude fat (Christie, 1993) on a machine Agilent 6890A GC (Agilent Technologies, USA).

2.4 Statistical analysis

The achieved values were statistically evaluated by standard methods using the Statgraphics plus 5.1 statistical software (Rockville, USA). A multifactor ANOVA was used for the individual treatment comparison at P = 0.05, with separation of the means by the LSD multiple-range test. For correlation analysis were used correlation and simple regression, where was selected simple correlation coefficient according to Pearson.

3 Results and discussion

The weather conditions of year can be considered as a decisive factor in sunflower cultivation (Veverková and Černý, 2012). This finding confirms the results of years 2018 and 2019 noted in Table 3 and 4. The statistically significant effect of weather conditions was observed on all experimental parameters (number of plants, number of heads, head diameter, weight of head, weight of thousand achenes, yield, oil content, oleic, linoleic, palmitic, and stearic acids) (Table 3). In 2018 were achieved a higher average yield (4.09 $t.ha^{-1}$), a higher content of oleic (57.55%), palmitic (5.19%) and stearic acid (3.84%). On the other hand, in 2019 were recorded higher average values of yield-forming elements, it means number of plants (60,574.32 $pcs.ha^{-1}$), number of heads (60,588.33 $pcs.ha^{-1}$), head diameter (261.88 mm), weight of head (232.29 g), weight of thousand achenes (89.51 g), oil content (45.67%), and linoleic acid (35.31%) (Table 4, 5). The quality of sunflower oil is mainly determined by the composition of saturated (palmitic, stearic) and unsaturated (linoleic and oleic) fatty acids (Kowalski, 2007). Another important factor affecting the composition of fatty acids are the agroecological effects of the environment, especially during ripening and development of achenes (Atanasi et al., 2010).

The diversity of hybrids is considered as an important factor affecting the production process and the final production of sunflower (Gholinezhad et al., 2009; Shafi

Table 3 Effect of experimental factors on production and fatty acid content in 2018–2019

Effect	Year	Hybrid	Treatment
Number of plants ($pcs.ha^{-1}$)	0.000335*	0.140914	0.096793
Number of heads ($pcs.ha^{-1}$)	0.001129*	0.149222	0.118351
Head diameter (mm)	0.000000*	0.011292*	0.000000*
Weight of head (g)	0.000000*	0.004384*	0.000003*
WoTA (g)	0.000000*	0.000000*	0.000000*
Yield ($t.ha^{-1}$)	0.000000*	0.000873*	0.000000*
Oil content (%)	0.000000*	0.000000*	0.000000*
Oleic acid (%)	0.000000*	0.000000*	0.000000*
Linoleic acid (%)	0.000000*	0.000000*	0.000000*
Palmitic acid (%)	0.000000*	0.000000*	0.000000*
Stearic acid (%)	0.000000*	0.000000*	0.000000*

* statistically significant effect by 0.95 confidence intervals

et al., 2013; Angeloni et al., 2017). Cultivated sunflower hybrids show a difference in oil content due to the different genetic basis (Pereyra-Irujo and Aguirrezábal, 2007; Gesch and Johnson, 2013). Statistically significant influence of hybrid was detected by head diameter, weight of thousand achenes, yield, oil content, oleic, linoleic, palmitic, and stearic acids (Table 3). Statistically significant higher average weight of thousand achenes was confirmed by Carrera 89.48 ±11.94 g, Marbelia CS 86.07 ±7.69 g, and Reasun DS-5 84.79 ±7.29 g in comparison with SY Gracia 79.51 ±9.43 g. The highest average yield was achieved by hybrid Reasun DS-5 3.92 ±0.43 $t.ha^{-1}$, but statistically significant differences were observed between Carrera and Reasun DS-5. The statistically significantly highest average oil contents were found by Carrera 45.65 ±2.71% with comparison of hybrids Reasun DS-5 45.54 ±1.79%, Marbelia CS 45.52 ±1.75%, and SY Gracia 44.90 ±2.11% (Table 5). Statistically significant differences were detected between hybrids in evaluation of fatty acid composition. The highest average content of oleic acid 76.24 ±11.83% was found at SY Gracia, linoleic acid 46.70 ±13.25%, and palmitic acid 5.37 ±0.77% at Carrera, and stearic acid 4.21 ±0.20% was achieved at Reasun DS-5. The lowest average contents of oleic acid 42.18 ±13.64% was found at Carrera, and linoleic acid 13.68 ±11.66%, palmitic acid 4.17 ±0.37% and stearic acid 3.52 ±0.20% at SY Gracia (Table 5).

Plant biostimulants have different classification and composition of active substances (Calvo et al., 2014). Their influence on the physiological and morphological properties of plants and tolerance to biotic and abiotic stress is important (Du Jardin, 2015; Van Oosten et al., 2017). Application of biostimulants had statistically significant effect on head diameter, weight of head, weight of thousand achenes, yield, oil content, oleic, linoleic, palmitic, and stearic acids (Table 3). In the evaluation of yield-forming elements (head diameter, weight of head, and weight of thousand achenes) and yield, statistically significant higher average values were found at treatments in comparison with untreated control (Table 4). The highest average yields 4.01 ±0.41 $t.ha^{-1}$ (Florone 15, 55) and 4.01 ±0.46 $t.ha^{-1}$ (Fertisilinn 15, 555) were recorded. The highest oil content 46.20 ±1.83% was achieved at variant Fertisilinn 15. The highest average oleic acid content 56.70 ±18.96% (Florone 15, 55) was found. Statistically significant highest average linoleic oil content 34.31 ±17.29% was achieved on variant Fertisilinn 55. In evaluation of palmitic acid content, statistically significantly highest average amount 4.97 ±0.49% was recorded on untreated control. Statistically significant highest average content of stearic acid 3.89 ±0.35% was achieved on Florone 55 (Table 5).

Strong positive correlation (Cohen, 1992) were recorded in the assessment of yield-forming elements (Figure 3; Table 6). A strong positive correlation was found in the assessment of weight of heads in relation to weight of thousand achenes. Higher weight of heads led to increased weight of thousand achenes. By increasing head diameter increased weight of head and thousand achenes (Table 6). Correlation relations were found in fatty acid composition. Very strong negative correlation was achieved between oleic acid and linoleic acid, where increasing content of oleic acid decreased amount of linoleic acid (Figure 4), what confirmed the finding of inverse relation between the amount of oleic and linoleic acid (Petcu et al., 2001). Strong negative correlation was found by palmitic and stearic acid in relation to oleic acid. Strong positive correlation was recorded at palmitic and stearic acid in relation to linoleic acid, and between stearic acid and palmitic acid (Table 6). The evaluated results confirmed a negative relation

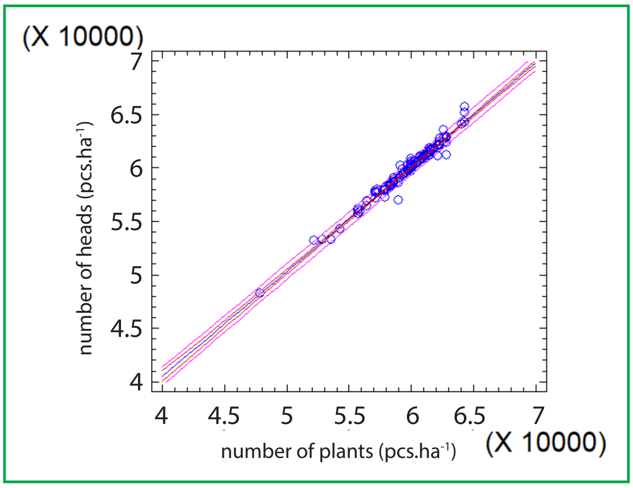

Figure 3 Very strong positive relation between number of plants and number of heads

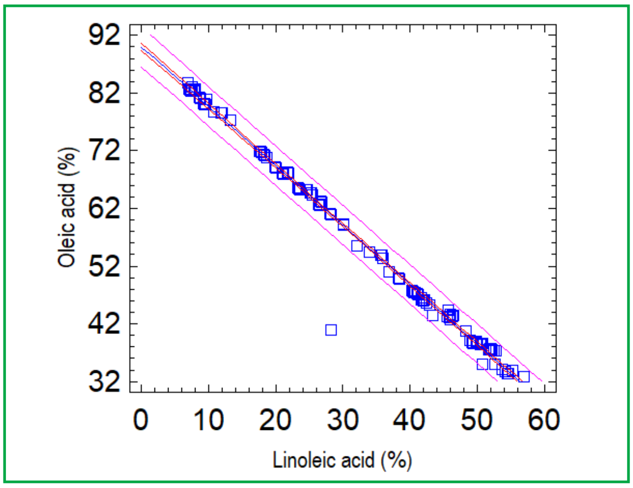

Figure 4 Very strong negative correlation between oil acid and linoleic acid

Table 4 Multifactor ANOVA of yield and yield-forming elements

		Number of plants (pcs.ha^{-1})	Number of heads (pcs.ha^{-1})	Head diameter (mm)	Weight of head (g)	Weight of Tousand Achenes (g)	Yield (t.ha^{-1})
Year	2018	59,944.63 ±2,967.95a	59,460.56 ±2,956.40a	246.05 ±21.54a	192.15 ±38.96a	80.42 ±9.86a	4.09 ±0.39b
	2019	60,574.32 ±1,027.82b	60,588.33 ±1,018.84b	261.88 ±29.12b	232.29 ±28.43b	89.51 ±7.52b	3.59 ±0.20a
Hybrid	Carrera	60,474.41 ±1,451.64a	60,566.27 ±1,435.47a	261.41 ±30.30a	201.58 ±48.95a	89.48 ±11.94b	3.76 ±0.35a
	SY Gracia	60,161.31 ±2,068.69a	60,211.16 ±1,999.71a	251.55 ±24.41a	212.33 ±41.15a	79.51 ±9.43a	3.91 ±0.44b
	Marbelia CS	59,711.34 ±2,955.58a	59,771.25 ±293.91a	247.95 ±19.66a	222.94 ±33.87a	86.07 ±7.69b	3.78 ±0.35ab
	Reasun DS-5	59,431.45 ±2,410.87a	59,549.11 ±2,406.55a	254.95 ±30.19a	212.03 ±29.79a	84.79 ±7.29b	3.92 ±0.43b
Variant	control	60,132.29 ±1,792.40a	60,161.46 ±1,562.82a	226.83 ±32.27a	181.91 ±34.08a	77.88 ±10.07a	3.58 ±0.26a
	Florone 15	60,605.08 ±1,724.76a	60,666.27 ±1,666.06a	260.92 ±16.27b	222.67 ±33.84b	90.34 ±6.46c	3.85 ±0.33bc
	Florone 55	60,137.99 ±2,114.24a	60,210.21 ±2,017.75a	256.33 ±24.69b	213.53 ±35.11b	85.03 ±8.83bc	3.89 ±0.35bc
	Florone 15, 55	58,831.68 ±3,633.31a	58,941.87 ±3,481.26a	253.13 ±19.14b	209.66 ±48.76b	83.83 ±10.38b	4.01 ±0.41c
	Fertisilinn 15	59,702.77 ±2,223.44a	59,866.64 ±2,374.16a	257.92 ±25.77b	220.46 ±26.47b	86.10 ±8.43bc	3.82 ±0.42bc
	Fertisilinn 55	60,541.67 ±1,636.08a	60,597.43 ±1,788.25a	258.71 ±23.92b	219.40 ±38.26b	86.69 ±11.32bc	3.74 ±0.38ab
	Fertisilinn 15, 55	59,660.90 ±2,162.70a	59,727.25 ±2,279.80a	263.92 ±26.57b	217.92 ±44.86b	84.86 ±9.47bc	4.01 ±0.46c

same small letters indicate non-significant differences (LSD test, $\alpha = 0.05$) between production seasons, hybrids, and biostimulation preparations; number near biostimulator indicates the growth phase, when the biostimulator was applied

Table 5 Multifactor ANOVA of oil content and fatty acids

		Oil content (%)	Oleic acid (%)	Linoleic acid (%)	Palmitic acid (%)	Stearic acid (%)
Year	2018	45.14 ±2.09a	57.55 ±16.95b	30.89 ±16.17a	5.19 ±0.73b	3.84 ±0.17b
	2019	45.67 ±2.14b	54.29 ±17.53a	35.31 ±17.04b	4.58 ±0.50a	3.76 ±0.40a
Hybrid	Carrera	45.65 ±2.71b	42.18 ±13.64a	46.70 ±13.25d	5.37 ±0.77d	3.77 ±0.17c
	SY Gracia	44.90 ±2.11a	76.24 ±11.83b	13.68 ±11.66a	4.17 ±0.37a	3.52 ±0.20a
	Marbelia CS	45.52 ±1.75c	62.11 ±6.91ab	26.70 ±5.77b	4.74 ±0.44b	3.69 ±0.16b
	Reasun DS-5	45.54 ±1.79c	43.16 ±4.33b	45.32 ±4.62c	5.26 ±0.33c	4.21 ±0.20d
Variant	control	44.65 ±1.17b	56.29 ±10.99bc	32.58 ±10.66ab	4.97 ±0.49c	3.85 ±0.24c
	Florone 15	45.41 ±3.00c	56.32 ±17.04bc	32.85 ±16.55b	4.87 ±0.69ab	3.80 ±0.29b
	Florone 55	44.38 ±2.30a	55.12 ±15.99ab	33.81 ±15.36c	4.93 ±0.69bc	3.89 ±0.35d
	Florone 15, 55	45.78 ±1.98e	56.70 ±18.96c	32.52 ±18.41a	4.84 ±0.74a	3.81 ±0.37b
	Fertisilinn 15	46.20 ±1.83f	56.35 ±19.92bc	32.88 ±19.22b	4.83 ±0.81a	3.74 ±0.31a
	Fertisilinn 55	45.80 ±1.79e	54.11 ±17.93a	34.31 ±17.29d	4.91 ±0.63bc	3.79 ±0.33b
	Fertisilinn 15, 55	45.61 ±2.00d	56.59 ±20.39c	32.74 ±19.82ab	4.83 ±0.82a	3.71 ±0.28a

same small letters indicate non-significant differences (LSD test, α = 0.05) between production seasons, hybrids, and biostimulation preparations; number near biostimulator indicates the growth phase, when the biostimulator was applied

Table 6 Correlation relations of production and qualitative parameters of sunflower hybrids affected by two different biostimulators in 2018–2019

	NoP (pcs.ha^{-1})	NoH (pcs.ha^{-1})	HD(mm)	WoH (g)	WoTA (g)	Yield (t.ha^{-1})	Oil (%)	OA (%)	LA (%)	PA (%)
NoP (pcs.ha^{-1})	1									
NoH (pcs.ha^{-1})	0.9882****	1								
HD (mm)	0.0643*	0.0718*	1							
WoH (g)	0.0385*	0.0487*	0.5581**	1						
WoTA (g)	0.1064*	0.1075*	0.5294**	0.6386***	1					
Yield (t.ha^{-1})	-0.2101*	-0.1961*	-0.0743*	-0.2075*	-0.2289*	1				
Oil (%)	0.0409*	0.0456*	0.0101*	-0.0705*	-0.0386*	-0.0751*	1			
OA (%)	-0.0436*	-0.0460*	-0.2166*	-0.0392*	-0.3165**	0.1145*	-0.1040*	1		
LA (%)	0.0594*	0.0632*	0.2283*	0.0591*	0.3280**	-0.1215*	0.1095*	-0.9951****	1	
PA (%)	-0.0824*	-0.0660*	-0.0756*	-0.2785*	-0.0003*	0.2245*	0.1705*	-0.7809***	0.7613***	1
SA (%)	-0.0656*	-0.0586*	0.0092*	-0.1074*	-0.0102*	0.1223*	0.0717*	-0.6715***	0.6596***	0.6116***

NoP – number of plants; NoH – number of heads; HD – head diameter; WoH – weight of heads; WoTA – weight of thousand achenes; OA – oleic acid; LA – linoleic acid; PA – plamitic acid; SA – stearic acid; effect size by Cohen (1992) at level <0.01; * weak correlation (-0.3 to +0.3); ** moderate correlation (-0.5 to -0.3 or 0.3 to 0.5); *** strong correlation (-0.9 to -0.5 or 0.5 to 0.9); **** very strong correlation (-1.0 to -0.9 or 0.9 to 1.0) between the content of oleic acid and linoleic acid, while the content of stearic acid was not positively related to the content of oleic acid and palmitic acid, but to linolenic and palmitic acid as states Wang et al. (2022).

4 Conclusions

The results of study realized by field polyfactorial experiments confirmed that Year significantly affected all studied parameters. Hybrid and treatment significantly affected all parameters except for both the number of plants and the number of heads. The application of biostimulants affects the main production parameters, and the quality of the oil through fatty acid content, where for highest yield were most suitable hybrid Reasun SD-5, application of both biostimulants in both growth stages. The use of biostimulants based on natural or microbial sources is increasing, which is also the result of increased use by farmers and researchers for their sustainability and environmentally friendly (Hasanuzzaman et al., 2022).

The very strong negative relationship in fatty acid composition between oleic and linoleic acid was confirmed by the correlation coefficient (r = -0.9951; P <0.01). Strong dependencies were recorded between head diameter × weight of head (r = 0.5581; P <0.01), head diameter × weight of thousand achenes (r = 0.5294; P <0.01), weight of head × weight of thousand achenes (r = 0.6386; P <0.01), oleic acid × palmitic acid (r = -0.7809; P <0.01), oleic acid × stearic acid (r = -0.6715; P <0.01), linoleic acid × palmitic acid (r = 0.7613; P <0.01), linoleic acid × stearic acid (r = 0.6596; P <0.01), and palmitic acid x stearic acid (r = 0.6116; P <0.01).

The results of study confirmed that for stabile achene yield with high oil content are suitable high oileic hybrids Reasun DS-5 and Carrera with application of biostimulats Florone and Fertisilinn simultaneously in phases 6–8 leaves and in the beginning of flowering. Sunflower is mainly planting for feed of livestock and food industry. Suitable content of linoleic acid, which is important for production of sunflower oil, was achieved by hybrid Carrera. Since the issue of the effect of orthosilicic acid has not been studied on commercial crops, we consider it appropriate to devote this strategy to other economically important crops as well.

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