THE EFFECT OF DROUGHT STRESS ON FATTY ACID COMPOSITION IN SOME ROMANIAN SUNFLOWER HYBRIDS

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ABSTRACT

Five Romanian sunflower hybrids were grown under greenhouse and field conditions. Two watering regimes for each genotypes were used: control variant in which plants were maintained at 70 % from total soil water capacity and stress treatment where starting with 7 days before and up to 12 days after flowering plants were irrigated no more than 40% from total soil water capacity. Changes in fatty acid composition of sunflower seeds due to water stress has been analysed by gas chromatography. Sunflower oil contains large amounts of unsaturated fatty acids, mainly linoleic (C18:2) and oleic acids (C18:1), with more than 60% and 28-35% respectively in sunflower oil produced in the South-Eastern part of Romania. There was a significant negative effect of drought on the oleic acid concentration in all studied sunflower hybrids. The reduction in the concentration of oleic acid was from 4 to 14 %. On the contrary, the linoleic acid concentration increases in sunflower seeds grown in drought stress.

Key words: drought stress, fatty acid composition, sunflower hybrids

INTRODUCTION

The fatty acid composition and oil content in sunflower seeds (*Helianthus annuus* L.) have been studied intensively in the last years.

Genotype is the most important factor that defines the fatty acid composition (Knowles, 1988), but also the environmental factors during the seed-filling period can widely affect the oil percentage and the unsaturated fatty acid composition of the oil. It has been documented that the ratio of oleic /linoleic acid increases under high temperature during seed maturation and, in opposition, it decreases under lower temperature conditions (Tremolieres et al., 1982). Water stress caused an increase in oleic acid in high oleic sunflower hybrids and also caused a reduction of it in standard hybrids (Baldini et al., 2000). So far, few work have been done on the effect of environmental factors such as drought on fatty acid composition of Romanian sunflower germplasm.

The objective of this study was to determine the changes in fatty acid composition of oil saturated and unsaturated lipids of five new released Romanian sunflower hybrids as response to water stress.

MATERIALS AND METHODS

Five Romanian sunflower hybrids, Alex, Favorit, Justin, Romina and Splendor, were grown in the greenhouse and in the experimental field at the Research Institute for Cereals and Industrial Crops at Fundulea, Romania, during 2000. The hybrids were produced and provided by the same institute. In the greenhouse experiment seeds were planted on May in 27 kg capacity pots filled with a mixture of 4:1 soil and sand.

Two water treatments were imposed: a) well watered or control, where plants were constantly irrigated and maintained up to physiological maturity under optimal soil moisture condition of 70% from total soil water capacity; 2) water stress, where starting with 7 days before and up to 12 days after flowering plants were irrigated no more than 40% from total soil water capacity. The treatments and hybrids were replicated four times. Day length and temperature were similar with the ambient. In the field experiment seeds were planted under dryland and irrigation conditions.

The fatty acids were analysed by gas chromatography (GS) according to the conventional method (Schulte and Weber, 1989). The transesterification of triglycerides to fatty acid methyl esters was performed with trimethylsulfoniumhydroxid (TMSH). The capillary column (BP x 70) by 25 m lengths on a DELSI gas chromatography with flame ionization de-

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Table 1. The effect of water stress on fatty acid compositions in sunflower seeds

	Alex			Favorit			Justin		
	Control	Water stress	Diff. %	Control	Water stress	Diff. %	Control	Water stress	Diff. %
Palmitic acid	6.36	7.1	+ 0.74	6.12	6.51	+ 0.39	6.03	6.66	+ 0.63
Stearic acid	6.24	6.1	- 0.14	4.52	3.19	- 1.33	4.05	3.85	- 0.2
Oleic acid	38.09	23.84	-14.25	31.47	27.35	- 4.12	33.59	23.59	- 10
Linoleic acid	46.45	60.53	+14.08	60.18	61.54	+ 1.36	54.64	64.11	+ 9.47

Table 1. continuation

	Romina			Splendor		
	Control	Water stress	Diff. %	Control	Water stress	Diff. %
Palmitic acid	7.1	7.79	+ 0.69	5.47	6.06	+ 0.59
Stearic acid	4.23	3.23	- 1.0	5.07	4.29	- 0.78
Oleic acid	28.15	20.34	- 7.81	35.95	27.94	- 8.01
Linoleic acid	57	68.09	+11.09	51.72	59.02	+ 7.3

tector (FID) was used. Injector and temperature detector were kept at 270 and 280^{0}C, respectively. The carrier gas was helium, with a flow rate of 20 ml/min. An electronic integrator was used to calculate the total area of the peaks. The area of each fatty acid peak was expressed as a percentage of the total area.

RESULTS AND DISCUSSIONS

The saturated fatty acid (palmitic and stearic acid) contents were insignificantly affected by water stress. The palmitic acid concentration increases under drought conditions (from 0.39% for Favorit to 0.74% for Alex hybrid) and stearic acid concentration decreased in the same conditions (from 0.14% for Alex to 1.33% for Favorit hybrid respectively) (Table 1).

There was a significant negative effect of drought on the oleic acid concentration in all studied sunflower hybrids. The decrease was more obvious for Alex and Justin (14.25 and 10.% respectively) than for Favorit hybrid (4.12%).

On the contrary, the linoleic acid concentration increases in sunflower seeds provided by drought variant. The proportion of linoleic acid in fatty acids from these seeds was from 59.02 to 64.11%.

Anova analyses for fatty acid composition have shown the very significant effect of genotype, treatment and their interaction for determination of fatty acid composition in sunflower (Table 2).

The research work of Baldini et al. (2000) revealed that water stress causes a significant reduction of about 15% in the concentration of oleic acid in standard hybrid. Baldini et al. (2000) have established that from the 8th days after flowering, with the increase in the biosynthesis of the oil, the enzyme Δ–9 desaturase started to be active. This enzyme has been proposed as being res-ponsible for the accumulation of oleic acid (18:1) by desaturing stearic acid (18:0), (Mckeon and Stumpf, 1982). Another enzyme leading to the oleic acid accumulation is Δ–12 desaturase, which catalyses the se-cond desaturation of oleic acid in linoleic acid (Stymme and Appelqvist, 1980).

The proportion of linoleic acid in fatty acids of the sunflower oil was between 50.40-65.39% for the 2000 crop (Table 3). The oleic acid concentration in the seeds of Justin hybrid from 2000 crop was similar in value with drought variant (23.44 and 22.95 % respectively, table 3). Splendor had lower oleic acid concentration under field conditions (Table 2), especially low rainfall during seed maturation in 2000 (Table 4).

Table 2. Anova analyses for fatty acid composition from sunflower seeds

Source of variances	F factor and significance			
	Palmitic acid	Stearic acid	Oleic acid	Linoleoc acid
A Factor: treatment (control, water stress)	47.485**	265.209***	3051.510***	1904.083***
B Factor: genotype	56.383***	133.687***	308.142***	191.458***
Interaction A x B	1.748***	7.073***	212.697***	82.243***

Table 3. The effect of hybrid and environment on fatty acid composition in sunflower

Fatty acid	ALEX			JUSTIN			SPLENDOR		
	Irrigated	Rainfall	Diff.	Irrigated	Rainfall	Diff.	Irrigated	Rainfall	Diff.
Palmitic acid (C 16:0)	6.40	6.11	+ 0.39	5.57	6.83	+ 1.26	6.10	6.28	+ 0.18
Stearic acid (C 18:0)	6.24	4.05	- 2.11	5.07	6.10	+ 1.03	4.30	4.25	- 0.05
Oleic acid (C 18:1)	39.09	33.59	- 5.5	33.95	33.21	- 0.74	23.92	21.99	- 1.93
Linoleic acid (C 18:2)	45.45	54.64	+ 9.19	53.72	50.40	+ 3.33	63.07	65.39	+ 2.32

Table 4. Summary of temperature and precipitation data in 2000 at Fundulea as compared to the multiannual average (1962-1994)

	Months					
	IV	V	VI	VII	VIII	IX
Monthly precipitation during 2000 growth cycle (mm)	33.0	25.0	26.3	10.3	78.7	3.8
Monthly average precipitation during 1962-1994 (mm)	45	60	70	70	55	48

CONCLUSIONS

The large amounts of unsaturated fatty acids, mainly linoleic (C18:2) and oleic acids (C18:1), with more than 60% and 28-35% respectively, can be found in sunflower oil produced in the Sout-Eastern part of Romania under normal conditions. Our results have shown that beside the genotype which is the most important factor that defines the fatty acid composition, the water stress also affects the fatty acid composition of sunflower oil. The saturated fatty acid (palmitic and stearic acid) contents were insignificantly affected by water stress. The palmitic acid concentration increases under drought conditions (with 0.39 to 0.74%) and stearic acid concentration decreases under the same conditions (up to 1.33). Water stress caused a decrease in oleic acid and an increase in the content of linoleic acid in standard sunflower hybrids (up to 14%).

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