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INFLUENCE OF IRRIGATION-WATER SALINITY ON LIPIDS OF *Crambe abyssinica* SEEDS

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Lipids of Crambe abyssinica *Hochst (Brassicaceae) seeds grown in hothouses in Israel and in the open in Uzbekistan in soil imported from the Aral Sea region were studied. It was found that the seed oil content decreased as the irrigation-water salinity increased. The content of total unsaturated fatty acids of neutral lipids was in the range 91.31–94.81%; of polar lipids, 69.59–83.78%.*

Keywords: lipids, fatty acids, salinity, *Crambe abyssinica* Hochst.

The evaporation of the Aral Sea led to the formation of an enormous area of sandy saline desert. The salinity and particulate count of the air worsened the ecological situation in the region and decreased the harvest of pasture and agricultural crops, including cotton, the principal industrial crop of Uzbekistan, the seeds of which are the main source of vegetable oil in the RU.

Scientists around the world are interested in the problem of using saline soils. This is evident from numerous publications on this topic in international journals. This is due to the fact that plants grown in saline soil will prevent the movement of sand, thereby lowering the air particulate count and improving the ecological situation of the region.

The influence of irrigation-water salinity on the yield of seeds, their oil content, and the fatty-acid composition of oil from *Matthiola incana* (L.) R. Br. and *Oenotera biennis* (L.) Scop. was studied before [1, 2]. It was found that increasing the irrigation-water salinity from EC = 1.0 dS/m to 6.0 dS/m did not have a negative influence on the yield of seeds and their oil content. The content of ω-3-acids even increased slightly.

The influence of irrigation-water salinity on the yield of potatoes and eggplant was investigated [3, 4]. It was noted that the harvest decreased with increasing salinity.

A study of the influence of salinity on the harvest of safflower seeds and the oil content of cotton seeds [5, 6] showed that the harvest of safflower seeds increased with increasing salinity. The oil content of cotton seeds decreased with increasing soil salinity as compared with a control from 24.8% to 20.4. Also, the quantitative composition of individual fatty acids changed [6].

We studied lipids from *Crambe abyssinica* Hochst (Brassicaceae) seeds grown in a hothouse in Israel in 2006 (I) and 2007 (II) and in the open in Uzbekistan in soil imported from the Aral Sea region in 2007 (III) and 2008 (IV) in order to improve the ecological situation in the corresponding regions, to obtain an additional amount of vegetable oil, and to expand its variety. The irrigation-water salinity was 1.5, 3.0, 6.0, and 9.0 dS/m.

At present *C. abyssinica* is grown as an oil crop [7].

Table 1 presents data for the content of neutral (oil content) (NL) and polar lipids (PL) in oil from *C. abyssinica* seeds. It can be seen that the NL content in seeds grown in both the hothouse and in the open decreased as the irrigation-water salinity increased in the range 1.5-6.0 dS/m. However, the oil content increased slightly for EC = 9.0 dS/m (I) and 6.0 (IV). The oil content in seeds from the second-year harvest (II and IV) turned out to be higher than in the first year of growth both in the hothouse and in the open (I and III). Apparently the plants adapted to the saline stress.

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TABLE 1. Content of Neutral and Polar Lipids from *Crambe abyssinica*, % of Seed Mass

EC, dS/m	I		II		III		IV	
	NL	PL	NL	PL	NL	PL	NL	PL
1.5	21.3074	0.83376	25.5764	1.0908	10.2731	1.0028	16.0775	1.0595
3.0	18.8253	0.90505	22.3028	1.1161	9.5328	1.2209	12.0187	1.2250
6.0	18.5986	0.95812	21.3403	1.0834	8.3144	1.2988	13.26475	1.29575
9.0	18.8453	1.14163	21.0858	1.1286	9.9778	1.4960	–	–

TABLE 2. Content of Carotinoids in *Crambe abyssinica* Seed Oil, mg%

EC, dS/m	I	II	III	IV
1.5	10.44175	8.2522	20.3919	13.34885
3.0	10.9427	6.9626	10.8524	17.05845
6.0	11.1760	8.1893	16.4750	17.51475
9.0	10.0315	10.3649	21.5194	–

TABLE 3. Fatty-Acid Composition of Neutral Lipids from *Crambe abyssinica*, GC, % of mass

EC, dS/m	Sample	Fatty acid											
		14:0	16:0	16:1	18:0	18:1	18:2	18:3	20:1	22:0	22:1	Total	
												sat.	unsat.
1.5	I	0.2	3.87	0.63	1.05	37.28	15.18	4.05	8.84	1.04	27.86	6.16	93.84
	II	0.16	3.23	0.35	0.77	37.92	11.35	4.38	9.83	1.06	30.96	5.22	94.78
	III	0.21	4.46	0.67	1.21	31.48	17.49	6.82	8.90	1.62	27.14	7.50	92.50
	IV	0.19	4.56	0.52	1.27	31.79	16.24	8.15	8.16	1.98	27.11	8.02	91.97
3.0	I	0.17	4.55	0.88	1.48	29.95	16.42	6.01	10.80	0.86	28.88	7.06	92.94
	II	0.16	3.51	0.31	0.76	38.24	11.38	4.50	10.10	1.27	29.77	5.70	94.30
	III	0.31	5.43	0.58	1.76	37.41	15.17	4.87	8.34	1.18	24.95	8.68	91.32
	IV	0.25	5.41	0.51	0.85	32.09	17.77	8.12	8.68	1.34	24.98	7.85	92.15
6.0	I	0.18	4.31	0.81	1.18	33.27	16.49	5.91	10.79	0.77	26.28	6.44	93.55
	II	0.14	3.27	0.40	0.72	38.04	11.97	4.95	9.48	1.06	29.97	5.19	94.81
	III	0.21	4.60	0.76	1.80	34.96	14.39	5.92	8.87	2.08	26.41	8.69	91.31
	IV	0.20	4.65	0.34	0.79	28.57	24.24	7.59	7.82	1.04	24.76	6.68	93.32
9.0	I	0.21	4.60	0.76	1.80	34.96	14.39	5.92	8.87	2.08	26.41	8.69	91.31
	II	0.16	3.24	0.27	0.97	39.39	11.25	3.60	8.26	1.40	31.46	5.77	94.23
	III	0.35	5.48	0.78	1.27	33.17	16.75	6.26	9.75	1.95	24.24	9.05	90.95

The PL content showed a tendency to increase with increasing irrigation-water salinity.

Table 2 presents results for the carotinoid content in *C. abyssinica* seed oil. It can be seen that the carotinoid content in oil of seeds grown in the hothouse was lower than in seeds grown in the open. This agrees with the literature [8, p. 118].

Table 3 shows that the content of saturated fatty acids was insignificant and less than 9.05%. The principal saturated acid was palmitic. Oleic, linoleic, and erucic acids dominated the unsaturated acids. However, the content of the last acid was much lower than in oil from seeds grown under natural conditions, where it amounted to 58.6% [9] and 57.07 [10]. The total unsaturated acids varied in the range 90.95–94.81%.

Palmitic, oleic, and linoleic acids dominated in fatty acids of PL (Table 4).

The content of erucic acid, which is characteristic of oil from seeds of Brassicaceae plants, was less than 5.89% in PL.

Changes in the quantitative content of individual acids in NL and PL were apparently due to adaptation of plants to the saline stress.

TABLE 4. Fatty-Acid Composition of Polar Lipids from *Crambe abyssinica*, GC, % of mass

EC, dS/m	Sample	Fatty acid											
		14:0	16:0	16:1	18:0	18:1	18:2	18:3	20:1	22:0	22:1	Total	
												sat.	unsat.
1.5	I	0.40	18.61	1.91	2.54	28.12	31.67	6.50	3.84	0.78	5.63	22.33	77.67
	II	0.24	14.25	1.73	0.86	39.61	27.78	4.63	4.14	0.87	5.89	16.22	83.78
	III	0.44	20.98	4.66	2.87	21.44	33.16	8.23	3.18	1.99	3.05	26.28	73.72
	IV	0.27	23.225	2.205	2.97	21.49	36.64	7.84	3.41	1.83	2.125	28.29	71.71
3.0	I	0.36	18.06	1.97	2.71	28.39	32.38	7.31	4.02	0.65	4.15	21.78	78.22
	II	0.25	16.72	1.87	0.76	39.33	28.49	4.32	3.35	0.69	4.22	18.42	81.58
	III	0.73	24.00	3.81	4.22	19.29	29.13	7.50	3.46	2.39	5.47	31.34	68.66
	IV	0.36	19.275	2.11	2.44	23.73	38.63	6.99	2.18	1.66	2.64	23.73	76.27
6.0	I	0.38	16.24	2.17	2.14	31.83	31.31	6.81	3.95	0.78	4.39	19.54	80.46
	II	0.32	15.62	2.16	1.07	36.87	29.17	5.36	4.02	0.88	4.53	17.89	82.11
	III	0.54	19.94	4.61	3.53	20.67	33.21	9.14	2.68	2.07	3.61	26.08	73.92
	IV	0.36	17.77	2.75	3.00	23.60	36.755	7.215	2.43	2.145	3.995	23.27	76.72
9.0	I	0.29	16.88	2.13	2.01	29.46	34.34	7.64	3.42	0.64	3.19	19.82	80.18
	II	0.20	16.95	1.18	0.53	34.06	32.48	5.80	3.86	0.66	4.28	18.34	81.66
	III	0.70	23.96	2.97	3.67	18.67	32.91	8.85	2.49	2.08	3.70	30.41	69.59

The results suggest that *C. abyssinica* adapted entirely to the saline stress and can produce fertile seeds containing a rather high percentage of oil including TAG with essential fatty acids.

EXPERIMENTAL

GC of fatty acid methyl esters was carried out on a Chrom-5 instrument with a flame-ionization detector using a steel column (2.5 m × 4 mm) packed with Reoplex-400 on Inerton N-AW (0.16–0.20 mm), thermostat temperature 190°C, N_2 and H_2 flow rate 30 mL/min.

The hydrolysis of NL and PL and the isolation of fatty acids and their methylation were performed as before [11]. The carotinoid content was determined by the literature method [12].

Seeds grown in a hothouse in Israel were sent to Uzbekistan, where they were sprouted and planted four each in 20-L containers. Weakly growing plants were removed, leaving one plant in every container.

Four irrigation-water salinity levels were studied with 12 plants of each variety at each level.

The appropriate irrigation-water salinity level was maintained by adding the required amount of NaCl and $CaCl_2$. Furthermore, plants were fed K, P, and N fertilizers because it is known that plants die in the Aral Sea region even if copious amounts of fertilizers are used.

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