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EFFECT OF SOIL SALINITY ON THE COMPOSITION OF OIL AND AMINO ACID AND ON THE OIL CONTENT OF SUNFLOWER SEED

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A pot-culture experiment was conducted to study the effects of salts on the oil composition, oil content and amino acid content of seed of 3 sunflower varieties. The oil percentage decreased with increasing soil salinity. As compared to control, the drop in oil content was 21.1 per cent at ECe of 12.0 mmhos/cm. Iodine, saponification and acid values were unaffected by salinity levels. Percentage of saturated and unsaturated fatty acids and their composition remained unaffected by salinity. Protein percentage in seed increased with increasing salinity, but the total uptake of nitrogen decreased as a result of the reduction in grain yield. Almost all amino acids increased with increasing soil salinity

INTRODUCTION

Large areas of Pakistan are affected by salinity, sodicity and water-logging. Selection and adaptation af salt tolerant crops is of utmost importance for utilizing the partially saline soils effectively and for making use of saline ground water. Sunflower is considersd a relatively salt tolerant plant. Soil salinity depresses oil content of seed, but has no effect on the chemical composition of safflower oil (Yermanos *et. al.*, 1964). Werkhoven *et al.* (1966) reported that exchangeable sodium percentage did not affect the fatty acid composition of safflower oil. Increase in salt content of the substrate caused a marked increase in N percentage in various portions of bean (Wadleigh and Gauch, 1942) and soybean plant (Ahmad and Muhammad, 1969) but the the total uptake of N decreased. Strogonov (1964) reported that chloride and sulphate salinity increased the amino acid contents from 10 to 15 and 18 per cent of the dry weight of the sunflower plant, respectively. Palfi and Juhasz (1968) also reported that paper chromotography of alcohol extracts of leaves of wheat, rice and beans showed a great increase in the total amino acids on saline soils.

Although some work has been done in foreign countries to assess the effect of soil salinity on oil and protein contents of safflower seed and other crops yet informatton is lacking about sunflower under local environmental conditions. The effects of soil salinity on oil composition, amino acid composition and oil content of sunflower seed are reported in this paper.

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MATERIALS AND METHODS

A salt free (ECe= 2.5 mmhos/cm.) sandy clay loam soil (21.6% clay) was collected from the surface 6 inches of the University Farm. The bulk sample was air-dried, passed through 2 mm. sieve and mixed thoroughly. The soil had cation-exchange capacity of 5.5 me./100g, saturation percentage =33, pH of saturated soil paste =7.9, free lime 1.6%, total phosphorus P =229 ppm and total nitrogen =0.04 per cent.

Three sunflower varieties viz. Armvirsk 3497, Negro and Vniimk 8931 were grown in glazed pots. Twenty five pounds of air-dry soil were added to each glazed pot. A basal dose of 150 lbs. of N, 50 lbs. of P and 50 lbs. of K per two million pounds of soil was mixed thoroughly with it at the time of planting seeds. The sunflower seeds were sown on September 3, 1969 and thinned to plants per pot one week after emergence. The first level of salinity (4.0 mmhos/cm) was produced 4 weeks after planting. Higher salinity levels were produced by step-wise increase in the salt content at intervals of 3 days each. The electrical conductivity of saturation extract (ECe) of the non-saline soil was 2.5 mmhos/cm. It was used as check. Salinity levels of 4.0, 6.0, 8.0, 10.0 and 12.0 mmhos/cm. were produced by adding a mixture of NaCl, Na_2SO_4, $CaCl_2$ and $MgCl_2$ in the ratio of 4 10 : 5 : 1 to give Na : Ca : Mg ratio of 14 : 5 : 1 and that of SO_4 : Cl of 1 : 1. Canal water was used for irrigation throughout growing season. The crop was harvested on January 3, 1970. The analysis of grain for oil content, oil composition and protein content was carried out by methods described by A.O.C S. (1950) and that of amino acids by using chromatographic method as given by Kausar (1961). The particle-size distribution and free lime in soil were determined by hydrometer and calcimeter methods described by Moodie, Smith and McCreery (1959). Total nitrogen and total phosphorus were determined by methods given by Jackson (1960). All other soil analyses were done according to methods given by U. S. Salinity Laboratory Staff (1954).

RESULTS AND DISCUSSION

The data presented in Table I show the effect of salinity on the oil percentage and acid value of oil of 3 sunflower varieties. The statistical analysis shows that increasing salinity levels decreased the oil contents of sunflower seed, but the results were non-significant between two successive salinity levels. Variety VNIIMK 8931 was the most sensitive and ARMVIRSK 3497 the most tolerant to salinity. The largest drop in oil content (21.1 per cent) occurred at ECe of 12.0 mmhos/cm. and was significantly different from all salinity levels except ECe of 8.0 mmhos/cm. This

reduction was due to decreased kernel percentage of seed, retarded development of seed and early maturity on higher salinity pots. These data agree with the results obtained by Yermanos *et al.* (1964). Variety NEGRO having lowest oil percentage (34.3) differed significantly from the other two varieties.

TABLE 1. *The effect of salts on oil percentage and acid value of oil of 3 sunflower varieties (average of 3 repeats).*

Varieties		EC of saturation extract, mmhos/cm 2.5	4.0	6.0	8.0	12.0	Avg. Value*
		Per cent oil in seed					
ARMVIRSK	3497	44.0	41.8	38.6	35.0	36.1	39.1a
NEGRO		38.9	35.6	33.8	32.9	30.3	34.3b
VNIIMK	8931	41.9	40.0	37.5	36.7	32.0	37.6a
Avg. value*		41.6 a	39.1 ab	36.6 bc	34.9 cd	32.8 d	
		*Acid value of seed oil***					
ARMVIRSK	3497	2.5	2.6	2.5	2.4	2.5	2.5
NEGRO		2.4	2.4	2.4	2.4	2.3	2.4
VNIIMK	8931	2.4	2.4	2.4	2.4	2.3	2.4
Avg. values		2.4	2.5	2.4	2.4	2.4	

* Average values followed by the same letter (s) are not statistically significant at P= 0.05 (Duncan's Multiple Range Test).

** Results are not statistically significant

The statistical analysis shows that salts have no significant effect on acid value of 3 sunflower varieties. This agreed with the results obtained by Yermanos *et al.* (1964). Varieties did not differ significantly from each other. Salts had no significant effect on the iodine and saponification values of oil (data not given) and on the percentage of saturated and unsaturated acids (Table 2). The inability of the salt treatments to change the chemical composition of the oil was confirmed by the fatty acid analysis, since the salts did not affect the fatty acid composition (data not given). These results are in agreement with the findings of Yermanos *et al* (1964) and Werkhoven *et al.* (1966). The iodine value, saponification value and the percentage of unsaturated acid of all varieties were significantly different from each other.

The data presented in Table 3 indicate the effect of salinity on the protein percentage of seed and total uptake of nitrogen by seed. The statistical analysis shows that increasing salinity levels increased the protein percentage of seed, but decreased the total uptake of nitrogen by seed. The protein content in seed increased relatively by 8.8 and 15.0 per cent at ECe of 8.0 and 12.0 mmhos/cm, respectively as compared to control and the increase was statistically significant. On the other hand the total uptake of nitrogen by seed was adversely affected because of reduction in grain yield as given in an other paper (Makhdum and Muhammed, 1971). This agrees with the results obtained by Wadleigh and Gauch (1942) and Ahmad and Muhammed (1969) They assumed that high salt concentration caused an increase in the osmotic pressure and hydrostatic stress, which in turn induced the condensation of simple amino acids to complex nitrogenous compounds. The other reason for increase in protein percentage may be the reduction in grain yield due to increasing salinity which resulted in the accumulation of nitrogen in stunted plants. Variety VNIIMK 8931 differed significantly from other two varieties.

TABLE 2. *The effect of salts on the percentage of saturated and unsaturated acids of oil of 3 sunflower varieties (average of 3 repeats)*

Varieties	EC of saturation extract, mmhos/cm. 2.5	4.4	6.0	8.0	12.0	Avg. values*
	Saturated acid percentage					
ARMVIRSK 3497	8.1	8.2	8.1	8.2	8.2	8.2 a
NEGRO	8.2	8.2	8.2	7.1	8.2	8.2 a
VNIIMK	7.9	7.8	7.9	7.1	7.9	7.9 b
Avg. values**	8.1	8.1	8.1	8.0	8.1	
	Unsaturated acid percentage					
ARMVIRSK 3497	81.1	81.3	80.9	81.1	81.2	81.1 b
NEGRO	80.4	80.3	80.4	80.6	80.2	80.2 c
VNIINK 8931	83.9	83.3	83.7	83.5	83.8	83.8 a
Avg. values**	81.8	81.8	81.7	81.7	81.7	81.7

* Average values followed by the same letter (s) are not statistically significant at P = 0.05 (Duncan's Multiple Range Test).

** Results are not statistically significant.

TABLE 3. *The effect of salts on the percentage of protein in seed and total uptake of nitrogen by seed of 3 sunflower varieties (average of 3 repeats)*

Varieties	EC of saturation extract, mmhos/cm					
	2.5	4 0	6.0	8.0	12.0	Avg. values*
	Protein percentage in seed					
ARMVIRSK 3597	21.4	22.0	22.5	23.1	24.7	22.7 b
NEGRO	20.3	20.9	21.9	22.0	23.8	21.8 b
VNIIMK 8931	23.2	23.7	24.5	24.5	26.2	24.6 a
Avg. values**	21.6 c	22.2 c	23 0 bc	23.5 b	24.9 a	
	Total uptake of nitrogen by seed (g/pot)					
ARMVIRSK 3596	1.6	1.4	1.3	1.2	1.2	1.34 b
NEGRO	1.5	1.4	1.4	1.3	1.3	1.36 b
VNIIMK 8931	1.6	1.5	1.5	1.5	1.5	1.52 a
Avg. values*	1.57	1.43	1.37	1.33	1.33	

* Average values followed by the same letter (s) are not statistically significant at P = 0,05 (Duncans') Multip e Range Test).

** Results are not statistically significant.

TABLE 4. *The effect of salts on the amino acid composition (g/16g of N) of sunflower meal of variety ARMVIRSK 3477*

Amino Acid	EC of saturation extract, mmhos/cm.				
Phenylalanine	2.5	4.0	6.0	8.0	12.0
Arginine	7.7	8.1	8.7	9.4	1270
Histidine	1.7	1.7	1.9	2.2	2.3
Isoleucine	3.8	3.9	4.3	4.5	5.2
Leucine	5.9	6.0	4.1	6.2	6.5
Lysine	0.6	0-7	0.8	0.8	1.1
Methionine	1.5	2.1	2.3	2.8	3.4
Phenylatanine	3.9	4.2	4.8	5.1	5.7
Threonine	3.2	3.4	3.7	3.8	4.0
Tryptophane	1.0	1.0	1.3	1.4	1.9
Tyrosine	1.6	1.9	2.0	2.1	2.5
Valine	4.0	4.4	4.8	4.9	5.2
Alanine	1.5	1.4	1.5	1.6	1.8
Serine	1.6	2.0	2.0	2.3	2.9
Cystine	0.6	0.6	0.9	1.0	1.3
Glutamic acid	2.6	2.8	3.5	3.7	4.0

Amino acid composition of meal protein of variety ARMVIRSK 3497 is given in Table 4. There is a gradual increase in the contents of amino acids with increasing salinity although there were large differences in relative increase in amino acids concentration. Greatest amount of arginine and least amount of lysine were found in meal protein of sunflower. Increasing amino acid contents with increase in soil salinity have also been reported by Strogonov (1964) and Palfi and Juhasz (1968).

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