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Effect of Salinity on Some Yield Parameters of Sunflower (*Helianthus annuus* L.)

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ABSTRACT

A green house study was conducted during spring 1998-99 to evaluate the effect of salinity on growth, yield, protein and oil contents of two sunflower genotypes viz FH-1 and FH-6. The EC levels were 1.5 (control), 3.0, 4.5 and 6.0 dS m^{-1}. The salinity levels were created with the addition of NaCl in the soil. Salinity adversely affected yield and yield components of sunflower. Protein contents of seed decreased with increasing salinity levels, but oil contents were not affected by salinity. The cultivar FH-6 was found relatively more salt tolerant as compared with FH-1.

Key Words: Sunflower; Salinity; Growth; Oil content

INTRODUCTION

Salinization is seriously affecting the economy by limiting crop productivity of large areas of Pakistan. About 0.2 to 0.4% of the total culturable land is being put out of cultivation each year due to salinity and water logging (Khan, 1998). Pakistan is deficit in edible oil production. The domestic production is hardly sufficient to meet 32% of the total demand and rest 68% is met through imports involving huge amount of foreign exchange (Anonymous, 1999). The promotion of sunflower could be successful to increase the domestic production provided proper cultivars are available which are suitable to different soil and climatic conditions. Salinity induces an adverse effect on all growth parameters of sunflower (Farah *et al.*, 1980; Hussain & Rehman, 1993). Plant height, leaf number and leaf area of sunflower decreased with an increment in salinity and had shown a reduction of 22, 9 and 37%, respectively at EC 10 dS m^{-1} but the response of different sunflower genotypes to salinity varied (Rehman & Hussain, 1998). Similarly, salinity stress significantly depressed yield and yield component of sunflower (Rehman & Hussain (1998). It was suggested that seed weight, seedling growth and higher K/Na ratio may be used as a criterion for early evaluation of sunflower genotypes for salinity tolerance (Hussain & Rehman, 1993).

MATERIALS AND METHODS

The experiments were carried out to study the effect of salinity on growth and yield of sunflower in the wire house of Botanical Garden, University of Agriculture, Faisalabad. Normal field soil was collected from the experimental area of Department of Botany. Soil was analysed for pH_3, ECe and saturation percentage. Then it was air dried, thoroughly mixed and pots were filled with 10 kg soil per pot. Salinity levels were developed with NaCl. The threshold level of sunflower for salinity tolerance is ECe 2.5 dS m^{-1} (NDSU, USA, Extension Service Bulletin May 1, 1992). Four salinity levels were: 1.5 (control), 3.0, 4.5 and 6.0 dS m^{-1}. Two varieties of sunflower FH-1 and FH-6 were used as experimental material and five seeds of each variety were sown on February 28, 1998. After two weeks of germination, three plants were kept in each pot for further observation. Pots were arranged in Completely Randomized Design with 10 replications for each treatment.

Data on achene yield and yield components were recorded. The seeds were analysed for N content (Winkleman *et al.*, 1986), and oil content was determined by Soxhlet apparatus by taking random seed samples of each treatment and genotypes. The protein content were calculated using the relationship: %N x 6.25 = % protein. Data were statistically analysed for the analysis of variance (Steel & Torrie, 1980). Various treatment means were compared by applying Duncan's New Multiple Range (DMR) Test.

RESULTS AND DISCUSSION

The statistical analysis revealed highly significant differences between varieties for the traits of achene yield per plant, capitulum diameter, 100-seed weight and protein content, while differences for oil content were non significant (Table I). Treatment differences were highly significant for 100-seed weight, achene yield per plant and significant for protein content. Variety x treatment interactions were highly significant for capitulum diameter, 100-seed weight and significant for

Table I. Mean square for various traits of sunflower

Source of variation	Achene yield (g)	Capitulum diameter (cm)	100-seed weight (g)	Achene yield (g)	Oil content (%)	Protein content (%)
Varieties (V)	13.354**	1.882**	0.768**	13.354**	1.042NS	71.381**
Treatments (T)	5.081**	0.239*	3.442**	5.081**	86.381NS	21.449*
V x T	0.128NS	0.324**	1.258**	0.128NS	136.245NS	19.331*

*Significant at P < 0.05;**Highly Significant at P < 0.01

protein content.

Achene yield per plant (g). The highest seed yield was 3.61 g at salinity level of 1.5 dS m^{-1} (control) while the lowest value for seed yield was 1.64 g at salinity level of 6 dS m^{-1} with 54.57% decrease in seed yield as compared to control (Table II). The salinity levels of 3 dS m^{-1} caused yield reduction of 1.66 and 23.54%, respectively, over control. The results were similar to those of Rehman and Hussain (1998a) who observed negative relationship between achene yield and salinity stress. The achene yield decreased with increase of salinity level. The highest achene yield was recorded in V_2 (FH-6) with the value of 3.64 g while the lowest achene yield was obtained in V_1 (FH-1) which was 2.14 g. Variety x salinity treatment interactions were non-significant, which revealed that both variables are independent of each other and both the varieties behaved similarly towards salinity.

Table II. Effect of salinity on achene yield (g) per plant in sunflower

Treatment	T_0	T_1	T_2	T_3	
Ece dS m^{-1}	1.5	3.0	4.5	6.0	VM
V_1 FH-1	2.73	2.71	2.08	1.07	2.14 b
V_2 FH-6	4.49	4.40	3.44	2.21	3.64 a
Treat. Means	3.61	3.55	2.76	1.64	
% ↑ or ↓ over control	-	-1.66	-23.54	-54.57	

VM= Variety means

Capitulum diameter (cm). The largest capitulum diameter of 3.84 cm was observed under 3 dS m^{-1}, while minimum diameter of 3.39 was accorded at 6 dS m^{-1} salinity level (Table III). A corresponding decrease in capitulum diameter over control was 1, 5 and 11% while statistically similar trend was observed at 4.5 dS m^{-1} and 3 dS m^{-1} salinity levels. The cultivar FH-6 showed greater capitulum diameter than FH-1. Variety x salinity interactions were significantly different for V_2T_0 and V_1T_3. Large capitulum diameter of 4.1 cm was observed in V_2T_0 while minimum (2.89 cm) was recorded under V_1T_3. The results are in conformity with Farah *et al.* (1980), who also recorded adverse effect of salinity on capitulum diameter.

Table III. Effect of salinity on capitulum diameter (cm) of sunflower

Treatment	T_0	T_1	T_2	T_3	
Ece dS m^{-1}	1.5	3.0	4.5	6.0	VM
V_1FH-1	3.53 abcd	3.45 bcde	3.25 de	2.89 e	3.28 b
V_2FH-6	4.10 a	3.36 cde	4.00 ab	3.90 abc	3.84 a
Treat. Means	3.81 a	3.84 b	3.62 ab	3.39 b	-
% ↑ or ↓ over control	-	- 0.78	- 4.98	-11.02	-

VM= Variety means

100-seed weight/plant (g). The highest 100-seed weight of 384 g was recorded at salinity level of 1.5 dS m^{-1} (control) while the weight was lowest (2.13 g) at ECe 6 dS m^{-1}, which showed 44.53% decrease over control. Maximum 100-seed weight was recorded by FH-6. Salinity, variety x salinity treatment was highly significant with maximum 100-seed weight recorded in V_2T_0 (3.84g) and minimum in V_2T_3 (2.13 g) while other salinity levels showed non-significant differences among themselves (Table IV).

Table IV. Effect of salinity on 100-seed weight (g) per plant in sunflower

Treatment	T_0	T_1	T_2	T_3	
ECe dS m^{-1}	1.5	3.0	4.5	6.0	VM
V_1FH-1	3.02 b	2.82 bc	2.37 bc	2.38 bc	2.65 b
V_2FH-6	4.67 a	3.06 b	2.41 bc	1.88 c	3.01 a
Treat. means	3.84 a	2.94 b	2.39 bc	2.13 c	
% ↑ or ↓ over control	-	-23.43	-37.76	-44.53	

VM= Variety means

Oil content. The F ratios for variety, salinity treatments and V x T were non-significant for oil content. There was a regular decrease in oil content of different salinity levels from T_0 (control) to T_3 (Table V). Maximum oil content (38.18%) was observed at 1.5 dS m^{-1} (control) salinity level while minimum oil content (29.60%) was observed at 6 dS m^{-1} salinity level with 22.47% decrease over control. A 16.89 and 7.67% reduction in oil content at 3 and 4.5 dS m^{-1}, respectively over control was recorded. Both varieties behaved in the same way at all salinity levels.

Table V. Effect of salinity on oil content (%) in

sunflower

Treatment	T_0	T_1	T_2	T_3	
Ece dS m^{-1}	1.5	3.0	4.5	6.0	VM
V_1FH-1	37.76	25.80	35.03	35.33	33.48
V_2FH-6	38.60	37.66	35.46	23.86	33.90
Treat. means	38.18	31.73	35.25	29.60	
% ↑ or ↓ over control	-	-16.89	- 7.6	-22.47	

VM= Variety means

Protein content. The highest protein percentage (24.66) was observed at 4.5 dS m^{-1} salinity level. The lowest protein percentage (20.36) was observed at 6 dS m^{-1} which caused 3.73% reduction over control (Table VI). Differential response of varieties to salt stress was also observed. The effect of salinity was more pronounced on V_2 (FH-6) as compared to V_1 (FH-1) as the reduction in protein content of V_2 was more than V_1, showing that salt stress was more detrimental for V_2 compared to V_1. Variety x salinity interaction was significant showing that both the parameters are not independent from each other. Data showed that treatment combination of V_1T_2 gave the highest protein content (28.84%) as compared to other treatment combinations. The other treatment combination shared the same letters that indicated both varieties behaved similar at all salinity levels.

Table VI. Effect of salinity on protein content (%) in sunflower

Treatment	T_0	T_1	T_2	T_3	
ECe dS m^{-1}	1.5	3.0	4.5	6.0	VM
V_1FH-1	21.58 b	24.58 ab	28.84 a	20.70 b	23.62 a
V_2FH-6	20.71 b	20.68 b	20.48 b	20.03 b	20.47 b
Treat. means	21.15 b	22.63 ab	24.66 a	20.36 b	
% ↑ or ↓ over control	-	+6.99	+16.59	-3.73	

VM= Variety means

CONCLUSION

All salinity levels had a drastic effect on yield and quality of sunflower. Seed yield per plant decreased significantly with the increasing levels of salinity.

Protein contents were also affected badly due to salinity levels. However, oil content remained un-affected by salinity treatments. FH-6 was found relatively more salt tolerant compared with FH-1. Its utilization in sunflower breeding for salt-affcted areas will be useful.

REFERENCES

Anonymous, 1999. *Economic Survey 1998-99.* Govt. of Pakistan, Finance Division, Economic Advisor's Wing, Islamabad.

Farah, M.A., M.A. Daoud, M.A. Barakat and H.K. Bakhati, 1980. Salt tolerance of 14 varieties of sunflower. *Agric. Res. Rev.,* 58: 99–111.

Hussain, M.K. and O.U. Rehman, 1993. Breeding sunflower for salt tolerance; Physiological basis for salt tolerance in sunflower (*Helianthus annuus* L.). *Helia,* 16: 77–84.

Hussain, M.K., A. Majeed and O.U. Rehman, 1995. Association of seedling growth and mature plant traits for salt tolerance in cultivated sunflower (*Helianthus annuus* L.). Helia, 18: 69–76.

Hussain, M.K., O.U. Rehman and A. Rakha, 1995. Inter-relationship of morpho-physiological parameters in sunflower for salt tolerance. *Sci. Int.,* 7: 79–83.

Khan, G.S., 1998. *Soil Salinity and Sodicity Status in Pakistan.* Soil Survey of Pak, Lahore, pp: 59.

Rehman, O.U. and M.K. Hussain, 1998. Effect of salinity on growth and development of cultivated sunflower (*Helianthus annuus* L.). *Pakistan J. Sci.,* 50: 45–52.

Rehman, O.U. and M.K. Hussain, 1998a. Estimation of genetic variability for yield and yield components in sunflower (*Helianthus annuus* L.) for salt tolerance. *Pakistan J. Sci.,* 50: 34–41.

Steel, R.G.D. and J.H. Torrie, 1980. *Principles and Procedures of Statistics.* 2nd Ed. McGraw Hill Book Co., Inc., New York, USA.

Winkleman, G.E., R. Amin, W.A. Rice and M.B. Tahir, 1986. *Methods and Manual of Soil Laboratory.* BARD. PARC. Islamabad, Pakistan

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