

Evaluation of Open Pollinated Sunflower (*Helianthus annuus* L.) Populations Under Water Stress and Normal Conditions

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ABSTRACT

Four open-pollinated sunflower populations, each having 13 lines, were evaluated in the field under normal and water stress conditions. The data on six maturity traits and 10 seedling traits were recorded and analyzed statistically. Head diameter, 100-achene weight and seed yield per plant were reduced under water stress. Significant but negative correlation of head diameter with fresh root and shoot weight was observed under water stress. Positive and significant correlation existed between dry shoot weight and seed yield per plant under water stress conditions.

Key Words: Sunflower populations; Water stress; Irrigation; Mature plant traits; Seedling traits; Correlations

INTRODUCTION

Sunflower has a maximum potential for bridging the edible oil gap in Pakistan as its seed contain high oil contents ranging from 35 to 40%. Physiological changes in plants, which occur in response to water stress conditions decrease photosynthesis and respiration (Human *et al.*, 1990; Hall *et al.*, 1990) and as a result overall production of the crop is decreased. Although, sunflower has good potential for drought tolerance because of its well developed root system, yet decrease in plant height, 100-seed weight, head diameter and seed yield per plant under water stress conditions has been observed (Vannozzi *et al.*, 1988; Attene & Porru, 1990; Ravishaankar *et al.*, 1991; Ali, 1997).

The objective of the present study was to investigate the effect of water stress on the growth and yield of sunflower populations. The information collected will be useful in planning the future breeding strategies for the improvement of sunflower cultivars for drought resistance.

MATERIALS AND METHODS

Four sunflower populations (G1, G2, G3 and G6), each having 13 lines were evaluated in the field under water stress and normal irrigated conditions. In water stress treatment, irrigation was restricted immediately after flowering of the plant. Seed was sown, keeping plant to plant and row to row distances of 23 and 76 cm, respectively. The experiment was laid out in a randomized complete block design under split plot arrangement, with two replications. The main plots consisted of normal irrigation and water stress as treatment. At maturity, the data were recorded for plant height (cm), number of leaves per plant, head diameter (cm), internodal length (cm), 100-achene weight (g) and seed yield per plant (g) from 10 randomly selected plants from each line of a sunflower

population. The sunflower germplasm evaluated in the field was also assessed at the seedling stage. Ten seeds from each line of a sunflower population were sown in iron trays filled with fresh river sand and placed in a wire house. The experiment was conducted in a randomized complete block design with three replications. The seedlings were uprooted after 14 days of planting and data on germination percentage, emergence index, emergence rate index, root length (cm), shoot length (cm), fresh root weight (g), fresh shoot weight (g), dry root weight (g), dry shoot weight (g) and root/shoot ratio were recorded.

The data collected were subjected to analysis of variance. Simple correlation of the seedling traits with the maturity traits was determined, and tested by using t-test (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

There were significant differences for head diameter, 100-achene weight and seed yield per plant among sunflower lines derived from G6 population. However, treatment x line interaction was significant, for plant height in G2, internodal length and seed yield per plant in G6 population (Table I). The pooled analysis of variance indicated significant differences for internodal length under normal irrigation and water stress. However, decrease in head diameter, 100-achene weight and seed yield was observed under water stress condition as compared to normal irrigation (Table II). These results are consistent with the work reported by Gimenez and Fereres (1987), Vannozzi *et al.* (1988), Attene and Porru (1990), Human *et al.* (1990) and Ravishaanka *et al.* (1991).

The evaluation of sunflower lines derived from the source populations for seedling traits revealed significant differences among lines, for emergence index in G2 and emergence rate index in G6 population. Likewise, differences among lines were significant for dry shoot

Table I. Mean squares from the analysis of variance for different maturity traits among lines derived from the sunflower populations evaluated under normal and water stress

SOV	DF	G1	G2	G3	G6
NUMBER OF LEAVES PER PLANT					
Replications	1	23.558	23.558	2.769	1.558
Treatments (Tr.)	1	16.173	16.173	0.077	3.25
Error [a]	1	16.173	10.173	0.308	20.942
Lines (L.)	12	0.516	0.651	1.285	0.817
Tr. x L.	12	0.381	1.215	1.285	0.792
Error [b]	24	0.615	0.907	1.080	0.708
PLANT HEIGHT					
Replications	1	1935.896	46.249	70.134	64.603
Treatments (Tr.)	1	2519.798	277.015	4248.62	1350.807
Error [a]	1	5432.951	746.63	57.688	428.548
Lines (L.)	12	70.321	71.741	118.267	123.209
Tr. x L.	12	53.533	163.238*	170.784	90.793
Error [b]	24	52.518	40.325	139.077	107.775
INTERNODAL LENGTH					
Replications	1	3.840	4.825	0.020	2.161
Treatments (Tr.)	1	16.838	5.363	8.840	0.634
Error [a]	1	3.000	1.628	0.496	0.160
Lines (L.)	12	0.471	0.672	0.236	0.723
Tr. x L.	12	0.712	0.457	0.860	1.046*
Error [b]	24	0.750	0.922	1.009	0.457
HEAD DIAMETER					
Replications	1	5.506	19.779	71.957	6.575
Treatments (Tr.)	1	55.373	14.134	27.318	82.984
Error [a]	1	24.647	0.649	0.699	2.691
Lines (L.)	12	1.622	1.161	1.661	5.258*
Tr. x L.	12	1.605	0.177	1.536	2.084
Error [b]	24	1.908	1.739	1.057	2.239
100-ACHENE WEIGHT					
Replications	1	3.526	1.663	10.530	0.236
Treatments (Tr.)	1	22.048	7.016	8.807	17.192
Error [a]	1	4.478	6.025	0.249	4.156
Lines (L.)	12	0.547	0.588	0.620	1.285*
Tr. x L.	12	0.896	0.184	0.347	0.382
Error [b]	24	1.370	0.512	0.562	0.516
SEED YIELD PER PLANT					
Replications	1	422.085	2.539	311.249	328.308
Treatments (Tr.)	1	5637.848	2177.673	1053.540	2696.256
Error [a]	1	1070.260	369.156	29.460	34.020
Lines (L.)	12	115.762	241.057	244.522	327.356*
Tr. x L.	12	90.632	80.183	207.905	395.100*
Error [b]	24	115.037	203.080	227.210	130.100

Table II. Mean squares from the analysis of variance for different maturity traits among sunflower populations and their respective lines evaluated under normal and water stress conditions

SOV	DF	No. of leaves/plant	Plant height	Inter-nodal length	Head diameter	100-achene weight	Seed yield/ plant
Replications	1	39.813	352.222	0.298*25.951	79.571	79.571	117.300
Treatments	1	8.889	14781.330	0.145	163.035	163.035	10622.901
Error [a]	1	31.543	884.771	6.324	11.008	11.008	153.287
Populations	3	7.979	2467.814	1.908	17.289	17.289	67.751
Tr. x Pop.	3	8.928	1538.303	2.614	5.591	5.591	314.139
Error [b]	6	4.614	1257.618	0.600	6.987	6.987	382.748
Lines	12	0.311	89.777	0.358	2.625	2.625	244.550
Tr. x L.	12	0.931	96.605	0.501	1.368	1.368	215.699
Pop. x L.	36	0.986	97.920	0.906	2.359	2.359	228.049
Tr. x Pop. x L.	36	0.914	127.181	0.784	1.345	1.345	152.707
Error [c]	96	0.828	84.924		1.736	1.736	168.857

* = Significant at 0.05 probability level

weight and root/shoot ratio in G1 population. Most of the correlation coefficients between seedling and mature plant

Table III. Simple correlation coefficients between seedling and agronomic traits among Sunflower populations evaluated under normal irrigation and water-stress applied immediately after flowering (in parenthesis)

Parameters	No. of leaves/ (Plant Bookmark not defined.	Plant height	Inter-(Nodal length	Head diameter	100-achene weight	Seed yield/ (Plant
Germination percentage	-0.304* (0.151)	-0.148 (0.086)	-0.117 (-0.117)	0.179 (-0.082)	0.119 (0.057)	0.083 (0.001)
Emergence index	0.141 (0.081)	-0.089 (0.023)	-0.260* (-0.068)	0.049 (0.049)	0.041 (-0.034)	0.025 (0.001)
Emergence rate index	0.282* (-0.060)	0.087 (-0.033)	-0.019 (0.146)	-0.113 (0.113)	-0.082 (-0.038)	-0.061 (0.045)
Fresh root length	0.036 (0.009)	0.130 (-0.051)	0.118 (0.054)	-0.025 (0.134)	-0.041 (0.081)	-0.053 (0.119)
Fresh shoot length	-0.113 (0.099)	-0.050 (0.155)	0.018 (-0.066)	-0.112 (-0.225)	0.070 (-0.099)	0.071 (-0.103)
Fresh root weight	-0.218* (-0.028)	-0.005 (0.007)	0.128 (0.018)	-0.190 (-0.221*)	-0.034 (-0.007)	-0.134 (-0.019)
Fresh shoot weight	-0.350* (-0.011)	-0.059 (0.023)	0.146 (-0.002)	-0.122 (-0.232*)	-0.100 (-0.011)	0.104 (-0.068)
Dry root weight	-0.179 (-0.041)	0.034 (-0.037)	0.140 (-0.086)	-0.116 (-0.086)	-0.016 (-0.079)	0.031 (-0.021)
Dry shoot weight	0.050 (0.030)	0.180 (0.073)	0.071 (-0.052)	-0.129 (0.020)	0.132 (-0.020)	0.206 (0.028*)
Root/Shoot ratio	-0.244* (-0.138)	-0.108 (-0.047)	0.124 (-0.002)	-0.073 (-0.168)	-0.052 (-0.102)	-0.070 (-0.028)

traits were non-significant (Table III). However, negative and significant correlation existed for germination percentage, fresh root weight, fresh shoot weight and root/shoot ratio with the number of leaves per plant under normal irrigation. Likewise, emergence rate index was significantly and positively correlated with number of leaves per plant under normal irrigation. None of the correlation coefficients was found to be significant between seedling traits and number of leaves per plant under water stress. Simple correlation coefficients between seedling traits and plant height with 100-achene weight were also non-significant under both irrigation and water stress conditions. However, negative and significant correlation existed between emergence index and internodal length under normal irrigation. Head diameter with fresh root weight and fresh shoot weight were negatively and significantly correlated under water stress conditions. Positive and significant correlation existed between dry shoot weight and seed yield per plant under water stress conditions.

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