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Evaluation of Sunflower (*Helianthus annuus* L.) Inbred Lines for Drought Tolerance

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ABSTRACT

Twenty five inbred lines of sunflower were evaluated in the field under water stress and normal irrigation. The data were recorded for eight plant traits. All the traits were reduced under water stress condition. The maximum decrease was observed in yield per plant, 100-achene weight and leaf area. Highly significant and positive correlation was recorded between yield per plant and other traits studied. 100-achene weight and head diameter contributed maximum variation to yield per plant. These traits are suggested to be used as selection criteria for higher yield per plant.

Key Words: Sunflower; Inbred lines; Water stress; Irrigation; Correlation

INTRODUCTION

Only 30% of edible oil requirement of Pakistan is met through the local production and rest of 70% through import costing huge amount of foreign exchange i.e. about 24020.92 million rupees (Economic Survey of Pakistan, 2000). This situation signifies the importance of growing non-conventional oilseed crops along with the conventional. Sunflower ranks second in the world as a source of vegetable oil after soybean among the non-conventional oilseeds. Its seed contains high oil content ranging from 35-40% with some types yielding upto 50% (Skoric & Marinkovic, 1986).

Out of 79.61 m ha total area of Pakistan, 4.40 m ha is drought prone (Economic Survey of Pakistan, 2000) which is a major hurdle in increasing area and production of crops. In the irrigated areas scarcity of water is also observed due to canal closure and insufficient water supply. Physiological changes which occur in plant in response to water stress are loss of cell turgor, closing of stomata, reduction in cell enlargement and reduced leaf surface area. These abnormalities ultimately decrease photosynthesis and respiration (Human *et al*., 1990; Hall *et al*., 1990) and as a result overall production of crop is decreased.

Sunflower has good potential for drought tolerance because of well developed root system and to withstand temporary wilting. Although sunflower is moderately tolerant to water stress yet its area and production is greatly affected by drought. If drought resistant cultivars are developed, sunflower can be grown successfully in areas where water is a limiting factor. The plant breeders are continuously trying to improve sunflower yield through improvement of various plant characters (Pasda & Diepenbrock, 1990).

The present work was planned to study effect of drought on yield and yield components of selected inbred lines of sunflower. The information will be important in developing sunflower cultivars tolerant to water stress.

MATERIALS AND METHODS

The present study was conducted in the research area of the Department of Plant Breeding and Genetics at the Post-graduate Research station (PARS), University of Agriculture, Faisalabad. The experimental material comprised of the following twenty five inbred lines of sunflower.

GIMSUN-16	GIMSUN-32	GIMSUN-59	GIMSUN-96	GIMSUN-105
GIMSUN-143	GIMSUN-183	GIMSUN-217	GIMSUN-226	GIMSUN-238
GIMSUN-259	GIMSUN-300	GIMSUN-359	GIMSUN-367	GIMSUN-425
GIMSUN-435	GIMSUN-456	GIMSUN-476	GIMSUN-500	GIMSUN-534
GIMSUN-637	GIMSUN-645	GIMSUN-681	GIMSUN-722	GIMSUN-741

The experiment was conducted in a randomized complete block design (RCBD) under split plot arrangement with three replications. The main plots comprised of two treatments i.e. water stress and normal irrigation. In water stress condition, one irrigation was provided at the seedling stage, 25 days after sowing while second at the flowering stage. Five irrigations were given under normal irrigation conditions. Seeds were sown keeping row to row and plant to plant distances of 75 and 25 cm, respectively. Date were recorded from ten randomly taken plants per replicate of each inbred line for days taken to flowering, days taken to maturity, plant height, head diameter, leaf area, 100-achene weight, yield per plant and stem dry weight.

The data recorded were subjected to analysis of variance. Simple correlation of achene yield per plant with the other traits under study was also determined and tested by using t-Test (Steel & Torrie, 1980)

RESULTS

Mean squares of different traits under drought and normal irrigation conditions (Table I) revealed highly significant differences between the two treatments for days taken to flowering, days taken to maturity, leaf area, head

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

SOV	DF	Days to flowering	Days to maturity	Leaf area	Plant height	Head diameter	Yield per plant	100-achene weight	Stem dry weight
Blocks	2	1.820	3.707	259.688	861.197	0.789	87.387	0.635	148.631
Treatments (T)	1	2739.210**	5766.000**	34542.090**	4039.480*	170.860**	7607.930**	45.650*	5341.720*
Error (a)	2	0.127	12.560	30.154	197.520	3.364	65.350	1.183	126.158
Genotypes (G)	24	21.137**	17.198**	722.434^{ns}	205.192**	1.840^{ns}	69.284^{ns}	0.281^{ns}	194.054**
G x T	24	6.554**	26.736**	395.903^{ns}	42.919^{ns}	1.688^{ns}	43.945^{ns}	0.202^{ns}	95.488**
Error (b)	96	1.216	2.939	464.257	63.822	1.257	46.105	0.193	52.686
C.V. (%)		1.45	1.57	26.78	4.99	8.83	21.41	10.07	14.28

C.V. = Coefficient of variability; ns = Non-significant * = Significant at 0.05 probability level; ** = Significant at 0.01 probability level

diameter and yield per plant. While for plant height, 100-achene weight and stem dry weight the treatments exhibited significant differences. The differences among the genotypes were highly significant for days taken to flowering, days taken to maturity, plant height and stem dry weight and non-significant differences were recorded for leaf area, head diameter, yield per plant and 100-achene weight. Genotype x treatment interaction was non-significant for leaf area, plant height, head diameter, yield per plant and 100-achene weight. However, significant interaction between genotypes and treatments was observed in stem dry weight and highly significant for days taken to flowering and days taken to maturity. Leaf area exhibited maximum variability as it had the highest coefficient of variability i.e. 26.78% followed by yield per plant and stem dry weight with coefficients of variability 21.41 and 14.28%, respectively. The lowest values were recorded for days taken to flowering (1.45%) and days taken to maturity (1.57%) indicating that the variability of the experiment was low for these traits.

Table II. Mean response of different traits of sunflower inbred lines under normal irrigation and water stress

Characters	Normal	Water stress	Decrease under stress over normal
Days to flowering	80.21	71.67	10.18 %
Days to maturity	115.49	105.09	10.69 %
Plant height (cm)	165.24	154.86	6.42 %
Leaf area (cm^2)	114.94	84.58	25.56 %
Head diameter (cm)	13.78	11.64	15.21 %
100-achene weight (g)	4.92	3.81	22.63 %
Yield per plant (g)	38.83	24.57	34.13 %
Stem dry weight (g)	56.80	44.87	19.56 %

Table III. Simple correlation coefficients and coefficients of determination between yield per plant and other traits

Characters	Correlation coefficients	Coefficients of determination (%)
Days to flowering	0.7797*	60.8
Days to maturity	0.7915**	62.7
Plant height (cm)	0.6563**	43.1
Leaf area (cm^2)	0.7441**	54.9
Head diameter (cm)	0.8652**	74.9
100-achene weight (g)	0.8761**	76.8
Stem dry weight (g)	0.7433**	55.3

Significant at *0.05 & ** 0.01 probability levels

Mean values of different traits of sunflower inbreds under normal irrigation and water stress conditions exhibited that under water stress the average performance of the inbreds was decreased for all the characters under study (Table II). The maximum decrease under water stress was observed in yield per plant that was 34.13% when compared with that of under normal irrigation condition, followed by leaf area and 100-achene weight with 25.56 and 22.63% decrease under water stress, respectively. Teama and Mahmoud (1994), Hang and Evans (1985), Hussain *et al.* (1994), Vannozi *et al.* (1988), El-Wakil and Gaafar (1988) and Gimenez and Fereres (1987) also reported decrease in plant height, leaf area, head diameter, 100-achene weight and yield per plant under water stress when compared with normal irrigation conditions. All the traits under study had positive and highly significant correlation with achene yield per plant (Table III). The strongest relation of achene yield per plant was observed with 100-achene weight and head diameter, respectively. The coefficients of determination revealed that maximum variation in achene yield per plant was contributed by 100-achene weight (76.80%) and head diameter (74.90%). It indicated that sunflower plants could be selected indirectly for high achene yield on the basis of head diameter and 100-achene weight. Similar findings have been reported by Deshmukh *et al.* (1986) and Rana *et al.* (1988).

On the basis of individual behaviour of inbred lines it was expressed that GIMSUN-32, GIMSUN-96, GIMSUN-143, GIMSUN-183, GIMSUN-226, GIMSUN-300, GIMSUN-358, GIMSUN-681 and GIMSUN-741 were less affected under water stress conditions as compared to other genotypes for days to flowering and maturity. In inbred lines GIMSUN-143, GIMSUN-183, GIMSUN-217, GIMSUN-681, GIMSUN-722 and GIMSUN-741 proved more drought tolerant for leaf area. Similarly GIMSUN-96, GIMSUN-183, GIMSUN-300, GIMSUN-500, GIMSUN-534, GIMSUN-722 and GIMSUN-741 were best for 100-achene weight and yield per plant under drought condition.

DISCUSSION

It was indicated from the results that yield per plant, 100-achene weight and leaf area were adversely influenced under drought conditions while days to flowering, days to maturity and plant height were less affected. It suggests that under water stress leaf area was reduced to lower the loss of water through transpiration and small amount of photosynthates was available for grain filling and ultimately yield per plant was highly reduced. The strong correlation of achene yield with 100-achene weight and head diameter suggests that if head diameter was more, more number of achenes would be produced on it and high 100-achene weight indicated the larger achene size. So, more large sized achenes would lead to a higher achene yield (Deshmukh *et al*., 1986; Rana *et al*., 1988). It was also indicated that the sunflower genotypes could be selected indirectly for high achene yield on the basis of head diameter and 100-achene weight.

CONCLUSION

It can be concluded from this study that yield and its components are reduced under water stress. Furthermore, indirect selection for high achene yield can be made on the basis of head diameter and 100-achene weight. The inbred lines GIMSUN-96, GIMSUN-105, GIMSUN-183, GIMSUN-500, GIMSUN-722 and GIMSUN-741 exhibited good performance for all traits under water stress condition.

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