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Effect of drought on yield traits of sunflower restorer lines

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Abstract

A study was conducted to screen eight sunflower restorer lines for tolerance to drought under field conditions based on yield characteristics. Moisture stress was imposed in stress plots from 45 DAS to harvest. Whereas, control plots were irrigated at 10 days intervals throughout the crop growth period. Results revealed that water stress showed repressing effect on yield related attributes like capitulum dry weight by 36%, total number of seeds per capitulum by 25%, seed yield per plant by 34% compared to control. Significant difference among R-lines was observed for head weight, test weight, harvest index and oil content. R-lines RGP 33-P5, RGP 50-P1, RGP 61-P1 and RGP 61-P2 showed high HI under water stress conditions. Most of the R-lines have increased oil content under stress. RGP 50-P1, RGP 60-P2 and RGP 61-P1 have decreased oil content under stress. Based on Stress Tolerance Index and seed yield under stress, RGP 21-P6 and RGP 61-P1 were identified as tolerant to water stress out of eight R-lines studied. These lines also showed superior morphological, physiological traits. RGP 32-P1 and RGP 33-P5 were found to be more sensitive.

Keywords: Sunflower, drought tolerance, screening, yield traits

Introduction

Sunflower (*Helianthus annuus* L.) is an important oilseed crop whose oil content varies from 25 to 50% of seed content. Sunflower oil contains large quantity of unsaturated fatty acids, mainly linoleic and oleic acid. Water stress is a major limiting factor for sunflower production in the many regions in the world especially when the frequency and amount of rainfall are often quite variable during sunflower growing season. These kinds of situations reduces crop yield and quality by limiting water and nutrient uptakes thereby restricting plant growth and development. Developing varieties and hybrids with high yield even under stress conditions was a cheap strategy compared to other agronomic practices to avoid yield loss. The primary objectives of this study was to evaluate the effect of drought stress on yield traits of sunflower restorer lines developed in Indian Institute of Oilseeds Research.

Materials and Methods

The study was conducted at Indian Institute of Oilseeds Research, Narkoda farm in a split plot design with control and water stress as main plot treatments and restorer lines and checks as subplot treatments. DRS-1 a commercial hybrid and 298-R an existing restorer line are used as checks. Trail was planted on 29-11-2018 with a spacing of 60 cm between rows and 30 cm between plants within the row. The crop was irrigated at ten days interval during the whole crop growth period, whereas water was withheld in stress treatment from 45 DAS to harvesting. Five tagged plants in each plot used for taking non destructive data were harvested and Capitulum diameter, capitulum weight, total number of seeds per capitulum, test weight, seed yield, oil content and harvest index were measured in the study by taking the average from five plants. Oil content of dry seeds was estimated by Nuclear Magnetic Resonance (NMR) method against a standard reference sample. After obtaining yield per plant under stress and non stress conditions stress tolerance index (STI) is calculated according to the formula given by Fernandez (1992) [4].

Results and Discussion

Quantification of traits under water deficit conditions was a requisite to identify the traits contributing to higher yields and R-line with maximum yield having better adaptability. Capitulum diameter was decreased by 10% under stress treatment, which was not significant. RGP 21-P6 recorded highest capitulum diameter of 12.7 cm in control and 11.1 cm under stress with 13% reduction. It was higher than restorer check 298R and lesser than hybrid check

DRSH-1. RGP61-P1 and RGP61-P2 are on par with restorer check 298-R. The reduction of capitulum diameter may be attributed to reduction in leaf area index and inefficient photosynthetic activity leading to poor translocation of

photosynthates from source to sink at flower bud initiation stage. The results are in accordance with the findings of Geetha *et al.* (2012)^[5], Buriro *et al.* (2015)^[3].

Table 1: Effect of drought stress on capitulum diameter

Treatment	Capitulum Diameter											Stress levels	R lines	Interactions	
	RGP 21-P6	RGP 32-P1	RGP 33-P5	RGP 50-P1	RGP 60-P2	RGP 61-P1	RGP 61-P2	RGP 95-P1	DRSH-1	298-R	Mean				
	C.D(p=0.05)														
Control	12.7	9.0	8.9	10.7	12.3	11.2	9.7	9.5	14.0	12.7	11.1	NS	0.81	1.61	1.84
Stress	11.1	8.2	8.9	8.9	9.1	10.0	9.7	8.5	13.7	10.9	9.9				
Mean	11.9	8.6	8.9	9.8	10.7	10.6	9.7	9.0	13.8	11.8	10.5				
% Reduction	13	9	0	17	26	11	1	10	2	14	10				

Capitulum dry weight was reduced significantly (36%) under stress treatment. No single R-line recorded significantly higher capitulum dry weight compared to the checks. Moisture stress at flower bud initiation stage causes abortion of ovaries and embryo and sterility of pollen due to insufficient assimilates for developing sinks and increase

percentage of unfilled grains or chaffy grains leading to decrease in capitulum dry weight and capitulum diameter (Reddy *et al.*, 2003)^[12]. The greater number of chaffy and unfilled seeds causes decrease in capitulum dry matter. This is further supported by the findings of Geetha *et al.* (2012)^[5], Santosh *et al.* (2016)^[13].

Table 2: Effect of drought stress on capitulum dry weight

Treatment	Capitulum Dry Weight											Stress levels	R lines	Interactions	
	RGP 21-P6	RGP 32-P1	RGP 33-P5	RGP 50-P1	RGP 60-P2	RGP 61-P1	RGP 61-P2	RGP 95-P1	DRSH-1	298-R	Mean				
	C.D(p=0.05)														
Control	17.5	25.5	10.4	22.3	17.7	14.2	30.3	16.9	20.0	15.8	19.0	8.29	NS	10.23	10.68
Stress	11.3	11.0	8.9	8.7	9.2	13.8	9.4	12.2	16.1	12.5	11.3				
Mean	14.4	18.3	9.6	15.5	13.5	14.0	19.9	14.5	18.0	14.1	15.2				
% Reduction	36	57	14	61	48	3	69	28	19	21	36				

Water stress significantly reduced total number of seeds per capitulum by 25% over control. RGP 95-P-1 followed by RGP 21-P6 and RGP 61-P1 had more total number of seeds per capitulum over other R-lines under control and stress conditions and were on par with both the checks. The reduction in number of seeds per capitulum might be due to

pollen sterility and reduced fertilization under moisture stress condition (Reddy *et al.*, 2003)^[12]. Nezami *et al.* (2008)^[8] attributed the reduction in number of seeds per capitulum due to reduction in leaf area and photosynthesis. Similar results were also reported by Buriro *et al.* (2015)^[3].

Table 3: Effect of drought stress on number of seeds per capitulum

Treatment	Number of Seeds Per Capitulum											Stress levels	R lines	Interactions	
	RGP 21-P6	RGP 32-P1	RGP 33-P5	RGP 50-P1	RGP 60-P2	RGP 61-P1	RGP 61-P2	RGP 95-P1	DRSH-1	298-R	Mean				
	C.D(p=0.05)														
Control	625	407	235	443	564	469	409	714	655	480	500	95.24	193.61	NS	NS
Stress	449	194	206	313	328	437	347	478	579	386	372				
Mean	537	300	221	378	446	453	378	596	617	433	436				
% Reduction	28	52	12	29	42	7	15	33	12	20	25				

The difference in test weight due to water stress was minimal and was not significant. Among R-lines RGP 60-P2 is on par with check 298-R under control and stress. RGP 21-P6 and RGP 33-P5 are on par with RGP 60-P2 under stress. Check DRSH-1 recorded higher test weight under both treatments and no R-line under study was on par with this. The reduction

in seed weight due to drought may be attributed to reduction of photosynthesis, translocation of assimilates and also to the dehydration of grains (Hossain *et al.*, 2010)^[7]. The decrease in test weight under stress was also reported by Banaei-Asl *et al.* (2013)^[2], Buriro *et al.* (2015)^[3].

Table 4: Effect of drought stress on test weight

Treatment	Test Weight											Stress levels	R lines	Interactions	
	RGP 21-P6	RGP 32-P1	RGP 33-P5	RGP 50-P1	RGP 60-P2	RGP 61-P1	RGP 61-P2	RGP 95-P1	DRSH-1	298-R	Mean				
	C.D(p=0.05)														
Control	3.1	2.7	2.8	3.2	3.7	2.7	2.6	1.7	4.5	4.0	3.1	NS	0.54	NS	NS
Stress	2.7	2.4	2.7	2.4	2.8	2.1	2.4	1.7	4.3	3.0	2.6				
Mean	2.9	2.5	2.7	2.8	3.3	2.4	2.5	1.7	4.4	3.5	2.9				
% Reduction	14	12	3	26	25	23	9	3	4	23	14				

Seed yield per plant recorded significant reduction (34%) under water stress. RGP 21-P6 recorded highest seed yield per plant in stress treatment which is at par with check 298-R and

less than DRSH-1. RGP 60-P2 and RGP 61-P2 are also on par with the check 298-R. The interaction between stress levels and R-lines was found to be significant. The decrease in yield

under stress might be due to decreased sink size (mainly number of seeds) and seed weight. It may be related with decreased photosynthetic efficiency by the degradation of

chlorophyll, lower production and translocation of organic material from source to sink. This was further supported by Buriro *et al.* (2015)^[3].

Table 5: Effect of drought stress on seed yield per plant

Treatment	Seed Yield Per Plant											Stress levels	R lines	Interactions	
	RGP 21-P6	RGP 32-P1	RGP 33-P5	RGP 50-P1	RGP 60-P2	RGP 61-P1	RGP 61-P2	RGP 95-P1	DRSH-1	298-R	Mean				
	C.D(p=0.05)														
Control	19.5	10.5	6.6	14.4	20.9	11.8	10.6	12.1	27.8	18.6	15.3	2.93	2.29	3.86	3.97
Stress	12.0	4.5	5.6	7.5	9.2	9.1	8.2	7.7	26.3	11.9	10.2				
Mean	15.8	7.5	6.1	10.9	15.0	10.5	9.4	9.9	27.1	15.3	12.7				
% Reduction	38	57	15	48	56	23	22	36	5	36	34				

Decrease in harvest index due to stress was not significant. RGP 21-P6 recorded highest harvest index among the studied R-lines and was on par with check 298-R under control and stress. DRSH-1 recorded highest harvest index and no line under study was on par with it. R-lines RGP 60-P2 is on par with check 298-R with 22% reduction. RGP 61-P1 and RGP 50-P1 recorded increase of harvest index under stress and were also on par with check. R-lines RGP 33-P5, RGP 50-P1, RGP 61-P1 and RGP 61-P2 recorded higher harvest index

under stress than under control. This may be due to greater reduction in biological yield than economic yield under stress in those R-lines. The reduction in harvest index due to drought may be attributed to reduction of photosynthesis, translocation of assimilates and also to the dehydration of grains (Hossain *et al.*, 2010)^[7]. Similar results were also reported by Gholinezhad *et al.*, (2009)^[6], Geetha *et al.* (2012)^[5].

Table 6: Effect of drought stress on harvest index

Treatment	Harvest Index											Stress levels	R lines	Interactions	
	RGP 21-P6	RGP 32-P1	RGP 33-P5	RGP 50-P1	RGP 60-P2	RGP 61-P1	RGP 61-P2	RGP 95-P1	DRSH-1	298-R	Mean				
	C.D(p=0.05)														
Control	29.7	15.3	11.9	18.8	29.6	17.9	11.3	25.1	39.7	27.9	22.7	NS	10.95	NS	NS
Stress	28.6	13.3	15.9	20.7	23.2	22.0	16.5	16.8	39.8	25.0	22.2				
Mean	29.2	14.3	13.9	19.8	26.4	20.0	13.9	20.9	39.8	26.4	22.5				
% Reduction or Increase	4	13	33	10	22	23	46	33	0	11					

Oil content was not influenced significantly by water stress. Though not significant, most of the R-lines has increased oil content under stress compared to control. R-lines RGP 50-P1, RGP 60-P2 and RGP 61-P1 has decreased oil content under stress by less than 5%. Highest oil content was recorded by RGP 21-P6 and is on par with both the checks with 5% increase compared to control. RGP 33-P5 has 12% increase in

oil content under stress. Oil content was almost not influenced from drought stress because the adjustment was at yield level while maintaining oil content. But there were many reports contrary to this where oil content decreases due to stress Alahdadi *et al.*, 2011^[11]. Conversely there was some increase in oil contents of lines as reported by Pekcan *et al.* (2015)^[10].

Table 7: Effect of drought stress on oil content

Treatment	Oil Content											Stress levels	R lines	Interactions	
	RGP 21-P6	RGP 32-P1	RGP 33-P5	RGP 50-P1	RGP 60-P2	RGP 61-P1	RGP 61-P2	RGP 95-P1	DRSH-1	298-R	Mean				
	C.D(p=0.05)														
Control	34.8	28.9	30.6	30.2	33.3	33.6	32.9	33.0	35.4	34.5	32.7	NS	1.68	NS	NS
Stress	36.4	31.3	34.3	28.7	31.6	33.1	33.3	34.3	37.0	35.3	33.5				
Mean	35.6	30.1	32.4	29.4	32.5	33.3	33.1	33.6	36.2	34.9	33.1				
% Reduction or Increase	5	9	12	5	5	1	1	4	5	2					

Among R-lines RGP 21-P6 (1.01) ranked first followed by RGP 60-P2 (0.82), RGP 61-P1 (0.46) and RGP 50-P1 (0.46). RGP 32-P1 (0.21) and RGP 33-P5 (0.16) were ranked least among the lines under study. RGP 21-P6 and RGP 60-P2 with

high STI can tolerate drought. Selections based on STI were also made in crops like in rice (Raman *et al.*, 2012)^[11] and maize (Papathanasiou *et al.*, 2015)^[9].

Table 8: Stress tolerance index of studied restorer lines

R-lines	STI	Rank
RGP 21-P-6	1.01	1
RGP 32-P-1	0.21	7
RGP 33-P5	0.16	8
RGP 50-P1	0.46	4
RGP 60-P-2	0.82	2
RGP 61-P-1	0.46	3
RGP 61-P-2	0.37	6
RGP 95-P-1	0.40	5

Conclusions

Based on Stress Tolerance Index and seed yield in stress, RGP 21-P6 and RGP 61-P1 were identified as tolerant to water stress out of eight R-lines studied. These lines also showed superior morphological, physiological traits along with yield attributes. RGP 32-P1 and RGP 33-P5 were found to be more sensitive.

Physiology of Sunflower (*Helianthus annuus* L.). Advances in Life Sciences. 2016; 5:10912-10916.

References

1. Alahdadi Iraj, Oraki Hussein, Parhizkar Khajani Fataneh. Effect of water stress on yield and yield components of sunflower hybrids. African Journal of Biotechnology. 2011; 10:6504-6509.
2. Banaei-Asl Farzad. Effect of drought stress on yield and yield components of some sunflower recombinant inbred lines. International Journal of Biosciences, 2013, 50-56.
3. Buriro Mahmooda, S Sanjrani A, Chachar Qamaruddin, Ahmed Nazir, Chachar Sadaruddin, Buriro B *et al.* Effect of water stress on growth and yield of sunflower. Journal of agricultural technology. 2015; 11:1547-1563.
4. Fernandez, G.C.J., 1992. Effective selection criteria for assessing stress tolerance. In: Kuo, C.G. (Ed). Proceedings of the International Symposium on Adaptation of Vegetables and Other Food Crops in Temperature and Water Stress. Tainan, Taiwan.
5. Geetha A, Suresh J, Saidaiah P. Study on response of sunflower (*Helianthus annuus* L.) genotypes for root and yield characters under water stress. Sabrao Journal of Breeding and Genetics. 2012(b); 44(1):28-41.
6. Gholinezhad Esmaeil, Amir Aynaband, Hasnzade, Abdollah, Gorban Noormohamadi, Bernousi Iraj *et al.* Study of the Effect of Drought Stress on Yield, Yield Components and Harvest Index of Sunflower Hybrid Iroflor at Different Levels of Nitrogen and Plant Population. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2009; 37(2):85-94.
7. Hossain MI, Khatun A, Talukder MSA, Dewan MMR, Uddin MS. Effect of drought on physiology and yield contributing characters of sunflower. Bangladesh Journal of Agricultural Research. 2010; 35(1):113-124.
8. Nezami A, Khazaeia HR, Rezazadehb ZB, Hosseinic A. Effects of drought stress and defoliation on sunflower (*Helianthus annuus*) in controlled conditions. Desert. 2008; 12:99-104.
9. Papathanasiou Fokion, Dordas Christos, Gekas Fotis, Pankou Chrysanthi, Ninou E, Mylonas Ioannis, Tsantarmas Konstantinos *et al.* The Use of Stress Tolerance Indices for the Selection of Tolerant Inbred Lines and their Correspondent Hybrids under Normal and Water-stress Conditions. Procedia Environmental Sciences. 2015; 29:274-275.
10. Pekcan Veli, Evci Goksel, Ibrahim Yilmaz M, Balkan Nalcayi Suna, Culha Erdal Sekure *et al.* Drought Effects On Yield Traits of Some Sunflower Inbred Lines. Agriculture Forestry. 2015; 61:101-107.
11. Raman A, Verulkar SB, Mandal NP, Variar M, Shukla VD, Dwivedi JL *et al.* Drought yield index to select high yielding rice lines under different drought stress severities. Rice. 2012; 5:31.
12. Reddy YAN, Shanker RU, Virupakshappa K. Studies on the sunflower genotypes under moisture stress conditions. Journal of Oilseeds Research. 1995; 12(2):292-294.
13. Santhosh Banothu, Narender Reddy Sadu, Prayaga Lakshmi. Effect of Water Stress on Growth and