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Evaluation of Terminal Drought Stress Tolerance of Sesamum Indicum L. Genotypes under the Sistan Region Conditions

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Abstract- In order to evaluate the yield, yield components and terminal drought stress tolerance, 16 genotypes of Sesamum indicum L. were examined in two separate experiments under non-stress and terminal drought stress conditions in a randomized complete blocks design (RCBD) with three replications. In non-stress conditions, irrigation was performed based on plant growth stages. Irrigation was discontinued since flowering stage by the end of growth season under terminal drought stress conditions. Comparative results of traits showed that genotypes had significant differences in terms of seed yield and yield components under stress and non-stress conditions. Comparative results of traits showed that the terminal drought stress reduced the number of capsules per plant, number of seeds per capsule and weight of 1000 seeds from 74 capsuls to 58 capsules, 40.65 seeds to 36.14 seeds and 3.28 g. to 2.66 g, respectively. TS-3 and Darab-14 genotypes had the highest seed yield, with values of 1141 kg/ha and 1115 kg/ha, respectively under non-stress conditions. In stress conditions, Darab-14 and Sistan genotypes had the highest seed yield with values of 856 kg/ha and 826 kg/ha, respectively. Darab-14 and Sistan genotypes had the highest seed yields in both non-stress and terminal drought stress conditions. According to the results, Darab-14 and Sistan genotypes can be used as drought-tolorant genetic basis in breeding programs due to the higher stability and yield than other genotypes under terminal drought stress conditions.

Keywords- *Drought stress, Sesamum indicum L., Terminal drought stress, Sistan.*

I. INTRODUCTION

The water resources deficit is one of the main factors limits production in agriculture systems in arid and semiarid regions which affect the range of their other resources as well as the use efficiency (Kenan, et al, 2007).

Sesamum indicum L. is known as an oilseed crop with medicinal properties (Weiss, 2000). Sesamum indicum L is a drought-tolerant plant (Boureima, et al, 2011& Weiss, 2000). Sesamum indicum L is cultivated in arid and semi-dry regions with following characteristics: high temperatures, high solar radiation, high evaporation requirement and unexpectedly droughts occurrence (Witcombe, et al, 2007). Sesamum indicum L is extensively cultivated in tropical and semi-tropical regions of the world (Roebbelen, et al, 1989). Nimitr, et al (1989) studied the water use efficiency (WUE) of 8 grown cultivars of Sesamum indicum L. under different irrigation regimes. They concluded that the lowest water regimes had the highest water use efficiency (WUE), while the highest irrigation regimes had the lowest water use efficiency. In this experiment, cultivar, 79-CB, showed the highest seed yield (1352 kg/ha). The cultivar, mks-81111, with 118 kg/ha was in the second rank (Nimitr & Nipa, 1989). Dilip, et al (1991) found that the increase of irrigation turns significantly increased the number of subsidiary branches, number of seeds per capsule and biomass per unit area. Kumar et al (1998) investigated the effect of irrigation on the yield of Sesamum indicum L. They found that irrigation at 30 and 60 days after planting increased the leaf area, the number of capsules per plant, weight of 1000 seeds and oil yield.

Mensah et al (2006) demonstrated that water restriction will result in reduced growth and yield of Sesamum indicum L. Hong et al (1985) found that the water deficit in the vegetative stage can reduce the yield of Sesamum indicum L. even to half due to reduced plant height. Al-Vakil and Ghaffar (1988) also concluded that the use of 6 irrigation regimes for Sesamum indicum L. without the removal of any water course led to highest yield and high water use efficiency (WUE).

The increase and development of the area under Sesamum indicum L. cultivation requires introduction of high potential genotypes compatible with the local conditions. The study of the agronomic traits and genetic diversity of the germplasm through conducting drought stress projects can be useful in this regard.

This experiment was carried out to evaluate and compare the yield and yield components of new genotypes of Sesamum indicum L. under terminal drought stress and non-stress conditions.

II. Materials and Methods

This experiment was carried out in the spring of 2010 in the research farm of the Agricultural Research Center and Natural Resources of Zahak in Sistan and Baluchestan Province, Iran. Zahak Research Station is located 25 km southeast of Zabol. The experimental region is located 483 meters above sea level, 61º 41' east longitudes and 30º 54' latitude. Annual precipitation is 53 mm. The mean annual maximum and minimum temperatures are 16 °C and 30 °C, respectively. Annual evaporation is 4500-4500 mm.

In order to evaluate the yield, yield components and terminal drought stress tolerance, 16 Sesamum indicum L. genotypes were examined in two separate experiments under non-stress and terminal drought stress conditions in a randomized complete blocks design (RCBD) with three replications. Each plot consisted of four 5 m rows with the distance of 50 cm from each other. Planting was done as wet-planting on 2010.05.36 using Winter Schweinsteiger plot device. Irrigation was done in normal condition based on plant growth stages on 2010.06.14, 2010.07.12, 2010.08.16 and 2010.08.29. Irrigation was discontinued under terminal drought stress conditions since flowering stage until the end of the growing season. However, in the early stages, irrigation was done similar to normal conditions on 2010.06.14 and 2010.07.12. In general, 2 times irrigation was performed under drought stress conditions (2 times less than control with 4 times irrigation).

After collecting all the data, statistical analysis was performed for all traits including analysis of variance and mean comparison by Duncan's method at the probability level of 5%.

III. Results and Discussion

A. Evaluation of yield components and seed yield of Sesamum indicum L. genotypes under non-stress condition

The analysis of variance revealed that there was a significant difference between genotypes at the probability level of 1% in terms of the number of capsules per plant (Table1). As can be seen from the table of mean comparison, TN-238 genotype had the highest number of capsules with 89 capsules which was placed in a same statistical group along with Darab-14 and TS-3 genotypes (Table2).

The results of variance analysis showed that the genotypes had a statistically significant difference at the probability level of 1% in terms of seeds per capsule (Table1). The mean comparison Table shows that TS-3, Darab-14, Local Jiroft and Darab-2 had the highest number of seeds per capsule with a mean of 51, 44, 42 and 42, respectively (Table2).

The results of variance analysis show that the genotypes had a significant difference at probability level of 1% in terms of seed yield (Table1). The mean comparison table showed that TS-3 and Darab-14 genotypes had the highest seed yield with the values of 1141 kg/ha and 1115 kg/ha which were placed in a same statistical group along with the Local Jiroft, Local Sistan, TN-238, Darab-2 and Pakistani genotypes. SG5-86365, TN-240, SG4-82215 and SG3-86365 genotypes had the lowest seed yield with an average of 724, 733, 786, 793 kg/ha, respectively (Table2).

Previous studies have also confirmed that the increase of irrigation turns led to increased seed yield. This is due to the reduction in competition among plants and increased number of subsidiary branches and the number of capsules per plant. Al-Vakil and Ghaffar (1988) also concluded that the use of 6 irrigation regimes for Sesamum indicum L. without the removal of any water course led to highest yield and high water use efficiency (WUE).

TABLE I. Analysis of variance (mean squares) of the number of capsules per plant, number of seeds per capsule, weight of 1000 seeds and seed yield of the Sesamum indicum L. genotypes under non-stress conditions

Seed Yield in Hectare	Weight of 1000 Seeds	Number of Seeds per Capsule	Number of Capsules per Plant	Degree of Freedom (DOF)	Variation Resources
28/771	0/052	28/521	3/583	2	Replication
53600/778**	0/041ns	33/376**	130/467**	15	Genotype
8741/237	0/046	9/542	24/183	30	Error
9/82	6/51	7/63	6/59	-	Variation coefficient

* and ** represent significant difference at the probability levels of 1% and 5%, respectively. ns denotes no significant difference.

TABLE II. Comparison of the average number of capsules per plant, number of seeds per capsule, weight of 1000 seeds and seed yield of the Sesamum indicum L. genotypes under non-stress conditions

Traits				Genotype
Seed Yield in Hectare	Weight of 1000 Seeds	Number of Seeds per Capsule	Number of Capsules per Plant	
1032/333ab	3/233 a	40/333 bcd	77/333 bcd	Local Sistan
960/667 bc	3/33 a	38/000 cd	80/667 bc	Safi-Abad
1033/667 ab	3/367 a	40/333 bcd	89/333a	TN-238
1074/667 ab	3/267 a	41/667 bc	72/000 de	Local Jiroft
1115/333 ab	3/267 a	43/667 b	81/000 bc	Darab-14
969/333 bc	3/233 a	41/333 bcd	73/667 bcd	Varamin
1030/333 ab	3/200 a	41/667 bc	70/000 def	Darab-2
1141/333 a	3/233 a	51/000 a	81/667 ab	TS-3
1024/000 ab	3/533 a	39/333 bcd	72/000 de	Pakistani Polowhita
992/000 abc	3/233 a	40/233 bcd	62/333 f	SG5- 84215
845/000 cd	3/233 a	39/333 bcd	77/333 bcd	Haji-Abad
733/000 d	3/367 a	39/667 bcd	65/000 ef	TN-240
724/667 d	3/400 a	38/667 bcd	72/333 cd	SG5-86365
971/667 bc	3/367 a	37/667 cd	73/000 cde	SG1-86365
793/333 d	3/000 a	36/333 d	72/333 cd	SG3-86365
786/667 d	3/367 a	38/333 cd	72/333 de	SG4-82215
951/758	3/2895	38/166	74/520	Average

Means without a common letters in each column have a significant difference.

B. Analysis of yield components and seed yield of Sesamum indicum L. genotypes under terminal drought stress conditions

The results of variance analysis revealed that there was a statistically significant difference at the probability level of 1% among studied genotypes in terms of the number of capsules per plant (Table3). As can be seen from Table of mean comparison, Darab-14 and SG4-82215 genotypes had the highest and lowest number of capsules per plants with 69 and 50 capsules, respectively (Table4).

The results of variance analysis showed that the effect of genotype on the number of seeds per capsule had a statistically significant difference at the probability level of 1% (Table3). The Table of mean comparison shows that Darab-14 and Local Sistan genotypes had the highest number of seeds per capsule with an average of 39. Varamin and SG 386365 genotypes had the lowest number of seeds per capsule with an average of 31 (Table4).

The analysis of variance shows that genotypes have a statistically significant difference at the probability level of 1% in terms of seed yield (Table3). The table of mean comparison shows that Darab-14 and Sistan genotypes had the highest seed yield with values of 866 kg/ha and 826 kg/ha, respectively. 86365-SG3 genotype had the lowest seed yield with the value of 376 kg/ha (Table4).

Heidari et al (2011) and Golestani and Pakniat (2007) reported similar results on the reduced seed yield and yield components of Sesamum indicum L. with increasing water deficit. It can be deduced that the reduction in yield in drought stress conditions mainly is due to the decrease in the number of capsules per plant, the number of seeds per plant and the weight of 1000 seeds. Westage and Boyer (1998) found that water stress during reproductive stages led to the inhibition of photosynthesis and thereby decrease in carbohydrate reserves and stunted growth in seeds and capsules. Pasban Islam (2011) reported that in normal and stress conditions, the number of seeds per capsule and seed weight had the most positive effects on the seed yield of Safflower.

Under drought stress conditions, water deficit affects the transport mechanism of photosynthesized material and reduces the seed reserves. Reduction in seed yield components could be the main reason for the reduction in seed yield (Hall et al, 1997).

Eskandari et al (2010) found that plant height, number of leaves per plant, biological function, and seed yield per unit area decreased with increasing the severity of water deficit. All of these traits were positively correlated with each other. This shows that reducing any of these traits could have a detrimental effect on the yield of Sesamum indicum L.

TABLE III. ANALYSIS OF VARIANCE (MEAN SQUARES) OF THE NUMBER OF CAPSULES PER PLANT, NUMBER OF SEEDS PER CAPSULE, WEIGHT OF 1000 SEEDS AND SEED YIELD OF THE SESAMUM INDICUM L. GENOTYPES UNDER TERMINAL DROUGHT STRESS CONDITIONS

Seed Yield in Hectare	Weight of 1000 Seeds	Number of Seeds per Capsule	Number of Capsules per Plant	Degree of Freedom (DOF)	Variation Resources
21373/188	0/133	7/271	1/668	2	Replication
5569/972**	0/026ns	24/044**	76/528**	15	Genotype
7677/210	0/041	5/715	14/732	30	Error
14/67	7/61	6/58	6/55	-	Variation coefficient

* and ** represent significant difference at the probability levels of 1% and 5%, respectively. ns denotes no significant difference.

TABLE IV. COMPARISON OF THE AVERAGE NUMBER OF CAPSULES PER PLANT, NUMBER OF SEEDS PER CAPSULE, WEIGHT OF 1000 SEEDS AND SEED YIELD OF THE SESAMUM INDICUM L. GENOTYPES UNDER TERMINAL DROUGHT STRESS CONDITIONS

Traits				Genotype
Seed Yield in Hectare	Weight of 1000 Seeds	Number of Seeds per Capsule	Number of Capsules per Plant	
826/000 a	2/667 a	39/000 ab	63/667 ab	Local Sistan
644/000 bc	2/667 a	37/333 bcd	56/333 cdef	Safi-Abad
649/000 bc	2/533 a	38/000 abc	56/333 cdef	TN-238
651/000 bc	2/667 a	41/333 a	59/333 bcde	Local Jiroft
866/000 a	2/733 a	39/333 ab	69/000 a	Darab-14
533/000 bcd	2/700 a	31/000 e	63/667 ab	Varamin
669/000 b	2/800 a	37/000 bcd	61/000 bcd	Darab-2
620/000 bc	2/533 a	33/667 de	60/667 bcd	TS-3
676/000 bc	2/700 a	37/667 abc	61/667 ab	Pakistani Polowhita
647/000 cde	2/667 a	33/667 bcd	64/000 ab	SG5-84215
546/000 bc	2/887 a	33/667 de	55/000 def	Haji-Abad
512/000 cde	2/633 a	34/333 cde	54/000 ef	TN-240
440/000 de	2/733 a	37/000 bcd	54/000 ef	SG5-86365
473/000 de	2/533 a	37/000 bcd	56/000 cdef	SG1-86365
376/000 de	2/633 a	31/333 e	53/333 ef	SG3-86365
427/000 e	2/600 a	37/000 bcd	50/333 f	SG4-82215
597/187	2/6678	36/1458	58/79168	Average

Means without a common letters in each column have a significant difference.

IV. CONCLUSION

According to the results of the present study, it was revealed that TS-3 and Darab-14 genotypes had the highest seed yield with the values of 1141 kg/ha and 1115 kg/ha respectively under non-stress conditions. Darab-14 and Local Sistan genotypes had the highest seed yield with the values of 866 kg/ha and 826 kg/ha under terminal drought stress conditions. Darab-14 and Local Sistan genotypes had higher stability and yield in both stress and non-stress conditions than other genotypes which could be notable and recommendable for Sistan region.

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