Middle-East Journal of Scientific Research 9 (5): 584-587, 2011
ISSN 1990-9233

Effects of Water Deficit on Some Traits of Three Sunflower Cultivars

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Abstract: In order to investigate the effects of water deficit on some of morphological traits of three sunflower cultivars, a split plot experiment based on random complete block design was conducted with three replications during growing of season 2009 at Agricultural Research Station of Tabriz Azad University. Water deficit at five levels (50, 100, 150, 200 and 250 mm evaporation from evaporation pan, Class A) was assigned to main- plots and cultivars (Aramvirsky, Allstar and Euroflour) to sub-plot. The results indicated that seed yield was amounted to 4865, 3815, 3252, 2450 and 2122 kg ha^{-1} when plots were irrigated after 50, 100, 150, 200 and 250 mm evaporation from the pan,repectively. Among the studied cultivars 'Armavirsky' produced higher yield than 'Allstar'. Increasing water stress decreased seed yield ha^{-1}, above ground dry weight of plant, stem diameter, head diameter, number of seeds per head, 100 seeds weight, harvest index and number of photosyntetically active leaves.

Key words: Sunflower · Water Deficit stress · Yield · Cultivar

INTRODUCTION

Maize (*Zea mays* L.) is great important crop for both human and animal feeding. It ranks the third position among cereal crops. In Iran, it is very important to increase production of maize to cover gap between production and consumption. Sunflower is one of the most important crops which are cultivated for producing grain oil. Its water demand has been estimated as 500-600 mm in one growth cycle [1]. The highest maize yield production depended on many factors I.e. cultivars, nitrogen and potassium fertilization [2].

Drought stress is one of the most important and widespread environmental stresses which limits agricultural products and decreases the production efficiency in semi-arid and rain-fed regions. It is believed that in order to increase the efficiency of breeding adaptive cultivars, the traits which are effective in increasing grain yield under water deficit conditions should be identified and used as selection criteria besides grain yield [3].

Total water use of sunflower during its life cycle is 450 mm, though it varies with regional climatic conditions [4]. Sunflower is most sensitive to water deficit stress in its flowering and seed maturity stages [5]. On the other hand, flower initiation and seed setting stages were reported as the sensitive stages of sunflower life cycle to water deficit [6]. Water deficit decreased sunflower grain yield by 20% but did not affect its harvest index [7]. Water stress considerably decreases the grain yield, biomass and vegetative growth period in sunflower [8]. Head number/unit area, grain number/head and grain weight are the important sunflower grain yield components. Oil content as an oil yield component it also highly important [4].

In a study on the effects of irrigation cut-off in different growth stages of sunflower cultivars, Kalhori [9] found that drought stress severely affected head diameter at flowering stage so that the lowest head diameter was observed at flowering stage when irrigation had been stopped.

In this study, it was attempted to identify the sensitive of three cultivars to drought stress and evaluating the effects of water deficit on Stem height, stem diameter, Head width, Number of seed, Total dry weight, Yield, Harvest index.

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MATERIALS AND METHODS

The experiment was carried out in a sandy loam soils with EC of 0.72 dsm^{-1} and pH of 7.9. During growing season of 2009-2010 at the Agriculture Research Station of the Islamic Azad University, Tabriz Branch, Iran. Tabriz is located at Lat38° 5' N and Long 46° 17' E about 1360 m above sea-level and its annual mean temperature is 13.04°C. The region is classified as cold and semi-arid. Its annual precipitation is 271.3mm.

The study was performed as a split-plot experiment based on randomized Complete Block Design with three replications. The water deficit at five levels (50, 100, 150, 200 and 250 mm evaporation from evaporation pan, Class A) was assigned to main- plots and cultivars (Aramvirsky, Allstar and Euroflour) to sub-plot. Before planting, the field was fertilized as recommended according soil test. Each sub-plot consisted of 4 rows with 5 meter length. Between row and within row spacing were 60 cm and 20cm, respectively. After planting, the field was irrigated once every 7 days up to R3 stage and then on the basis of water deficit at five levels. At harvest time, the traits measured included stem diameter, head diameter, number of seeds, yield, harvest index. Data were statistically analyzed by MSTAT-C software. Treatments means were compared using the least significant difference test at 5% probability level.

RESULTS AND DISCUSSION

Analysis of variance show traits influenced different level of water stress on the parameter of stem width, head diameter, seed weight, seed number, shoot dry weight, grain yield and harvest index significant. Also significant effects on stem height stem diameter, number of seed weight, dry shoot and hectare grain yield and harvest index.

Stem Height: Mean stem height showed traits (Table 3) Aramvirsky with 237 cm is the most stem height and Euroflour with 190.1 cm and Allstar with 174.3 cm had the little stem height.

Differences of cultivars (Aramvirsky, Euroflour and Allstar) were in this traits arising from genetic differences.

Stem Diameter: Compare mean that the most stem diameter in control with 50 mm evaporation 19.89 mm and the little was maximum stress conditions 250 mm evaporation to 16.46 mm (Table 2). Between the controls treatment (irrigation after 50 mm evaporation) with 100, 150 mm evaporation and irrigation treatments after 100 mm evaporation after irrigation with 150, 200 mm evaporation and between treatments with 150 mm evaporation after irrigation treatments 200, 250 mm evaporation was not significantly differences. But the increasing of water deficit stress of 150 mm to down had significant differences on these traits compare with the control. This shows that above 150 mm the optimal growth occurred, but water stress and reduction growth due to decreased cell division. Also growth rate was significantly decreased. Sadras *et al*. [10] also confirmed the above results. Mean cultivar weren't difference between Aramvirsky, Euroflour, while the Allstar were significantly than others in stem diameter.

Head Diameter: Under drought stress most of food materials, stored in the seed from and head. Minimum in 250 mm irrigation treatment (with 135. 8 mm) were observed. The most diameters in control with an average 192.2 mm were observed (Table 2).

There were significant differences in head diameter among different stress levels and among cultivars. So that no-stress treatment had the greatest and stress at head formation treatment had the lowest head diameter.

Table 1: Analysis of variance of for some traits affected by drought stress in different sunflower cultivars

		Mean squares					
SOV	df	Stem diameter	Head diameter	Seeds number per head	100 seeds weight	Total dry weight	Harvest index
Replication	2	4.172	50.625	2914107.47*	0.167	*8149043.61*	0.64
Stress level (A)	4	15.376**	2130.497**	6638411.67**	6.192**	68609122.09**	42.62*
Error A	8	1.375	118.835	485104.47	0.140	1068397.97	8.11
cultivar (B)	2	32.126**	477.558*	19915833.8**	0.672	61604215.25**	270.18**
A×B	8	2.021	40.789	574719.3	0.163	4832899.60	12.89
Error B	20	1.596	98.614	303102.03	0.382	2066035.48	10.47
Coefficient of variation	-	6.96	6.45	6.95	12.93	14.85	9.44

**,* Significant at 5% and 1% levels of probability, respectively. ns, not significant

Table 2: Mean comparison of some traits as affected by drought stress and different sunflower cultivars

Stress levels	Stem diameter (mm)	Head diameter (mm)	Seeds numbers per head	100 seeds weight (g)	Total dry weight (kg/ha)	Harvest index (kg)
50	19.89^{a}	192.2^{a}	9138^{a}	6.469	13580^{a}	36.84^{a}
100	18.85^{ab}	170.3^{b}	8222^{ab}	5.241^{b}	11280^{b}	35.74^{a}
150	18.10^{abc}	154.8^{bc}	7952^{bc}	4.621^{c}	9088^{c}	34.74^{ab}
200	17.47^{bc}	141.7^{cd}	7398^{bc}	4.219^{cd}	7699^{cd}	32.31^{b}
250	16.46^{c}	135.8^{d}	6870^{c}	3.877^{d}	6770^{d}	31.80^{b}

Means with the same letter(s) in each column are not significantly different.

Table 3: Mean comparison for interaction of some as affected by drought stress and different sunflower

	Mean squares					
Cultivar	Stem diameter (mm)	Head diameter (mm)	Seeds numbers per head	Yield (kgha^{-1})	Total dry weight (kg/ha)	Harvest index (kg)
Aramvirsky	19.40^{a}	168.2^{a}	8507^{a}	3559^{a}	11760^{a}	30.10^{c}
Allstar	16.54^{b}	147.4^{b}	6588^{b}	3032^{b}	7710^{c}	39.32^{a}
Euroflour	18.51^{a}	161.1^{a}	86530^{a}	3282^{ab}	9579^{b}	34.26^{b}

Means with the same letter(s) in each column are not significantly different.

The effect of drought stress on decreasing head diameter has been reported in other studies [9]. Head diameter is one of the essential traits which are decreased under moisture stress and adversely effects yield components like seeds number per head. Mozzafari *et al*. [4] found that drought stress always had negative effects on head diameter. Selection of genotypes with greater head diameter is one of the objectives of sunflower breeding programs.

Dandria *et al*. [11] also obtained similar results. Among cultivars, Aramvirsky and Euroflour by average 168.2 and 161.1 mm diameter(maximum) and Allstar by average 147.4 mm of diameter less the others (Table 3).

Expression that can possibly increasing the diameter Aramvirsky and Euroflour, due to the dry weight and stem diameter and reducing diameter of Allstar cultivar because the decreasing dry weight and stem diameter.

Seeds Number per Head: The results showed that, water stress decreased number of seeds per head. Difference between the number of seeds at 50 and 100 mm evaporation was not significant (Table 2).

Reducing number of seed occurred in head by stress or increasing unfilled seeds or two of them.

100 Seed Weight: Weight of 100 seeds by moisture stress decreasing. Thus increasing in evapotranspiration and reduction plant water potential cause reducing the low efficiency of photosynthesis and photosynthetic production of materials.

On the other hand competitive effects of absorption of food grain have decreased. Treatments mean that the highest weight of 100 grains irrigation treatments after 50 mm evaporation average 6.469 g, the lowest 100 seed weight was in maximum stress treatment mean 3.877 g, respectively (Table 2).

Total Dry Weight: Irrigation treatments were after 50 mm evaporation with an average 13580 kg/ha, the high product due to increase vegetative development and yield components. The little Dry weight in irrigation treatments after 250 mm evaporation equivalent to 6770 kg/ha of water, Thus biomass decreases (Table 2).

In general, increasing distance between the irrigation levels, shoot dry weight per hectare to downtrend. This process weight shoots (stem, leaf and head) and reduced leaf area and photosynthetic production in the result of water deficit during growth (or reproduce) will confirm.

Cox and Joliffe [7] reported that reduced 22 to 50 percent a result of soil moisture deficiency.Also, the result by Jasso du Rodriguez *et al*., [12] is verifiable. Mean the study shows that Aramvirsky cultivar in class A, Euroflour in class B and Allstar cultivar in the C class (Table 3).Aramvirsky cultivar with 11760 kg /ha, the highest and the lowest mean dry weight (7710 kg/ha) with a mean Allstar cultivar.

Harvest Index: Harvest index of important physiological parameters that indicate the percentage of photosynthetic material transfer organs to seed. The most harvest index equivalent to 36.84 percent in control and the lower by maximum stress treatment was equivalent to 31.80 percent. Kalhori [9] showed that drought stress decreased harvest index which is consistent with the results of the current study.

Reduced harvest index in results of Fereres *et al*. [13] has also been reported.

REFERENCES

1. Alyari, H., F. Shekari and F. Shekari, 2000. Oil seeds. Amidi press. Tabriz. pp: 182.
2. El-Bana, A.Y.A.and M.A.Gomaa, 2000. Effect of N and K fertilization on maize grown in different populations and newly reclaimed sandy soil. Zagazig. J. Agric. Res., 27(5): 1179-1190.
3. Kordovani, P., 1997. Arid Regions. Vol. 1. Tehran University Press.
4. Mozzafari, K., 1995. Cause analysis of sunflower under water stress and normal conditions. M.Sc. Thesis Agriculture College of Karaj. Iran.
5. Chimenti, C.A., J. Pearson and A.J. Hall, 2002. Osmotic adjustment and yield maintenance under drought in sunflower. Field crops Res., 75: 235-246.
6. Mir-hosseini Dehabadi, S.R., 1988. Effects of different irrigation levels on the yields of three sunflower cultivars. M.Sc. Thesis. Tarbiat Moddares University, pp: 147.
7. Cox, W.J. and G.D. Jolliffe, 1986. Growth and yield of sunflower and soybean under soil water deficits. Agron. J., 78: 226-230.
8. Kamel, M. and M. Khiyavi, 2002. Study of effects of drought stress on some physiological traits and yield components of sunflower. Proceedings to 7th Iranian Agriculture and Plant Breeding Conference Seed and Plant Research Institute. Karaj. Iran. pp: 594.
9. Kalhori, H., 2002. Study of effects of drought stress at different growth stages on grain yield and yield components of different sunflower cultivars. M.Sc. Thesis. Agriculture Department. Tehran University, pp: 118.
10. Sadras, V.O., D.J. Cannor and D.M. Whitefield, 1998. Yield, yield components and source- sink relationships in water - stressed sunflower. Field Cross Res., 31: 27-39.
11. Dandria, R., F.Q. Chiaranda, V. Magliulo and M. Mori, 1995. Yield and soil water uptake of sunflower Sown in spring and summer. Agron, J., 87: 1122-1128.
12. Jasso de Rodriguez. D., B.S. Phillips, R. Rodriguez-Garcia and J.L. Angulo snachez, 2002. Grain yield and fatty acid composition of sunflower seed for cultivars developed under dry land conditions. Agron. J., 25: 132-142.
13. Fereres, W., C. Gimenez and J.M. Fernandez, 1986. Genetic variability in sunflower cultivars under drought. Yield Relationships Aust. J. Agric. Res., 37: 573-582.