Journal of Novel Applied Sciences
Available online at www.jnasci.org
©2013 JNAS Journal-2013-2-9/299-302
ISSN 2322-5149 ©2013 JNAS

Effect of Water Stress on Quantitative and Qualitative Characteristics of Yield in Sunflower (Helianthus annuus L.)

Hamid Reza Mobasser* and Abolfazl Tavassoli

Department of Agriculture, Zahedan Branch, Islamic Azad University, Zahedan, Iran.

Corresponding author: Hamid Reza Mobasser

ABSTRACT: To determine the effects of water deficiency in reproductive growth stages of sunflower (Helianthus annuus L.) a field experiment was conducted as split-plot arranged in a Randomized Complete Block Design with four replications in 2004-05 of Islamic Azad University research field of Zahedan, Iran. In this experiment, there were 4 levels of irrigation, S_0: complete irrigation, S_1: halted irrigation at squaring, S_2: halted irrigation at 50% flowering, S_3: halted irrigation at grain filling as main plot, and cultivars in 3 levels, V_1: Zaria, V_2: Alstar, V_3: Azargol as sub factor. The result of this study highlight that irrigation treatments was significant on plant height, seed number of head, 1000 grain weight, yield grain, oil yield and oil percent. Most of grain yield, oil and oil percent were at complete irrigation. Experiment cultivars was different together from grain yield, oil yield, stem diagonal, seed number of plate, 1000 grain yield, plate diagonal, plant height, number of leaf and harvest index. The Azargol was better characteristics to other cultivars. In this experiment cultivars showed different reaction at halted irrigation treatments.

***Keywords*:** Sunflower, Yield, Water Stress, Oil content

INTRODUCTION

Sunflower (Helianthus annuus L.) is an important oilseed crop of the family composite originated in southern Asia and is known to have been cultivated in China, India, Egypt and Iran (Ashri and Knowles, 1960). The oil content of safflower seed ranged between 35 to 50% that consists of about 90% unsaturated fatty acids, placing it as one of the best oils for popular consumption (Tahmasebpour et al., 2011).

This crop adapted to relatively low rainfall areas receiving winter and spring rainfall with a low humidity during flowering and maturation (Knowles, 1976).

Water is essential at every stage of plant growth and agricultural productivity is solely dependent upon water and it is essential at every stage of plant growth, from seed germination to plant maturation (Turner, 1991). Drought stress is one of the most important abiotic stress factors which are generally accompanied by heat stress in dry season (Dash and Mohanty, 2001). Due to water deficits, the physiology of crop is disturbed which causes a large number of changes in morphology and anatomy of plant.

Drought stress is a major limiting factor for plant growth and development worldwide and, in Iran, too. Sunflower is a well adapted to drought crop, essentially because of the powerful water uptake due to its efficient root system (Belhassen, 1995). However, it has been found that both quantity and distribution of water has a significant impact on seed yield and seed quality in sunflower (Krizmanic et al., 2003; Iqbal et al., 2005). Intensity of yield reduction by drought stress depends on the growth stage of crop, the severity of the drought and tolerance of genotype (Lorens et al., 1987). Petcu et al, (2001) showed that grain yield of sunflower hybrids was affected by drought stress with the low status treatment yielding 10-13% less than the control treatment. Igbal et al. (2005) reported a trend in yield decline and reduce of yield components due to water stress treatments. Razi and Asad,

(1998) indicated that drought stress at flowering stage was observed to be a limiting factor for seed filling, so significant reduction of unfilled seeds was observed as a result of irrigation missing.

The objective of this study was to investigate the effects of water stress on the growth, yield and seed oil content of sunflower cultivars and introducing the best cultivar for resistance to drought periods in Sistan region, Iran.

MATERIALS AND METHODS

This experiment was conducted in 2004-05 cropping at Agriculture Research Farm of Islamic Azad University, Zahedan, Iran. The site lies at longitude 61°53´, and latitude 25°28´ and the altitude of the area is 1370 m above sea level. It has a warm dry climate with the mean minimum and mean maximum of air temperatures of 7, 21 and 29°C, respectively. The mean annual rainfall is about 55 mm 5. The annual pan evaporation is about 4500 mm. The soil characteristics of Agriculture Research Farm is sandy-loam in texture, pH = 8.0 and electrical conductivity (EC) = 2.6 ds.m^{-1} (soil and water properties of experiment is shown in (Tables 1 and 2).

Table 1. The result of some soil chemical characteristic before planting (depth 0-30)

Manganese (ppm)	Zinc (ppm)	Copper (ppm)	Iron (ppm)	Absorbent potassium (ppm)	Available phosphorus (ppm)	total N (%)	organic carbon (%)	pH	EC Ds/m
7.16	0.3	0.29	2.6	2.5	4.7	4.3	0.2	8.0	2.6

Table 2. Irrigation water chemical characteristics of field

Sodium adsorption ratio	Percent solution of sodium	Total cations	Na	Ca	Cl	Co_3H	co_3	pH	EC Ds/m
10.2	77	20.1	15.5	4.6	12.0	5.2	0	7.8	2.0

The experimental design was split plot using randomized complete block design with three replications. Treatment was consisted of irrigation in 4 levels, S_0: complete irrigation, S_1: halted irrigation at squaring, S_2: halted irrigation at 50% flowering, S_3: halted irrigation at grain filling as main plot; and cultivars in 3 levels, V_1: Zaria, V_2: Alstar, V_3: Azargol as sub factor.

Before planting, 200 kg/ha P (as triple super phosphate) and 150 kg/ha K (as potassium sulfate) was added to the respective treatments, while 150 kg/ha N as urea was applied in two doses; half at planting and the remaining half at 55 days after planting. Sunflower was planted manually in March 2004. Experiment plots were designed with 50 cm row to row distance and 20 cm between plants. Seeds were sown 5 cm deep. Weeds were removed by hand. After planting, irrigation was applied as required during the growing season.

Data collected (obtained by combining the four center rows at each experiment unit) included: plant height, seed number of head, 1000 grain weight, yield grain, oil yield and oil percent.

Seed oil content was determined according to A.O.A.C. (1990) using soxhlet apparatus and diethyl ether as a solvent.

The data were analyzed using MSTATC software; mean comparison was done using Duncan multiple comparison at 5% probability.

RESULTS AND DISCUSSION

Plant height

In this study, plant height affected by irrigation treatments ($P < 1\%$), so that the maximum and minimum plant height respectively was achieved from complete irrigation treatment with mean 117.833 cm and irrigation treatments in stage of halted irrigation at squaring with 104.750 cm (Table 3). Water stress causes deceleration of cell enlargement and thus reduces stem length by inhibiting inter nodal elongation and also checks the tillering capacity of plants (Ashraf and O'Leary, 1996). Soriano et al., (1994) reported that adequate irrigation lead to increase of plant height in sunflower. Interaction effect of irrigation treatments and cultivars in plant height was significant ($P < 5\%$). Maximum and minimum plant height was achieved from treatments of S_0V_1 and S_1V_2 with mean 136 cm and 95 cm respectively (Table 4).

Seed number per head

The results of variance analysis showed that effect of treatments of irrigation and cultivars was significant on seed number per head ($P < 1\%$). The highest number of seeds obtained from treatment of complete irrigation. The lowest seed number per head was seen from treatment of stress in flowering stage (Table 3). Among cultivars

treatments the maximum number of seeds obtained from Zarya cultivar and the lowest was achieved from Allstar cultivar (Table 3).

Interaction effect of irrigation and cultivars treatments not significant on seed number per head in the 5% probability level.

1000 grain weight

According to results of variance analysis effect of treatments of irrigation and cultivars was significant on 1000 grain weight (P < 1%). The highest 1000 grain weight (56.583 g) obtained from treatment of complete irrigation and the lowest amount of oil yield (41.242 g) was seen from treatment of stress in flowering stage (Table 3). The decrease of vegetative growth in condition of water shortage lead to decrease of photosynthesis materials production in plant and finally decrease of 1000 grain weight.

Among cultivars treatments the most 1000 grain weight obtained from Azargol cultivar (53.794 g) and the lowest amount of it was achieved from Zarya cultivar (40.525 g) (Table 3).

The interaction effect between irrigation and cultivar treatments was significant (P < 5%). Maximum and minimum 1000 grain weight was achieved from treatments of S_0V_3 and $S_2V_1$with average 66.175 g and 42.275 g respectively (Table 4).

Grain yield

The results of variance analysis showed that effect of treatments of irrigation and cultivars was significant on grain yield (P < 1%), so that the highest grain yield from treatment of complete irrigation with an average 4700 kg and the lowest grian yield was seen in treatment of halted irrigation at squaring with yield average 3245 kg. D `Andria et al., (1995) during the two-year study found that the most sensitive life stage of sunflower irrigation is time of squaring, and can improve the yield of this plant (Table 3). Soriano et al., (1994) concluded that sunflower seed yield was the most sensitive to water stress after anthesis. He also emphasized the need of irrigation management under limited water supply, especially during the reproductive period.

Among cultivars treatments the highest grain yield obtained from cultivar of Azargol with average 4300 kg and the lowest yield about 3450 kg was achieved from cultivar of Zarya (Table 3). This matter can be by reason of higher resistance of Azargol cultivar to water deficit and having a high leaf surface duration reproductive stage. The interaction of irrigation and cultivars on grain yield was significant (P < 5%), so that the highest and lowest grain yield was achieved from treatments of S_0V_3 (5750 kg) and S_1V_1 (2846 kg) respectively (Table 4).

Oil seed percentage

In this study the effect of oil seed percentage under irrigation treatments was significant at 5% probably level, but cultivar treatments and interaction effect of these two factor wasn't significant on oil seed percentage. The highest oil percentage (41.98%) obtained from treatment of complete irrigation and lowest amount of it (36.97%) was achieved from treatment of stress in flowering stage (Table 3).

Oil yield

The results of variance analysis showed that effect of treatments of irrigation and cultivars was significant on grain yield (P < 1%). The highest oil yield (1980 kg/ha) obtained from treatment of complete irrigation and the lowest amount of oil yield (1207 kg/ha) was seen from treatment of stress in flowering stage (Table 3). Probably adequate irrigation during the vegetative stage, leaf development and grain filling stage can increase grain weight and oil storage. Razi and Asad (1998) reported the results similar to this experiment.

Among cultivars treatments the most oil yield obtained from Azargol cultivar (1712 kg/ha) which can be due to the high yield of grain this cultivar compared to other cultivars and the lowest amount of it was achieved from Zarya cultivar (1350 kg/ha) (Table 3).

The interaction between irrigation and cultivar treatments was significant (P < 5%). Maximum and minimum oil yield was achieved from treatments of S_0V_3 and $S_2V_1$with average 2490 kg/ha and 1099 kg/ha respectively (Table 4).

Table 3. Effect of irrigation and sulphur levels on factor measured

Treatments	Plant height (cm)	Seed number of head	1000 grain weight (g)	Yield grain (ton/ha)	Oil yield (kg/ha)	Oil percent (%)
Irrigation						
S_0	125.083 a	847.500 a	56.853 a	4.700 a	1.980 a	41.980 a
S_1	104.750 c	708.833 c	45.633 bc	3.245 c	1.256 c	38.650 b
S_2	116.750 b	796.917 b	41.242 c	3.267 c	1.207 c	36.970 b
S_3	117.833 b	856.833 a	48.567 b	4.127 b	1.547 b	38.020 b
Cultivar						
V_1	124.813 a	856.688 a	40.525 c	3.456 b	1.350 b	38.950 a
V_2	100.938 a	750.625 b	49.700 b	3.754 b	1.450 b	38.440 a
V_3	122.563 a	800.250 ab	53.794 a	4.293 a	1.712 a	39.310 a

Means followed by similar letters in each column are not significantly different at the 5% level of probability

Table 4. Mean comparison of interaction effects of factors measured

Treatments	Plant height (cm)	1000 grain weight (g)	Yield grain (ton/ha)	Oil yield (kg/ha)
S_0V_1	136.00 abc	42.00 d	3.87 bcd	6.60 bcd
S_0V_2	100.75 de	61.57 a	4.47 b	1.84 b
S_0V_3	126.75 abc	66.17 a	5.57 a	2.49 a
S_1V_1	114.75 abcde	42.27 d	2.84 f	1.10 d
S_1V_2	95.50 e	45.47 cd	3.46 cdef	1.33 cd
S_1V_3	104.00 cde	49.15 bc	3.42 cdef	1.33 cd
S_2V_1	126.50 a	33.57 e	3.04 ef	1.09 d
S_2V_2	96.25 bcde	43.92 cd	3.08 def	1.51 cd
S_2V_3	127.50 ab	46.22 cd	3.67 bcdef	1.37 bcd
S_3V_1	132.00 abcd	44.25 cd	4.05 bc	1.59 bcd
S_3V_2	100.25 e	47.82 cd	3.99 bc	1.47 bcd
S_3V_3	126.00 ab	53.62 b	4.32 b	1.65 bc

Means followed by similar letters in each column are not significantly different at the 5% level of probability

REFERENCES

A O A C. 1990. Assoc. Office. Agri. Chemists, 'Official methods of analysis', Editor Hormitz, W. 10th edition, Washington DC, USA, pp: 129.

Ashraf M, O'Leary JW. 1996. Effect of drought stress on growth, water relations and gas exchange of two lines of sunflower differing in degree of salt tolerance. Int. J. Plant Sci., 157: 729-732.

Ashri A, Knowles PF. 1960. Cytogenetics of safflower (*Carthamus* L.) species and their hybrids. Agron. J., 52: 11-17.

Belhassen E. 1995. An example of interdisciplinary drought tolerance study. Looking for physiological and molecular markers of low cuticular transpiration. Int. Congress on integrated studies on drought tolerance of higher plants, "Interdrought 95", Montpellier, France.

Dash S, Mohanty N. 2001. Evaluation of assays for the analysis of thermo tolerance and recovery potentials of seedlings of wheat (*Triticum aestivum* L.) cultivars. J. Plant Phys., 158: 1153-165.

Iqbal N, Ashraf MY, Ashraf M. 2005. Influence of water stress and exogenous glycinebetaine on sunflower achene weight and oil percentage. International Journal of Environmental Sciences and Technology, 5(2): 155-160.

Knowles PF. 1976. Safflower. In: Simmonds NW, Ed. Evolution of crop plants. London: Longman.

Krizmanic M, Liovic I, Mijic A, Bilandzi M, Krizmanic G. 2003. Genetic potential of OS sunflower hybrids in different agroecological conditions. Sjemenarstvo, 20(5/6): 237-245.

Petcu E, Arsintescu A, Stanciu D. 2001. The effect of hydric stress on some characteristics of sunflower plants. Romanian Agricultural Research, 16: 15-22.

Razi H, Asad MT. 1998. Evaluation of variation of agronomic traits and water stress tolerant in sunflower conditions. Agricultural and Natural Resources Sciences, 2: 31-43.

Soriano MA, Villalobos FJ, Fereres E, Orgaz F, Borin M, Sattin M. 1994. Response of sunflower grain yield to water stress applied during different phonological stages, Abano-Padovo, Italy, pp.18-22.

Tahmasebpour B, Aharizad S, Shakiba M, Babazade Bedostani A. 2011. Safflower genotypes responses to water deficit. Int. J. Agric. Sci., 1(2): 97-106.

Turner LB. 1991. The effect of water stress on the vegetative growth of white clover (*Trifolium repens* L.): Comparison of long-term water deficit and short-term developing water stress. J. Exp. Bot., 42: 311-316.