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Influence of Water Stress and Sowing Date on Sunflower Yield and Oil Percentage

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Abstract: The effect of water stress and sowing date on yield and oil percentage has been studied in sunflower (*Helianthus annuus* L.). For this purpose, one standard hybrid (Euroflor) sown in spring at the 3 different dates were cultivated in Western Iranian under 5 water regimes, viz I_1, IW/CPE (irrigation water: cumulative pan evaporation) ratio 0.6. I_2, at 25 days after sowing + flower-bud initiation; I_3, at 25 days after sowing + complete flowering; I_4, at 25 days after sowing + seed filling; I_5, at 25 days after sowing + complete flowering + seed filling in 2007. Yield, its main component and oil percentage were positively affected by irrigation and by the earlier sowing date. At early sowing date the yield and yield components showed notable increase. The increase in these parameters observed also in supplementary irrigation.

Key words: *Helianthus annus* L., sowing date, irrigation, water stress, yield, oil percentage

INTRODUCTION

Water stress is considered one of the most important factors limiting plant performance and yield world wide. Effects of water stress on a plant's physiology, including growth, yield and oil percentage has been studied extensively (Ribas-Carbo *et al*., 2005; Iqbal *et al*., 2005). Numerous studies have shown that yield and oil percentage is reduced when normal spring sowing date is delayed in subtropical environments. The observed lower yields associated with late planting have been variously hypothesized as due to warmer temperature during the growth period, which promotes excessive early stem growth; reduce time flowering and reduced incident radiation photosynthesis, which affects dynamics of grain filling (Abelardo *et al*., 2002). Whit most plants the maintenance of growth and function depends on maintaining relatively high water content in the protoplasm.

This is because many important physiological processes such as leaf enlargement, stomata opening and photosynthesis are directly affected by a reduction in leaf water potential. In plants water deficits have been shown to decrease both growth and yield (Flagella *et al*., 2002).

The aim of this study was to evaluate the influence of irrigation and 3 sowing dates on seed yield, yield component and oil percentage of sunflower grown in a sub- arid environment. That in order to get deeper in sight into the effects of main agronomic techniques adopted in Iranian climate on seed yield and quality of sunflower.

MATERIALS AND METHODS

This study was conducted in 2006 at a farm of Agricultural researches center located in west Iran, Urmia (37°43'E, 45°2'N) on a flat silt loam clay soil having 0.12% total nitrogen contented (Kjeldhal method), 12.5 ppm assumable phosphorus (Olsen Method, P_2O_5), 800 exchangeable potassium (Ammonium acetate Method, K_2O), 1.20% organic matter (Walchy-Black method). Seeds of sunflower genotype (Euroflor) were obtained from the company of oil seeds of Urmia.

Experiment was laid out in a split-plot design with 3 replications. There were 3 planting dates in main plot, viz 5 May, 20 May, 5 June and 5 irrigations schedules in subplots, viz I_1, IW/CPE (irrigation water: cumulative pan evaporation) ratio 0.6. I_2, at 25 days after sowing + flower-bud initiation; I_3, at 25 days after sowing + complete flowering; I_4, at 25 days after sowing + seed filling; I_5, at 25 days after sowing + complete flowering + seed filling. A pre-sowing irrigation of 100 mm was applied to ensure good germination of the crop and post-sowing irrigation each of 60 mm depth were given as per treatment. The quantity of water was measured with the help of 15 cm throat Parshall flume fixed in the irrigation channel.

Plants were sown in rows planted 0.6 m apart, with the seeds placed 0.25 m apart along the row. The crop of 5 May, 20 May and 5 June, was harvested on 22nd August, 6th and 21st September, respectively. Seed yield and 100-achene weight was recorded.

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Analysis of variance of the data from each attribute was computed using the SAS computer program (version 9). The Duncan's new multiple range tests at 5% level of probability was used to test among mean values (Iqbal *et al*., 2005).

RESULTS AND DISCUSSION

Both yield parameters and the oil percentage showed significant differences in relation to the sowing date and the water regime (Table 1 and 2). The more favorable irrigation regime resulted in a better yield performance. Due to a higher number of seeds per head and 1000 achene weight, the early sowing date (5th May) resulted highest seed yield (2.004 ton ha^{-1}) (Table 1).

Irrigation exhibited a highly significant positive effect on seed yield. The highest seed yield was obtained from I_1 irrigation treatment (1.686 ton ha^{-1}) (Table 1) due to an increase of both 1000 seed weight and the number of seeds per head.

Combine analysis of variance showed that the effect of sowing date on 1000 achene weight and seed number per head was significant (Table 1). The highest 1000 achene weight was obtained from D_1 (5th May) (64.20 g). Oslo analysis showed that D_1 resulted highest seed number per head (2098) (Table 1).

The highest seed number per head obtained from I_1 irrigation treatment (1984). Too I_1 irrigation treatment resulted highest1000 seed weight (63.22 g) (Table 1).

Analysis of variance showed that the effect of sowing date and water stress on oil percentage was significant (Table 2). Early sowing date (5th May) resulted highest oil percentage (36.74%). An increase in oil percentage similar to that obtained with the earlier sowing date was observed under irrigation and highest oil percentage obtained from I_1 irrigation treatment (35.85 %) (Table 2).

The highly positive effect of irrigation on seed yield confirms the key role of supplementary irrigation at critical growth stages, particularly sensitive to water stress (Flagella *et al*., 2002). The decrease in yield, yield component and oil percentage in different sunflower genotype has also been reported by many workers. These workers clearly indicated that sunflower drought tolerant lines showed less reduction in yield plants in respect of susceptible lines (Agele *et al*., 2007; Flagella *et al*., 2002).

Flagella *et al*. (2002) reported that both yield parameters and oil fatty acid composition showed significant difference in relation to the water regime. These results were agreement with our results.

Concerning the effect of the sowing time, we observed a yield increase in the early sowing with respect to the later one. Our results are agreement with those already reported for standard genotype sown in spring in western Iran. Infect anticipation sowing time from May to March (Barros *et al*., 2004) caused a marked yield increase. This behavior might be as crib able to the best soil water content in the early stage of plant development.

Flagella *et al*. (2002) reported that early sowing generally yielded more seed with a higher oil percentage than later planted sunflower. So, the choice o f the sowing date reveals a decisive factor for the good performance of the crop, above all when water availability exerts a limiting effect. Seed yield is strongly influenced by the water use of the crop during the later crop stages and thus, by the precipitation during these stages (Barros *et al*., 2004). Different planting dates caused flowering and seed development to occur during periods of widely different temperatures, radiation and day length. So a correct decision on the planting date should be based in a through understanding of the environmental factors influencing sunflower growth, yield and oil percentage.

Table 1: Influence of sowing date and water regime on the mean values of seed yield

	Sowing date*			Water regime**				
Parameters	D_1	D_2	D_3	I_1	I_2	I_3	I_4	I_5
Seed yield (ton ha^{-1})	2.004^{A}	1.114^{B}	1.123^{B}	1.6^{A}	1.0^{D}	1.2^{C}	1.3^{B}	1.4^{B}
1000 achene weight (g)	64.20^{A}	51.06^{B}	46.83^{B}	63.2^{A}	41.9^{D}	51.2^{C}	54.5^{C}	59.2^{B}
Achene/head (No.)	2098^{A}	1362^{B}	1261^{B}	1984^{A}	1182^{D}	1442^{C}	1545^{C}	1716^{B}

Table 2: Influence of sowing date and water regime on the oil percentage

	Sowing date*			Water regime**				
Parameters	D_1	D_2	D_3	I_1	I_2	I_3	I_4	I_5
Oil percentage	36.74^{A}	28.16^{B}	21.23^{B}	35.5^{A}	21.3^{D}	27.6^{C}	28.6^{Bc}	30.3^{B}

Values in a row followed by the same letter are not significantly, according to Duncan's test at $p<0.05$; *D_1, D_2 and D_3, 5th May, 20th May, 5th June, respectively; **I_1, I_2, I_3, I_4 and I_5, IW/CPE (irrigation water: cumulative pan evaporation) ratio 0.6. at 25 days after sowing flower-bud initiation; 25 days after sowing+ complete flowering; 25 days after sowing+ seed filling; 25 days after sowing+ complete flowering+ seed filling, respectively

CONCLUSION

In conclusion, in Iranian environment, supplementary irrigation and early sowing resulted in a notable rise in seed yield.

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