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Survey of yield and yield components of sunflower cultivars under drought stress

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ABSTRACT

The experiment was investigated to survey of yield and yield components of sunflower cultivars under drought stress in 2012 in Kabootatabad of Esfahan farm. An experiment was conducted in split plot and was designed in randomized complete block with three replications. Irrigation was as main plots in 3 levels (control (normal irrigation), irrigation of 130 mm evaporation from pan evaporation, irrigation of 180 mm evaporation from pan evaporation) and cultivars as subplots was at 5 levels (Zaria, Hysun 36, Favorit, Lakumka and Master). The results showed that the effect of irrigation regime on biological yield, grain yield and harvest index were significant, so that the maximum and minimum values of these traits were observed in the control and irrigation treatment after 180 mm evaporation from pan respectively. Significant effect were observed amount cultivars in biological yield and oil percentage, so in two traits that the highest biological yield and oil percentage obtained in Favorit cultivar and the lowest was obtained in Zaria cultivar. Also the interaction between stress × cultivar was significant on the grain yield trait and oil percentage, and Hysun 36 cultivar at an irrigation level of 180 and 130 mm evaporation from pan had the highest and lowest yield, respectively. Also Master cultivar had highest seed oil percentage with control and Master cultivar had lowest seed oil percentage of irrigation level of 180 mm evaporation of pan, also a Master cultivar at control showed the highest amount of oil present and Master treatment showed the least amount of seed oil at an irrigation level of 180 mm evaporation from pan least.

Key words: oil present, stress and Hysun 36 cultivar.

1- INTRODUCTION

One of the most important farm management to achieve optimum plant population growth and good performance, providing enough water for plants in order to plant not to be affected by water stress at critical stages of growth. Fereres et al., (1983) found that sunflower leaf surface rapidly decreases by the effect of drought stress and thereby causes a negative effect on seed yield. Yegappan et al., (1982) stated that draught stress caused aging leaves, reduced leaf number, diameter, leaf area and yield of sunflower. In The sunflower plant, number of heads per unit area, seed number per head and seed weight, are major components of yield (Holt, 1984). Zaffaroni and Schneiter (1989) showed that the number of seeds per

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head is the most important yield component and should be considered in order to increase yield. Beard and Geng (1982) in their study found that the number of seeds per head yield is more important in determining seed yield than grain weight. Erid Jones (1984) reported that the most significant effect of soil water on sunflower plant is reduction of seed yield and this reduction of soil water does not have much effect on the oil yield. Cox and Jolliff (1986) found by the effect of drought stress production of dry matter in sunflower decrease up to 50% and the yield decreases up to 51 %, and level of head decreases up to 38 % compared to the normal decrease. Fereres et al., (1986) found that there is no significant linear correlation between sensitivity index of stress with air organ biomass and seed yield in a comparison of three-year normal condition and water stress in Sunflower. But there is a correlation between harvest index and seed yield in stress condition. Merill and Rawlins (1979) showed that the frequency of enough irrigation causes weight gain and better distribution of roots in the very deep of the soil. But increased few irrigation, distribution and density of roots in the soil deep down range. The high frequency of irrigation had dry weight about 25 to 40 percent of air organ than less irrigation. Chimenti et al., (2002) stated that the occurrence of stress at anthesis to physiological maturity had no significant effect on biomass and water stress on yield, size significant effect on yield and harvest index. Toole and Moya (1981) stated that occurrence of stress had a significant effect on biomass and at the final stage of pollination and stress at a stage of physiological maturity of seed, seed length and harvest index. Water deficit during flowering and pollination may affect seed yield of sunflower due its effects on reproductive organs and increase the number of empty seeds in the head. Mozaffari et al., (1996) stated about the effect of drought stress on percentage of sunflower oil that percentage of oil does not damage at draught stress. Because seed oil is quantitative traits that controls by a large number of genes. The sunflower is a crop that can withstand a variety of environmental conditions, particularly drought and due to the developed root system, it has high efficiency in extracting water from the soil, provided that the soil is very deep and the soil structure is not limited by root development. Sunflower is relatively resistant to heat and cold and can be somewhat tolerated them without damage. An early frost in the fall that destroys the corn and soybean does not harm it. These adaptations resulted that the cultivation of it is possible in a wide range of climatic conditions (Khajepour, 2009). The main aim of this study was identified the best cultivar to drought stress in terms of yield because sunflower is one of important oilseed crops and there is a water shortage situation in most places of the world, so an experiment was conducted entitled Survey of yield and yield components of sunflower cultivars under drought stress.

2- MATERIALS AND METHODS

Study the adaptation of new cultivar of oil sunflower was conducted for summer planting of the crop year of 2012 in research station Kabootar Abad located in the village of Kabootar Abad of Esfahan. The geographical location of the farm is at 25 km East Esfahan along the longitude 51 degrees 48 minutes east and latitude 32 degrees 40 minutes North 1555 meters above sea level. The experiment was a split plot in a randomized complete block design with three replications. Class A pan was used To determine the level of irrigation water from evaporation Irrigation treatments were transcribed. As main plots in 3 levels: 80 mm irrigation based on evaporation (conventional irrigation), irrigation based on of 130 mm evaporation from pan evaporation, irrigation based on 180 mm evaporation from pan evaporation and sunflower cultivars as subplots in five levels including Zaria, Hysun 36, Favorit, Lakumka and Master cultivars. Each plot consisted of four 5-meter line and the time of doing stress was started after the establishment of the plant and from 6 leaves in experimental plots. Row spacing of 60 cm and plants spacing of row 20 cm was considered, so plant density was 83,333 plants per hectare. The stage of complete maturity was considered when the back of the petals is brown and leaves were dry, 6 plants successive were selected from the middle row of the four per plot. Then the number of seeds was counted and their weight was measured. In order to determine the seed yield and HI in maturity stage Examples was removed from the exit of stems from second to forth rows and by removing a half feet long from the beginning and end of row as a peripheral effect. The heads were separated and dried in the open air. After drying, grain weight of treatments and kernel percentage with seed yield and other traits were determined. Percentage of oil samples from complete seeds of each plot was evaluated in the laboratory using sox let petroleum ether solvent. Data were analyzed by means of statistical analysis and averages were compared with Duncan's multiple range tests at probability level of five percent if the effect of experimental treatment was significant. MSTATC and SAS software using statistical calculations and plotting graphs were done using EXCEL software.

3- RESULTS AND DISCUSSION

3-1- 1000 KERNEL WEIGHT

Effect of irrigation regimes on sunflower seed weight was not significant (Table 2). Results showed that the highest grain weight (464.6 g) belongs to irrigation treatment based on 180 mm evaporation from the pan which was not significantly different from other treatments. The lowest seed weight (412.8 g) was obtained by irrigation treatment based on 130 mm evaporation from the pan (Table 3). Effect of different cultivars of sunflower on seed weight was not significant (Table 2). The highest grain weight (469.2 g) belonged to Zaria cultivar which was not significantly different from other treatments. The lowest seed weight (415.5 g) was obtained by Master cultivar (Table 3). Therefore, the results indicate that increasing severity of drought stress reduced grain growth and increased grain weigh. The results indicate that increasing severity of drought stress decreased seed weight. It seems that decreasing seed weight under drought stress is because of reduction of the grain filling period and premature aging. In fact draught stress reduced seed weight and seed number by reducing the leaf area. Perhaps drought stress had a negative effect on the current and further transmission of the photosynthesis materials. And finally the transmitted material to grain decreases. And this has led to shrinkage and weight loss of grains. Ahmadi et al., (2006) reported that reduction of grain weight of different cultivars in response to drought stress indicates a lack of demand for photosynthesis material for seeds under these conditions.

3-2- BIOLOGICAL YIELD

Effect of irrigation regimes on biological yield of sunflower at probability level of 1% ($p \leq 0.01$) was significant (Table 2). Comparison of means showed that most (32190 $kg.ha^{-1}$) biological yield belonged to irrigation treatment based on control which had not significant difference with other treatments. Lowest (25779 $kg.ha^{-1}$) belonged to 180 mm evaporation from pan biological function (Table 3). Effect of different sunflower cultivars on biological yield was not significant (Table 2). Most (29501 $kg.ha^{-1}$), biological yield belonged to a Favorit cultivar which had no significant difference with other cultivars. Lowest (27981 $kg.ha^{-1}$), biological yield belonged to Hysun 36 cultivar (Table 3). Increase in biological yield can be caused by the increase of leaf area index which led to increase of crop growth rate. Reduction of irrigation intervals by improvement of physiological increased dry matter accumulation in vegetative organs and biological yields. Pankovic et al., (1999) stated that water deficits during flowering to budding stage end have the most negative effect on the yield of sunflower hybrids.

3-3- GRAIN YIELD

Effect of irrigation regimes on grain yield of sunflower at 1 % probability level ($p \leq 0.01$) was significant (Table 2). Comparison Results showed that the highest grain yield with rate of 3612.1 $kg.ha^{-1}$ owned control which had no significant difference with other treatments. The lowest grain yield with a rate of

3103.6 kg.ha^{-1} owned irrigation treatment based on 180 mm evaporation from the pan (Table 3). Effect of different cultivar of sunflower on grain yield cultivars was not significant (Table 2). The highest grain yield (3432.2 kg.ha^{-1}) owned by the Master cultivar which had not significant difference with other figures. The lowest grain yield (3305.1 kg.ha^{-1}) belonged to the Master cultivar (Table 3). However, the interaction of irrigation treatments on different cultivars at one percent ($p \leq 0.01$) probability level was significantly (Figure 1). Hysun 36 cultivar at an irrigation level of 180 and 130 mm evaporation from pan had the highest and lowest yield, respectively (Figure 1). Increase of yield stress in stress condition can be attributed to water defect and reduced the growth period and increased reproductive phase. It seems that a moderate intake of water during different stages of growth i.e. flowering and grading will lead to improve grain yield of sunflower. Because During these stages two major components of grain yield (seed number and seed weight and 1000 kernel weight) are formed. Meanwhile enough irrigation in growth stage contributes to the desirable development of leaf area and photosynthesis of plants. Reducing seed yield in conditions of limited irrigation can be contributed to the effect of water defect due to lack of water which is along with the acceleration of aging and reduction of filling period of grain, the signals sent from roots to leaves and induced stomata and final reduction of the proportion of net photosynthesis. It seems that a balanced intake of water during various developmental stages of flowering and grading improved grain yield of sunflower. Because During this stage the most important yield components (seed number in head and seed weight) are formed. Also enough Watering during the vegetative stage causes leaf development and photosynthesis of plants. Mazaheri laghab et al., (2001) stated that poor irrigation regime not only reduces leaf area and premature aging but also decrease of seed yield. In fact, the reason of seed yield loss due to drought stress a decrease in current photosynthesis and remobilization of during grain filling material can be attributed. The Human et al., (1990) in their experiments under severe stress at flowering, pollination and seed formation known to cause yield reduction.

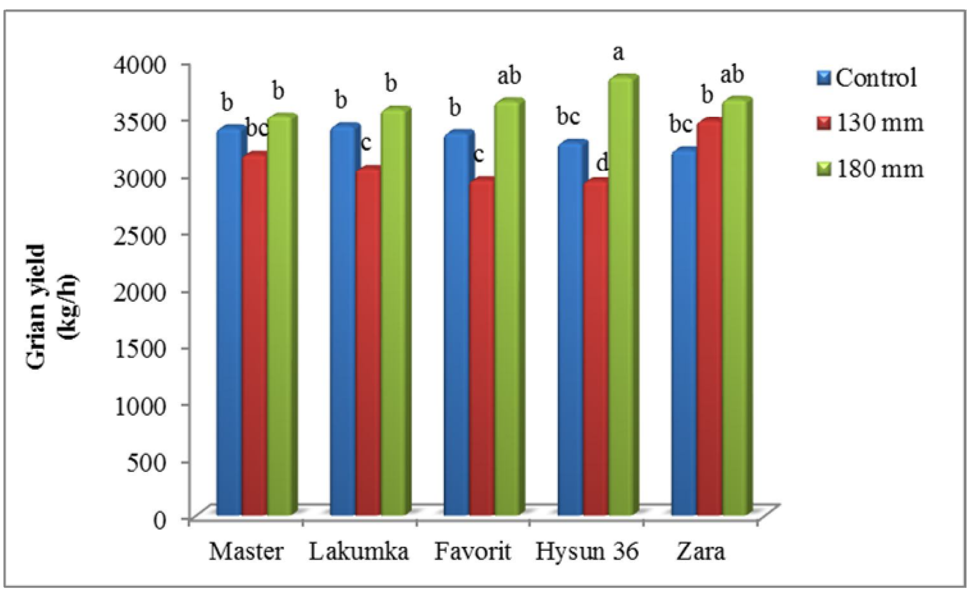

Figure 1- Interaction of stress and cultivar on grain yield of sunflower affected by three different irrigation treatments

The columns that are common in a letter lacking a statistical difference based on Duncan test at 5% probability level.

3-4- HI

Effect of irrigation regimes on the sunflower harvest index was significant at the 5% probability level (Table 2). Results of Comparison of means showed that most HI belonged to control treatment which had no significant difference with other treatments. Lowest HI belonged to treatments based on 130 and 180 mm evaporation from the pan (Table 3). Effect of different cultivars of sunflower on harvest index was not significant and the comparison also showed no significant differences (Table 2). Harvest index is defined as the ratio of economic yield to biological yield. The results indicated that drought stress reduced the total dry matter in critical times. Therefore, harvest index decreases due to poor reservoir, photosynthesis cannot be available at the reproductive parts and this can reduce the growth of seeds and finally harvest index decreases. Results of Flenet et al., (1996) showed HI, increased by mild stress but decreased by drought stress, but the intensity, the index declined. Chimenti et al., (2002) stated that occurrence of stress at the final stage of maturity had no significant effect on biomass and stress at a stage of physiological maturity on seed yield, seed size and harvest indexResults of Fereres et al., (1986) showed that drought stress caused a decline of HI of all sunflower genotypes.

3-5- OIL PRESENT

Effect of irrigation regimes on percentage of sunflower oil was significant at the probability level ($p \leq 0.01$) (Table 2). Comparison of means showed that most (43.15 %) percent of oil owned control treatment which was not significantly different from other treatments. Lowest (42.02 %) percent of oil owned irrigation treatment based on 180 mm evaporation from pan (Table 3). Effect of different cultivates of sunflower was not significant on an oil percentage (Table 2). Most (43.46 %) percent of oil owned Favorit, which was significantly different compared with other cultivars. Lowest (41.30 %) percent of oil owned Zaria cultivar (Table 3). The interaction effect of irrigation treatments on different cultivars at one percent ($p \leq 0.01$) was significant (Table 2). Master cultivar at control showed the highest amount of oil (49.9%) and Master treatment showed least amount of seed oil (39.58%) at irrigation level of 180 mm evaporation from pan least (Figure 2). Decrease of oil percentage in Control treatment is because increase of water consumption increases excessive vegetative growth and delayed maturation of immature seed at the time of harvest also reduction of the percentage of oil in the severe stress treatment is because of impaired grain filling , which increases the skin of sunflower seeds. Moisture Stress actually reduces the number of seeds in length of the seed the amount of oil has distributed in smaller tank and the oil percentage has not been affected (Cox and Jolliff, 1986). Sunflower oil yield per unit area is because of grain yield per unit area and seed oil percentage. Mozaffari et al., (1996) has quoted about the effect of drought stress on the sunflower oil percentage that the oil percentage does not damage in drought stress because seed oil is a quantity that controls by many genes.

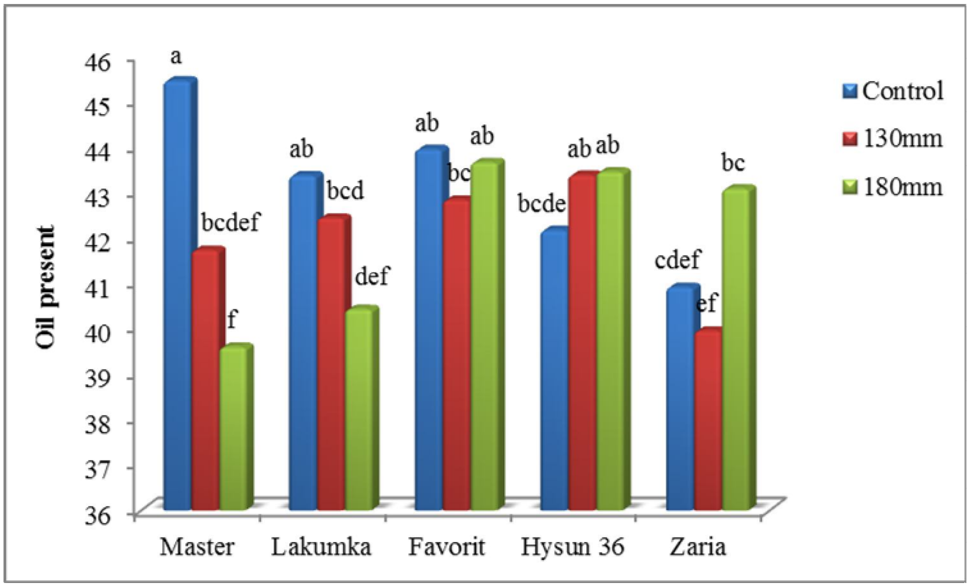

Figure 2- Interaction of stress and cultivar on oil present of sunflower affected by three different irrigation treatments
The columns that are common in a letter lacking a statistical difference based on Duncan test at 5% probability level.

CONCLUSION

The results indicate that the effect of irrigation treatments on seed weight, seed yield, oil percentage, harvest index, biological yield was significant so that the maximum amount of grain weight, grain yield, and biological treatment in irrigation treatment based on 180 mm evaporation from the pan and maximum percentage of oil was obtained by control treatments. From the above results it can be understood that Favorit cultivar is less suitable for the cultivated area than other cultivars in stress irrigation.

Table 1 - Changes in atmospheric temperature (° C) and total monthly rainfall (mm)

month	Total monthly precipitation (mm)	The absolute minimum (°C)	The absolute maximum (°C)	The average monthly (°C)	The mean minimum (°C)	The mean maximum (°C)
July	2	10.2	42.4	27.4	17.5	37.2
August	0	13.6	40.2	26.5	16.3	36.7
September	8	10.4	37	23.8	13.4	34.2
October	25	4.6	33.4	18.2	8.6	27.9
November	40	-0.4	25.4	12.8	4.9	20.6
December	12	-3.8	16.2	5.5	0	11.1

Table 2- Analysis of variance of field traits

SOV	df	Mean square: 1000 kernel weight	Biological yield	Grain yield	Harvest index	Oil present
Replication	2	56678.1^{**}	594791146.2^{**}	6655014.02^{**}	0.0004	158.27^{**}
Stress	2	11276.9^{ns}	163565300.5^{**}	975655.48^{**}	0.008^{*}	6.19^{ns}
Ea	4	4762.03	62204332.7	231764.02	0.0001	2.66
Cultivar	4	4419.03^{ns}	2966841.01^{ns}	23617.31^{ns}	0.0001^{ns}	6.35^{*}
Eb	24	954.6	986446.37	21140.8	0.0001	1.88
Stress× Cultivar	8	12192.62	10257309.29^{ns}	82908.54^{**}	0.0002	9.28^{**}

ns, * and ** are no significant and significant at 5 and 1 % probability levels, respectively

Table 3. The mean effect of treatments on all traits

SOV	1000 kernel weight (g)	Grain yield ($Kg.ha^{-1}$)	Biological yield ($Kg.ha^{-1}$)	HI (%)	Oil present (%)
Irrigation levels					
Control(Normal)	423.1 a	3322.8 b	32190 a	11 a	43.15 a
130 Stress	412.8 a	3103.6 b	27611 b	10 b	42.05 a
180 Stress	464.6 a	3612.1 a	25779 c	10 b	42.02 a
Cultivar					
Master	415.5 a	3348.4 a	28456 a	10 a	42.24 abc
Lakumka	416.8 a	3334.3 a	27981 a	10 a	42.06 bc
Favorit	426.5 a	3305.1 a	29501 a	10 a	43.46 a
Hysun 36	439.5 a	3310.8 a	28322 a	10 a	42.98 ab
Zaria	469.2 a	3432.2 a	28375 b	11 a	41.30 c

Means in each column ,followed by at least one similar letter are not significantly different level-using Duncan's Multiple Range Test.

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