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ORIGINAL ARTICLES

The Response of Morphological Traits in Safflower Cultivar to Drought Stress (*Carthamus tinctorius* L.)

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ABSTRACT

For determination of drought tolerance of spring safflower cultivars and studying yield and yield components in control and stress conditions, an experiment was conducted. Irrigation in two levels (control and drought at rosette ending period) in main plots and 12 cultivars as (Syrian, PI-537598,Gila, Lesaf, Dinger, 697, Cw- 4440, PI-250536, Hartman, Kino-76, LRV-51-51, S541) as subplots arranged in a RCBD base split plot in three replicates. In plots that were under water stress (stress from the end stages of forming stem growth) do not have any irrigation. Results of analysis of variance showed that the genotype effect of simple traits , days to flowering and growing period the one percent level and on oil yield is significant($P<0.05$). Highest grain yield in irrigated conditions to variety of S541(3845 kg\ha) and in Conditions without irrigation have variety of PI 250536(463.7 kg\ha). That are recommended for Agriculture in the region for the experiment.

Keywords: *Safflower , cultivars, water stress, irrigation.*

Introduction

Safflower is a highly branched, herbaceous, thistle-like annual or winter annual, usually with many long sharp spines on the leaves. The plant has a strong taproot which enables it to thrive in dry climates. The florets are self-pollinating but seed set can be increased by bees or other insects. Safflower is one of humanity's oldest crops, but generally it has been grown on small plots for the grower's personal use (Gyulai 1996). not including a large number of small garden plots throughout India and Pakistan harvested for local use (Johnston *et al*., 2002). Oil has been produced commercially and for export for about 50 years, first as an oil source for the paint industry, now for its edible oil for cooking, margarine and salad oil. Over 60 countries grow safflower, but over half is produced in India (mainly for the domestic vegetable oil market). Safflower, a strongly tap-rooted annual plant from the family Asteraceae, is native to the Middle East. It is resistant to saline conditions (Bassil and Kaffka., 2002) and to drought stresses (Bassiri *et al*., 1977). Safflower is usually planted in California in the spring to prevent excessive vegetative growth leading to poor seed yield (Kaffka and Kearney., 1998).The number of capitula per plant and the number of filled seeds per plant in safflower were shown to be linearly correlated with each other (Steer and Harrigan., 1986). Saini and Westgate (2000) pointed out that all of the reproductive sub phases of safflower are sensitive to water deficit.Water stress during early reproductive growth stages reduces seed and/or flower numbers per capitulum. Parameshwarappa and Meghannavar (2001) showed that the number of capitula, seed weight, and seed oil content varies considerably in the safflower population. Mozaffari and Asadi (2006) studied safflower mutant genotypes under normal and drought conditions and reported a positive correlation among capitulum diameter, number of seeds in the capitulum, and seed oil content. Path analysis revealed that the number of seeds in the capitulum, 100-seeds weight, stem diameter under irrigated conditions, days to 50% flowering, and capitulum diameter under drought stress conditions had the greatest positive direct effects, and capitulum weight had the greatest negative direct effects on seed yield. Effatdoust *et al*., (2004) determined that the number of capitula per plant, number of filled and hollow seeds per capitulum under no stressed conditions, and 1000- seeds weight and number of seeds per capitulum under stressed conditions were suitable traits for the selection of drought tolerant spring safflower genotypes. Lovelli *et al*., (2007) showed that the harvest index in safflower did not significantly change in 5 irrigation regimes with a restoration of 100%, 75%, 50%, 25%, and 0% of the maximum crop evapotranspiration, but seed yield declined sharply when drought was severe (Lovelli *et al*., 2007) Yau (2006) indicated that late sowing of spring safflower in a semiarid and high-elevation Mediterranean environment resulted in lower seed yield as later flowering does not allow an escape from the terminal drought and heat. It was reported that the seed yield of safflower decreased sharply when drought stress was severe (Lovelli *et al*., 2007). Omidi Tabrizi (2006) evaluated safflower genotypes under 3 different environmental conditions, in Karaj, Isfahan, and Darab in Iran, and indicated significant differences among genotypes in seed and oil yield. Iran, with an annual 240 mm of rainfall, is classified as a dry region of the world. Current estimates indicate that 25% of the world's agricultural

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lands is now affected by water stress. It can be said that it is one of the most devastating environmental stresses. The high yield of a plant in sufficiently irrigated conditions is not necessarily related to high yield under drought stress and vice versa. Depending on which stage of growth a plant experiences drought stress, it reacts quite differently to the stress (Gales,1983). The aims of this research were to study the effects of late season drought stress on seed and oil yields and their components, and to evaluate their relationships among spring safflower genotypes.

Material and Methods

This study, conducted in spring 2009 was performed at the Farm of the Zanjan local. According to the weather , the region with 120 to 150 days dry, a warm, dry Mediterranean climate regions And having a cold, wet winters , hot summers and dry semi-arid areas is considered public. The average annual rainfall , 243 mm of rainfall occurs mainly in late autumn and early spring. Irrigation as the main factor in two levels, regular irrigation and irrigation (stress) the varieties include 12 levels: Syrian, PI-537598,Gila, Lesaf,Dinger, 697, Cw-4440, PI-250536, Hartman, Kino-76, LRV-51-51, S541 were sub –plots. If a small test plots in a randomized complete block design with three replications. In plots that are under water stress (stress from stem end of bloom growth stages), no irrigation was done. But in the spring when soil moisture conditions, irrigation after rainfall to 60% of field capacity was reached in the seventh stage of the irrigation. Determination of agronomic traits of each experimental plot, 10 plants were randomly selected and their morphological characteristics were measured. According to statistical data model factorial design in Split plot analysis of variance was simple and mean comparison using Duncan's multiple range test was performed. Comparison of data for analysis and statistical software SPSS and Excel software was used for drawing diagrams.

Results and Discussion

Days to Flowering:

Analysis of variance showed that the simple interaction of irrigation and irrigation and varieties The trait days to flowering was significant ($P<0.05$). The varieties of this trait was significant ($P<0.01$). The mean Comparison of effect irrigation and varieties showed that Maximum number of days to flowering under irrigation has Varieties of the S541(89.3 day) and minimum number of days to flowering of the Gila (81.6 day). Most of these traits in non- irrigated conditions, the S541 is the variety. As a result of irrigation has increased the number of days to flowering and is more in condition irrigation (Table 1).

The number of capitula per Plant:

Results of analysis of variance showed that Simple effect of irrigation, cultivars and varieties and irrigation effect on the trait number of capitul per plant was significantly.Yield components of capitul, including the number of capitul per plant, number of seeds per capitul and seed weight, each has different effects on performance and In contrast, drought stress at different growth stages have different sensitivities. Ashri *et al* (1974), The study found that safflower varieties(903 variety) the most important component of yield in safflower plant is in capitul number. And number of seeds per capitul, but the lines of Iran is of less importance, also no effect on yield and seed weight (Table 1).

During the growth period:

Results of analysis of variance showed that Simple effect of irrigation and varieties on the property during the growing season was significantly ($P<0.01$) and While the interaction between cultivar and irrigation had no significant effect on this trait (Table 1). The varieties in this trait was observed that the mean During the period of maximum growth of variety S541 white 141.7 day and minimum of value of this attribute has Gila variety white 137.2 day.

Grain Yield:

Results of analysis of variance showed that Simple effect of irrigation on grain yield is significantly(P(0.01) and as the effect of cultivars and varieties , and irrigation of the interaction has no significant effect on this trait. The mean effect of irrigation and varieties showed the highest yield has in the irrigated varieties S541(2845 kg\ha). And the lowest grain yield under irrigation is the variety of PI-537598 (2519 kg\ha) (Table 1). The study by Patel and *et al*. (1993) took the stage to flowering and grain filling as a critical stage as the safflower to

irrigation. In another study by Samarthia and Muldoon (1995) took them in different combinations of irrigation at different growth stages were used safflower.

Oil Yield:

Results of analysis of variance showed that Simple interaction effects of irrigation and irrigation on yield and seed oil varieties is significant (P<0.01) and The simple effect of varieties on the oil yield has significant (P<0.05). The mean effect of irrigation and varieties showed the highest oil yield seed varieties under irrigation is the S541(1198 Kg\ha). At the lowest oil yield under irrigation has Dinger varieties (738.9 Kg\ha) (Table 1). Among the environmental factors that have an effect on the amount of oil , water can increase the amount of oil (Korgman and Hobbs., 1975). If the stress is reduced (Mailer and Cornish.,1987). Jensen *et al* (1996), Showed that not significantly affected mild water stress on canola , seed yield and seed oil but the severe drought stress, seed yield and oil yield significantly decrease.

Table 1: Mean Comparison the Effect of Cultivars and Irrigation on Some Agronomic Traits of Safflower

Treatment	Days to Flowering	Capitula per Plant	During the Growth Period	Grain Yield	Oil Yield
Irrigation (A)					
Irrigation(I_1)	85.6a	10.5a	118.0a	3041.1a	833.6a
Without- Irrigation(I_2)	88.3b	9.9a	160.0b	380.9b	109.6b
Variety (B)					
Syrian(1)	141.0a	8.6bc	88.3b	1736abc	518.9ab
PI-537598(2)	138.3cd	10.12abc	87.0bcd	1445c	441.1b
Gila(3)	137.2d	11.7a	84.3bcd	1690abc	437.6b
Lesaf(4)	138.3cd	9.5abc	85.3def	1708abc	493.0b
Dinger(5)	138.0cd	11.6a	84.6ef	1541bc	429.3b
697(6)	138.8cd	11.2abc	86.5bcd	1589abc	483.4b
Cw 4440(7)	140.5ab	11.4ab	88.0bc	1482bc	426.9b
PI 250536(8)	139.0ab	10.5abc	87.0bcd	1964ab	532.1ab
Hartman(9)	140.5ab	8.5c	90.3a	1823abc	544.4ab
Kino-76(10)	137.8cd	8.9abc	85.0ef	1897abc	548.8ab
LRV-51-51(11)	137.5cd	10.5abc	86.2cdef	1600abc	464.0b
S 541(12)	141.7a	10.5abc	91.8a	2060a	460.4a
Irrigation*variety(A*B)					
A1B1	121.3e	8.0e	87.3cde	3093bcde	928.5bc
A1B2	117.7gh	10.5abcde	87.0cde	2519e	767.8c
A1B3	116.0h	14.0a	81.7h	2964bcde	767.0c
A1B4	116.7gh	10.3abcde	85.0efg	2982bcde	862.8bc
A1B5	116.3h	10.4abcde	82.7gh	2667de	738.9c
A1B6	116.7gh	12.3abcd	85.0efg	2760cde	839.1bc
A1B7	119.0fg	10.8ab	88.0cd	2630e	760.0c
A1B8	117.7gh	10.6abcde	85.3cdef	3463ab	932.3bc
A1B9	120.0ef	8.0e	83.0fgh	3349abcd	1003.0b
A1B10	117.3gh	8.4de	85.0fgh	3389abc	981.4b
A1B11	117.3gh	10.1abcde	89.3bc	2834bcde	825.3bc
A1B12	120.3ef	10.6abcde	89.3bc	2845a	1198a
A2B1	160.7bcd	9.3bcde	89.3bc	378.3f	109.2d
A1B2	159.0cd	9.6bcde	87.0cde	370.7f	114.5d
A2B3	158.3d	9.3bcde	87.0cde	415.3f	108.2d
A2B4	160.0bcd	8.6cde	85.7def	433.7f	123.2d
A2B5	159.7bcd	12.6abcde	86.7cde	415.3f	119.7d
A2B6	159.0cd	10.0bcde	88.0cd	4193.0f	127.7d
A2B7	162.3ab	10.0bcde	88.0cd	333.7f	93.8d
A2B8	160.3bcd	10.3bcde	88.7c	463.7f	131.2d
A2B9	161.0bcd	9.0bcde	91.7b	296.7f	85.9d
A2B10	158.3d	9.3bcde	87.0cde	404.3f	116.2d
A2B11	159.7bcd	11abcde	87.3cde	367.0f	102.8d
A2B12	163.0a	10.3abcde	94.3a	274.3f	82.7d
Significant (M.S)					
Irrigation (A)	*	ns	**	**	**
Variety (B)	**	ns	**	ns	*
A*B	*	ns	ns	ns	**
CV %	1.67	19.7	1.69	21.6	20.7

Means with similar letter were not significant at the 5% probability level.
Levels of significant:* =P< %5, **= P<%1 and NS = not significant

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