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The Evolution of Dehydration on yield and yield component spring safflower cultivars (*Carthamus tinctorius* L.)

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ABSTRACT

Safflower, *Carthamus tinctorius* L., is a member of the family Composite or Asteraceae, cultivated mainly for its seed, which is used as edible oil and as birdseed. 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 6 cultivars as (Syrian, Gila, Lesaf, Dinger, Hartman, and S541) as subplots arranged in a RCBD base split plot in three replicates. Results showed that irrigation and cultivar interaction was significant in harvest index, seed oil percentage, and oil yield. Mean comparison showed that S541 with 16680 kg/ha in control and Lesaf with 2032 kg/ha in stress condition produced highest biologic yield, meanwhile Dinger with 12810 kg/ha in control and Lesaf with 1599 kg/ha in stress condition produced the least biologic yield. Highest oil percentage was 31.1% and 29.12% in control and stress conditions belonged to S541. Meanwhile Gila with 25.9% in control and with 26.6% in stress condition produced the least oil percentage. Highest oil content was 1198 kg/ha and 123.2 kg/ha in control and stress conditions respectively belonged to S541 and Lesaf. Meanwhile Dinger with 738.9 kg/ha in control and S541 with 82.7 kg/ha in stress condition produced the least oil content.inorganic material in compare with The control sample.

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INTRODUCTION

Traditionally, the crop was grown for its flowers, used for coloring and flavoring foods and making dyes, especially before cheaper aniline dyes became available, and in medicines. 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. In India the crop has traditionally been grown in the winter dry season in mixtures with other crops, such as wheat and sorghum. After emergence, the crop maintains a rosette form for some weeks before rapid elongation to mature height. 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 [16]. Not including a large number of small garden plots throughout India and Pakistan harvested for local use [2]. 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). Production in the USA, Mexico, Ethiopia, Argentina and Australia comprises most of the remainder. China has a significant area planted to safflower, but the florets are harvested for use in traditional medicines and the crop is not reported internationally. Safflower oil is used by farmers locally. However, safflower can be a potential oilseed crops for low-rainfall areas [6].Safflower, a strongly tap-rooted annual plant from the family Asteraceae, is native to the Middle East. It is resistant to saline conditions [3]. And to drought stresses [4]. Safflower is usually planted in California in the spring to prevent excessive vegetative growth leading to poor seed yield [9].

Parameshwarappa and Meghannavar [20] showed that the number of capitula, seed weight, and seed oil content varies considerably in the safflower population [20]. Mozaffari and Asadi [18] 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 [18]. 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 [25]. Saini and Westgate

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[23] pointed out that all of the reproductive sub phases of safflower are sensitive to water deficit [23].Water stress during early reproductive growth stages reduces seed and/or flower numbers per capitulum. 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*., [5] 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 [5]. It was reported that the seed yield of safflower decreased sharply when drought stress was severe [14,16]. 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 [14]. 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 [26]. Kar *et al*. found that the highest water use efficiency was achieved by safflower with the mean values of 3.04 and 1.23 kg ha-1 mm-1 when 3 and 1 supplemental irrigations were applied, respectively [10,12]. 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. 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.

MATERIALS AND METHODS

This study, conducted in spring 2010 was performed at the Farm of the Agricultural Research Institute (Karaj, Iran). 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 6 levels; Syrian, Gila, Lesaf, Dinger, Hartman and 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. Mean comparisons were conducted with Duncan ($p<0.05$) using SAS software.

RESULTS AND DISCUSSION

Biological Yield:

Analysis of variance showed that the simple interaction of irrigation ($P<0.05$) and varieties and varieties and irrigation($P<0.01$) on the property has significant.The mean effect of irrigation and varieties showed the highest biological yield varieties under irrigation and drought stress, S541 (16680,1599 Kg/ha) and in conditions without irrigation has Lesaf variety. Omidi and *et al*., [19] concluded that in their experiments biological yield and seed yield of safflower as a positive and significant correlation exists [2,19].

Grain Yield:

Compare the effect of irrigation on the property showed that obtained the highest amount of irrigation in this trait (3041.1 kg/ ha). The mean effect of irrigation and varieties showed the highest yield in the irrigated varieties S541(3845 Kg/ha), variety Dinger(2667 Kg/ha) has in conditions without irrigation .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 [21]. In another study by Samarthia and Muldoon (1995) took them in different combinations of irrigation at different growth stages were used safflower [11, 24].

Oil Content:

Analysis of variance showed that has significant, variety effect ($P<0.01$) and the interaction of irrigation and varieties effect ($P<0.05$) on seed oil content(Table1). Comparison showed that the interaction of irrigation and varieties the highest of amount seed oil Content under irrigation and without irrigation, the has variety S541(31.1 ,29.12 %). Abdullah [1] Have reported safflower oil content are not affected by irrigation regimes but

Patel-pG & patel-ZG [21], Concluded that oil content will be affected by irrigation regimes, With the increase in oil content and water also increases [1,13,21]

Oil Yield:

Results of analysis of variance showed that the simple effect of irrigation ($P<0.01$) on this attribute is significant. The mean effect of irrigation and varieties showed the highest oil yield in irrigated conditions, the variety of S541(1198 Kg/ha) and Lesafe(123.15 Kg\ha) variety has of conditions without irrigation(Table1). Among the environmental factors that have an effect on the amount of oil, water can increase the amount of oil [7.8]. If the stress is reduced [15,22]. Some researchers, 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 [17].

Table 1: Mean Comparison the effect of cultivars and planting row spacing on some canola agronomic traits.

Treatment	Biological Yield	Grain Yield	Oil Content	Oil Yield
Irrigation (A)				
I_1= Irrigation	13953 a	3041.1 a	29.1a	833.6a
I_2= Without- Irrigation	1754.9 b	380.9b	28.7a	109.6b
Variety (B)				
Syrian	7865 bc	1736 abc	29.48 abc	518.9 ab
Gila	7725bc	1690 abc	26.33f	437.6 b
LESAF	7755 bc	1708 abc	28.69 bcde	493.0 b
Dinger	7269 c	1541 bc	28.31de	429.3 b
Hartman	7679 bc	1823abc	29.58 ab	544.4 ab
S541	9140a	2060 a	30.16a	460.4 a
Irrigation*variety(A*B)				
I_1V_1	14090 bcd	3093 bcde	30.10 abcde	928.5 bc
I_1V_2	13780 bcd	2964 bcde	25.97 i	767.0 c
I1V3	13480 cd	2982 bcde	28.91 cdef	862.8 bc
I_1V_4	12810 d	2667 de	27.73 fgh	738.9 c
I_1V_5	13690 bcd	3349 abcd	30.0 abcde	1003.0 b
I_1V_6	16680 a	3845 a	31.19 a	1198 a
I_2V_1	1636 e	378.3 f	28.85 def	109.2 d
I_2V_2	1674 e	415.3 f	26.69 hi	108.2 d
I_2V_3	2032 e	433.7 f	28.47 fg	123.2 d
I_2V_4	1729 e	415.3 f	28.88 def	119.7 d
I2V_5	1668 e	296.7 f	29.15 bcdef	89.9 d
I_2V_6	1600 e	274..3 f	29.12 bcdef	82.7 d
Significant (M.S)				
A	*	**	N.S	**
B	*	N.S	**	N.S
A*B	**	N.S	*	**
CV%	9.54	21.16	2.70	20.75

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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