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The Effects of Different Soil Irrigation on Yield and its Related Traits in Spring Safflower Cultivars in Iran

[1]Younes Sharghi, [2]Masoumeh Kochak, [2]Samane Adeli

[1]Assistant Prof., Department of Agriculture, Islamshahr Branch, Islamic Azad University, Islamshahr, Iran
[2]Department of Agriculture, Islamshahr Branch, Islamic Azad University, Islamshahr, Iran

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ABSTRACT

Background: Safflower is one of humanity's oldest crops, but generally it has been grown on small plots for the grower's personal use. Is an important oilseed crop in the agricultural systems of many arid and semiarid areas where its yield is often restricted by water deficit and high temperatures during the reproductive growth. Seed yield can be primarily limited even by the relatively short period of soil moisture shortage during the reproductive development. **Objective:** 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 (Cw 4440, PI 250536, Hartman, Kino-76, LRV-51-51 and S541) as subplots arranged in a RCBD base split plot in three replicates. **Results:** Compare the effect of irrigation on the property showed that obtained the highest amount of irrigation in this trait (3253.98 Kg.h-1). The mean effect of irrigation and varieties showed the highest yield in the irrigated varieties S541 (4114.2 Kg.h-1), variety Hartman (464.1 Kg.h-1) has in conditions without irrigation .

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INTRODUCTION

The production and processing of oil seeds had been noticed from many years ago due to its important at nourishment and industry. Safflower is cultivated in massive area of Asia, Africa and Ocean [6]. The date of safflower cultivation reaches 3500 years ago in Egypt [3]. Probably safflower was domesticated in North East of India, Iran and Turkey [6,19]. 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 [5]. Safflower, a strongly tap-rooted annual plant from the family Asteraceae, is native to the Middle East. It is resistant to saline conditions and to drought stresses [2]. Safflower is usually planted in California in the spring to prevent excessive vegetative growth leading to poor seed yield [7]. 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 [17]. Saini and Westgate (2000) pointed out that all of the reproductive sub phases of safflower are sensitive to water deficit [15,25].Water stress during early reproductive growth stages reduces seed and/or flower numbers per capitulum [14, 24]. Parameshwarappa and Meghannavar (2001) showed that the number of capitula, seed weight, and seed oil content varies considerably in the safflower population [12,21]. 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 [10,18]. 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

Corresponding Author: Younes Sharghi, Department of Agriculture, Islamshahr Branch, Islamic Azad University, Islamshahr, Iran.
E-mail: sharghi@iiau.ac.ir

capitulum under stressed conditions were suitable traits for the selection of drought tolerant spring safflower genotypes [5,23]. 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 [9,15].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 [18,28]. It was reported that the seed yield of safflower decreased sharply when drought stress was severe [9,1]. Kar *et al*. (2007) 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 [8,12]. Supplemental irrigation also had a significant effect on grain yield. Therefore, while applying 1 irrigation, only 392 kg ha- 1 of grain yield was obtained, and yield was enhanced by 48% when 2 irrigations were applied over the single irrigation. With 3 irrigations, 1258 kg ha-1 of grain yield was obtained, 220% higher than for a single irrigation. 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 [11,20]. 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 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. 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 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; Cw 4440, PI 250536, Hartman, Kino-76, LRV-51-51 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. Comparison of data for analysis and statistical software SPSS was used for drawing diagrams.

RESULTS AND DISCUSSION

Plant height:

Results of analysis of variance showed that the simple effect of irrigation and varieties is significant on plant height ($P<0.01$). Average number of varieties found in the S541 has the highest plant height (Table 1). Vilson (1986), the effect of drought stress on vegetative growth of said land by reducing the growth among the nodes, is low the stem height. Drought effects on nutrient absorption, transport and physiological processes can reduce plant growth the reduced growth, reduced cell size and has to pore volume of the cell (Nagarjan and Bansal., 1991).

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 (17847.6 2 $Kg.h^{-1}$) and in conditions without irrigation has Hartman variety (2174.2 $Kg.h^{-1}$). Omidi and *et al*.,(2006) concluded that in their experiments biological yield and seed yield of safflower as a positive and significant correlation exists [11,20].

Grain Yield:

Compare the effect of irrigation on the property showed that obtained the highest amount of irrigation in this trait (3253.98 $Kg.h^{-1}$). The mean effect of irrigation and varieties showed the highest yield in the irrigated varieties S541(4114.2 $Kg.h^{-1}$), variety Hartman (464.1 $Kg.h^{-1}$) 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 [13]. In another study by Samarthia and Muldoon (1995) took them in different combinations of

irrigation at different growth stages were used safflower [16,22,26]. Alyari (2000) showed that the seed yield per plant has the significant correlation with the number of capitula, the number of seed per capitula, capitula diameter, 1000 seed weight and the number of lateral branches , and also the number of capitula is the most important part of yield component in safflower [3,27].

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 (33.4 , 31.2 %). Komar (1991) and Yazdisamadi (1997), Have reported safflower oil content are not affected by irrigation regimes but Patel-pG & patel-ZG(1996), Concluded that oil content will be affected by irrigation regimes, With the increase in oil content and water also increases [13,22]. Ehdaie (1984) indicated to the excellence of Nebraska 10 due to oil percentage (32%) and Urmia local cultivar due to the rate of seed protein (23.36) [6,4].

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

Treatment	Plant height	Biological Yield	Grain Yield	Oil Content
Irrigation (A)				
Irrigation (I1)	102.61a	14929.7 a	3253.98 a	31.2a
Non- Irrigation(I2)	55.96b	1877.7 b	380.9b	30.7a
Variety (B)				
Cw 4440(V1)	83.51bc	8415.5 bc	1857.52 abc	31.6 abc
PI 250536(V2)	76.06cde	8265.7bc	1808.3 abc	28.2f
Hartman(V3)	72.23e	8297.8 bc	1827.56 abc	30.7 b-e
Kino-76(V4)	75.86cde	7777.8 c	1648.8 bc	30.31de
LRV-51-51(V5)	85.65b	8216.5 bc	1950.61 abc	31.68 ab
S 541(V6)	93.00a	9779.8a	2204.20 a	32.3a
Irrigation*variety(A*B)				
I_1V_1	105.68bc	15076.3 bcd	3309.5 b-e	32.2 a-e
I_1V_2	98.62c	14744.6 bcd	3171.5 b-e	27.8 i
I1V3	94.51c	14423.6 cd	3190.7 b-e	30.9 c-f
I_1V_4	97.51c	13706.7 d	2853.7 de	29.7 fgh
I_1V_5	112.46b	14648.3 bcd	3583.4 a-d	32.1 a-e
I_1V_6	123.59a	17847.6 a	4114.2 a	33.4 a
I_2V_1	61.34de	1750.5 e	404.8 f	30.9 def
I_2V_2	53.50def	1791.1 e	444.4 f	28.6 hi
I_2V_3	49.94ef	2174.2 e	464.1 f	30.5 fg
I_2V_4	54.22def	1850.03 e	444.4 f	30.9 def
$I2V_5$	58.85def	1748.7 e	317.4 f	31.2 b-f
I_2V_6	62.41d	1712.0 e	293.5 f	31.2 b-f
Significant (M.S)				
A	**	*	**	N.S
B	**	*	N.S	**
A*B	N.S	**	N.S	*
CV%	8.2	12.3	17.2	4.3

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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