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Evaluation of Iranian Safflower Cultivars Reaction to Different Sowing Dates and Plant Densities

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Abstract: Two experiments were conducted to evaluate reaction of Iranian safflower to different sowing dates and plant density at Saveh region, during 2006-2008. The experimental design was set up as split split plot in a randomized complete block with three replications. Sowing dates and cultivars consider as main and sub plots respectively, under three plant densities as sub sub plots. The effects of sowing dates on some traits including seed and oil yields, flower yield, plant height, Leaf Area Index (LAI), Crop Growth Rate (CGR) and Net Assimilation Rate (NAR), were studied. The results showed that late planting in safflower canopy caused a significant decrease in seed and oil yields. Combined analysis of two years, demonstrated that Padideh cultivar showed the highest grain and oil yields (2850 and 779kg/ha) at plant density of 40 plant/m^2 in the first sowing date. Goldasht cultivar with 160 Kg/ha produced the highest flower yield at the highest plant density and first planting time (Sep20).

Key words: Safflower · Sowing date

INTRODUCTION

Safflower (*Carthamus tinctorius L.*) is an annual, broadleaf oilseed crop of the family compositae adapted mainly to dry land and irrigated cropping systems [1]. It originated in southern Asia and is known to have been cultivated in China, India, Iran and Egypt. [2]. Safflower was originally grown for the flowers that were used in making red and yellow dyes for clothing and food preparation [3].

Safflower is being grown in over 60 countries but India is contributing about 50% of production. In Iran the safflower cropped area has increased over last few years and reached about 10000 ha during 2008 whereas during 1997 it was 200-300 ha [4]. Safflower is an important oilseed crop with 35-40 % oil. It has been used as a source of edible oil and dying since ancient times [5].

Around the world, safflower is mainly grown for its edible oil for cooking, salad oil and margarine. Research linking health and diet has increased the demand for the oil, which has the highest polyunsaturated/saturated ratios of any oil available. It is nutritionally similar to olive oil, with high levels of linoleic oroleic acid, but much less costly. Polyunsaturated fats are associated with lowering of blood cholesterol [6].

The recommended range of sowing dates for winter types of safflower cultivars in Iran is from Sep. 20 to Oct. 20, this vary depending on climatic conditions [7].

Bageri [8] concluded that late planting in safflower showed a decrease in seed and oil seed and some important traits such as head per plant and seed per head. Spring types of safflower should be planted during the last week of April or the first two weeks of May at Lethbridgen station in Canada [9].

Omidi [10] reported that the number of seeds per head is associated with the increase of seed yield in safflower and concluded that selection for number of head per plant was effective for the improvement of the yield.

Yazdi-Samadi and Abd-Mishani [11] grouped all Iranian and American safflower genotypes into 5 clusters according to their similarities and revealed similar genetic bases in the genotypes.

Zongwen [12] in a classification of 89 accessions of safflower reported that accessions from India possessed high diversity and accessions from Turkey were closely related to those from the other Middle East countries.

Bagawan and Ravikumar [13] reported a positive correlation between number of heads per plant and grain yield Johnson *et al.* [14] indicated that grain yield was positively correlated with seed weight and plant height.

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Table 1: Soil farm trial characters at two depth

Soil depth Cm	N %	p %	K %	PH	EC Ds/cm	Soil Texture$_{[cao]}$
0-30	0.77	14.1	111	7.1	2.2	Silty clay Loam,
30-60	0.70	11.3	99	7	3.1	Silty Loam

Table 2: Some Geographical conditions of experimental location

Year	Mean temperature °C	Rainfall (mm)	Maximum temperature °C	Minimum temperature °C
2006-2007	35	241	41	10
2007-2008	32	276	39	8

The purpose of the present study was to evaluate both optimum sowing dates and plant density in yield of safflower varieties.

MATERIALS AND METHODS

This experiment was carried out over a two –year period at Saveh Eslamic Azad University in Iran. Longitude 50, 20', latitude 35, 16' and altitude 1030 m above sea level. The Tables 1 and 2 show different soil characters and some geographical conditions of experimental locations.

The experimental design was set up as split split plot in a randomized complete block with three replications, with Four sowing dates as main plots (Sep. 20, Sep 30, Oct. 10 and Oct. 20) three new cultivars as sub plot (Padideh, Goldasht and Varamin 295) under three plant densities (20, 40 and 13.3 plant/m^2) as sub sub plots.

Experimental plots consisted of rows 3 m long and 0.5 m apart. After emergence, manual thinning was used to obtain normal density. For the experiment, 70kg/ha of P2O5 as ammonium phosphate and 25kg/ha of nitrogen as urea were supplied prior to sowing and 30kg/ha of nitrogen as urea at the start of stem elongation. Weeds were controlled by manual weeding before stem elongation. Irrigation was applied at 7 stages: After emergence, stem elongation, bud formation, beginning of flowering, 50% flowering, finishing of flowering and seed filling. Data on yield per plant and yield components and other agronomic traits were recorded on plants randomly selected from the two middle rows. The harvesting areas (3 m^2) determined after deletion of the plot sides, were from two middle rows. The data for each experiment were analysed by MSTATC software for comparison of the mean values by the Duncan test at the 1% level.

RESULTS

The results of the combined analysis of variance, after homogeneity test for error variances, are summarized in Table 3. F. test of different sources of variation revealed that there were no significant differences of the year effects, while sowing planting; plant density and cultivar were significant at 1% probability level.

Table 4 showed yields and yield components comparison. The highest seed and oil yields (2850 and 850Kg/ha), flower yield (130Kg/ha) and plant height (179cm) were observed in the first planting date (sep. 20). Study of different plant density showed that the highest seed and oil seeds (2880 and 770 Kg/ha), flower yield (144Kg/ha) and plant height (178cm), obtained from 40 plants in m2 respectively.

No significant differences were observed in different cultivars for seed and oil and flower yields. However cultivars did not significantly ($P<0.01$) influence seed and oil yields and flower yield, during the two years of the study. [15] reported similar results in study of spring safflower genotypes. The results of this study demonstrated that l plant height became decreased in late planting time and higher plant densities. In this situation, relative humidity being high, in lack of direct sun shines, therefore desirable temperature and cause to auxin reduction especially in some parts of stem in shadow. Auxin as a class of plant growth substance that have an essential role in coordination of many growth and behavioral processes in the plant life cycle.

Usually planting date, plant density and genotypes play an important role in amount of leaf area in crop canopy. The results showed a significant difference among LAI and NAR, as in late planting time caused decrease in Leaf Area Index (LAI), Crop Growth Rate (CGR), Net Assimilation Rate (NAR), due to more leaves shattering and more observed sun light by left leaves in

Table 3: Mean squares for yield and yield components

S.OV	df	MS: Seed yield Kg/ha	Oil yield Kg/ha	Flower yield Kg/ha	Plant height Cm	LAI	CGR (gm^{-2} day^{-1})	NAR (gm^{-2} d ay^{-1})
(Y)	1	3966555.7ns	353017.8ns	99869.9ns	100.99ns	1.59ns	66.36ns	2.21ns
E_a	4	4988706.6	88971.4	80140.6	589.9	4.48	55.699	100.54
(S)	3	64365948.6**	6581541.2**	300835.6**	14134.4**	69.66**	3289.3**	417.33**
(S×Y)	3	152211.3ns	57119.4ns	6989.9ns	9.4ns	1.02ns	7.28ns	1.21ns
E_b	12	299315.7	36601.1	4966.7	99.8	1.23	3.9ns	36.66
(D)	2	2755723.9**	372883.6**	19832.2*	1940.6**	1.01ns	125.7**	1.47ns
(Y×D)	2	8020.3ns	398.4ns	289.41ns	3.4ns	0.99ns	0.9ns	2.14ns
(S×D)	6	1135990.6**	114402.9**	14928.66**	290.9**	2.66**	11.1ns	9.66ns
(Y×D×S)	6	999.2ns	2433.8ns	599.30ns	2.6ns	0.88ns	0.2.2ns	2.33ns
E_c	32	285622.7	20111.8	2699.8	36.4	1.2	14.444ns	19.9
(C)	2	4927014.*	200.9ns	6820.8ns	522.9**	0.999ns	0.11ns	39.77**
(Y×C)	2	1146.7ns	22799.8*	599.66ns	2.1ns	0.879ns	0.66ns	1.14ns
(S×C)	6	406624.4**	998.9ns	9913.41**	302.2**	0.89ns	36.99**	9.66ns
(Y×S×C)	6	4499.3ns	10401.1ns	309.88ns	1.5ns	0.66ns	0.3ns	1.5ns
(D×C)	4	229998*	2522.2ns	1930.6ns	99.9**	1.02ns	1.01ns	33.11**
(Y×D×C)	4	4399.9ns	25487.9*	100.9ns	2.70ns	1.12ns	0.99	1.12ns
(S×D×C)	12	274455.7**	25492.3*	7966.7**	102.6**	1.9**	3.25ns	21.66**
(Y×S×D×C	12	2708.3ns	2909.8ns	4018ns	3.6ns	0.53ns	0.08ns	0.99ns
E_d	96	79200.1	8389.4	1410.9	23.22	0.404	1.01	5.11

*, ** Significant at the 5% and 1% level of probability
Ns= Non significant

Table 4: Yield and yield components comparison for main,sub and sub sub plots

Treatment		Seed yield Kg/ha	Oil yield Kg/ha	Flower yield Kg/ha	Plant height Cm	LAI	CGR (gm^{-2} day^{-1})	NAR (gm^{-2} day^{-1})
Sowing dates	Sep. 20	2850a	855a	130.3a	179.1a	4.8a	31.8a	8.06c
	Sep. 30	2710a	758.9b	125.6a	160.2b	2.1b	21.9b	9.5b
	Oct. 10	2408b	744b	115.7b	155.5c	1.7c	18.9c	12.2b
	Oct. 20	2301b	736b	119.1b	150.7c	1.5c	21.9b	15.9a
Plant densities /m2	13.3	2415b	699b	139.3	150.8c	3.01a	25.9a	13.3a
	20	2511b	790a	126.6	166.3b	2.99a	26.6a	13.2a
	40	2880a	777b	144.9	178.3a	3a	20.9b	13.1a
Cultivars	Padedeh	2890a	780a	140.2a	180.1a	2.26a	24.2a	12.01b
	Goldasht	2760a	755a	155.8a	162.5b	2.01ab	23.9a	13.3a
	Varamin-295	2850a	729a	149.9a	179.9a	1.99ab	24.1a	13.9a

Means followed by similar letters in each column are not significantly different at the 1% level

Table 5: Yield and yield components comparison for different treatments

Sowing dates	Plant densities /m²	Cultivar	Seed yield Kg/ha	Oil yield Kg/ha	Flower yield Kg/ha	Plant height (Cm)
Sep. 20	13.3	Padideh	2405 b	640 a	111 b	160 a
	20		2610 a	650 a	115 b	161 a
	40		2850 a	775 a	120 b	179 a
	13.3	Goldasht	1999 c	446 c	130 a	120 b
	20		2010 c	477c	140 a	131 b
	40		2400 b	504 c	160 a	141 b
	13.3	Varamin-295	2310 b	633 a	120 b	131 b
	20		2450 ab	640 a	130 a	145 b
	40		2500 a	690 a	140 a	169 a
Sep. 30	13.3	Padideh	2500 a	540 c	100 b	139 b
	20		2590 a	567 b	115 b	141 b
	40		2790 a	621 a	119 b	159 a
	13.3	Goldasht	2010 c	448 c	130 a	122 b
	20		2100 b	457 c	140 a	125 b
	40		2300 b	482 c	150 a	130 b
	13.3	Varamin-295	2590 a	597 b	110 b	132 b
	20		2500 a	600 b	120 b	141 b
	40		2600 a	600 b	130 b	151 a

Table 5: Continued

Oct. 10	13.3	Padideh	2370 b	639 a	80 c	121 b
	20		2410 b	704 a	99 b	130 b
	40		2500 a	759 a	100 b	146 b
	13.3	Goldasht	1860 c	480 c	110 b	110 c
	20		1990 c	482 c	121 b	119 b
	40		2100 b	576 b	131 b	120 b
	13.3	Varamin-295	2111 b	693 a	90 b	120 b
	20		2210 b	735 a	100 b	130 b
	40		2300 b	750 a	110 b	140 b
Oct. 20	13.3	Padideh	2000 c	675 a	91 b	110 c
	20		2100 b	670 a	95 b	120 b
	40		2300 b	753 a	100 b	130 b
	13.3	Goldasht	1870 c	482 c	110 b	100 c
	20		1907 c	504 c	115 b	110 c
	40		2010 c	552 b	121b	122 b
	13.3	Varamin-295	1990 c	777 a	90 b	111 c
	20		2000 c	750 a	99 b	115 c
	40		2100 b	750 a	110 b	129 b

Means followed by similar letters in each column are not significantly different at the 1% level

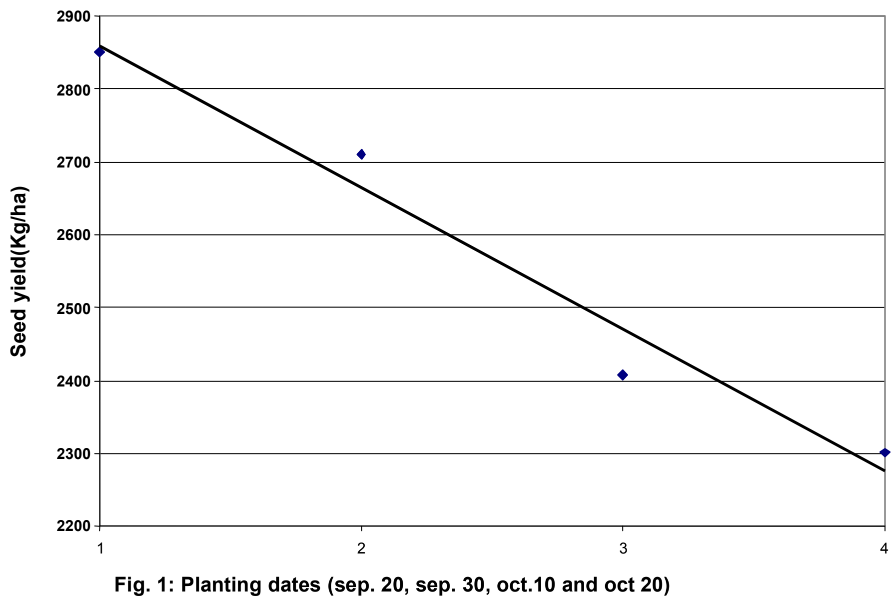

Fig. 1: The relation between sowing dates and seed yield which follows the linear equation: of y=-194.9 x +3054

flowering time. Existence of high NAR in low rate of LAI, at the same time, showed high Light Saturation Point in safflower.

The average of CGR was also significant in different sowing dates and plant density, revealed that late planting and high density, caused decrease in the rate of CGR. It related to disability of plant canopy to produce enough dry matter (Table 3).

Sowing dates, plant densities and cultivars interaction effects were significant at 1% level (Table 3). The results of seed and oil yields and flower yield comparison for different sowing dates and densities in different cultivars are shown in Table 5.

There were significantly different results values between plant heights on the treatments. The maximum plant height (179cm) achieved from Padedeh cultivar in Sep.20 less than 40 plant/m^2.

Seed and oil yields varied in different sowing dates and plant densities in each year, as the highest seed yield (2850Kg/ha) and oil yield (779kg/ha) were achieved from Sep.20 under 40 plant/m^2 in Padideh. Cultivar it can be related to disability of plants to use environment potential.

The range of flower yield in the treatments was 80 to 160 Kg/ha. Goldasht cultivar with 160 Kg/ha flower yield produced the highest yield at the highest plant

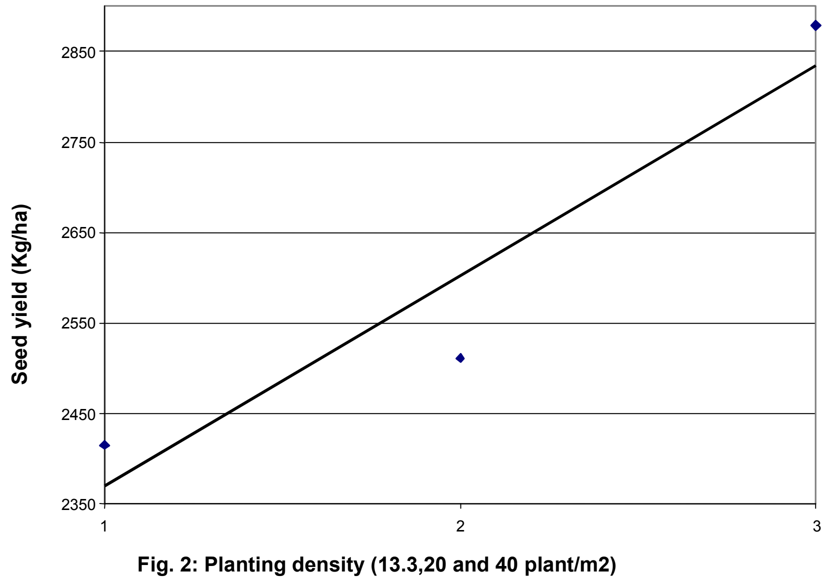

Fig. 2: The relation between plant density and seed yield which follows the linear equation: of y=-232.5 x +2137

density, in Sep. 20. possibly due to excessive number of heads per unit area.

It can be concluded that the higher number of heads per plot caused more flower yield, comparing with high number of heads per plant.

The relationship between sowing dates and seed yield followed the linear equation: of y=-194.9 x +3054 representing yield decrease against late sowing dates. The regressive relation of plant density and seed yield showed a linear equation: of y=-232.5 x +2137.On the basis of this equation, seed yield increase against high plant density (Figures 1-2).

REFERENCES

1. Rohini, V.K. and K.R. Sankara, 2000. Embryo Transformation, A Practical Approach for Realizing Transgenic Plants of Safflower (*Carthamus tinctorius* L.). Annals of Botany, 86: 1043-1049.
2. Ashri, A. and P.F. Knowles, 1960. Cytogenetics of safflower (*Carthamus* L.) species and their hybrids. Agron. J., 52: 11-17.
3. Li, D. and H. Mundel, 1996. Safflower: (*Carthamus tinctorius L.*), Promoting the conservation and use of underutilized and neglected crops. 7. IPGCPR, Catersleben/ IPGRI, Rome, Italy, pp: 83.
4. Omidi, A.H., H. Khazaei and S. Hongbo, 2009. Variation for Some Important Agronomic Traits in 100 Spring Safflower (*Carthamus tinctorius* L.) Genotypes. American-Eurasian J. Agric. & Environ. Sci., 5(6): 791-795.
5. Kolsarıcı, O., S. Alluşoğlu and M.D. Kaya, 2005. The Effects of Tillage and Nitrogen Doses onWater Use Efficiency, Soil Moisture and Seed Characters of Safflower (*Carthamus tinctorius* L.) in Wheat Safflower Rotation System. Vith International Safflower Conference, Istanbul, 6-10 pp: 126-131.
6. Weiss, E.A., 2000. Oilseed Crops. Blackwell. Sci. Ltd, Oxford, UK, pp: 364.
7. Omidi, A.H., 2000. A review of agro-breeding safflower researches in Iran and the world. Zeitoon, 142: 14-19.
8. Bagheri, M., 1998. Evaluation of different sowing plant on seed and oil yields in safflower cultivars. The 5 th Iranian Crop Production & Breeding Congress. Isfahan.
9. Mundel, H., 1994. Row spacing and seedling rates to optimize safflower yield on the Canadian provinces. 74(2): 319-321.
10. Omidi, A.H., 1994. Evaluation of safflower genotypes for yield and yield components. Second Iranian Congress on Crop Production and Breeding, Karaj-Iran.
11. Yazdi Samadi, B. and C. Abd-mishani, 1989. Cluster analysis in safflower. Second International Safflower Conference INDIA, 9-13 Jan. pp: 119-126.

12. Zongwen, Z., 2001. Genetic diversity and classification of safflower (*Carthamus tinctorius* L.) germplasm by Isozyme. V International Safflower Conf. USA, pp: 157-163.
13. Bagavan, I. and R.L. Ravikumar, 2001. Strong undesirable linkages between seed yield and oil components- A problem in safflower improvement. Proceeding of the vth International Safflower Conference, USA, July 23-27, pp: 103-107.
14. Johnson, R.C., P.B. Ghorpade and V.C. Bradley, 2001. Evaluation of the USDA core safflower collection for seven quantitative traits. V International Safflower Conf. USA., pp: 143-149.
15. Omidi Tabrizi, A.H., 2001. Correlation between traits and path analysis for grain and oil yield in spring safflower. Proceeding of the Vth International Safflower Conference, USA, July 23-27, pp: 95-98.