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ORIGINAL ARTICLE

Study of safflower varieties for flower and grain yields and Fatty acids composition

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Abstract: In order to Study of safflower varieties for flower yield, grain and oil yields and Fatty acid composition in safflower varieties. The experiment was arranged as split plots in a randomized complete block design with 3 replicates. The treatments composed of: removal of florets every 3 (b1),6 (b2),9 (b3)days after initiation of flowering and control (bo-intact plants) as sub factors and 2 varieties Isphahan local and Fo2 as main factors (a1,a2).The analysis of variance showed that the difference between varieties (main factors) were not significant both for grain and oil yield, but the differences among sub factors were highly significant ($P<0.01$) for grain and oil yield. Varieties x florets removal interaction were non- significant. Fatty acid compositions were examined for the varieties. The results showed no significant differences for all fatty acids among treatments (main plots, sub plots and their interaction.

Key words:

Introduction

Safflower (*Carthamus tinctorius* L) is one of humanity's oldest crops, but generally it has been grown on small plots for the grower's personal use and it remains a minor crop with world seed production around 800 000 t per year [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. It is possible to collect the petals mainly from non-spiny crop of safflower. A number of non spiny varieties and hybrids are available which have the petal yield potential of 120 to 150 kg/ha under rainfed conditions and 180 to 250 kg/ha under irrigated conditions. Petals can be collected after the crop matures, so that dye and oilseed can be obtained from the same crop.

Additions of safflower florets are well known for their use, as food colouring is a widespread ancient tradition. Rice, soup, sauces, bread and pickles take on a yellow to bright orange colour from the florets. Addition of 3 per cent yellow pigment extracted from petals of safflower in sweetened yoghurt has more acceptability as compared to commercial sample.

Safflower petals contain water soluble dye, carthamidin and alkali soluble, carthamin pigments in different proportions depending on the colour of flower. The safflower florets contain carthamidin to the extent of 28-36% and carthamin to the extent of 0.3-0.6%. Herbal tea can be prepared from petals.

The safflower petals contain yellow B and red pigment, safflower factor, safflower glycocide and safflower benzyl glycocide. Safflower florets are also nutritious containing about 11% amino acids and many vitamins and minerals. The concentration of elements in the safflower petals was 5 to 40 ppm Cu; 7-37 ppm Zn which has beneficial effects for

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various ailments in many of the ayurvedic preparations. Gamma linolenic acid was identified in safflower petal oil, which is an essential constituent and plays an important role in various biochemical pathways in the human body. In Iran, the safflower cropped area has increased over the last few years reaching about 10000 hectares in 2090, where as in 1997 it was 200-300 hectares, it is mostly used for grain ,oil and flower production.Usually the farmers remove the florets at the end of flowering when the colour and its quality in not so good, therefore find out the appropriate stage of florets removal is important [9].

The results reported by Nie Zheng *et al* [5] indicate that the height of branching is positively correlated with flower yield per plant and they also showed [4] that the most important direct effects on flower yield are plant height, branching height, and number of seed per head, and the high yielding safflower varieties always have taller individuals lower branches, more effective heads, fewer ineffective heads and longer flowering period. A.K. Rajvanshi, [7] developed a new safflower petal collector that can harvest about 3-4 Kg of petals/day and thus one acre of petal harvesting can take place in 27 days. The objective of the present study was to assess the effects of florets removal on grain and oil yield and other relationships in spring safflower

Materials and methods

In this study, two spring safflower varieties and three various removal florets stages were evaluated in the Karaj-Iran. Experimental design was a split plot based on randomized complete block arrangment with 3 replications. Two varieties, Isphahan local and Fo2 represented the main plots, (a1,a2) and 3 removal florets stages every 3 (b1),6 (b2),9 (b3)days after initiation of flowering and control (b0-intact plants) represented the sub plots. The plots were 12 rows 0.5-m apart and 12-m long. 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% of 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:

Days from sowing to flowering

Days from sowing to end of flowering

Branch number :number of secondary and tertiary branches recorded on the selected plants.

The data of the experiment were analysed by MSTATC software for comparison of the mean values by the Duncan test at the 1% level.

Results and disscussion

The results of simple analysis of variance demonstrated that differences among treatments (main plots ,sub plots and their interaction) were highly significant ($P<0.01$) for the some important traits. The difference for grain yield (gr /plot), flower yield (Kg/ha), Seed Weight / head (gr), days to flowering and flowering period in main factors, and number of branches per plant,seed weight per head, days to flowering in sub plots were not significant. Study of varieties based on different traits showed that, the highest grain yield (1224 gr/plot) and number of branches (17.75),achieved from Isphahan local variety (a1).

The results showed that,the removal of florets, every 3days after initiation of flowering (b1) led to increase in grain yield (1287gr/plot), flower yield (142 kg/ha), and flowering period (22 days).Also the effects of floret removal over 8different treatment, (interaction effects) were evaluated on above traits.The results showed that grain yield per plot, number of branches per plant and days to flowering were not significant. The average of flower yield in interaction effects between varieties with removal of florets was significant and revealed that removal of florets, every 3 days after initiation of flowering in Isphahan local variety (a1b1)had the highest grain(1224 gr/plot) and flower yields (153 Kg/ha), that probably related to increasing of flowering period in the same treatment (23 days).

The greatest seed weight per head was recorded as 7.1 gr in the removal of florets, every 3 days after initiation of flowering Isphahan local variety (a1b1), whereas the least recorded as 3.9 gr in removal of florets, every 9 days after initiation of flowering in Isphahan local variety (a1b3). The flowering period as another important traits was affected by the removal of florets. The highest flowering period was also belong to removal of florets, every 3 days after initiation of flowering in Isphahan local variety (a1b1) (Table 1). There were highly positive significant correlations between grain yield and flower yield with: number of branches per plant ($r=0.372$), ($r = 0.703$). As a conclusion, The results indicated that removal of florets at early stage (every 3 days after initiation of flowering) has positive effect on grain and flower yields which can be due to higher seed weight in head and number of branches in plant respectively. The results of analysis of variance demonstrated that the differences among genotypes were not significant for fatty acids (Table2). These results indicated that there is not variation among the genotypes for the trait.

Table 1: Grain and some important traits of safflower genotypes in different levels of sub and main factors

Traits	Grain yield (gr /plot)	No Branches /plant	Flower yield (Kg/ha) /head (gr)	Seed Weight	Days to flowering	Flowering period
			Treatments			
a1	1224.5 a	17.75 a	136.5 a	5.4 a	99.5 a	19.5 a
a2	1053.8b -a	14.5 b	119.2 a	4.8 a	114 a	18.7a
b0	1047.75 b	15.5 a	115 b	4.7 a	110.5 a	18 bc
b1	1267.75 ab	17 a	142 a	6.5 a	99.85 a	22 a
b2	1282.6 a	16a	136.5 a	5.3 a	101 a	19.5 ab
b3	958.65 a	16 a	118 b	4 a	113 a	17.5 bc
a1bo	1103.3 a	17 a-	121 c	4.5 ab	98 a	18 bc
a1b1	1289.2 a	19 a	153 a	7.1 a	115 a	23 a
a1b2	1485a	18 a	147 ab	6.2 ab	110 a	20 a-c
a1b3	1020.8 a	17 a-	125 bc	3.9 b	99.7 a	18 bc
a2bo	992.2 a	14 a-	109 c	4.9 ab	101 a	18 bc
a2b1	1246.3 a	12 a	131 bc	6 ab	113 a	21 ab
a2b2	1080.2 a	12 a	126bc	4.5 ab	111 a	19 bc
a2b3	896.5 a	13 a	111c	4.1 ab	100 a	17 c

a1= Isphahan local variety
a2= Fo2 variety
bo= intact plants
b1= removal of florets, every 3days after initiation of flowering
b2=removal of florets, every 6days after initiation of flowering
b3= removal of florets, every 9 days after initiation of flowering
Different letters in each column shows significant differences at 0.01 probability

Table2: The positional composition (mol%) of fatty acid in of safflower genotypes in different levels of sub and main factors

Traits			fatty acid			
Treatments	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3
a1	7.99 ns	0.11 ns	2.84 ns	15.9 ns	72.52 ns	0.63 ns
a2	6.98	0.15	3.10	16.2	73.13	0.61
b0	8.1	0.14	2.94	16.10	72.09	0.60
b1	7.81	0.15	3.12	15.80	72.5	0.61
b2	8.11	0.10	3.02	16.01	72.02	0.57
b3	7.92	0.13	2.98	16.2	72.01	0.7
a1bo	7.81	0.13	2.99	14.99	73.52	0.56
a1b1	7.5	0.14	2.56	16.22	72	0.61
a1b2	7.02	0.14	2.98	15.98	73.3	0.58
a1b3	7.51	0.12	3.01	16.11	72.7	0.55
a2bo	7.71	0.13	3.98	15.96	72.66	0.54
a2b1	7.81	0.11	3.01	16.2	72.2	0.57
a2b2	7.91	0.14	2.82	16.3	72.3	.057
a2b3	6.98	0.15	3.11	16.3	72.8	0.55

a1= Isphahan local variety
a2= Fo2 variety
bo= intact plants
b1= removal of florets, every 3days after initiation of flowering
b2=removal of florets, every 6days after initiation of flowering
b3= removal of florets, every 9 days after initiation of flowering
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