



Study of floret removal effects on grain and oil yield and their components in spring safflower.

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Abstract

The effects of florets removal on grain and oil yield and their components in safflower varieties were investigated at the research farm of S.P.I.I in 1999. 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. In this study correlation among traits, in different florets removal stages (bo, b1, b2, b3), were compared by classification of recorded data in four groups (a1bo, a2bo), (a1b1, a2b1), (a1b2, a2b2), (a1b3, a2b3). The results showed that there were highly positive significant correlations between grain yield/plant with: plant height, oil yield/plant and oil yield/plot and also between grain yield/plot with number of head per plant, grain yield/plant, oil yield per plant and plot in the all groups.

Keywords: Safflower - oil yield, varieties - grain yield/plant

Introduction

Safflower (*Carthamus tinctorius* L.) is a member of the family Compositae or Asteraceae, cultivated mainly for its seed, which is used as edible oil and bird seed and its flowers used for colouring and flavouring foods and making dyes (Li, D et al., 1996). Over 60 countries grow safflower but over half is produced in India. China has a significant area planted to safflower but florets are harvested for use in traditional (Corleto, A et al.,).

In Iran, the safflower cropped area has increased over the last few years reaching about 5000 hectares in 2000, 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 is not so good, therefore find out the appropriate stage of florets removal is important (Omiditabrizi, A.H. 2000).

The results reported by Nie Zheng et al (1987) indicate that the height of branching is positively correlated with flower yield per plant and they also showed (1993) 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.

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 early spring of 1999, 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 arrangement 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. Data on yield per plant, yield components and other agronomic traits were obtained by calculating the mean of representative plants. Some important collected data were: plant height, number of secondary branches, number of heads per plant, number of seeds per head, 100 seed weight, seed yield per plants and plot, oil yield per plant and plot.

Simple correlations were used to evaluate traits interrelationships and relationship to seed and oil yield in 4 groups (a1bo,a2bo), (a1b1,a2b1), (a1b2,a2b2), (a1b3,a2b3).

Results and Discussion

The results of analysis of variance (Table1) showed that the difference for grain and oil yield were not significant in main factors, however the highest grain and oil yield (1407 and 653 kg ha⁻¹) achieved from Isphahan local variety. Highly significant ($P < 0.01$) were observed in sub factor, the grain and oil yield (1600.8, 539 kg/ha) were obtained when the florets remove every 3 days after initiation of flowering (b1).

Varieties x florets removal interaction indicated no differential effects of florets removal on grain and oil yield, the highest grain and oil yield (1172.2, 402 kg/ha) were produced from Isphahan local variety when its florets removed every 3 days after initiation of flowering (a1b1). Table 2 shows some important agronomic characteristics of treatments (a1bo,...,a2b3), the highest number of heads/plant (18) number of seeds/head (52), 100.S.W (41gr), Grain yield/plant (18gr), Grain yield/plot (417gr), Oil yield/plant (6.1gr), Oil yield/plot (147gr) and plant height(90Cm) were belong to ,a2b1, a1bo, a1b1,a2b1, a1b1, a2b1, a1b1, a2b3 respectively. In this study correlation among traits, in different florets removal stages (bo, b1, b2, b3), were compared by classification of recorded data in four groups (a1bo, a2bo), (a1b1, a2b1), (a1b2, a2b2), (a1b3,a2b3).

The results showed that there were highly positive significant correlations between grain yield per plot with: number of heads per plant ($r = 0.372$), ($r = 0.433$), ($r = 0.473$), ($r = 0.419$), seed yield per plant ($r = 0.531$), ($r = 0.459$), ($r = 0.513$), ($r = 0.34$), and oil yield per plant ($r = 0.520$), ($r = 0.44$), ($r = 0.51$), ($r = 0.351$) and oil yield per plot ($r = 0.945$), ($r = 0.978$), ($r = 0.958$), ($r = 0.953$) in four mentioned groups. These values confirm that the grain yield per plant is significantly correlated with plant height ($r = 0.463$), ($r = 0.473$), ($r = 0.431$), ($r = 0.45$), oil yield per plant ($r = 0.971$), ($r = 0.973$), ($r = 0.960$), ($r = 0.970$), and also with oil yield per plot ($r = 0.490$), ($r = 0.470$), ($r = 0.501$), ($r = 0.401$) in the groups.. The results indicated that removal of florets at early stage (every 3 days after initiation of flowering) has positive effects on grain and oil yield which can be due to higher seed weight, when the means of number of seed per head and 100.S.W were compared using T-Test (table 4).

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Table1-Grain and oil yield (kg/ha) of safflower genotypes in different levels of sub and main factors

Tr aits	Grain yield (kg/ha)	Oil yield (kg/ha)
Tr eatments		
a 1	1407ns	653 ns
a 2	1330 ns	610 ns
b o	1323b	458b
b 1	1600a	539a
b 2	1343ab	479ab
b 3	1210b	416b
a 1bo	1003 ns	345 ns
a 1b1	1172 ns	402 ns
a 1b2	350 ns	338 ns
a 1b3	928 ns	323 ns
a 2bo	902 ns	314 ns
a 2b1	1133 ns	372 ns
a 2b2	982 ns	344 ns
a 2b3	815 ns	280 ns

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 (DMRT).



Table 2- Range , Means of safflower traits in different treatments

Treatments	No heads/plant Range-Mean		No Seed/head Range-Mean		100.S.W (g) Range-Mean		Grain Yield/plant (g) Range-Mean		Grain Yield/plot (g) Range-Mean		Oil Yield/plant (g) Range-Mean		Oil Yield/plot (g) Range-Mean		Plant height (cm) Range-Mean	
a1bo	7-17	10.8	31-52	42	31-36	34.3	10-16	12.5	317-350	334.	3.2-5.6	4.1	111-120	115	69-87	78
a2bo	7-14	9.8	31-49	41	31-36	33.9	9-13	11.2	292-311	300	3.1-4.5	3.7	100-112	105	66-79	74
a1b1	10-16	13.4	25-49	38	35-41	37.5	10-16	12.8	356-417	391	3.2-5.4	4.2	125-147	134	48-84	70
a2b1	9-18	13.1	33-49	41	32-40	36.8	9-18	12.3	210-339	309	2.9-6.1	4.1	71-127	101	45-81	64
a1b2	8-16	12.2	30-44	36	32-35	33.2	10-15	12.4	300-343	317	3.4-5.2	4.2	103-124	113	60-86	75
a2b2	9-16	13.3	23-45	34	30-39	33.2	8.6-17	12.2	296-377	328	2.9-5.6	4.1	103-134	115	54-89	72
a1b3	10-15	12.7	32-40	37	32-35	33	10-13	11.7	301-314	304	3.4-4.4	3.9	103-107	106	60-81	70
a2b3	8-16	12.7	23-45	35	31-37	33.4	9-17	12.5	210-314	287	2.7-5.6	4.3	71-115	99	54-90	75

a1= Isphahan local variety

bo= intact plants

b1= removal of florets, every 3days after initiation of flowering

b2=removal of florets, every 6days after initiation of flowe

b3= removal of florets, every 9 days after initiation of flowering



Table 3 . Correlation coefficients of safflower traits in different treatments groups(a1bo,a2bo), (a1b1,a2b1), (a1b2,a2b2),(a1b3,a2b3)

Traits	Treatment	NoHeads/Plant	NoSeeds/Head	No.Sec.Branches	Plant Height	GrainYield/Plant	100.Seed.Weight	Oilyield/ plant	GrainYield/Plot	Oil yield/Plot
No.Heads/Plant	1	-	-0.716**	-0.051	0.643**	0.318*	0.170	0.352*	0.372*	0.268
	2	-	0.104	0.138	0.512**	0.454**	0.052	0.481**	0.433**	0.389**
	3	-	-0.116	0.342*	0.333*	0.311	0.078	0.276	0.472**	0.098
	4	-	-0.084	0.336*	0.288	0.272	-0.077	0.256	0.419**	-0.367*
NoSeeds/Head	1	-	-	-0.160	-0.423**	-0.04	-0.106	-0.046	-0.129	-0.094
	2	-	-	0.049	0.217	0.029	-0.131	0.058	-0.065	-0.119
	3	-	-	-0.212	-0.212	0.049	0.035	-0.013	0.104	0.191
	4	-	-	-0.212	-0.212	0.034	-0.151	0.003	-0.031	-0.149
No.Sec.Branches	1	-	-	-	0.119	0.137	0.134	0.125	-0.053	0.095
	2	-	-	-	0.341*	0.201*	-0.056	0.209	0.084	0.059
	3	-	-	-	0.355*	0.300	0.258	0.426*	0.315*	0.206
	4	-	-	-	0.355*	0.451**	0.086	0.361*	0.092	-0.160
Plant Height	1	-	-	-	-	0.463**	0.444*	0.432**	0.493**	0.272
	2	-	-	-	-	0.473**	0.304	0.444**	0.415**	0.415**
	3	-	-	-	-	0.431**	0.097	0.467**	0.200	-0.097
	4	-	-	-	-	0.451**	-0.156	0.425**	0.148	0.086
GrainYield/Plant	1	-	-	-	-	-	0.269	0.971**	0.531**	0.490**
	2	-	-	-	-	-	0.524**	0.973**	0.459**	0.470**
	3	-	-	-	-	-	0.198	0.960**	0.513**	0.501**
	4	-	-	-	-	-	-0.315	0.970**	0.340*	0.401**
100.Seed.Weight	1	-	-	-	-	-	-	0.279	0.237	0.064
	2	-	-	-	-	-	-	0.476**	0.029	0.089
	3	-	-	-	-	-	-	0.149	0.355*	0.370
	4	-	-	-	-	-	-	0.390**	-0.057	0.121
Oilyield/ plant	1	-	-	-	-	-	-	-	0.520**	0.480**
	2	-	-	-	-	-	-	-	0.449**	0.250
	3	-	-	-	-	-	-	-	0.516**	0.201
	4	-	-	-	-	-	-	-	0.351*	0.198
GrainYield/Plot	1	-	-	-	-	-	-	-	-	0.945**
	2	-	-	-	-	-	-	-	-	0.978**
	3	-	-	-	-	-	-	-	-	0.958**
	4	-	-	-	-	-	-	-	-	0.953**
Oil yield/Plot	1	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-

1=a1bo,a2bo 2=a1b1,a2b1 3=a1b2,a2b2 4=a1b3,a2b3 *and**significant at the 5%and1%levels of probability respectively

Table 4- Comparison of No. seeds /head and 100 . S.W.means using t-test

Treatment	bo	b1	b2	b3
Traits				
No seeds/head (bo)	-	1.763 ^{ns}	5.93 ^{**}	6.98 ^{**}
100 .S.W (b1)	7.811 ^{**}	-	2.37 ^{ns}	2.04 ^{ns}