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Assessment of the effects of florets abolition on grain, oil yield and other associations 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 SPII (Seed and Plant Improvement Institute (Karaj, Iran)) 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(b^1), 6(b^2), 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 (a^1, a^2). 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 (b^o, b^1, b^2, b^3) were compared by classification of recorded data in four groups (a^1bo, a^2bo), (a^1b^1, a^2b1), (a^1b^2, a^2b^2), and (a1b^3, a^2b^3). 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 (*Carthamus tinctorius*), florets harvest, oil yield, grain yield.

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. Its flowers are used for coloring and flavoring foods and making dyes (Li and Henning, 1996). Over 60 countries grow safflower of which over half is produced in India. China has a significant area planted to safflower but florets are harvested for use in traditional (Corleto et al., 1997).

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 to 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 color and its quality are not so good, therefore finding out the appropriate stage of florets removal is important (Omidi, 2000).

The results reported by Nie et al. (1987) indicate that the height of branching is positively correlated with flower yield per plant and they also showed (Nie, 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,(a^1, a^2) and 3 removal florets stages every 3(b^1), 6(b^2), 9(b^3) 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, and 100 seed weight, seed yield per plants and plot, oil yield per plant and plot.

Table 1. Grain and oil yields ($Kgha^{-1}$) of safflower genotypes in different levels of sub and main factors.

Trait and treatment	Grain yield ($Kgha^{-1}$)	Oil yield ($Kgha^{-1}$)
a^1	1407^{ns}	653^{ns}
a^2	1330^{ns}	610^{ns}
B^0	1323^{b}	458^{b}
b^1	1600^{a}	539^{a}
b^2	1343^{ab}	479^{ab}
b^3	1210^{b}	416^{b}
a^1b^0	1003^{ns}	345^{ns}
a^1b^1	1172^{ns}	402^{ns}
a^1b^2	350^{ns}	338^{ns}
a^1b^3	928^{ns}	323^{ns}
a^2b^0	902^{ns}	314^{ns}
a^2b^1	1133^{ns}	372^{ns}
a^2b^2	982^{ns}	344^{ns}
a^2b^3	815^{ns}	280^{ns}

a^1= Isphahan local variety, a^2= Fo2 variety, b^o= intact plants, b^1= removal of florets, every 3 days after initiation of flowering, b^2= removal of florets, every 6 days after initiation of flowering, b^3= removal of florets, every 9 days after initiation of flowering, Different letters in each column shows significant differences at 0.01 probabilities (DMRT).

Simple correlations were used to evaluate traits interrelationships and relationship to seed and oil yield in 4 groups (a^1bo, a^2b^o), (a^1b^1, a^2b^1), (a^1b^2, a^2b^2) and (a^1b^3, a^2b^3).

RESULTS AND DISCUSSION

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

Varieties x florets removal interaction indicated no differential effects of florets removal on grain and oil yield, the highest grain and oil yields (1172.2 and 402 $Kgha^{-1}$) were produced from Isphahana local variety when its florets removed every 3 days after initiation of flowering (a^1b^1). Table 2 shows some important agronomic characteristics of treatments (a^1b^o,…,a^2b^3), the highest number of heads/plant (18) number of seeds/head (52), 100.S.W (41 g), Grain yield/plant (18 g), Grain yield/plot (417 g), Oil yield/plant (6.1 g), Oil yield/plot (147g) and plant height(90 cm) were belong to a^2b^1,a^1b^o, a^1b^1 ,a^2b^1, a^1b^1, a^2b^1, a^1b^1, and a^2b^3, 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(a^1b^o, a^2b^o), (a^1b^1, a^2b1), (a^1b^2, a^2b^2), and (a^1b^3, a^2b^3). 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 = 351) and oil yield per plot (r = 0.945),(r = 0.978),(r =0.958),(r= 0.953) in four mentioned groups (Table 3).

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), (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 effect on grain and oil yields 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).

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

Trait and treatment	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	
a^1b^0	7-17	10.8	31-52	42	31-36	343	10-16	12.5	317-350	334.	3.2-5.6	4.1	111-120	115	69-87	78
a^2b^0	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
a^1b^1	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
a^2b^1	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
a^1b^2	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
a^2b^2	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
a^1b^3	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
a^2b^3	8-16	12.7	23-45	35	31-37	33.4	9-17	12.5	210-314	287	2.7-5.64.3		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 flower, b3= removal of florets, every 9 days after initiation of flowering.

Table 3. Correlation coefficients of safflower traits in different treatments groups (a^1b^o, a^2b^o), (a^1b^1, a^2b^1), (a^1b^2, a^2b^2), (a^1b^3,a^2b^3).

Trait	Treatment	No. of Heads/Plant	No. of Seeds/Head	No. of secondary branches	Plant height	Grain yield/Plant	100-Seed weight	Oil yield/Plant	Grain yield/Plot	Oil yield/Plot
No. of 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*
No. of Seeds/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. of secondary 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

Table 3. Contd

	1	-	0.269	0..971**	0.531**	0.490**
Grain	2	-	0.524**	0..973**	0.459**	0.470**
yield/Plant	3	-	0198	0..960**	0.513**	0.501**
	4	-	-0.315	0.970**	0.340*	0.401**
	1		-	0.279*	0.237	0.064
100-Seed	2		-	0.476**	0.029	0.089
weight	3		-	0.149	0.355*	0.370*
	4		-	0.390**	-0.057	0.121
	1			-	0.520**	0.480**
Oil	2			-	0.449**	0.250
yield/Plant	3			-	0.516**	0.201
	4			-	0.351*	0.198
	1				-	0.945**
Grain	2				-	0.978**
yield/Plot	3				-	0.958**
	4				-	0.953**
	1					-
Oil yield/Plot	2					-
	3					-
	4				-	

1=a^1bo,a^2b^o 2=a^1b^1,a^2b^1 3=a^1b^2, a^2b^2 4=a^1b^3, a^2b^3 *and**significant at the 5% and 1%levels of probability respectively.

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

Treatment and trait	b^o	b^1	b^2	b^3
No seeds/head (b^o)	-	1.763^{ns}	5.93^{**}	6.98^{**}
100 .S.W (b1)	7.811^{**}	-	2.37^{ns}	2.04^{ns}

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