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Assessment of Genetic Diversity in Safflower (*Carthamus tinctorius* L.) Genotypes Using Agro-Morphological Traits

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ABSTRACT

To study the genetic diversity and relationships among traits, a field experiment was carried out on 20 genotypes of safflower (Carthamus tinctorius L.) under rain-fed condition in randomized complete block design with three replications at the rain-fed research farm of Dry-land Agriculture Research Station, Sararood, Kermanshah, Iran. Agro-morphological traits, including Days to 50% Flowering, Days to Finish Flowering, Days to physiological Maturity, Plant Height, Head (capitulum) number per Plant, Seed number per primary Head, Thousand Seed Weight, Yield, Oil Percent and Oil Yield per Hectare were recorded for all genotypes. Analysis of variance showed that safflower genotypes were significantly different for all of the characteristics studied, except Thousand Seed Weight (TKW). Oil yield has a positive and considerable correlation with yield. Cluster analysis grouped the 20 genotypes within 4 clusters, each of which having 12, 2, 5 and 1 genotypes. The results of study showed that between evaluated genotype, Faraman cultivar has the best seed and oil yield and other characteristics, thus it can be used as a suitable parent in a hybrid breeding program in future.

Key words: Agro-morphological traits, *Carthamus tinctorius* L., genetic variation, safflower, cluster analysis.

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is one of the plants which have a high adaptation to different conditions such as resistance to drought and it is suited to be grown in arid and semi-arid regions [8]. In Iran, research efforts have been undertaken to diversify the farming systems, and the government is encouraging the cultivation of various oilseed crops, including safflower [10]. Edible oil production has been a high priority in Iranian agriculture in recent years because of increasing demand for domestic consumption and a huge burden on national economy for meeting this demand through imports [1]. Iran is one of the richest sources of safflower. For instance of the 2042 safflower genotypes deposited at the western regional plant introduction station Pullman, WA, USA, 199 of them are of Iranian origin [4].

The creation of new genotypes is based firstly on the identification, collection, assembly, multiplication, evaluation and conservation of genetic resources, which are available for breeding of desirable characters of safflower [3]. Genetic diversity of some safflower germplasm has been previously investigated based on the agro-morphological traits [2, 7, 11].

The present study was conducted to assess the genetic diversity of different genotypes of safflower using agro-morphological traits as well as determine the relationship among yield and their components using agro-morphological traits.

MATERIALS AND METHODS

Eighteen germplasm lines chosen from a preliminary screening test among 121 Iranian and exotic safflower varieties along with two cultivated safflower genotypes including Sina and Faraman were grown based on Randomized Complete Blocks Design (RCBD) with three replication at the rain-fed research farm of Dry-land Agricultural Research Station, Sararood, Kermanshah, Iran in 2010-2011 growing season. The Sararood research station is located in west of Iran (Latitude 34°20'North and Longitude 47°20'East) at an elevation of 1351 m, and receives an average of 472 mm of precipitation per year. The soil of the experimental area was silty-clay-loam, pH was 7.5 and organic matter content of 1%. Prior to planting 80 kg ha-1 of nitrogen and 60 kg ha-1 P2O5 were applied. Sowing date was last week of Oct. The genotypes used in this study are given in Table 1.

Table 1. The safflower genotypes used in the present study

Genotype Number	Genotype Name	Flower Coor	Leaf spin
1	SNC. 397	yellow	+
2	16-14-S6-58-21	orange	+
3	168-S6-58/41	orange	+
4	35-14-4	yellow	+
5	47-S6/5811	yellow	+
6	357/S6/697	red	+
7	SV-S6-58/11	yellow	+
8	16/V-51/426	yellow	+
9	SNC. 809	yellow	+
10	Isfahan 24	yellow	-
11	351/LR55/697	orange	+
12	298/S6-7-58/697	orange	+
13	401	Red	-
14	RC-1033	yellow	+
15	6LR/55 - 65 7	yellow	+
16	47	red	-
17	5-LRV51/206	red	-
18	PI-592391/sunset	orange	+
19	Sina	yellow- orange	+
20	Faraman	red	-

The plot sizes were 4.0×1.0 m. Standard cultural practices were followed for raising the crop. The characters studied were Days to 50% Flowering (DF), Days to Finish Flowering (DFF), Days to physiological Maturity (DM), Plant Height (PH), Head (capitulum) number per Plant (HP), Seed number per primary Head (SH), Thousand Seed Weight (TKW), Yield, Oil Percent (OP) and Oil Yield per Hectare (OYH). Analysis of variance of data and Clustering of genotypes was performed using SPSS 13.0 software (SPSS Inc., Chicago, USA).

RESULTS AND DISCUSSION

The results of analysis of variance are presented in Table 2. Analysis of variance showed that safflower genotypes were significantly different for all of the characteristics studied, except Thousand Seed Weight (TKW).

Table 2. Analysis of variance for agro-morphological traits in safflower genotypes

Sources	Mean square										
	Df	DSF	DFF	DMS	PLH	SH	H/P	TKW	YIELD	PO	OIL YIELD
Replication	2	0.317	2.217	0.617	0.200	2.117	1.717	0.925	1869.211	0.545	255.769
Genotype	19	41.126**	44.227**	10.277**	31.624**	4.442*	0.396*	54.051 ^{ns}	33179.403*	23.912*	5663.589**
Error	38	0.492	3.594	0.459	3.989	2.082	0.190	29.350	14575.852	6.210	1780.129
C.V. (%)		1.07	2.55	0.65	3.45	9.32	9.12	16.63	21.49	8.58	22.50

**, ** Significant at the 5% and 1% respectively*
ns= non significant

Table 3. Mean of agro-morphological traits in safflower genotypes

Genotype Number	DSF	DFF	DMS	PLH	SH	H/P	TKW	YIELD	PO	OIL YIELD
1	73.66 A	84.66 A	106.67 A	61 AB	18.66 A	5.33 AB	28.40 BC	453.33 CD	27.03 DEFG	123.27 CDE
2	72 B	83.66 AB	106.67 A	58 BCDE	17 ABC	4.66 BCD	29.10 BC	445 CD	23.66 G	105.13 E
3	71.66 B	83.66 AB	106 AB	61 AB	17 ABC	5 ABC	28.90 BC	575 ABCD	31.86 ABCD	184.40 BCDE
4	66 CD	77 CDEF	105.67 ABC	62.66 A	16 ABCD	4.66 BCD	42 A	673.30 ABC	30.50 BCDE	204.63 BC
5	62.66 F	74.66 EF	102 GH	57.66 BCDE	15 BCD	4 D	30.80 BC	428.30 D	28.40 BCDEFG	121.67 CDE
6	66.66 C	75.66 DEF	104.67 CDE	53.33 F	16 ABCD	4.66 BCD	38.60 AB	701.70 AB	32.60 AB	228.60 AB
7	65 DE	79 CD	103 FG	56 DEF	15 BCD	4.66 BCD	30.40 BC	501.70 BCD	29.13 BCDEF	146.07 BCDE
8	65 DE	79 CD	104 DEF	62.66 A	14.33 CD	4.66 BCD	25.70 C	550 ABCD	29.10 BCDEF	159.93 BCDE
9	61 G	77.66 CDE	101.67 HI	53.33 F	14.66 BCD	5 ABC	38.4 AB	506.67 BCD	27.26 DEFG	140.27 CDE
10	72 B	84.66 A	105.67 ABC	59.33 ABCD	15.33 BCD	4.66 BCD	34.50 ABC	511.70 BCD	29.80 BCDEF	152.47 BCDE
11	64.66 E	76.66 DEF	105 BCD	58.33 BCDE	17.33 AB	5 ABC	35.30 ABC	501.67 BCD	30.03 BCDEF	150.83 BCDE
12	65 DE	75.66 DEF	105.67 ABC	53.33 F	17 ABC	4.33 CD	27.80 BC	466.67 BCD	25.36 FG	118.67 DE
13	62 FG	74 EFG	101.67 HI	60 ABC	17 ABC	4.66 BCD	31.70 ABC	521.67 BCD	27.96 BCDEFG	147.77 BCDE
14	65 DE	75.66 DEF	100.67 I	56.66 CDEF	18.66 A	5 ABC	33.20 ABC	450 CD	27.50 CDEFG	124.30 CDE
15	66.66 C	79 CD	105 BCD	56.66 CDEF	15.66 BCD	5 ABC	29.10 BC	695 AB	29.56 BCDEF	204.67 BC
16	63 F	77 CDEF	105 BCD	58.33 BCDE	16 ABCD	4.66 BCD	31.20 BC	701.67 AB	26.06 EFG	180.67 BCDE
17	63 F	71 G	103.67 EF	62.66 A	14.66 BCD	4.66 BCD	35 ABC	595 ABCD	32.40 ABC	193.57 BCD
18	62.66 F	73.66 FG	104 DEF	53.33 F	16.33 ABCD	5.66 A	30.70 BC	510 BCD	29.23 BCDEF	151.37 BCDE
19	63 F	76.66 DEF	102 GH	55 EF	13.66 D	4.33 CD	33.20 ABC	675 ABC	27.50 CDEFG	187.77 BCDE
20	64.66 E	80.66 BC	102 GH	60 ABC	15.33 BCD	5 ABC	37.70 AB	773.33 A	36.16 A	282.83 A

Table 4. Range and mean of different characters of safflower

Characters	Range	Mean
DF (d)	60 – 74	65.76
DFF (d)	70 – 89	77.98
DM (d)	100 – 107	104
PH (cm)	52 – 63	57.95
SH (no.)	13 – 20	15.93
HP (no.)	4 – 6	4.78
TKW (g)	24.40-50.00	32.58
YIELD	373.30-943.30	561.8
OP	23.00-39.70	29.05
OIL YIELD (OYH)	89.10-361.50	165.44

Mean and Range of agro-morphological traits in safflower genotypes are showed in Table 3 and 4 respectively. Comparison of genotypes by L.S.D. test indicated significant differences in studied characters. The plant height ranged between 52 cm (357/S6/697, 298/S6-7-58/697 and PI-592391/sunset) and 63 cm (35-14-4, 16/V-51/426 and 5-LRV51/206), but the mean for those 20 accessions was of 57.95 cm. PI-592391/sunset had the highest amount of head (capitulum) number in plant and SNC.397 and RC-1033 indicated higher amounts of seed number in capitulum. The highest and the lowest seed yield were belong to Faraman (773.33 Kg/ha) and 47-S6/5811 (428.30 Kg/ha), respectively. Finally Faraman with 282.83 kg/h and 16-14-S6-58-21 with 105.13 kg/h ranked the highest and lowest in terms of Oil Yield, respectively.

Pearson correlation coefficients for agro-morphological traits of 20 safflower genotypes are shown in Table 5. Oil yield has a positive correlation with thousand seed weight, Yield and Oil Percent yield.

Table 5. Pearson correlation coefficients for agro-morphological traits of 20 safflower genotypes

Characters	DF	DFF	DM	PH	SH	HP	TKW	YIELD	OP	OIL YIELD
DF	1									
DFF	0.777**	1								
DM	0.675**	0.490**	1							
PH	0.290*	0.151	0.162	1						
SH	0.213	0.049	0.117	0.011	1					
HP	0.107	0.110	0.151	-0.023	0.021	1				
TKW	-o.204	-0.244	-0.135	0.049	-0.041	0.190	1			
YIELD	-0.145	-0.122	-0.039	0.152	-0.164	-0.041	0.307*	1		
OP	-0.048	-0.131	-0.147	0.225*	-0.053	0.090	0.170	0.456**	1	
OIL YIELD	-0.122	-0.150	-0.104	0.211	-0.104	0.011	0.327*	0.932**	0.734**	1

Rainfall decreased by 25% during 2010-2011 growing season caused more severe drought stress on plants. Therefore, different characteristics such as yield components and consequently oil yield were lower than normal years. Similar results have also been reported by Bartuleanu [3].

Ehdai and Noormohammadi [5] evaluated yield and its components in two safflower genotypes (Nebraska and Mahali Arak). They found significant positive correlation between seed yield and seed number in capitulum, 1000 seed weight and seed oil percent, and seeds in capitulum were different between two genotypes.

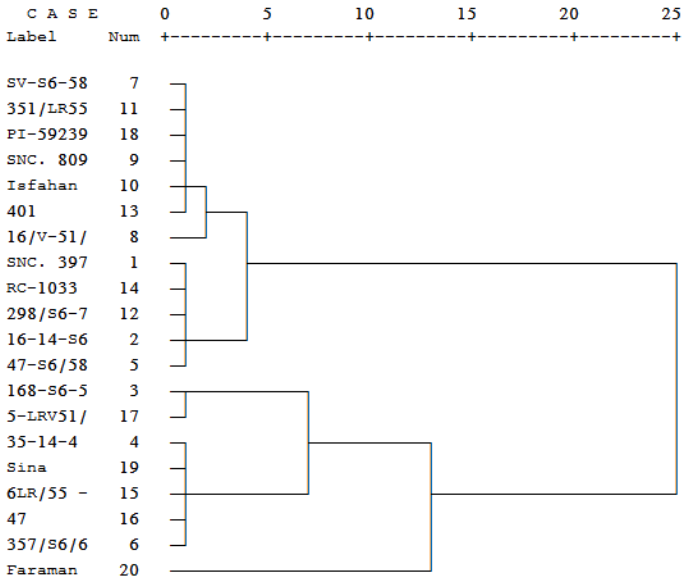

Figure 1. Dendrogram of cluster analysis for 20 safflower genotypes based on agro-morphological traits

SNC.397 line had the highest number of days to start and end of flowering and it was the latest cultivar among all studied genotypes. But when it faced with severe water stress during grain filling, 1000-seed weight lost (28.4 g) and consequently severely reduced seed and oil yield. Against the Faraman cultivar has the highest seed and oil yield. This cultivar was early-flowering and early-maturating and compared to most of genotypes was higher and its capitulum was greater. Of course that should be considered necessarily the earliest genotype hadn't the highest yield

(such as RC-1033) and balance between agronomic traits is more important. This was confirmed by lack of significant correlation between grain yield and other traits.

Cluster analysis of genotypes based on under study traits, with cutting dendrogram from 5 distances, located them in four groups, each of which having 12, 2, 5 and 1 genotypes respectively (Figure 1). Faraman alone formed a single cluster IV.

CONCLUSION

According to the results, between evaluated genotype, Faraman cultivar has the best seed and oil yield and other characteristics, thus it can be used as a suitable parent in a hybrid breeding program in future. Also 357/S6/697 genotype that located in a statistical class with Faraman and had high oil yield and high seed oil content and coarse grain (seed weights) can therefore be selected as a superior genotypes for rainfed conditions.

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REFERENCES

[1] K. Alizadeh, *Int. J. Agri. Biol*., **2005**, 7, 389-391.
[2] A. Ashri, *Euphytica*, **1975**, 24, 651–659.
[3] C. Bratuleanu, In: A. Corleto, H. H. Mundel (Ed.), 4th International Safflowers Conference, 2-7 June **1997**, Bari, Italy (Adriatica Editrice, Italy 1997) 196-204.
[4] M. Deharo, J.C. Lopez del Rio, M.A. Garica, M.J. Palomares and Fernandes-Martinez, Evaluation of the world collection of safflower for oil quality and other seed characters. *Sesame and Safflower newsletter*, **1991**, 6, 94-97.
[5] B. Ehdai, G. Noormohammadi, *Agric. J. Chamran University Iran*, **1984**, 9, 28-38.
[6] J. Gilbert, International safflower production – an overview, In: 7th International Safflowers Conference, **2008**, Wagga Wagga, Australia.
[7] A. A. Jaradat, M . Shahid, *Euphytica*, **2006**, 53, 225–244.
[8] A. Khalili Mosavi, R. Taghizadeh, H. Khazaei, A. H. Omidi Tabrizi, *J. on Plant Science Res*, **2009**, 13, 1.
[9] P. F. Knowles, *Econ. Bot.*, **1955**, 9, 273-299.
[10] S. S. Pourdad, R. Mohammadi, *Asian J Plant Sci*., **2008**, 7, 1, 100–104.
[11] S. A. Safavi, S. M. Safavi, A. S. Safavi, *American Journal of Scientific Research*, **2011**, 19, 22-26.
[12] D. Sehgal, S. N. Raina, *Euphytica*, **2005**, 146, 1, 67-76.
[13] E. A. Weiss; Castor, sesame and safflower, Leonard Hill, London, **1971**.