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Biodiversity of drought resistance and indirect selection in safflower (*Carthamus tinctorius* L.) genotypes

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Abstract

Determination of the biodiversity, drought resistance indices and identify the resistant genotypes, were achieved using ten spring safflower cultivars. The cultivars were sown at drought and non-drought stress conditions in the layout randomized completely block design with three replications during 2013-2014 farming season. Assessment of simple correlation coefficients among drought resistance indices and seed yield of cultivars showed that geometric mean of productivity (GMP) and stress tolerance index (STI) enable to identify cultivars having a high potential yield and tolerance to drought stress and because of that were recognized as the best resistance indices. Biplot graphical display designed that Sterling, Nebrasks10, land race Kuseh and Gila is the most drought resistance cultivars and U.S.10 is the most drought susceptible. Classification of cultivars using biplot analysis revealed that crosses between Sterling, Nebraska10, Landrace Kuseh and Gila with S149 cultivars having maximum genetic distance are qualified to recommendation for genetic improvement of yield potential and drought resistance *via* selection in spring safflower cultivars.

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Introduction

Drought usually is the most important abiotic stress that affects crop production. Hence, selection for drought resistance and production of tolerant cultivars with high yield potential is the main objective of breeding programs. Many researchers (Passioura, 1996; Richards, 1996; Quarrie *et al.*, 1999) believed that tolerance to drought stress must be done via genetic improvement of seed yield in crops. Stress susceptibility index, stress tolerance index, geometric mean of productivity, mean of productivity and tolerance index have been introduced as the most important criteria in this connection (Quarrie *et al.*, 1999). In small-grained cereals increase in STI, GMP and MP criteria may causes seed yield improvement (Fernandez, 1992). On the other hand, breeding for seed yield improve plant architect automatically (Quarrie *et al.*, 1999).

Purdad (2004) reported the efficiency of GMP and STI indices in identifying and selection of drought resistant safflower cultivars. Abolhasani and Saidi (2006) studied safflower lines in drought and non-drought stress condition. E2428 and Ac-Sunset have highest and lowest tolerance to drought based on STI index. Arslan (2010) and Ashkani *et al* (2012) introduced STI and GMP indices as the best criteria in screening of the resistant safflower cultivars.

The aims of this study were determination of the biodiversity of drought resistance, identify the best selection criteria as well as screening of the resistant genotypes and classification of the safflower genotypes in order to identify the best crosses parents for genetic improvement of drought stress resistance.

Material and methods

Cultivars and experimental design

Ten spring safflower cultivars namely; Isfahan28 (1), US.10 (2), Land race kuseh (3), Arak2811 (4), S149 (5), Nebraska10 (6), Gila (7), C111 (8), S2110 (9) and Sterling (10) were planted at the beginning of March 2013 at the research field of Islamic Azad University in randomized complete block design. Experiment involved two separate stress and non-stress designs. One considered as the normal and another as the drought stress conditions.

Cultivation practices

The plots comprising four rows were 2 m long and 0.5 m apart. Distance between plants with in rows was 0.05 m. Therefore, plant density were 400,000-plant ha^{-1}. In spring 2013, the trial in stress condition was not supplied with irrigation, while another trial was irrigated every 10 days. Amount of precipitation was 152 mm. Measurement for plant seed yield(g) was achieved on 10 normal plants randomly selected from two middle rows from each plot in two experiments.

Drought resistance indices

SSI, STI, GMP, MP and TOL indices were computed based on plant seed yield measurements in drought and non-drought stress conditions and the formulas that recommended by Fischer and Maurer (1978), Fernandez (1992) and Rosielle and Hambelen (1982). Simple correlation coefficients between drought resistance criteria and seed yield in two conditions were estimated using $SPSS_{16}$ software.

Statistical procedures and software

Principal component analyses were achieved on drought resistance criteria and seed yield in two conditions as seven variables. Then, biplot display of 10 safflower cultivars was provided based on the plot of pc_2 on pc_1 in order to distinguish the resistant and susceptible genotypes. These analyses were done by $Statgraphics_{2.1}$ software.

Results and discussion

Correlation coefficients between drought resistance criteria and seed yield of genotypes in drought and non-drought stress conditions (Table 1) revealed that STI and GMP have positive and significant relationship with seed yield of genotypes in two conditions. Therefore, these criteria are able to screening the high yield potential and tolerant genotypes from the susceptible and because of that determined as the best drought resistance indices in safflower cultivars (Fernandez, 1992; Kristine *et al.*, 1997; Arslan, 2010; Ashkani *et al.,* 2012).

Principal component analyses designed that 98% of total variation exists among the data is accounted for by first and second components (Table 2). Biplot display of ten safflower cultivars based on these two components classified the genotypes in four groups (Fig. 1).

Table 1. Simple correlation coefficients between drought resistance indices .

Variables	Yp	Ys	SSI	Tol	MP	GMP	STI
Yp	1						
Ys	0.19	1					
SSI	0.89 *	0.25	1				
Tol	0.47	-0.71 *	0.73 *	1			
MP	0.90 **	0.59	0.62	0.08	1		
GMP	0.87 *	0.64 *	0.58	0.01	0.99 **	1	
STI	0.86 *	0.67 *	0.54	-0.01	0.98 **	0.99 **	1

* , ** : Significant at 5% and 1% probability levels, respectively.

The first component accounted for 65.6 % of total variation between the data (Table 2) and correlated positively with seed yield of genotypes in drought and non-drought stress conditions, STI and GMP as the best resistance indices. On the other hand, selection based on the higher amounts of STI, GMP and seed yield in drought and non-drought stress conditions provides the genotypes having high yield potential and tolerant to drought stress. Therefore, selection for higher amounts of the first component targets this aim. The first component was entitled as yield potential and tolerance to drought stress.

Table 2. Eigen values, cumulative percent of variance and eigen vectors for drought resistance indices in spring safflower cultivars

Components	Eigen values	Cumulative variance (%)	Yp	Ys	SSI	TOL	MP	GMP	STI
1	4.590	65.520	0.444	0.225	0.226	.091	0.463	0.458	0.455
2	2.300	98.370	0.201	-0.574	0.439	0.625	-0.086	-0.128	-0.146

The second component accounted for 32.8% of total variation between the data and correlated negatively with seed yield of genotypes in drought stress condition, STI and GMP and positively with SSI. Therefore, selection based on the lowest amounts of the second component provides the genotypes that were less susceptible to drought stress. The second component was entitled as susceptibility to drought stress. These results are inconsistent with reports given by Farshadfar *et al.* (2001) and Purdad (2004).
Biplot display (Fig. 1) revealed that Sterling, Nebraska10, Land race Kuseh and Gila have the highest yield potential and the lowest susceptibility to drought stress. U.S.10 cultivar has the special adaptation to stress condition. Isfahan28, Arak2811, C111 and S2110 have the special adaptation to non-drought stress conditions. Finally, S149 cultivar has the lowest yield potential and the highest susceptibility to drought stress. The similar results reported by Abolhasani and Saeidi (2006), Arslan (2010) and Ashkani *et al.* (2012) in safflower, Farshadfar *et al.* (2001) in Chickpea, Kristine *et al.* (1997) in common bean and Golparvar (2003) in bread wheat.

In conclusion, Sterling, Nebraska10, Landrace Kuseh and Gila as the highest yielding cultivars and the lowest susceptibility to drought have the maximum genetic distance with S149 cultivar as the lowest yielding and the highest susceptibility to drought stress. Therefore, crosses between these two group cultivars and selection with in its progeny in segregating generations is recommended for genetic improvement of yield potential and drought stress resistance in safflower cultivars.

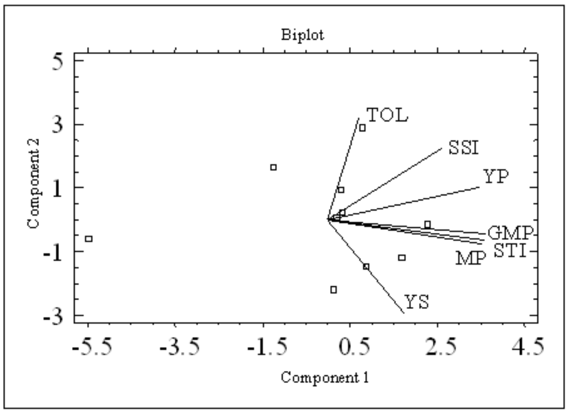

Fig. 1. Biplot display of ten spring safflower cultivars using drought resistance indices.

References

Abolhasani Kh, Saeidi G. 2006. Evaluation of drought tolerance of safflower lines based on tolerance and sensitivity indices to water stress. Journal of Science and Technology of Agriculture and Natural Resources **10 (3)**, 419-422.

Arslan B. 2010. Assessing of heritability and variance components of yield and some agronomic traits of different safflower cultivars. Asian Journal of Plant Sciences **6(3),** 554-557.

Ashkani J, Pakniyat H, Ghotbi V. 2012. Genetic evaluation of several physiological traits for screening of suitable spring safflower genotypes under stress and non-stress irrigation regimes. Pakistan Journal of Biological Sciences **10(14),** 2320-2326.

Farshadfar A, Zamani MR, Motallebi M, Imam-jomeh A. 2001. Selection for drought resistance in Chickpea lines. Iranian Journal of Agricultural Sciences **32,** 65-77.

Fernandez GC. 1992. Effective selection criteria for assessing plant stress tolerance. In proceeding of a symposium, Taiwan, 13-18 Aug, 257-270 p.

Fischer RA, Maurer R. 1978. Drought resistance in spring wheat cultivars. I, grown yield responses. Australian Journal of Agricultural Research **29,** 897-912.

Golparvar AR. 2003. Genetic analysis of drought resistance in bread wheat cultivars. Ph.D. Thesis. Islamic Azad University, Science and research branch of Tehran. 286 p.

Kristin AS, Serna RR, Perez FI, Enriquez BC, Gallegos JAA, Vallejo PR, Wassimi N, Kelley JD. 1997. Improving common bean performance under drought stress. Crop Science **37,** 43-50.

Passioura JB. 1996. Drought and drought tolerance. Plant Growth Regulation **20,** 79-83.

Purdad SS. 2004. Assessment of drought resistance in safflower lines and cultivars in spring planting. Proceedings of the 8th Iranian congress of crop production and plant breeding. 24.

Quarrie SA, Stojanovic J, Pekic S. 1999. Improving drought tolerance in small-grained cereals: A case study, progress and prospects. Plant Growth Regulation **29,** 1-21.

Richards RA. 1996. Defining selection criteria to improve yield under drought. Plant Growth Regulation **20**, 157-166.

Rosielle AT, Hambelen J. 1981. Theoretical aspects of selection for yield in stress and non-stress environments. Crop Science **21,** 943-945.