7th International Safflower Conference
WAGGA WAGGA AUSTRALIA

Evaluation of stability and adaptability for new spring safflower lines in different environmental conditions of Iran

A.H. Omidi
Seed and Plant Improvement Institute, Karaj, Iran, omidixyz@yahoo.com

Abstract
The stability of seven spring safflower cultivars and lines were evaluated in five different environmental conditions of Karaj, Isfahan, Eslamabad, and Zargan, in Iran, for two years (2002- 2004). Simple analysis of variances of grain and oil yields from each experiment showed significant differences among the genotypes. After having homogeneity test for error variances combined analysis of variance was performed. F.test of different sources of variation revealed that the effect of genotype x year x location interaction was significant (P<1%). Analysis of the grain and oil yields using Eberhart and Russell method showed significant difference for the main effects of genotype and genotype x environment (linear) interactions and non- significant difference for deviation from regression for some genotypes. According to the classification of genotypes based on the mean of grain and oil yields, coefficient of regression and deviation from regression, the new line I.L.111 with its high grain and oil yields and stability was selected as a desirable genotype.

Key words: Safflower - grain and oil yields – stability - adaptability

Introduction

Safflower (*Carthamus tinctorius L.*) has been grown since ancient times (4500 BC) in Egypt, Morocco, China and India to obtain carthamin from the flowers, a dye that may be either yellow or red. It has been cultivated in Iran for centuries in small amounts for the extraction of dye from its florets, while Its importance, as an oil seed crop, has only been realized since 1970 (Ahmadi and Omidi,1997).

Iran is one of the richest germplasm sources of safflower. For instance, of the total 2042 safflower genotypes deposited at the Western Regional Plant Introduction Station, Pullman, WA,USA,199 were found to be of Iranian origin (De haro et al.,1991). Safflower cropped area in Iran has increased over the last few years , reaching to about 20000 hectares in 2001, where as it was only 200-300 hectares in 1999 (Omidi Tabrizi,2001).

Genotype x environment interactions are of the major importance to the plant breeders in developing improved varieties. When varieties are compared with over different environments their relative performances usually differ, to overcome this constraint, stability analyses should be carried out (Eberhart and Russell , 1966).

Plaisted and Peterson (1959) presented a method to characterize the stability of yield performance when several varieties were tested at a number of locations within A year, the variety with the smallest mean value as a stable variety. Francis and Kannenberg(1978) used the coefficient of variation (Cv) to measure varietal stability in multi environment trials.

Finlay and Wilkinson (1963) used regression coefficient (bi) as stability parameter. Eberhart and Russell (1966) suggested that a stable variety will be the one with high mean (Xi) , regression coefficient of unity(bi=1.0) and less deviation from regression (S^2di=0).Lin and Binns (1982) proposed variance within locations(MS/L) as the stability parameter. In this method , genotypes were grouped according to similarity of response to environment and then assessed for, within groups average effect.

B.Y.Samadi and A.Bagheri (2005) by using of 121 genotypes to study of genetic diversity in yield and its components, reported that appearance of some foreign cultivars with clusters related to Iranian landraces showed that they have the same origin and suggest that the foreign cultivars have been introduced from Iran.

Dehro *et al* (1991) in a study of 199 safflower genotypes, collected from 37 different countries showed that the oil percent varied by genotype and environmental conditions. Longkui, (1993) reported that variety FO2 is an adaptable and stable safflower genotype because it had desirable traits for drought, cold and salinity tolerance and was disease resistant and thus it can be easly grown in various environmental conditions. Narkhede and Pati (1990) studied the environmental interaction of 9 safflower genotypes for yield and yield components and reported that variety J.S.LF-48 was a stable genotype.

Elfada *et al* (2005) in study of genotype and environment interaction in safflower reported that BS-62929 and P1-572475 revealed the highest stability of all genotypes tested. Rudra *et al* (2005) evaluated ten promising safflower lines in three different locations of India and reported that on the basis of stability parameters and overall mean , 98-29,BIP-2,98-51 and A1 were identified as stable performance suitable for cultivation in the rainfed agro-ecosystem of Northen Karnataka. M.J.Mahasi et al (2005) reported that selection for hybridization should be based on genetic diversity rather than geographic diversity.

The objective of this research was to evaluate the stability of some safflower cultivars for seed oil and grain yields, using Eberhart and Russell method of stability analysis.

Materials and methods

Seven new spring types safflower lines and cultivars were evaluated for stability of seed oil and grain yields based on Eberhart and Russel (1966)method in randomized block design with four replication in two years (2003-2004) and five locations (Karaj, Isfahan, Zargan,Eslamabad and Arak) where the years and locations were considered as random variables, while genotypes was account as fixed variable. Experimental plots consisted of 4 rows with 3-m long and 0.5-m apart .After emergence manual seedling thinning were used to obtain normal density. In these experiments, 70 Kg/ha of P2O5 and 25 Kg/ha of nitrogen were applied prior to sowing and 30 Kg/ha of nitrogen used as top dressing at the start of stem elongation. Weeds were controlled by hand prior to stem elongation, bud formation , beginning of flowering, 50% of flowering, finishing of flowering and seed filling. After having homogeneity test for error variances, combined analysis of variance was performed. List of the safflower genotypes and some geographical characteristics of the locations are shown in table 1 and 2 respectively. The genotypes, based on the mean grain and oil yields, coefficient of regression and deviation from regression were classified in different groups .

Table 1. List of safflower lines and cultivars

No	Name	Selected from
1	L.S.P	Selected from Fars landraces
2	ARAK 2811	Selected from Arak landraces
3	I.L.111	Selected from Arak landraces
4	Isphahan-14	Selected from Isphahan landraces
5	Fo2	China
6	K.H.48.154	Selected from cross
7	E.S.68	Selected from Isphahan landraces

Table 2 . Some geographical conditions and annual precipitation of experimental locations

Location	Altitude	Longitude	Latitude	Rainfall(mm)
Karaj	1300	57°.00	35°.48	250-300
Isfahan	1650	50°.49	33°.7	150
Zargan	1603	52°.43	28.29	250
Eslamabad	1346	26°.26	28.29	500
Arak	1755	49°.43	34.50	250

Results and Discussion

1-Simple and Combined Analysis of Variance:

The results of simple analysis of variance demonstrated that differences among genotypes were highly significant (P<0.01) for seed oil and grain yields in three locations and three years. There was a large variations in seed yield among locations in 3 years ,from 1072 Kg/ha to 1994 Kg/ha in Karaj and Arak (2002and2003). Line I.L.111 was classified in class A for grain yield in different years and locations except in Eslamabad and Arak in 2002. The oil yield data showed that the performance of lines and varieties Were different among locations in 3 years. Mean oil yield ranged from 300 Kg/ha to 672.6 Kg/ha in Karaj and Arak (2003).

The results of combined analysis of variance for seed oil and grain yields showed that year x location and also year x location x genotypes interactions are highly significant. This means that the genotypes respond in different climatic conditions thus, they could be classified based on experimental sites.

2- Stability analysis:

Stability analysis of seed oil and grain yields in different environments showed that the variance of genotypes and genotypes x environment (linear) interactions were significant at 1% probability, but mean squares of deviations from the regression was not significant for grain and oil yields. It can be concluded that there was a clear linear relationship between grain and oil yields and environment indices, therefore, genotypic reactions do not have any vacillations as follows:

2-1- Classification of the genotypes based on grain yield:

Group A(+): The group with well adapted genotypes which their grain yields exceeded the population mean in all environments . The genotype I.L.111 and Esfahan-14 were assign to this group. They produced above-average yields in all years at all locations, which indicated that they have good general adaptability.

Group A(O): The group with an average stability over all environments and grain yield equal to mean population. The genotype K.H.48.154 was classified in this group.

Group A(-): The genotype L.S.P was classified in this group, that produced below-average grain yield and it is poorly adapted to all environments.

Group B: The group with genotypes specially adapted to unfavorable environments. The genotypes FO2 and E.S.168 with less deviation from regression were classified in this group.

Group C: The genotypes in this group are suitable for favorable environments. The cultivar arak-2811 was classified in this group.

2-2- Classification of the genotypes based on oil yield:

Group A(+): Mean seed and oil yields of the genotypes in this group exceeds that of population mean in all environments . The genotypes Esfahan-14 was classified in this group.

Group A(O): This group has an average stability value of oil yield equal to mean population over all environments. The genotypes Arak 2811,E.S.68 andIL.111were classified in this group.

Group B: The group with genotypes specially adapted to unfavorable environments. The genotypes FO2,L.S.P and K.H.48.154 were classified in this group.

Based on Eberhart and Russel (1966) it can be concluded that when stability parameters exceeds grain yield that of population mean, coefficient of regression is equal to unity (bi=1.0) and also the deviation from regression is as small as possible (S^2di= 0), line no.3I.I.11 by having a grain yield of 1707 Kg/ha and 409Kg/ha respectively, can be recommended for cultivation in areas where this study was carried out (table 3 and 4).

Table 3.Mean grain yields (kg.ha $^{-1}$) of cultivars/lines and their related stability parameters.

Cultivar/line	Mean yield	R^2	bi	S^2di
1	1300 d	0.42 ^{ns}	0.90 ^{ns}	10203.94 ^{ns}
2	1549 b	0.15 ^{ns}	0.63 ^{ns}	30254.09 ^{ns}
3	1707 a	0.11 ^{ns}	0.94 ^{ns}	22193.46 ^{ns}
4	1653 a	0.41 ^{ns}	1.09 ^{ns}	20763.55 ^{ns}
5	1462c	0.59 ^{ns}	1.47 ^{ns}	17148.99 ^{ns}
6	1474 bc	0.18 ^{ns}	1.005 ^{ns}	69467.49 ^{ns}
7	1460 c	0.75 ^{ns}	1.403 ^{ns}	1994.385 ^{ns}
10	2136.9	80.3	1.280 ^{ns}	7662.5 ^{ns}

** Significant at the 1% level of probability.
Ns= Non significant.

Table 4.Mean oil yields (kg.ha $^{-1}$) of cultivars/lines and their related stability parameters.

Cultivar/line	Mean yield	R^2	bi	S^2di
1	368 e	0.5838 ^{ns}	1.72 ^{ns}	938.45 ^{ns}
2	438 c	0.2735 ^{ns}	0.90 ^{ns}	3215.4 ^{ns}
3	409 d	0.088 ^{ns}	0.90 ^{ns}	677.35 ^{ns}
4	477 b	0.4049 ^{ns}	0.91 ^{ns}	1415.04 ^{ns}
5	429 cd	0.5941 ^{ns}	1.33 ^{ns}	1396.85 ^{ns}
6	503 a	0.3251 ^{ns}	1.34 ^{ns}	6157.37 ^{ns}
7	433 cd	0.5974 ^{ns}	1.035 ^{ns}	455.35 ^{ns}

** Significant at the 1% level of probability.
Ns= Non significant.

References

Ahmadi,M.R.and A.H.Omidi.1997.Evaluation of 25 safflower (*Carthamus tinctorius L.*) genotypes for their morpho-agronomic characters. Proceedings of IV International Safflower Conference.Italy.218-221

Deharo, A.,M . Del Rio, J .C Lopez, M.A.Garcia, M.J.Palomares and J. Fernandes Martines.1997. Evaluation of the world collection of safflower for oil quality and other seed characters. Sesame & Safflower Newsl., 6:94-99

Eberhart, S.A., and W.A.Russell.1966. Stability parameters for comparing varieties. Crop Science 6: 36-40

Elfadi, E. Y., C. Reinbrechi., C. Frick, S. V. Witzke, S . Rudolphi, W. Claupein 2005. Genotype by environment interaction in safflower grown under organic farming system in central Europe. VIth International Safflower Conference 6-10 June, 2005, Istanbul, Turkey.pp.39-43

Esendel, E.,K., Kevesolgl, N.Ulsa and S. Aytac.1992. Performance of late auttum and spring planted safflower under limited environment. Proceeding of Third International Safflower Conference. China, 221-248

Finlay, K. and G.V.Wilkinson.1963. The analysis of adaptation in plant breeding programme.Australian Journal of Agricultural Research. 14:743-745

Francis, T.R. and L.W.Kannenberg.1978. Yield stability studies in short season maize: I.A.Descripitive method for grouping genotypes. Canadian Journal of Plant Science.58:1029-1034

Li, D. and H.Mundel 1996. Safflower. Promoting the conservation and use underutilized and neglected crops.7.IPGCPR, Catersleben/IPGR,Rome,Italy. 83-p.

Lin, C.S., and M.R.Binns.1985. Procedural approach for assessing cultivar- location data: Pairwise genotype-environment interaction of test cultivars with checks. Can.J.Plant Sci.65:1065-1071.

Longkui, M.1993.The adaptation of Fo2 safflower to the natural condition in Jinchugh area.Proceeding of Third International Safflower Conference. China. pp550-553

Mahasi , M . J., R . S., Pathak , J . N .Wachira, T . C. Riungu and J . W . Kamundia . 2005 . Development and evaluation of safflower for the marginal rainfall areas of Kenya: morphological characterization, genetic diversity and adaptation studies.2005. VI th International Safflower Conference 6-10 gune,2005, Istanbul,Turkey.pp.31-38

Narkhede, B.N.and A.M.Patil.1990. Phenotypic stability in safflower. Journal of Maharashtra Agricultural University.15(1): 95-96.

Omidi Tabrizi, A.H.2001.Correlation between traits and path analysis for grain and oil yield in spring safflower. Proceedings of the Vth International Safflower Conference, USA,July .pp 95-98.

Perkins, J.M., and J.L.Jinnks.1968. Environmental and genotypes- environmental component of variability. III.Multiple lines and crosses. Heredity ,23:339-356.

Plaisted, R.L., andL.C.Peterson.1959.A technique for evaluating the ability of selection to yield consistently in different locations and seasons. American Potato Journal 36:381-385

Rudra.V.,B.N.Harish.,S.D.Yaragoppa.2005.Phenotypic stability for safflower advanced breeding lines under rainfed ecosystem of north Karnataka. VI th International Safflower Conference 6-10 gune,2005,Istanbul,Turkey.pp.26-30

Yazdi Samadi B. and A.Bagheri.2005.Genetic diversity in Iranian and foreign safflower genotypes. VI th International Safflower Conference 6-10 gune,2005, Istanbul,Turkey.2-pp.21-23