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Genotype x Environment Interaction and Stability Parameters in Safflower

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G x E interaction and stability parameters of 18 genotypes of safflower under three diverse environments for yield and its related traits were studied. It was observed that G x E interaction was significant for all the traits studied. The results indicated that linear and non-linear components of G x E interaction were responsible for the differences in the stability of genotypes observed.TSF 16 was observed to be desirable for days to 50% flowering, days to maturity and 100-seed weight whereas, TSF 10 was found to be stable for days to maturity and test weight. Further TSF 4, TSF 8, TSF 1 and TSF 15 had high seed yield and non significant (bi>1) deviation indicating that these genotypes would perform better in favourable conditions whereas, TSF 7 and TSF 17 with bi<1 and non significant s^2di values indicated that these genotypes would perform well in unfavourable conditions.

Key words: Stability parameters, safflower, G x E interaction

The effects of genotype x environment on phenotypes may not always be independent. The phenotypic response to change in environment is not same for all the genotypes. The consequences of variation on phenotype depend upon the environment. Since, G x E interaction has masking effect on genotype (Comstock and Moll, 1963). Hence, these interactions are of considerable importance to plant breeders in identifying the genotypes suitable for favourable location/ environment and assume importance for potential expression of characters under interest. The importance of G x E interactions is recognized well and these are known to be heritable and statistical techniques are available to estimate them. The main efforts of geneticists are to reduce them or scale them out. The genotypes adjusting their phenotypic state in response to the environment so that they are able to give their maximum yield are near maximum economic returns are called “well buffered” genotypes (Allard and Hansche, 1964). Hence, the present investigation was carried out utilizing 18 genotypes over three diverse environments to assess the stability of seed yield and its component traits in safflower.

Materials and Methods

The present experiment was conducted during three years (2007-08, 2008-09 and 2009-10 *rabi* season) in randomized block design with three replications at Agricultural Research Station, Tandur. Each entry was sown in 6 rows of 5m length with a distance of 45 cm and 20 cm between rows and plants, respectively. The recommended packages of practices for rainfed conditions were adopted. In each replication, the observations were recorded on five randomly selected plants in each plot on seed yield and related traits *viz.*, days to 50 per cent flowering, days to maturity, number of effective capitula per plant, number of seeds per capitulum, and 100-seed weight (g). Plot means are subjected to stability analysis as per the model given by Eberhart and Russell (1966).

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Results and Discussion

Significant difference among the genotypes pooled over environments indicated considerable amount of genetic variability among the genotypes for all the characters studied. The genotype x environment interaction was significant for all the characters studied which indicated the differential response of the genotypes under different environments. Similar results were reported by Beena Nair *et al.,* (2002). Hence the data were subjected to stability analysis following the statistical model suggested by Eberhart and Russell (1966) to get information on the stability and adaptability of individual genotypes. Significant mean sum of squares due to genotypes, environments and environments (linear) for all the traits indicated significant variation among the genotypes and environments (Table1).

The G x E interactions were significant for all the characters *viz*., days to 50 per cent flowering, days to maturity, plant height, number of effective capitula per plant, number of seeds per capitulum, 100-seed weight and seed yield which suggested that genotypes interacted differently to different environments. The genotypes manifested genetic differences for their regression on environmental index as evident from the significance of G x E

Table 1. Joint regression analysis for yield and yield components in safflower

Source	df	Days to 50% flowering	Days to maturity	Number of effective capitula per plant	Number of seeds per capitulum	100-seed weight (g)	Seed yield (kg/ha)
Rep with in Env.	6	0.702	1.210**	7.673**	2.107	0.021*	22280.570**
Genotypes	17	14.001**	17.757**	16.749**	51.614**	0.552**	89336.190**
Env+(Gen*Env)	36	3.099*	3.025**	34.436**	36.062**	0.241**	114098.90**
Environments	2	6.352*	24.479**	353.167**	242.335**	2.247**	151809.00**
Gen *Env	34	2.907*	1.763**	15.687**	23.928**	0.123**	31511.130**
Env. (Lin.)	1	12.703*	48.959**	706.333**	484.671**	4.493**	3036182.00**
Gen*Env (Lin.)	17	4.390*	3.284**	29.933**	46.403**	0.239**	61327.010**
Pooled deviation	18	1.345*	0.282**	1.361	1.372	0.006	1601.058
Pooled error	102	0.804	0.511	1.989	5.007	0.022	5581.515
Total	53	6.596	7.750	28.763	41.050	0.340	106156.10

*- Significant at 5% level, **- Significant at 1% level

(linear) component for seed yield, plant height, number of effective capitula per plant, number of seeds per capitulum and 100-seed weight .The variances owing to pooled deviation were significant for days to 50 per cent flowering and days to maturity indicating the involvement of non linear component for the differences in the stability among genotypes for these traits. These results are in agreement with the earlier findings of Hegde *et al*., (1997).

Phenotypic stability of the genotypes was measured by three parameters viz., mean performance over environments (μ), regression coefficient (bi) and deviation from regression (s^2di). Breese (1969) and Paroda and Hayes (1971) emphasized that linear regression should simply be regarded as a measure of response of the particular genotype, whereas deviation from regression should be considered as measure of

Table 2. Estimates of different stability parameters in 18 safflower genotypes

Genotype	Days to 50% flowering			Days to maturity			Number of effective capitula per plant			Number seeds per capitulum			100-seed weight (g)			Seed yield (kg/ha)		
	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di	Mean	bi	s^2di
TSF 3	76.78	-0.43	-0.63	108.0	0.80	-0.31	19.88	1.78	-2.30	35.67	0.56	-4.57	4.86	0.86	-0.02	947.33	1.03	5715.62
TSF 4	81.44	2.15	3.34	111.8	1.14	-0.45	15.88	1.13	-2.23	32.22	0.34	-4.73	4.89	1.04	-0.01	1111.00	2.07	-3835.23
TSF 5	79.33	-0.12	-0.59	110.1	0.59	-0.55	17.11	1.48	-1.95	29.78	0.82	-2.00	4.84	0.91	-0.02	1083.89	1.02	-6373.45
TSF 6	75.44	0.21	-0.76	107.3	1.56	-0.28	20.33	0.85	-2.05	25.22	3.25	-4.49	5.44	2.58	-0.01	1157.78	0.93	-4081.54
TSF 7	79.33	0.00	-0.80	111.0	1.29	-0.43	19.11	-0.41	-1.66	39.67	-0.49	-1.86	5.09	2.04	-0.02	1574.89	-0.26	-6043.48
TSF 8	80.88	-0.22	-0.76	113.3	1.25	-0.54	21.22	-0.30	-2.01	31.67	2.83	-4.64	5.11	1.68	-0.01	1105.22	1.59	-6415.78
TSF 9	78.89	-0.22	-0.76	109.8	0.65	-0.52	20.67	1.30	-1.70	25.11	0.37	-4.72	4.82	0.49	-0.02	1233.89	0.40	-1076.84
TSF 10	79.00	0.00	-0.80	111.0	1.47	-0.39	17.67	0.40	-1.58	25.89	2.07	-4.65	5.30	0.91	-0.02	1242.44	0.60	-5597.56
TSF 11	78.78	-1.61	0.55	109.8	0.48	-0.21	24.00	1.37	-2.16	25.86	0.34	-4.73	6.51	2.67	-0.02	1040.78	1.12	-6471.25
TSF 12	81.33	0.64	-0.42	112.8	1.41	-0.53	21.11	0.05	-2.09	23.67	2.11	-2.88	5.64	0.48	-0.02	1017.00	2.13	-1724.58
TSF 13	80.89	0.43	-0.63	112.4	1.62	-0.49	19.67	0.85	-2.30	25.00	2.20	-4.78	5.58	0.11	-0.02	1368.56	0.86	-4451.65
TSF 14	79.33	3.22	8.52	110.4	0.33	-0.54	16.22	-0.31	-2.15	28.33	2.05	-4.77	5.24	1.33	-0.02	1004.78	0.87	-608.78
TSF 15	75.89	0.39	2.28	107.5	-1.84	-0.54	20.22	1.65	-1.56	29.33	1.35	-3.88	5.00	1.14	-0.01	1347.33	1.18	-6502.56
TSF 16	80.56	1.07	0.24	108.7	2.55	-0.34	18.00	0.39	-2.16	29.78	-0.65	-4.00	5.32	0.86	0.00	1027.00	0.97	-6237.32
TSF 17	82.22	-0.11	-0.73	112.6	2.00	-0.55	22.22	1.97	-1.81	28.67	1.67	-3.62	5.43	0.07	-0.02	1360.22	-0.01	-6261.89
Manjira	79.00	-1.18	-0.23	111.3	-1.15	0.53	22.22	1.93	5.80	25.67	-0.68	3.10	5.77	0.91	-0.02	1185.44	1.39	-5511.78
Sagarmuthyalu	82.78	4.85	0.40	113.6	2.39	0.75	18.67	1.29	7.52	31.89	-1.45	-2.82	5.10	1.52	0.00	981.56	0.94	5910.63
TSF 1	82.89	8.87	1.62	117.0	1.47	-0.39	23.78	2.58	-0.57	28.78	1.30	-2.97	4.82	-1.60	-0.01	1364.89	1.18	-5537.85
Mean	79.71			111.06			19.89			28.94			5.26			1175.22		

stability. The data showed that five genotypes TSF-7, TSF-13, TSF-15, TSF-17and TSF-1were found to be stable for high yield which expressed high seed yield, non significant linear (bi) and non linear components (s^2di) . These genotypes were also found to be stable for important yield components i,e., number of effective capitula per plant, number of seeds per capitulum and 100-seed weight. The data also revealed that five genotypes viz., TSF-4, TSF-8, TSF-15, Manjira and TSF-1were found to be stable under favourable environments having high seed yield , significant regression coefficient (bi>1) and non significant deviation from regression whereas four genotypes *viz*,. TSF-7, TSF-10, TSF-13 and TSF -9 were found to be stable for unfavourable / poor environments having high seed yield, significant regression coefficient (bi<1) and non significant deviation from regression. Patil *et al.*, (2005) and Rao *et al*., (2007) reported similar results in safflower.

In the present study, the genotypes TSF-7, Sagarmuthyalu, TSF-3 and TSF-4 showed high mean values for number of seeds per capitulum and 100 seed weight, less than unity regression coefficient and non significant deviation from

regression indicating stable performance over unfavorable environments. The genotypes TSF-11, TSF-12, TSF-8, TSF-17, Manjira and TSF-1 showed high mean values for number of effective capitula per plant out of which the genotypes TSF-11, TSF-15, Manjira and TSF-1recorded more than unit regression coefficient and non significant deviation from regression thereby indicating stable performance under favourable environment for this trait.

In general the present investigation revealed that the genotypes identified as stable for seed yield also showed stability from one or more important component traits like number of effective capitula per plant, number of seeds per capitulum and 100-seed weight. This indicated that stability of various component traits might be responsible for the observed stability of various genotypes for seed yield.

Hence, chances of selection of stable genotypes for seed yield could be enhanced by selecting for stability for yield components. Grafius (1959) also observed that stability of seed yield might be due to stability of various components. Three genotypes TSF-6, TSF- 16 and Sagarmuthyalu are highly responsive to average environments as indicated by regression coefficients nearer to unity, will further be tested over time and space for increasing the productivity before commercialization.

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