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GENOTYPE X ENVIRONMENT INTERACTION, STABILITY AND GENETIC DIVERSITY STUDY IN LINSEED FOR YIELD AND YIELD ATTRIBUTES UNDER DRYLAND SITUATION

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ABSTRACT

Nineteen genotypes of linseed *(Linum usitatissimum* L.) were evaluated for the three environments during 1989-90 to 1991-92 and stability for parameters studies for yield and yield attributes. G X E (linear) interaction was significant for number of branches/plant and highly significant for plant height, number of seeds/ capsules and number of capsules/plant. The environment III (1991-92) gave the highest yield and was favourable for most of the characters. Based on D^2 values 19 genotypes were grouped into seven clusters. Twelve genotypes were sorted out on the basis of stability and genetic divergence for yield and yield attributes.

KEY WORDS : Linseed, Cluster, Environment Index, Genetic Divergence, Genotype x Environment Interaction, Stability.

Linseed *(Linum usitatissimum* L.), an important oilseed crop, is grown in India. Significant shift in crop productivity may be possible by breeding crop varieties for their stability for yield and yield components. Genotype x environment interactions are of considerable importance in a breeding programme. In the recent years, much emphasis has been laid on the nature of genotype x environment interaction and on the techniques used for analysis of such interactions. These parameters have been studied in many crops for measuring phenotypic stability. This paper reports results on the environment interaction, genetic divergence and phenotypic stability of 19 genotypes in linseed.

MATERIALS AND METHODS

The experimental material consisted of 19 promising genotypes of linseed and these were grown in three environments during *rabi* (winter) 1989-90 to 1991-92 under dryland conditions at the Birsa Agricultural University experimental area. The plot size of 4 m long having 6 rows and distance between plants and rows was maintained 25 cm and 10 cm, respectively in randomised block design with three replications. Five randomly selected competitive plants were utilised to record the data for seven traits (Table 1). Stability parameters were estimated as per Eberhart and Russell (1966). Estimates of genetic divergence were calculated based as pooled data of seven characters over 3 environments. Mahalanobis D^2 statistics was used to measure the genetic divergence and grouping in various clusters done by Toucher's methods as described by Rao (1952)

RESULTS AND DISCUSSION

Analysis of variance indicated presence of significant variability of genotypes for all the characters except days to maturity. The pooled analysis of variance showed significant genotype x environment interactions when tested against pooled error, which was also reported earlier by Verma *et al.* (1994). Kumar *et al.* (1986) reported significant difference for number of siliquae on main shoot, number of seeds/ siliqua and seed yield/plant at pooled error. Kumar (1988) showed significant G x E interaction for plant height, days to maturity, number of pods on main shoot and seed yield/plot. The partitioning of environment + genotype x environment interaction into different components revealed that the environment (linear) was significant for all characters, indicating that the response for the environments was predictable. Genotype x environment (linear) interaction was significant for number of branches/plant and number of capsules/ plant. However, the pooled deviations from regression were significant. The parameter S^{-2} d_1 may be comparatively more important for interpreting the stability status of all the characters.

The mean squares due to varieties, when tested against pooled devi[illegible] were highly significant for

days to 50 per cent flowering and significant for plant height, number of branches per plant and number of capsules per plant. E + (G x E) was significant for plant height, days to 50 per cent flowering and days to maturity and highly significant for number of seeds per capsule and number of capsules per plant. Highly significant pooled deviation indicated that genotypes differed considerably for their stability. The pooled analysis of variance (Table 1) revealed that both linear and non-linear component to G x E interaction were significant for plant height, number of seeds per capsule, number of branches per plant and number of capsules per plant whereas the non-linear component of G x E was significant for days to 50 per cent flowering and seed yield per plant. This indicated that predictions of performance for plant height, number of seeds per capsule, number of branches per plant and number of capsules per plant were possible in different environment. Highly significant differences due to linear and non-linear component of G x E interaction indicated the importance of both linear ($S^{-2}d_i$) components in the expression of plant height, number of seed per capsule and number of capsules per plant.

It appeared that during 1991-92, dryland condition was the most favourable environment for expression of plant height, days to 50 per cent flowering, number of capsules per plant and seed yield (Table 3) as they had additive environment index. During the year 1989-90 dryland condition was the most favourable environment for expression of all traits except days to 50 per cent flowering and seed yield. However, in 1990-91 most of the characters was unfavoured as its negative environment index and only number of seeds per capsule and number of branches per plant was favoured as they had positive environment index.

All genotypes showing above average stability and adaptability to unfavourable environmental conditions for plant height, as these had high mean, bi close to unity and deviation from the regression is zero and non-significant except BAUL 3, BAUL 8, BAUL 65-2, BAUL 95-1 BAUL 138, BAUL 147, RIC 33, Sweta and BAUL 189-2, which may be grown only in poor environment (Table 2). For days to 50 per cent flowering, the genotypes BAUL 65-2, BAUL 95-1, BAUL 135, BAUL 165, LCK 8657 and Sweta had above average stability and adaptability to unfavourable environmental conditions.

The genotypes BAUL 3, BAUL 8, BAUL 9, BAUL 135 , BAUL 138, BAUL 160, LCK 1657 and Shubhra had high mean with unit bi and non-significant deviation from regression indicating above-average stability and adaptability to unfavourable environmental conditions for number of seeds per capsule. The genotypes T 397 and RLC 33 showed their suitability in poor environment. With respect to maturity all the

Table 1. Pooled analysis of variance for different components of variation and environment index for different characters in linseed under dryland conditions

Characters		Mean sum of square						
Source	df	Plant height	Days to 50% flowering	Number of seeds/ Capsule	Days to maturity	Number of branches/ plant	Number of capsules/ plant	Seed yield
Variety	18	29.194^{*++}	7.084^{**++}	1.177^{++}	1.715	2.636^{*++}	509.071^{*++}	0.517^{++}
Year	2	53.147^{*++}	7.491^{*++}	17.446^{**++}	4.018*	2.628^{++}	2061.256^{**++}	1.213^{++}
Variety x Year	36	13.436^{++}	1.084^{++}	1.322^{++}	1.055	0.823^{++}	223.704^{**++}	0.393^{++}
Year (linear)	1	106.294^{**++}	14.982^{**++}	34.893^{**++}	8.036^{**}	5.255^{*++}	4122.512^{**++}	2.427^{*++}
Variety x year (Linear)	18	16.748^{++}	0.230	1.340^{++}	0.973	0.608^{+}	203.996^{++}	0.311
Pooled deviation	19	9.592^{++}	1.835^{++}	1.235^{++}	1.077	0.983^{++}	230.602^{++}	0.451^{+}
Pooled error	108	3.547	0.279	0.272	1.496	0.286	15.205	0.206
				ENVIRONMENT INDEX				
Winter 1989-90		0.713	-0.281	0.922	0.509	0.233	9.085	-0.134
Winter 1990-91		-1.911	-0.439	0.071	-0.123	0.206	-11.318	-0.158
Winter 1991-92		1.198	0.719	-0.994	-0.386	-0.429	2.283	0.201

*, ** Significant at 5% and 1% probabilily levels (Pooled deviation); +, ++ Significant at 5% and 1% probability levels (pooled error).

genotypes (except BAUL 138 and BAUL 159-4) showed above average stability and adaptability to unfavourable environmental condition. LCK 8657, BAUL 3, Shubhra, BAUL 160 and BAUL 286-5 did well in poor environmental condition. In all the genotypes except BAUL 3, BAUL 8, BAUL 9, 65-2, BAUL 95-4, BAUL 138, and BAUL 165 had above average stability and adaptability to unfavourable environmental conditions. However, BAUL 3, BAUL 9, BAUL 95-1 and BAUL 195-4 do well in poor environment only. The most stable genotype was LCK 8657 ($S^{-2}d_1$ = -0.272) for number of branches per plant.

Above-average stability and adaptability to unfavourable environment were found in all the genotypes BAUK 135, BAUL 147 and Sweta. The genotypes Shubhra, RLC 33 and BAUL 160 perform well in poor environment. The most of the genotypes had significant $S^{-2}d_1$. The most stable genotype was BAUL 147 ($S^{-2}d_1$ = -7.258) for number of capsules per plant. All the genotypes excepting BAUL 9, BAUL 65-2, BAUL 95-1, BAUL 135, and BAUL 159-4 had above-average stability to unfavourable environment for seed yield per plant as they had high mean, bi close to unity and non- significant $S^{-2}d_1$. Sweta and BAUL 138 showed their ability to do well only in poor environment. The most stable genotype was T 397 ($S^{-2}d_i$ = - 0.206).

On basis of stability results of different characters, BAUL 135, LCK 8657 and Sweta were the stable genotypes for the most of the characters under study. Labana *et al.* (1980) in Indian mustard, Rao and Singh (1984) in linseed, Singh and Gupta (1984) and Kundu and Khurana (1988) and Verma *et al.*, (1994) in toria also identified stable genotypes for seed yield and other attributes.

Table 2. Genotypes stable for seed yield and various characters forming different clusters on the basis of D^2 analysis

Character	Genotypes	Plant height	Days to 50% flowering	No. of seeds/ Capsule	Days to maturity	No. of branches/ plant	No. of capsules/ plant	Mean	Seed yield		Stable for diff. characters
									bi	$\overline{S^2}di$	
I	BAUL 3			+	+			5.350	0.698	-0.198	3
	BAUL 95-1		+		+			4.877	3.960	0.088	2
	BAUL 138		+	+			+	5.063	-1.082	-0.162	4
	BAUL 147		+		+	+	+	5.283	0.072	-0.042	5
	BAUL 160			+	+		+	5.157	0.541	-0.185	4
	BAUL 165	+	+		+		+	5.050	0.841	0.209	5
	BAUL 195-4	+	+		+	+	+	5.013	2.731	0.373	6
	BAUL 189-2		+		+	+	+	6.002	-0.464	0.534	5
	Shubhra	+		+	+	+	+	5.247	0.620	0.135	6
	Sweta	+	+		+	+	+	4.653	-0.973	0.074	6
II	T 397	+		+	+	+	+	5.423	1.635	-0.206	6
	BAUL 8		+		+			5.210	0.407	-0.154	3
	BAUL 286-5	+	+		+	+		4.740	2.320	-0.078	5
III	LCK 8657	+	+	+	+	+	+	5.503	1.678	-0.001	7
IV	BAUL 9	+	+	+	+			4.770	3.591	0.700	4
	BAUL 159-4		+			+		4.260	0.355	2.296	2
V	RIC 33		+	+	+	+	+	5.233	1.830	-0.089	6
VI	BAUL 135	+	+	+	+	+	+	5.367	-2.002	0.710	7
VII	BAUL 65-2		+		+			4.790	1.941	0.646	3
Mean		55.687	66.281	7.873	135.807	5.019	80.996	5.131			
SEM ($\overline{X}$)		2.190	0.958	0.786	0.794	0.701	10.758	0.475			
SEM (bi)		1.309	1.526	0.817	1.596	1.885	1.031	1.878			
r ($\overline{x}$, $\overline{S^2}$di)		0.182	0.130	0.151	0.110	0.210	0.002	0.121			
r ($\overline{X}$, bi)		0.100	0.123	0.121	0.115	0.131	0.120	0.110			
r (bi, $\overline{S^2}$di)		0.115	0.125	0.155	0.122	0.111	0.088	0.118			

Table 3. Clustering of 19 genotypes in linseed under dryland environments

Cluster	Total No. of Genotypes	Genotype
I	10	BAUL 3, BAUL 95-1, BAUL 138, BAUL 147, BAUL 160, BAUL 165, BAUL 195-4, BAUL 189-2, Shubhra, Sweta
II	3	T 397, BAUL 8, BAUL 286-5
III	1	LCK 8657
IV	2	BAUL 9, BAUL 159-4
V	1	RLC 33
VI	1	BAUL 135
VII	1	BAUL 65-2

Table 4. Intra- and inter- cluster distance (D^2 values) in linseed under dryland environments

Cluster	I	II	III	IV	V	VI	VII
I	9.869	23.028	14.263	26.082	14.389	17.451	23.015
II		7.248	34.071	17.165	17.345	34.736	116.845
III			0.000	47.761	21.067	9.516	33.463
IV				6.702	32.887	49.769	18.864
V					0.000	18.890	26.150
VI						0.000	37.997
VII							0.000

Genetic diversity

Based on D^2 values, 19 genotypes were grouped into seven clusters (Table 4). Ten genotypes clustered in cluster I, 3 in cluster II, 2 in cluster IV whereas other clusters had single genotypes. There was no parallelism between geographical distribution and genetic diversity as genotypes even evolved at Birsa Agricultural University, Ranchi, exhibited considerable genetic diversity and were scattered in different clusters. Similar observations have been made by Singh and Bains (1968). Diversity within the groups from intracluster distance as it ranged from 6.702 (cluster IV to 9.869(cluster I). Minimum inter-cluster distance (9.516) was observed between cluster III and VI, showing closer relationship between genotypes of these clusters. Maximum interclusters distance (49.769) was noted between cluster IV and VI which indicated wider genetic diversity between themselves followed by cluster III and IV, II and VII. The inter-cluster distances also did not bear any definite pattern with regard to geographical origin of genotypes because the cluster having genotypes from distant geographical region did not necessarily had high inter- cluster distances and vice-versa. Canonical analysis (Table 5) indicated that 98.19 per cent of total variation accounted for contribution of various characters for diversity and variations, accounted for Z_1 was 81.7734 per cent and Z_2 and Z_3 were 13.0809 and 3.3357 per cent respectively. Out of accounted variation for diversity, days to maturity contributed maximum (40.12%) followed by seed yield (20.58%) and plant height (17.54%). Contribution of other characters are negligible. It indicates seed yield, days to maturity and plant height as basic yield attributes. Similar results have also been reported by Ranga Rao *et al.* (1980) in safflower and Haque *et al.* (1994) in linseed.

Stability and genetic diversity

Twelve genotypes selected on the basis of stability and higher mean for grain yield belong to different clusters. BAUL 147, BAUL 165, BAUL

Table 5. Canonical vactors alongwith contribution of quantitative characters in linseed under dryland environemnts

Characters	Canonical Vectors			Contribution % to diversity (D^2)
	Z_1	Z_2	Z_3	
Plant height	0.0550	-0.6413	-0.2328	17.54
Days to 50% flowering	0.0005	0.1735	0.1000	0.58
Number of seeds/plant	-0.0009	0.0564	-0.4361	0.00
Days to maturity	1.0998	0.0709	0.0607	40.12
Number of branches/plant	0.0349	0.0564	0.0817	10.58
Number of capsules/plant	0.0215	0.3179	-0.6386	10.58
Seed yield/plant	-0.2077	0.2482	0.2099	20.58
Variation % accounted	81.7734	13.0809	3.3357	
for Total variation ($Z_1 + Z_2 + Z_3$)	98.19			

195-4, BAUL 189-2, Shubhra and Sweta belong to cluster II, T 397 and BAUL 286-5 to cluster II and LCK 8657, RLC 33, BAUL 135, and BAUL 65-2 one each to clusters III, V, VI and VII, respectively (Table 2). Therefore, considering the D^2 analysis and stability of yield and yield attributes making crosses among the selected genotypes of cluster IV (BAUL 9 and BAUL 159-4) with the genotype of VI (BAUL 135), cluster III (LCK 8657) with the genotypes (BAUL 9 and BAUL 159-4), Cluster VI (BAUL 135) with cluster VII (BAUL 65-2) and cluster II (T 397) and BAUL 286-5) with cluster VI (BAUL 135) is recommended and is expected to provide enough genetic variability to select for yielding and stable segregates in the segregating generations.

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CULTURAL AND PHYSIOLOGICAL STUDIES OF *Fusarium oxysporum* f.sp. *sesami* CAUSING WILT DISEASE OF SESAMUM

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ABSTRACT

Cultural studies of *Fusarium oxysporum* f.sp. *sesami* were carried out on six different medium *viz.* Asthana and Hawker's medium, Czapek, Dox's Agar medium, Potato Dextrose Agar, Rechards medium and Wakman's medium. Out of these, the fungus showed luxuriant growth and maximum sporulation on Potato Dextrose Agar medium. The profuse growth and sporulation of *Fusarium oxysporum* f.sp. *sesami* was recorded at 27^0C temperature. Further it was observed that the fungus growth and sporulation was maximum at pH range between 6.5 and 7.5.

KEY WORDS : Cultural and Physiological Studies, Fusarium Wilt, Sesamum

Sesamum is one of the important oilseed crops grown in Maharashtra. Area under sesamum cultivation is less as compared to other oilseeds crops like groundnut, sunflower and safflower. The situation is also the same in respect of production (Anon., 1983). Sesamum is often threatened by several diseases such as wilt caused by *Fusarium oxysporum* f.sp. *sesami*.

During the *kharif* season there was a heavy mortality of sesamum at the Central Research Station, P.K.V., Akola. Taking into consideration of the severity of wilt disease various studies on pathogen *viz* cultural characters on different solid media, effect of temperature on growth and sporulation, effect of pH on growth and sporulation were undertaken for further investigation.