Phenotypic stability for yield and other desirable characters in high quality protein maize (*Zea mays* L.)

JITENDRA BHASKAR and S.S. VERMA

Department of Genetics and Plant Breeding, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar-263 145 (U.S. Nagar, Uttarakhand)

ABSTRACT: The genotypic response with respect to environmental fluctuations due to genotype × environment interaction is less defined and non-predictable. The main objective of any maize breeding programme is to develop high yielding varieties/hybrids with better degree of stability over a wide range of environments. A set of 21 quality protein maize (QPM) inbred lines and 3 quality protein maize (QPM) inbred testers with their sixty three single crosses and three checks were evaluated in three different environments, like., normal (recommended dose of nitrogen, E_1), low-nitrogen (E_2) and excess soil moisture (E_3) in order to examine their yield stability across changing environmental conditions. Results indicated significant G × E interaction mean squares for all the traits suggesting impact of variable environments on the performance of the genotypes. Crosses having desired stability for grain yield may be released as promising hybrids.

Key words: Changing environments, stability, quality protein maize

Stability in performance is one of the most desirable properties of a genotype to be released as a variety for wide adaptation. For a plant breeder, the interaction of genotype × environment is of major importance to develop improved varieties. It assumes added importance in the breeding of dry land crops, such as maize, which are more subjected to the vagaries of weather. It is, therefore, very important that stable genotypes are evolved which can withstand such uncertain conditions.

The response of genotypes of environmental fluctuations due to genotype × environment (G × E) interaction is less defined and non-predictable. Performance of crop in terms of yield over environments repeated in space and time has been always a challenge. Phenotype is the result of interplay of genotype and its environments. Therefore, it was considered desirable to carryout stability analysis for parents and their resultant crosses on the basis of data obtained from different environments. Statistical methods for determining stability of genotypes in diverse environment are usually used to assist plant breeder in selecting superior genotypes.

MATERIALS AND METHODS

The present investigation was undertaken with twenty one quality protein maize parental lines, three broad base QPM testers and their sixty three single crosses alongwith three checks (Table1) during *Kharif,* 2009 at G.B. Pant University of Agriculture and Technology, Pantnagar; in randomized block design with three replications. Experiments were sown in one row plots of 4 meter length with row to row spacing of 75 cm and plant to plant distance of 25 cm. Observations were recorded on days to 50 per cent tasselling, 100-kernel weight and grain yield for evaluation of genotypes for phenotypic stability.

The mean values for different quantitative traits in respect of each genotype were used for phenotypic stability analysis. The stability parameters were calculated by the procedure given by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

In present investigation, phenotypic stability for yield and other characters under different environments are presented in the Tables 2, 3 and 4, respectively.

The mean squares due to genotypes were significant for all three characters (Table 2) i.e., days to 50 % tasselling,100 kernel weight (g) and grain yield (q/ha), indicating sufficient variability among the genotypes, however, mean squares due to environments were also significant for all the characters, which also indicated

Table 1: Quality Protein Maize inbred lines, testers and checks selected for study

S.No.	Pedigree	Pedigree code
Lines		
1	DQPMC-3 (Y) ⊗101-1-2-1-1	L_1
2	DQPMC-3 (Y)⊗112-1-1-1-1	L_2
3	Pool 17C_8(TEYFQPM) -B-1-1-1-1	L_3
4	Pool 17C_8(TEYFQPM) -B-76-1-1-1	L_4
5	Pool 17C_8(TEYFQPM) -B-93-1-1-1	L_5
6	DQPMC-3(Y)⊗56-2-3-1-1	L_6
7	DQPMC-3(Y)⊗135-2-1-1-1	L_7
8	DMRQPM-03-103-#-3-1-1-1	L_8
9	DQPMC-3(Y)⊗31-1-3-2-1-1	L_9
10	DQPMC-3(Y) 50-1-1-1-1	L_{10}
11	Pool 18C_8(TEYFQPM) -B-9-1-2-1-1	L_{11}
12	POP 61 C_9(TEYFQPM) -B- 20-1-1-1	L_{12}
13	DMRQPM-03-101-#-⊗ -1-1-1	L_{13}
14	DMRQPM-28-5-⊗ -⊗ -#-⊗3- ⊗ -1-2-1	L_{14}
15	DMRQPM-18-⊗-⊗ -#-⊗2-⊗ -1-2-1	L_{15}
16	DMRQPM-17-⊗-⊗ -#-⊗1-⊗-2-1-1	L_{16}
17	DQPMC-3(Y)⊗2-1-1-2-1	L_{17}
18	DQPMC-3(Y)⊗4-1-2-1-1	L_{18}
19	DQPMC-3(Y)⊗14-2-1-2-1	L_{19}
20	POP 61 C_9(TEYFQPM) -B-23-1-2-1	L_{20}
21	POP 61 C_9(TEYFQPM) -B-35-2-1-1	L_{21}
Testers		
1	DMRQPM-03-106-#-⊗-1-1-1	T_1
2	DMRQPM-03-103-#-⊗-2-3-1	T_2
3	Pool 17C_8(TEYFQPM) -B-57-2-1-1	T_3
Checks		
1	HQPM-1	C_1
2	Shakti-1	C_2
3	Pragti	C_3

Table 2: Pooled analysis of variance for grain yield and other characters in quality protein maize over three environments

Source of variation	Mean squares			
	d.f.	Days to 50% tasselling	100 kernel weight (g)	Grain yield (q/ha)
Genotype (G)	56	2.50**	19.67**	321.18**
Environment (E)	2	105.54**	806.97**	3897.81**
G × E	112	1.61	12.80**	100.41**
E + (G × E)	114	2.77**	21.62**	142.60**
E (Linear)	1	211.09**	1613.95**	7795.63**
G × E (Linear)	56	1.88	13.86	114.01**
Pooled deviation	57	1.33**	11.60**	85.85**
Pooled error	336	0.067	0.0231	0.00073
Total	170	2.683	17.67	201.69

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

sufficient differences among the environments. Highly significant mean squares due to G × E interaction for all the traits indicated differential response of genotypes in different environments. The mean squares due to environment (linear) were highly significant for all the characters, whereas, genotypes × environment (linear) mean squares showed significant differences for grain yield (q/ha). The non-linear (pooled deviation) mean squares due to G × E interaction were also highly significant for all the characters.

The mean performance of genotypes for days to 50 per cent tasselling, ranged from 48.67 to 52.33 with an overall mean of 49.69 (Table 3). Among the 24 parents, all except L_{11} showed bi value non-significant by different from unity (bi=1) indicating average response over environments and all the parents except L_9 L_{12} L_{13} L_{17}, T_1 and T_2 had non-significant S^2di value from zero indicating lines to be stable for days to 50 percent tasselling over environments. The most desirable and stable lines having low mean indicating early tasselling than overall mean

Table 3: Stability parameters for grain yield and other characters in different genotypes pooled over environments

Genotype	Days to 50% tasselling			100 kernel weight			Grain yield		
	$\overline{X}$i	bi	S^2di	$\overline{X}$i	bi	S^2di	$\overline{X}$i	di	S^2di
Parent									
L_1	48.67	0.951	1.721	20.04	1.633	24.40**	61.80	1.014	107.76
L_2	48.67	0.951	1.721	34.86	1.079	22.36**	35.49	3.504*	466.15**
L_3	49.00	0.932	0.495	36.33	1.062	2.19	34.87	1.037	45.37
L_4	48.67	1.001	0.131	31.41	1.436	4.11	44.36	1.064	100.65
L_5	48.67	0.982	0.080	35.83	1.945	43.12**	39.67	0.914	13.43
L_6	48.67	1.026	1.398	35.40	0.992	3.13	40.09	1.018	11.03
L_7	48.67	1.036	1.398	35.63	3.106	18.21**	50.71	4.652**	29.05
L_8	49.00	1.025	0.069	36.36	0.936	1.06	25.51	1.029	119.7
L_9	49.00	0.156	14.398**	36.23	1.807	25.27**	26.61	-0.688	114.08
L_{10}	49.67	1.011	0.131	34.40	2.479	31.03**	48.62	4.133**	13.48
L_{11}	49.33	13.025**	0.069	33.43	2.116	0.54	30.83	1.035	11.71
L_{12}	48.34	4.261	22.375**	40.07	1.024	0.46	34.93	0.738	57.06
L_{13}	49.67	2.145	16.791**	38.56	0.105	12.99**	33.87	3.78*	6.23
L_{14}	50.00	1.025	0.069	34.66	1.017	26.79**	19.73	0.273	82.83
L_{15}	50.00	1.025	0.069	35.60	1.593	1.21	21.02	1.908	39.81
L_{16}	49.33	0.952	0.080	34.29	0.695	1.00	12.92	-0.102	0.11
L_{17}	48.00	0.156	10.398**	34.70	1.852	27.35**	16.82	0.469	12.57
L_{18}	48.67	1.965	0.117	37.57	1.924	25.20**	21.95	0.825	52.92
L_{19}	48.67	1.023	0.117	35.03	1.247	28.44**	34.98	0.998	56.4
L_{20}	49.00	1.024	0.117	30.60	0.638	88.07**	28.73	1.794	19.9
L_{21}	49.33	1.009	0.357	34.47	0.969	27.48**	30.41	1.608	115.48
T_1	48.33	1.396	19.295**	35.63	0.523	23.44**	13.99	0.165	12.29
T_2	48.77	1.658	20.083**	35.37	0.684	12.15**	31.96	0.283	732.75**
T_3	49.00	0.763	1.168	35.26	0.761	22.17**	13.15	0.045	15.78
L_1 X T_1	49.67	1.009	0.357	37.20	-1.218*	26.02**	47.74	3.237*	428.57**
L_1 X T_2	51.00	2.946	0.168	34.90	0.462	22.53**	34.71	3.988*	10.52
L_1 X T_3	50.33	1.924	0.117	39.00	0.781	18.86**	16.27	-0.666	23.76
L_2 X T_1	50.67	2.433	0.024	37.13	1.045	0.07	43.80	2.26	305.21**
L_2 X T_2	51.00	1.025	0.069	34.56	-1.202*	0.79	16.51	0.39	10.80
L_2 X T_3	50.33	2.182	2.694	36.07	0.792	32.04**	30.69	1.023	10.94
L_3 X T_1	52.00	1.527	3.063	36.57	4.113	32.87**	16.68	0.838	7.54
L_3 X T_2	52.33	1.909	3.983	31.80	2.632	9.26*	19.29	1.477	23.86
L_3 X T_3	49.00	3.077	1.650	33.93	1.398	3.18	52.77	1.035	0.19
L_4 X T_1	50.00	2.815	0.061	37.60	0.973	10.43**	26.30	-0.088	0.08
L_4 X T_2	50.00	2.171	1.474	37.10	0.604	10.83**	21.88	0.807	53.80
L_4 X T_3	50.33	14.276**	0.713	36.83	0.374	12.43**	33.76	1.085	556.34**
L_5 X T_1	49.00	14.407**	-0.112	35.40	0.682	1.18	21.02	1.908	39.84
L_5 X T_2	50.67	2.044	3.102	36.59	0.535	11.95**	33.91	1.099	35.31
L_5 X T_3	51.33	-13.025**	0.069	38.40	2.164	18.52**	30.99	1.074	12.63

Genotype	**Days to 50% tasselling**			**100 kernel weight**			**Grain yield**		
	$\bar{X}i$	**bi**	**S^2di**	**$\bar{X}i$**	**bi**	**S^2di**	**$\bar{X}i$**	**di**	**S^2di**
L_6 X T_1	49.33	1.025	0.069	36.85	2.506	79.19**	39.05	3.072*	503.26**
L_6 X T_2	50.33	2.433	-0.024	31.72	0.420	0.66	16.95	0.578	13.32
L_6 X T_3	51.67	0.905	3.612	33.34	1.183	6.68	20.07	0.358	77.79
L_7 X T_1	51.00	1.669	1.997	38.50	1.027	0.65	34.79	1.016	44.46
L_7 X T_2	51.67	1.669	1.997	37.47	2.005	0.92	36.86	0.479	212.81*
L_7 X T_3	50.67	2.302	0.099	36.76	0.556	13.78**	30.56	2.747	511.72**
L_8 X T_1	50.33	2.433	-0.024	37.87	0.996	1.46	34.79	0.995	122.91
L_8 X T_2	50.00	1.407	-0.112	36.28	1.073	10.74**	39.31	1.025	15.66
L_8 X T_3	49.33	0.992	-0.117	32.86	2.233	13.33**	34.00	0.899	137.70
L_9 X T_1	49.67	1.007	-0.112	34.96	1.165	5.09	14.09	-0.209	1.70
L_9 X T_2	51.33	1.538	0.316	36.26	3.245	11.80**	25.29	0.197	28.64
L_9 X T_3	50.00	2.564	1.107	35.26	0.513	22.32**	42.72	1.012	32.09
L_{10} X T_1	49.33	1.038	0.316	34.70	0.563	0.62	39.52	1.077	14.33
L_{10} X T_2	50.00	1.538	0.316	37.57	0.524	13.97**	39.54	1.082	14.21
L_{10}X T_3	49.67	1.025	0.069	38.49	3.229	29.04**	22.20	0.089	32.60
L_{11} X T_1	49.67	0.894	-0.008	36.38	1.218	0.51	34.87	2.359	599.97**
L_{11} X T_2	49.67	1.012	-0.112	35.97	0.369	4.18	39.94	0.986	116.70
L_{11} X T_3	49.33	0.894	-0.008	36.00	3.375	113.27**	39.75	0.936	108.48
L_{12} X T_1	49.50	15.894**	-0.008	31.43	2.907	0.16	38.31	1.074	37.81
L_{12} X T_2	49.17	-14.381**	0.194	34.54	0.125	0.01	35.54	0.137	180.44*
L_{12} X T_3	48.83	0.912	-0.080	36.37	2.102	65.80**	34.02	1.024	36.47
L_{13} X T_1	48.67	1.001	-0.131	36.77	2.617	22.97**	36.57	0.258	217.65*
L_{13} X T_2	48.67	1.025	1.721	36.83	0.956	4.19	34.11	0.093	212.41*
L_{13} X T_3	48.67	0.984	0.898	37.43	-2.36*	36.44**	33.15	1.095	107.75
L_{14} X T_1	48.67	-0.001	-0.131	34.36	0.584	23.99**	28.93	0.301	1.01
L_{14} X T_2	49.00	0.912	0.080	38.56	2.913	41.08**	25.68	0.156	2.21
L_{14} X T_3	49.33	0.981	0.194	35.63	0.564	4.07	36.37	0.958	140.40
L_{15} X T_1	49.33	0.913	0.083	34.47	1.117	4.14	30.92	0.156	186.87*
L_{15} X T_2	48.67	1.001	0.131	35.56	0.227	39.44**	15.07	-0.229	0.57
L_{15} X T_3	49.00	1.041	2.375	36.33	1.016	1.66	28.70	0.99	9.78
L_{16} X T_1	48.67	-13.644**	0.895	37.84	2.364	32.03**	18.76	0.556	0.69
L_{16} X T_2	49.67	0.943	0.898	36.47	0.978	1.52	31.89	1.089	152.67
L_{16} X T_3	49.00	0.912	0.080	34.90	1.48	14.77**	32.19	0.845	1.44
L_{17} X T_1	49.33	1.001	0.131	32.90	1.846	1.95	22.28	0.233	33.27
L_{17} X T_2	49.00	1.025	0.069	35.46	0.733	0.36	34.18	0.943	3.22
L_{17} X T_3	48.67	1.032	0.193	35.66	1.153	4.19	34.41	0.901	5.39
L_{18} X T1	50.00	1.538	0.316	36.83	3.768	22.95**	18.98	0.158	1.26
L_{18} X T_2	49.33	0.893	0.496	35.20	1.117	7.1**	20.86	0.813	0.09
L_{18} X T_3	49.67	0.894	0.008	33.23	0.137	16.39**	29.75	0.164	215.10*
L_{19} X T_1	50.33	12.001**	0.131	35.50	0.935	35.54**	25.39	0.221	227.80*
L_{19} X T_2	50.00	0.381	0.194	39.42	0.241	12.09**	21.50	-0.087	331.67**
L_{19} X T_3	49.67	1.002	0.193	37.06	0.976	2.18	24.57	0.017	335.37**
L_{20} X T_1	48.83	0.912	0.080	36.33	2.194	33.71**	26.11	0.597	325.25**
L_{20} X T_2	49.17	0.981	0.194	34.12	-1.232*	59.99**	46.15	0.892	12.60
L_{20} X T_3	49.83	-0.644	0.895	34.38	1.683	32.06**	38.65	0.965	7.83
L_{21} X T_1	50.00	0.763	1.168	34.49	1.577	35.61**	39.54	0.293	36.38
L_{21} X T_2	49.00	0.982	0.193	34.00	1.004	2.20	41.81	0.928	0.381
L_{21} X T_3	48.67	0.944	0.895	35.50	0.269	2.15	42.17	0.973	10.39
HQPM- 1	52.00	0.164	4.587*	34.63	1.731	0.56	24.54	1.466	26.55
Shakti - 1	49.00	1.012	0.080	35.49	2.376	39.15**	20.39	0.558	61.46
Pragati	50.67	0.152	5.541*	35.43	1.303	1.90	61.80	1.114	107.76
Mean	49.69	1.00		35.70	1.00	30.38	1.00		
SE (±)	0.61	0.55		2.4	0.60		6.55	0.98	

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

(<49.69), bi = 1 and S^2di = 0 for early flowering were L_1, L_2, L_3, L_4, L_5, L_6 L_7, L_8, L_{10}, L_{16}, L_{18}, L_{19} L_{20}, L_{21} and T_3. The crosses $L_4 \times T_3$, $L_5 \times T_1$, $L_5 \times T_3$, $L_{12} \times T_1$, $L_{12} \times T_2$, $L_{16} \times T_1$ and $L_{19} \times T_1$ exhibited significant bi values from unity. All the crosses had non-significant S^2di values except checks, HQPM-1 and Pragati. The most desirable i.e. having mean lower than the population mean and stable (bi = 1 and S^2di = 0) crosses over environments were $L_1 \times T_1$, $L_6 \times T_1$, $L_8 \times T_3$, $L_9 \times T_1$, $L_{10} \times T_1$, $L_{10} \times T_3$, $L_{11} \times T_1$, $L_{11} \times T_2$, $L_{11} \times T_3$, $L_{12} \times T_3$, $L_{13} \times T_1$, $L_{13} \times T_2$, $L_{13} \times T_3$, $L_{14} \times T_1$, $L_{14} \times T_2$, $L_{14} \times T_3$ $L_{15} \times T_1$, $L_{15} \times T_2$, $L_{15} \times T_3$, $L_{16} \times T_2$, $L_{16} \times T_3$, $L_{17} \times T_1$, $L_{17} \times T_2$, $L_{17} \times T_3$, $L_{18} \times T_2$, $L_{18} \times T_3$, $L_{19} \times T_3$, $L_{20} \times T_1$, $L_{20} \times T_2$, $L_{21} \times T_2$, $L_{21} \times T_3$ and check Shakti-1 for this trait.

The mean performance of genotypes for 100 kernel weight, ranged from 20.04 to 40.07 with an overall mean of 35.7 and bi values from -1.113 to 16.63 (Table 3). All the parents showed bi values non-significantly different from unity indicating their average performance, while lines, L_3, L_4, L_6, L_8, L_{11}, L_{12} L_{13}, L_{15} and L_{16} exhibited non-significantly different S^2di values from zero. All the three testers exhibited significantly different S^2di values from zero. The most desirable and stable lines were L_3, L_8 and L_{12} across the environments. All the crosses except for $L_1 \times T_1$, $L_2 \times T_2$, $L_{13} \times T_3$ and $L_{20} \times T_2$ exhibited non-significant bi values from unity indicating average response. Similarly the crosses, $L_2 \times T_1$, $L_2 \times T_2$, $L_3 \times T_3$, $L_5 \times T_1$, $L_6 \times T_2$, $L_6 \times T_3$, $L_7 \times T_1$, $L_7 \times T_2$, $L_8 \times T_1$, $L_9 \times T_1$, $L_{10} \times T_1$, $L_{11} \times T_1$, $L_{11} \times T_2$, $L_{12} \times T_1$, $L_{12} \times T_2$, $L_{13} \times T_2$, $L_{14} \times T_3$, $L_{15} \times T_1$, $L_{15} \times T_3$, $L_{16} \times T_2$, $L_{17} \times T_1$, $L_{17} \times T_2$, $L_{17} \times T_3$, $L_{19} \times T_3$, $L_{21} \times T_2$, $L_{21} \times T_3$ and Pragati showed non-significant S^2di values from zero showing their stable performance over environments. The crosses showing desirable stability i.e., high mean (>35.7, bi = 1, S^2di = 0) were $L_2 \times T_1$, $L_7 \times T_1$, $L_8 \times T_1$, $L_{13} \times T_2$, $L_{15} \times T_3$, $L_{16} \times T_2$, and $L_{19} \times T_3$ across the environments.

The mean performance of genotypes for grain yield, ranged from 12.92 to 61.8 with an overall mean 30.53. The range of bi values was -1.312 to 2.695. All the lines except L_2, L_7, L_{10}, L_{13}, exhibited bi values non-significantly different from unity indicating average response. All the parental lines except L_2 and T_2, exhibited magnitude of S^2di non-significantly different from zero by showing their stable performance across the environments. Although, mostly lines exhibited bi and S^2di values near about unity and zero, respectively, but lines, L_1, L_3, L_4, L_5, L_6, L_{11} L_{12} and L_{19} had higher mean value than the population mean. So these lines were considered as most desirable and stable one. The hybrids except $L_1 \times T_1$, $L_1 \times T_2$ and $L_6 \times T_1$ exhibited bi values non-significantly different from unity indicating their average performance over environments. All the hybrids except $L_1 \times T_1$, $L_4 \times T_3$ and $L_{11} \times T_1$, showed S^2di values non-significantly different from zero indicating their stable performance over environments. Among all the hybrids, the most desirable and stable i.e., having high mean (>30.38), bi = 1 and S^2di = 0 were $L_2 \times T_3$, $L_3 \times T_3$, $L_5 \times T_2$, $L_5 \times T_3$, $L_7 \times T_1$, $L_7 \times T_3$, $L_8 \times T_1$, $L_8 \times T_2$, $L_8 \times T_3$, $L_9 \times T_3$, $L_{10} \times T_1$, $L_{10} \times T_2$, $L_{11} \times T_2$, $L_{11} \times T_3$, $L_{12} \times T_1$, $L_{12} \times T_3$, , $L_{13} \times T_3$, $L_{14} \times T_3$,

Table 4: Parental lines and single crosses with desirable and stable performance for grain yield and other characters

S.No.	Character	Parental line	Single cross
1.	Days to 50% tasselling	L_1, L_2, L_3, L_4, L_5, L_6 L_7, L_8, L_{10}, L_{16}, L_{18}, L_{19}, L_{20}, L_{21} and T_3	$L_1 \times T_1$, $L_6 \times T_1$, $L_8 \times T_3$, $L_9 \times T_1$, $L_{10} \times T_1$, $L_{10} \times T_3$, $L_{11} \times T_1$, $L_{11} \times T_2$, $L_{11} \times T_3$, $L_{12} \times T_3$, $L_{13} \times T_1$, $L_{13} \times T_2$, $L^{13} \times T_3$, $L_{14} \times$ T1, $L_{14} \times T_2$, $L_{14} \times T_3$ $L^{15} \times T_1$, $L_{15} \times T_2$, $L_{15} \times T_3$, $L_{16} \times T_2$, $L_{16} \times T_3$, $L_{17} \times T_1$, $L_{17} \times T_2$, $L_{17} \times T_3$, $L_{18} \times T_2$, $L_{18} \times T_3$, $L_{19} \times T_3$, $L_{20} \times T_1$, $L_{20} \times T_2$, $L_{21} \times T_2$, $L_{21} \times T_3$ and Shakti-1
2.	100 kernel weight (g)	L_3, L_8 and L_{12}	$L_2 \times T_1$, $L_7 \times T_1$, $L_8 \times T_1$, $L_{13} \times T_2$, $L_{15} \times T_3$, $L_{16} \times T_2$, and $L_{19} \times T_3$
3.	Grain yield (q/ha)	L_1, L_3, L_4, L_5, L_6, L_{11}, L_{12} and L_{19}	$L_2 \times T_3$, $L_3 \times T_3$, $L_5 \times T_2$, $L_5 \times T_3$, $L_7 \times T_1$, $L_7 \times T_3$, $L_8 \times T_1$, $L_8 \times T_2$, $L_8 \times T_3$, $L_9 \times T_3$, $L_{10} \times T_1$, $L_{10} \times T_2$, $L_{11} \times T_2$, $L_{11} \times T_3$, $L_{12} \times T_1$, $L_{12} \times T_3$, $L_{13} \times T_3$, $L_{14} \times T_3$, $L_{16} \times T_2$, $L_{16} \times T_3$, $L_{17} \times T_2$, $L_{17} \times T_3$, $L_{20} \times T_2$, $L_{20} \times T_3$, $L_{21} \times T_1$, $L_{21} \times T_2$, $L_{21} \times T_3$

$L_{16} \times T_2$, $L_{16} \times T_3$, $L_{17} \times T_2$, $L_{17} \times T_3$, $L_{20} \times T_2$, $L_{20} \times T_3$, $L_{21} \times T_1$, $L_{21} \times T_2$, $L_{21} \times T_3$ and check Pragati for this trait. Similar findings were advocated by Adams and Shank (1959), Sharma and Bhalla (1982), Jha *et al.* (1986), Mahajan and Khehra (1992), Choukan (1999), Dehganpour and Mogadam (1999), Agrawal *et al.* (2000), Cardoso *et al.* (2000), Srivastava (2001), Reddy and Ahuja (2004) and Kumar and Singh (2004).

CONCLUSION

In the present investigation the inbred lines L_1, L_2, L_3, L_4, L_5, L_6 L_7, L_8, L_{10}, L_{16}, L_{18}, L_{19} L_{20}, L_{21} and tester T_3 were found to be most desirable and stable for days to 50% tasselling, however, lines L_3, L_8 and L_{12} were stable for 100-kernel weight. The inbred lines, L_1, L_3, L_4, L_5, L_6, L_{11} L_{12} and L_{19} were found to be most desirable for grain yield. The stability of single crosses for grain yield and other characters are presented in Table 4. The overall results of the stability revealed that none of the single cross hybrids showed stable performance for all the characters over all the environments except $L_{16} \times T_2$.

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