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Phenotypic stability analysis of maize hybrids -2005

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ABSTRACT

Genotype x environment interaction has special importance in the breeding of rainfed crops, such as maize, which are more subjected to the uncertainness of weather, especially at a time when the climate change is on the cards world over. Eighteen maize hybrids along with two checks were evaluated in a Randomized Block Design with three replications during *kharif*-2005 at five locations spreading over different agro-climatic zones of Himachal Pradesh. Six hybrids (X-6060, PMZ-4, JKMH-1512, IB-6301, Navaneet-7191 and PG-2408) and one composite (Girija) showed promise with respect to their stability and general adaptability across the locations for seed yield and other traits. The hybrid Star 56-7132 exhibited stability and responsiveness to better environments for seed yield, whereas the hybrid DMH-849 displayed stableness and responsiveness to unfavourable environments for plant height. It was concluded that yield as well as various yield components may be taken into account while evaluating genotypes for stability performance over environments. To measure stability of genotypes, regression (S^2di) appeared to be a more important criterion than regression coefficient (bi).

Key words : Maize, H x E interaction, Regression, Stability.

INTRODUCTION

Genotype x environment (G x E) interaction is of significance to a plant breeder in developing high yielding and stable hybrids / varieties. It assumes added importance in the breeding of rainfed crops, such as maize, which are more subjected to the uncertainness of weather, especially at a time when the climate change is on the cards world over. It is, therefore, essential that stable genotypes are evolved which can withstand such fluctuating environmental conditions of Himachal Pradesh where maize is the principal crop for food and feed and is cultivated in all sorts of agro climatic conditions ranging from foot hills to high mountainous regions. Hence, an attempt was made, in the present study, to identify high yielding stable maize hybrids among 18 hybrids by evaluating them at five diverse locations in the north western Himalayan region.

MATERIALS AND METHODS

Eighteen maize hybrids along with two checks were evaluated in a Randomized Block Design with three replications during *kharif*-2005 under five locations spreading over different agro-climatic zones of Himachal Pradesh, *viz.*, Bajaura, Dhaulakuan, Kangra, Sundernagar and Palampur. The sowing was completed during the first fortnight of June at all the locations and recommended package of practices was followed to raise the crop. Data were recorded on plot basis for days to 50 per cent tasseling, days to 50 per cent silking, days to 75 per cent maturity and seed yield; and on ten randomly taken plants for cob placement height (cm) and plant height (cm). Seed yield of each hybrid was calculated at 15per cent moisture content and converted into q/ha. Stability parameters for different characters were computed using the regression approach of Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The analysis of variance of pooled data (Table 1) indicated significant differences among hybrids and environments for all the traits studied suggesting the presence of variability among hybrids and environments. Significant mean squares for hybrids x environments (H x E) interactions were observed for days to 50 per cent tasseling and silking, cob placement height, plant height and grain yield indicating differential response of hybrids across the environments for these characters. The partitioning of H x E interactions into linear and non linear components showed that mean sum of squares due to both components played an important role in total H x E interaction for different characters. Significant variance due to environments (linear) for all the characters studied indicated considerable differences among the environments and their pre-dominant effects on the characters. This could be due the variations in weather and soil conditions over different locations. The H x E (linear) interactions was significant for days to 50 per cent maturity, cob placement height and seed yield

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Table 1: Pooled analysis of variance for different characters in maize hybrids over five locations

Source	d f	Days to 50% tasseling	Days to 50% silking	Days to 75% maturity	Cob placement	Plant height	Grain yield
Hybrid (H)	19	33.42*	34.18*	50.61*	334.75*	418.24*	280.62*
Environment (E)	4	357.21*	306.72*	18191.60*	3073.05*	31145.24*	5212.64*
Hybrid x Environment	76	12.71*	12.33*	51.98	160.86	395.02*	196.77*
Environment + (H x E)	80	21.89*	19.24*	926.03*	204.60*	1682.34*	322.93*
Environment (linear)	1	1428.85+	1226.92+	72766.32+	12292.13+	124582.10+	20850.69+
H x E (linear)	19	2.22	1.97	45.30+	79.39+	105.10	123.37+
Pooled deviation	60	4.67*	4.59*	7.59	42.79*	133.18	43.99*
Pooled error	190	0.30	0.31	10.09	15.29	55.55	16.63

* Significant against pooled error m. s. at P≤0.05; + significant against pooled deviation m. s. at P≤0.05

indicating thereby the predictability of performance of hybrids and their linear response under varied environmental conditions for these traits. The hybrids responded considerably to the environmental fluctuations for these traits. Significant pooled deviations for all the traits, except days to 50 per cent maturity and plant height, suggested that the deviation from linear regression also contributed substantially towards the differences in stability of hybrids thereby indicating difficulty in predicting the performance of hybrids over environments for these characters. However, even for unpredictable traits, prediction can still be made on considering stability parameters of individual genotypes (Singh *et al*., 1991; Pan *et al*., 2007). The significant differences among maize genotypes and G x E interaction for seed yield and other traits have also been reported by Mahajan *et al*. (1991), Dodiya and Joshi (2003) and Kaundal and Sharma (2006).

According to Eberhart and Result model (1966), an ideal genotype may be characterized as having high mean ($x = \mu$) performance with unit regression coefficient (b=1) and minimum (non significant) deviation from regression ($s^2di=0$). Accordingly, the mean (x) and deviation from regression (s^2di) are considered as measures of stability and linear regression (bi) is used for evaluating the hybrid response.

The stability parameters were worked out for days

Table 2: Estimated stability parameters for different maize hybrids over five locations

Sr. No.	Hybrids	Days to 50% tasseling			Days to 50% silking			Plant height (cm)			Grain yield (q/ha)		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
1.	X-6060	62	1.05	7.39*	65	1.08	6.66*	219.71	1.08	79.94	68.71	0.88	17.61
2.	X-9401	59	1.13	2.42*	63	1.06	2.24*	219.79	0.93	54.63	63.46	1.09	7.37
3.	POLO	61	0.81	3.57*	64	0.90	3.06*	221.71	1.25	79.60	75.63	1.38	52.45*
4.	Vijay-7102	56	0.83	9.14*	59	0.75	7.54*	224.13	0.99	46.86	63.63	0.99	18.07
5.	Star 56-7132	53	1.08	0.91*	56	1.01	0.60	213.47	0.92	63.60	70.33	1.34*	28.84
6.	Navaneet-7191	53	0.94	0.82*	57	0.99	0.77*	204.99	0.99	6.65	55.69	1.18	50.72*
7.	JKMH-1512	58	0.94	0.44	61	1.07	1.22*	200.73	0.99	11.92	73.12	1.21	55.67*
8.	JKMH-1701	57	0.95	2.53*	60	0.84	4.69*	202.16	0.91	148.57*	72.20	0.81	70.77*
9.	PG-2408	58	0.71	6.57*	61	0.70	5.49*	212.76	1.05	50.92	52.61	0.65*	3.64
10.	PG-2465	62	0.57	1.38*	65	0.61*	1.45*	218.39	1.17	176.38*	60.64	1.61*	22.77
11.	PG-2475	59	1.07	2.99*	62	1.05	2.35*	224.49	1.16*	28.86	74.73	1.38	51.27*
12.	DMH-849	58	1.00	9.74*	62	0.97	6.68*	215.37	0.74*	57.91	64.14	1.48*	40.00*
13.	DMH-879	58	1.21	10.15*	61	1.22	10.04*	215.03	1.11	118.28*	65.63	0.63	108.31*
14.	9572-A(Apoorva)	60	1.19	22.04*	64	1.12	25.55*	231.37	1.10	266.88*	75.27	0.89	63.07*
15.	IB-6301(Superfast)	59	0.98	1.53*	62	1.03	0.71	214.79	0.92	87.96	65.80	0.91	104.52*
16.	KDMH-3875	60	1.24	0.64	63	1.22	1.04*	223.11	0.92	51.89	56.51	0.71	51.52*
17.	Girija (Check)	59	0.98	0.14	62	0.90	0.42	218.23	0.89	53.77	53.26	0.55	51.42*
18.	PMZ-4 (Check)	62	0.95	2.39*	65	1.02	1.43*	216.84	0.10	65.10	73.97	1.27	10.80
19.	Ankur Mitra	61	1.23	3.85*	64	1.34	4.82*	221.69	1.04	134.45*	62.09	0.51	1.54
20.	Ankur Bhanu	56	1.13	4.69*	59	1.17	5.08*	193.71	0.76	1079.48*	59.37	0.51	69.44*
	Population mean	59	-	-	62	-	-	215.6	-	-	65.34	-	-

* indicates significance of value at P≤0.05

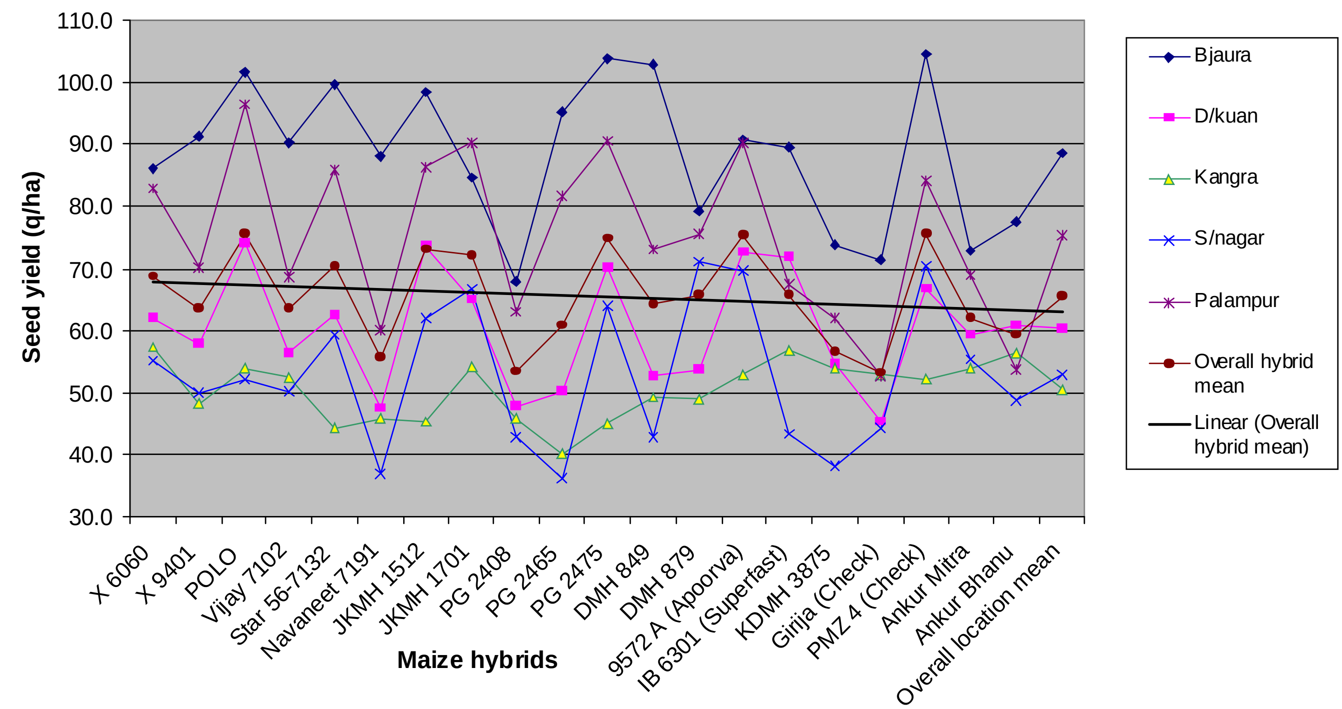

Fig. 1: Mean performance of maize hybrids for seed yield at five locations in HP during 2005

to 50 per cent tasseling and 50 per cent silking, plant height and seed yield where the H x E interaction was observed to be significant. Three hybrids, namely, X-6060, PMZ-4 (check) and Star 56-7132 displayed stable performance ($S^2di=0$) accompanied by above average mean performance($x = \mu$) for seed yield (Table 2 and Fig. 1). Out of these, two hybrids X-6060 and PMZ-4 were identified as having general adaptability across the environments (bi=1) and the hybrid Star 56-7132 exhibited responsiveness for favourable environments (b>1).

Early flowering and early maturing genotypes are considered to be ideal ones so as to fit into different cropping sequences with changing environmental conditions. Two genotypes, namely, JKMH-1512 hybrid and Girija composite (check) having unit regression and non significant deviations from regression with slight earliness for days to 50 per cent pollen shed (tasseling) were considered to be stable having general adaptability over environments. Three genotypes, Star 56-7132 hybrid, IB-6301 (Superfast) hybrid and Girija composite (check) showed stableness ($S^2di=0$) and general adaptability (bi=1) with earliness ($x = \mu$) for days to 50 per cent silking (Table 2).

During *kharif* season, especially in hills, wind and hail storms coupled with heavy rains are quite frequent resulting in lodging (root as well as stem lodging) of tall plants. Therefore, short statured and sturdy plant type is preferred in such situations. In the present investigation, six hybrids with shorter plant type ($x = \mu$), showed stableness ($S^2di=0$) over locations. Out of these, five hybrids, *viz*., Star 56-7132, Navaneet-7191, JKMH-1512, PG-2408, and IB-6301 (Superfeast) could be identified as having general adaptability across the locations (bi=1) and one hybrid DMH-849 displayed responsiveness to poor environments (bi<1) only (Table 2).

It may be summarized that, although, no single hybrid was found to be desirable simultaneously for all the characters with stable performance across the locations, however, potential stable maize genotypes for different characters have been identified in the present study. Six hybrids (X-6060, PMZ-4, JKMH-1512, IB-6301, Navaneet-7191 and PG-2408) and one composite (Girija) showed promise with respect to their stability and general adaptability across the locations for seed yield and other traits (Table 3). The hybrid Star 56-7132 exhibited stability and responsiveness to better environments for seed yield, whereas the hybrid DMH-849 displayed stableness and responsiveness to unfavourable environments for plant height. These genotypes may be considered for cultivation in the state of Himachal Pradesh or may be involved in further studies. Earlier workers have also used stability analysis to identify potential stable genotypes for different traits (Mani and Singh, 1999 and Dodiya and Joshi, 2003). It is concluded that yield as well as various yield

Table 3: Maize hybrids identified for stability and adaptability

Trait	Number of hybrids identified for			
	Stableness ($S^2di \sim 0$)	General adaptability ($S^2di \sim 0$, $bi \sim 1$)	Specific adaptability	
			Better environment ($S^2di \sim 0$, $bi > 1$)	Poor environment ($S^2di \sim 0$, $bi < 1$)
Seed yield (q/ha)[x ? µ]	3	2 (X-6060 and PMZ-4)	1 (Star 76-7132)	-
Days to tasseling [x ? µ]	2	2 (JKMH-1512 and Girija)	-	-
Days to silking [x ? µ]	3	3 (Star 76-7132, IB-6301 and Girija)	-	-
Plant height [x ? µ]	6	5 Star 76-7132, Navaneet-7191, JKMH-1512, PG-2408 and IB-6301)	-	1 (DMH-849)

components may be taken into account while selecting / evaluating genotypes for stability performance over environments. To measure stability of genotypes across the environments / locations, deviations from regression (S^2di) appeared to be a more important criterion than regression coefficient (bi). Mahajan and Khera (1991) have also emphasized that the linear regression (bi) may simply be regarded as a measure of response of particular genotype and deviations from regression (S^2di) should be given more weightage as a measure of stability.

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