Electronic Journal of Plant Breeding, 1(3): 239- 243(June 2010)

Research Article

Stability analysis in maize (*Zea mays* L.) hybrids across locations

S.Lata, S.Guleria, Jai Dev, G.Katna, B.C.Sood, V.Kalia and Anand Singh

Abstract :
Maize (*Zea mays* L.) cultivars vary in their performance and response to variable environmental conditions. Fifteen genotypes were tested at three locations covering different agro-climatic zones of the hill state (Himachal Pradesh). Analysis of variance and stability analysis were computed. Variances due to genotypes, environments and G x E interaction were significant for yield and its related traits. G x E interaction (linear) component was non-significant indicating the equal importance of both linear and non-linear interaction. It was concluded that yield and its related traits may be taken into account while evaluating genotypes for stability performance over environments. Hybrids PMZ 4, Vivek 21, 110-08-01 and Bisco 1141 showed high mean performance for grain yield coupled with average regression coefficient (βi =1) and least deviation from regression coefficient (S^2di) and thus were identified stable over different locations. However, most of the genotypes showed significant deviation mean square (S^2di) or regression coefficient (βi) for all the remaining traits implying that these were unstable and thus did not show general adaptability. Some hybrids showed relatively good performance in one location whereas some in other indicating the possibility to develop location specific hybrids.

Key words:
Environment, genotype, maize (*Zea mays* L.), stability, regression .

Introduction

Phenotype (P) is the product of the genotype (G) of the individual, the environment (E) that the phenotype is exposed to and the interaction that occurs between the genotype of the individual and the environment (G x E). Genotype x environment interactions is of major importance to the scientist in developing improved varieties. When varieties are compared over a series of environments, the relative ranking usually differs. For plant breeders, large genotype by environment (G x E) interaction impede progress from selection and have important implications for testing and cultivar release programmes. In fact, G x E interactions are as much a function of the genotype as they are of the environment and so are partly heritable (Hill, 1975). Statistically, G x E interactions are detected as a significantly different pattern of response among the genotypes across environments and biologically, this will occur when the contributions (or level of expression) of the genes regulating the trait differ among environments (Basford and Cooper, 1998). Therefore, an ideal approach in plant breeding is to develop cultivars that have fairly uniform performance (low G x E) over a range of environments with the ability to utilize the resources in high yielding environment. .So, the present study was undertaken to identify high yielding and stable maize hybrids, in a range of environment for its cultivation in the North Western Himalayan region.

CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur – 176062 India
Email: slatasharma@gmail.com

Material and Methods

During *Kharif* 2008, thirteen maize hybrids (comprising of hybrids from private and Govt. sector) including two checks (PMZ 4 and Girija Composite) were evaluated at three diverse locations of the state comprising mid as well as low hills *viz.*, Bajaura, Kangra and Palampur. The trials were conducted in Randomized Complete Block Design (RCBD). For raising of the crop recommended package of practices were followed. Data were recorded on plot basis for days to tasseling, silking and maturity and grain yield. The data on cob placement height (cm) and plant height (cm) were recorded from ten randomly taken plants.

The stability of yield performance for each genotype was calculated by regressing the mean yields of individual genotypes on environmental index and calculating the deviations from regression as suggested by Eberhart and Russell (1966). However, regression coefficient (βi) was considered as an indication of the response of the genotype to varying environments while mean square for deviations from regression (S^2di) was used as the criterion of stability as suggested by Becker and Leon, 1988.

Results and Discussion

On the basis of overall performance over three locations with respect to seed yield (q/ha), none of the entries could statistically out yield the hybrid check, PMZ 4 (Table 1). The mean grain yield of the hybrids across the locations ranged from 69.79 q/ha (EHL 1610) to 87.21 q/ha (PMZ 4). As many as six entries *viz.*, Vivek 21, 900M, 110-08-01, Bisco1141, DKC 7074, and Bisco1111 were statistically on par with the hybrid check for seed yield. Two entries *viz.*, Vivek 21 and 900M gave significantly higher seed yield than composite Girija check and all other entries were statistically on par for seed yield with the composite check Girija. This indicated that the rank of the genotypes varied from one testing location to the other testing location confirming the presence of G x E interaction and for high yield potential specific breeding programmes are necessary for specific location.

The combined analysis of variance for stability (Table 2) revealed significant genetic variability for all the traits studied, as well as the presence of variability among hybrids and environments. Significant mean squares for genotypes x environment (G x E) interactions were observed for all the traits *viz.*, days to 50 per cent tasseling, silking and maturity; cob placement and plant height; plant stand and grain yield. The presence of significant G x E interaction showed the inconsistency of performance of maize hybrids across the environment. Further, partitioning of G x E interaction into G x E linear and non-linear portions exhibited that both were important and revealed that all the traits accounted for G x E interaction. Significant variance due to environments (linear) for all the traits studied indicated considerable differences among the environments and their pre-dominant effects on the traits. This could be due to the variations in weather and soil conditions over different locations. Significant pooled deviations for all the traits 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 traits. Similar results in maize have been reported by Scapim *et al.* (2000), Worku *et al.* (2001), Rasul *et al.* (2005) and Kaundal and Sharma (2006).

Stability analysis for grain yield indicated that hybrids Vivek 21, 110-08-01 and Bisco 1141 showed average regression coefficient ($\beta i = 1$) and least deviation from regression coefficient (S^2di), hence identified as stable in performance over the locations (Table 3). The hybrids 900 M, DKC 7074 and Bisco 1111, though exhibited high mean performance with average regression coefficient but deviation from regression was significant, depicting differential performance over the varying environments and thus were unstable. These hybrids did not perform consistently stable for cob placement height as they showed significant deviation from regression (S^2di) except for Vivek 21, which was stable. Plant stand was unstable over the locations in all these hybrids as regression coefficient was significant from one except for DKC 7074 in which the plant stand was stable. All the hybrids were unstable for days to tasseling, silking, maturity and plant height over the locations since the stability parameters S^2di and/or βi deviated consistently from zero and one, respectively. Mani and Singh (1999) and Dodiya and Joshi (2003) also reported similar findings for stability parameters while identifying the potential stable genotypes over the locations.

It is concluded that yield and its related traits may be taken into account while selecting/evaluating genotypes for stability performance across the environments. To measure stability of genotypes across the environments, deviations from regression (S^2di) appeared to be more important criteria than regression coefficient (βi). Mahajan and Khera, 1992 have also emphasized that the linear regression (βi) 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. The result also indicated that, in some areas, distribution of rainfall during the growing period is the determining factor for the performance of maize genotypes. Thus, in these areas where we have abnormal distribution of rain in some years, testing of maize genotypes across the years may assist to select varieties which give good yield during the years with even distribution of rain and relatively good performance in the year of uneven distribution of rain.

References

Basford, K.E. and Cooper, M. 1998. Genotype x environment interactions and some considerations of their implications for wheat breeding in Australia. *Australian J. Agric. Res.,* **4** : 153-174.

Becker, H.C. and Leon, J. 1988. Stability analysis in plant breeding. *Plant Breeding,* **101** : 1-23.

Dodiya, N.S. and Joshi, V.N. 2003. Genotypic x environment interaction and stability analysis for yield and maturity in maize (*Zea mays* L.). *Crop Res.*, **26** : 110-113.

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

Hill, J. 1975. Genotype x environment interaction: A challenge for plant breeding. *J. Agric. Sci.,* **85** : 477-493.

Kaundal, R. and Sharma, B.K. 2006. Genotype x Environment interaction and stability analysis for yield and other quantitative traits in maize (*Zea mays* L.) under rainfed and high rainfall valley areas of the sub mountain. *Res. on Crops*, **7** : 171-180.

Mahajan, V. and Khera, A.S. 1992. Stability analysis of kernel yield and its components in maize (*Zea mays* L.) in winter and monsoon seasons. *Indian J. Genet.,* **52** : 63-67.

Mani, V.P. and Singh, N.K. 1999. Stability analysis in maize (*Zea mays* L.). *Indian J. Agric. Sci.,* **77** : 38-41.

Rasul, S., Khan, M., Javed, M. and Haq, I. 2005. Stability and adaptability of maize genotypes of Pakistan. *J. Appl. Sci. Res.,* **1** : 307-312.

Scapim, C., Oliveira, V., Braccin, A., Cruz, C., Andrade, C. and Vidigal, M. 2000. Yield stability in maize and correlations among the parameters of Eberhart and Russell, Lin and Binns and Huehn models. *Genet. & Mol. Biol*., **23** : 287-292.

Worku, M., Zelleke, H., Taye, G., Tolessa, B., Wllde, L., Abera, W., Gula, A. and Tuna, H. 2001. Yield stability of maize genotypes across locations. *Seventh Berseen and Southern African Regional Maize Conference*, Feb. 11-15: 139-142.

Table 1: Overall performance of maize hybrids for seed yield (q/ha) under mid hill condition of H.P. during *kharif* 2008

Entry/Var.	Company / Organisation	Locations (3)					% increase over checks	
		Bajaura	Kangra	Palampur	Overall mean	Rank	'PMZ 4'	'Girija'
115K-08-05 (SC)	Kanchan Ganga	87.38	66.56	70.13	74.69	9	-14.36	-1.99
900M (MSC)	Monsanto India	106.05	62.15	90.59	86.26	3	-1.09	13.19
Bisco 1121 (DC)	Bisco Biosciences	77.58	63.93	78.72	73.41	11	-15.82	-3.67
Girija Composite*©	CSK HPKV	81.64	69.18	77.81	76.21	8	-12.61	-
Vivek-21 (SC)	VPKAS, Almora	101.12	70.37	87.40	86.29	2	-1.16	13.23
110-08-01 (SC)	Kanchan Ganga	91.76	83.96	78.85	84.86	4	-2.69	11.35
Euro 1201 (SC)	Energy International	86.70	65.74	75.94	76.13	10	-12.70	-0.11
EHL 1610 (SC)	HPKV (Bajuara)	81.08	68.26	60.03	69.79	15	-19.97	-8.42
Bisco 1141 (DC)	Bisco Biosciences	86.11	78.63	75.59	80.11	5	-8.14	5.11
Vivek-23 (SC)	VPKAS, Almora	88.73	55.67	71.60	72.00	13	-17.44	-5.22
Bisco 1840 (DC)	Bisco Biosciences	82.64	65.74	65.34	71.24	14	-18.31	-6.52
EHL 1611 (SC)	HPKV (Bajuara)	80.41	69.74	69.72	73.29	12	-15.96	-3.83
Bisco 1111 (DC)	Bisco Biosciences	71.25	91.52	70.73	77.83	7	-10.76	2.12
DKC 7074 (DC)	Monsanto India	93.43	76.44	70.39	80.09	6	-8.16	5.09
PMZ-4 © (MSC)	-do-	85.43	84.85	91.35	87.21	1	-	14.43
SE ±		4.05	3.41	3.11	3.55			
CV (%)		8.08	8.26	7.13	7.88			
Grand Mean		86.75	71.52	75.61	77.96			

Note: SC: Single Cross, MSC:Modified Single Cross, DC: Double Cross, c: Check, * : Composite.

Table 2. Combined analysis of variance for stability for different characters in maize over four locations

Source	df	Days to 50% tasseling	Days to 50% silking	Cob placement height (cm)	Days to maturity	Plant height	Plant stand	Grain yield (q/ha)
Genotype	14	73.43*	71.73*	376.25*	85.36*	473.56*	11.06*	104.52*
Environment	2	210.62*	197.47*	1191.20*	451.93*	7824.38*	1435.62*	932.88*
Geno. x Env.	28	11.25*	10.73*	249.22*	45.74*	408.35*	31.19*	221.11*
Env. + (E x G)	30	17.54*	16.51*	156.92*	44.36*	648.66*	105.39*	130.97*
Env. (linear)	1	412.25*	394.94*	2382.40*	903.88*	15648.8*	2871.24*	1865.71*
G x E (linear)	14	6.45*	5.82*	19.63	17.13	61.67	14.61	93.41
Pooled deviations	15	0.98*	1.26*	136.70*	12.48*	196.51*	5.73	50.39*
Pooled error	84	0.22	0.15	14.58	0.38	29.56	2.60	12.57

* Significant at P≤0.05

Table 3. Stability parameters for different maize hybrids over locations

Entry/vty.	Days to 50% tasseling			Days to 50% silking			Cob placement height (cm)			Days to75% maturity			Plant height			Plant stand			Grain yield (q/ha)		
	Mean	**βi**	**S^2di**	**Mean**	**βi**	**S^2di**	**Mean**	**βi**	**S^2di**	**Mean**	**βi**	**S^2di**	**Mean**	**βi**	**S^2di**	**Mean**	**βi**	**S^2di**	**Mean**	**βi**	**S^2di**
115K-08-05	65.67	1.15*	0.02	67.44	1.14*	0.01	110.89	0.73	154.55*	110.11	1.37*	1.88*	226.33	1.02	1.84	69.11	1.17	11.85*	74.69	1.40*	2.55
900M	64.44	1.42	1.40*	67.11	1.39	4.14*	115.78	0.67	105.09*	109.89	1.37	4.41*	236.89	0.46	210.75*	73.00	1.32*	0.36	86.26	2.56	172.27*
Bisco 1121	56.67	-0.15*	0.18	58.89	-0.19*	0.04	101.33	0.86	9.28	102.00	0.45	15.98*	211.33	0.87	58.51	70.44	1.11*	1.19	73.41	0.68	76.96*
Girija Comp ©	59.89	0.58*	0.01	62.22	0.52*	0.35	106.44	0.99	21.35	102.22	1.52	28.73*	229.22	0.96	80.33	68.11	0.90	21.51*	76.21	0.71	17.35
Vivek-21	53.00	0.84	0.26	55.67	0.87*	0.01	83.78	1.30	35.69	94.44	0.48*	3.74*	206.89	1.15	15.88	71.67	1.12*	0.15	86.29	1.85	47.78
110-08-01	63.11	0.65*	0.24	65.56	0.77*	0.28	105.78	0.59	145.91*	106.11	1.31	2.39*	224.44	0.77*	0.01	69.78	0.84*	0.77	84.86	0.64	32.32
Euro 1201	57.89	1.13*	0.01	60.22	1.24*	0.01	99.67	0.22	282.99*	96.67	0.96	7.79*	221.56	1.00	56.88	67.44	0.40*	0.55	76.13	1.28	12.97
EHL 1610	53.00	1.55*	0.82	55.33	1.51*	0.12	92.78	1.15	199.72*	95.44	0.55	7.22*	194.22	1.18	807.50*	69.33	1.47	38.93*	69.79	1.06	84.84*
Bisco 1141	53.78	1.17*	0.15	55.89	1.16	0.56	92.76	1.24	96.19*	95.78	0.52*	1.68	211.11	1.40*	16.58	70.56	0.95*	0.09	80.11	0.58	15.87
Vivek-23	52.56	1.50*	1.45*	55.44	1.45*	1.10*	87.78	1.24	153.91*	95.11	0.56*	0.99	203.33	1.06	374.07*	72.33	1.23*	1.07	72.00	2.03*	30.86
Bisco 1840	62.11	0.38	4.05*	64.22	0.43	3.07*	117.67	1.53	91.79	101.22	0.34	37.50*	226.33	0.78	39.80	68.56	0.57*	0.27	71.24	1.20	15.20
EHL 1611	52.33	1.16*	0.11	54.56	1.17	0.45	85.67	0.87	117.36*	100.00	0.67	21.99*	201.44	1.40*	5.13	69.22	0.83	2.96	73.29	0.75	5.19
Bisco 1111	56.22	0.81	1.48*	58.33	0.78	4.27*	105.56	1.44	182.50*	99.56	1.01	51.11*	213.00	1.00	23.40	69.56	0.92*	0.01	77.83	-1.04	146.46*
DKC 7074	63.56	1.29	0.98*	66.11	1.39	1.18*	112.33	0.98	78.28*	105.33	2.46*	0.77	233.78	1.07	33.70	71.89	0.98	3.86	80.09	1.31	70.15*
PMZ 4 ©	63.89	1.46	3.54*	66.11	1.31	3.29*	112.33	1.13	375.88*	106.78	1.58*	1.00	216.22	0.82	1223.3*	74.22	1.13*	2.43	87.21	-0.08	25.05

* Significant at $P \leq 0.05$.