Indian J. Genet., **62**(4): 316-318 (2002)

Implication of seed size and vigour on field emergence in maize (*Zea mays* L.)

G. Katna[1], H. B. Singh, J. K. Sharma and G. S. Sethi

Department of Plant Breeding & Genetics, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur 176 062

(Received: August 2001; Revised: November 2002; Accepted: November 2002)

Abstract

The investigation was designed to explore the possibility of identifying some lines/crosses of maize (*Zea mays* L.) suitable to germinate and strive well under moisture stress conditions. Ten crosses showed high field emergence. Few crosses also depicted high seed vigour. High seed density was directly associated with high field emergence. The parents performing better for different seed traits and tests also contributed for better field emergence in the crosses.

Key words: Maize, vigour, accelerated aging test, osmotic stress test, field emergence

Introduction

In Himachal Pradesh maize (*Zea mays* L.) is grown under rainfed conditions occupying an area of about 0.31 million hectares with average yield of 19.90 quintals/hectare, which is slightly higher than the national average of 17.21 quintals/hectare [1]. Keeping in view its yield potential, still there is a considerable scope for yield improvement in the region. Due to late onset of monsoon, sufficient moisture is not available to the germinating crop. Further, emerging seedlings do not sustain under moisture stress conditions for a long period. This affects the plant stand and yield. The varieties presently under cultivation in the region do not give high seedling vigour and thus pose problems in field emergence under stress conditions. Thus, an effort has been made to identify the inbred lines developed from crosses developed through germplasm of Himalayan origion and them. Combining ability was estimated to identify whether any cross combination shows high field emergence and reflects it through any vigour test or seed trait.

Materials and methods

The 66 F_1 crosses, 12 parents and 3 checks (EHB-1520, KH-101, PSCL-3436) were evaluated during 1998 in the Seed Technology Laboratory of CSK HPKV, Palampur and the data was recorded for seed traits *viz.*, 100-seed weight (g), 100-seed volume (ml), seed density (g/ml), accelerated aging test (at 40 ± 1°C for 96 hours), osmotic stress test (-5 bar by using PEG 6000), germination percentage, seed vigour index and field emergence. Accelerated aging test was conducted as suggested by Byrd and Delouche [2] and osmotic stress test as per the method of Langer-Werff [3]. Standard germination test was carried out using top of paper method in seed germinator at 25 ± 1°C temperature and 90 ± 5 per cent relative humidity, as per the guidelines of ISTA [4]. Final count was recorded on seventh day. Seedling vigour index was calculated as the per cent of the multiple of coleoptile length and standard germination. The general combining ability (*gca*) and specific combining ability (*sca*) effects were estimated following Griffing's method-2, model-I [5].

Results and discussion

Analysis of variance for combining ability showed significant differences for mean sum of squares for all the seed traits *viz.*, weight, volume and density of seeds, and tests *viz.*, accelerated aging test, osmotic stress test, germination (%), seed vigour index and field emergence (Table 1). Significance of *gca* and *sca* variances revealed wide diversity among the inbreds and cross combinations for their general and specific combining ability effects, respectively, for all the traits. Mazur [6] observed high variability in seedling emergence from seeds having variable shape, size and sowing dates. Qadri *et al.* [7] and Mathur *et al.* [8] express similar view w.r.t. grain yield and plant stand in normal and stress environment.

The *gca* effects are of direct utility to decide the next phase of the breeding programme, since it is a general view that better general combiner inbreds may

[1]Present address: CSK HPKV, Regional Research Station, Bajaura 175 125

Table 1. Analysis of variance showing ms values for combining ability for seed traits and vigour tests in maize

Character	Source:	Mean squares due to *gca*	*sca*	error
	df:	11	66	77
100-seed weight		4.78*	2.44*	0.99
100-seed volume		4.15*	1.45*	0.46
Seed density		0.0009*	0.0009*	0.0002
Accelerated aging test		22.18*	23.01*	4.98
Osmotic stress test		44.01*	28.49*	6.47
Germination percentage		8.82*	5.57*	3.17
Seed vigour index		4.71*	3.56*	2.35
Field emergence		74.98*	32.97*	8.21

*Significant at $P \leq 0.05$.

yield better crosses. The gca effects among the parents revealed that parent P_4 was good general combiner for seed traits *viz.*, field emergence, germination percentage, seed density and accelerated aging test. Other parents P_2 and P_3 were the good general combiners for field emergence coupled with seed density, and thus can be utilized in developing superior genotypes (Table 2). A comparison of the general combining ability effects of the parents and their corresponding crosses indicated that any sort of combination among the parents have given hybrid vigour over the parents which might be due to favourable dominant genes, overdominance or epistatic action of genes, Matzinger and Kempthorne, [9]. Significant *sca* is the indication of relative importance of interactions in determining the performance of single cross. $P_5 \times P_{10}$ was the best combination with respect to field emergence and supported by osmotic stress test, accelerated aging test, 100-seed weight and 100-seed volume. $P_1 \times P_8$ the other superior cross for field emergence and 100-seed volume (Table 3). Milosevic *et al.* [10] reported that field emergence was supported by cold test and accelerated aging test; Kurdikeri *et al.* [11] by soaking in water or PEG 6000, whereas, Lovato

Table 3. Best three crosses based upon significant desirable *sca* estimates having high *per se* performance for seed traits and vigour tests in maize

Character	Desirable combinations
100-seed weight	$P_5 \times P_{12}$ (30.35), $P_5 \times P_{10}$ (30.11), $P_9 \times P_{12}$ (30.02)
100-seed volume	$P_5 \times P_{10}$ (24.50), $P_5 \times P_{12}$ (24.50), $P_9 \times P_{12}$ (24.50)
Seed density	$P_3 \times P_{11}$ (1.30), $P_4 \times P_{10}$ (1.30), $P_1 \times P_{11}$ (1.29)
Accelerated aging test	$P_1 \times P_3$ (94.00), $P_9 \times P_{11}$ (94.00), $P_4 \times P_7$ (93.50)
Osmotic stress test	$P_6 \times P_{11}$ (89.50), $P_4 \times P_5$ (88.00), $P_3 \times P_4$ (86.50)
Germination percentage	$P_6 \times P_{11}$ (100.00), $P_3 \times P_5$ (99.00), $P_8 \times P_{10}$ (99.00)
Seed vigour index	$P_1 \times P_7$ (32.10), $P_5 \times P_6$ (30.92), $P_3 \times P_4$ (30.58)
Field emergence	$P_5 \times P_{10}$ (93.00), $P_1 \times P_8$ (92.00), $P_6 \times P_{12}$ (92.00)

Figures in parenthesis designate *per se* values.

Table 2. The *gca* effects of parents for seed traits and vigour tests in maize

Parents	Characters: 100-seed weight	100-seed volume	Seed density	Accelerated aging test	Osmotic stress test	Germination percentage	Seed vigour index	Field emergence
P_1	-0.40	-0.29	0.00	0.12	-0.79	0.39	-0.07	-2.95*
P_2	-0.63*	-0.75*	0.01*	-1.20*	-2.93	-0.33	-0.31	1.55*
P_3	-0.39	-0.46*	0.01*	0.94	0.61	0.49	-0.10	3.33*
P_4	-0.56*	-0.64*	0.01*	1.30*	-0.25	1.39*	-0.80*	3.76*
P_5	0.27	0.21	0.00	0.33	1.39*	-0.80*	0.43	0.48
P_6	-0.10	0.00	-0.01*	1.87*	1.50*	0.89	-0.34	0.98
P_7	-0.82*	-0.54*	-0.01*	-0.60	2.36*	-1.26*	0.63	-2.38*
P_8	0.18	0.18	0.00	1.05	3.00*	0.10	0.40	0.76
P_9	0.12	0.29	-0.01*	-0.38	-0.82	0.17	0.32	-3.52*
P_{10}	0.48	0.32	0.00	-1.95*	-1.46*	-0.33	-1.07*	-0.95
P_{11}	0.87*	0.71	0.00	0.55	-1.32*	0.39	0.91*	0.26
P_{12}	0.97*	0.96*	-0.01	-2.02*	-1.29	-1.08*	-0.01	-1.31
SE (gi)	0.25	0.17	0.004	0.57	0.65	0.46	0.39	0.73

*Significant at $P \leq 0.05$

and Balboni [12] reported that standard germination test was not a good indicator of field emergence, except for standard sowing date.

References

1. **Anonymous**. 1999. FAO Quarterly Bulletin of Statistics, **12**: 25-27.
2. **Byrd H. W. and Delouche, J. C.** 1971. Deterioration of soyabean seeds in storage. Proceedings of the Association of Official Seed Analysts, **61**: 42-57.
3. **Langer-Werff J. V., Ogata G. and Eagle H. F.** 1961. Control of osmotic pressure of culture solution with polyethylene glycol. Sci., **133**: 1486-1487.
4. **International Seed Testing Association**. 1985. Handbook on tetrazolium testing. Zurich: ISTA, 72p.
5. **Griffing B.** 1956b. A generallsed treatment of the use of diallel cross in quantitative inheritance. Heredity, **10**: 31-50.
6. **Mazur M. and France P.** 1994. The effects of size and shape of seed on standard emergence of maize. Ristlina Vyroba, **40**: 179-187.
7. **Qadri M. I., Aggarwal K. N. and Sangri A. K.** 1983. Combining ability under two population sizes for ear traits in maize. Indian J. of Genet., **43**: 208-211.
8. **Mathur R. K., Chunilal P., Bhatnagar S. K. and Singh V.** 1998. Combining ability for yield, phenological and ear characters in white seeded maize. Indian J. of Genet., **58**: 177-182.
9. **Matzinger D. F. and Kempthorme D.** 1956. The modified diallel table with partial inbreeding and interactions with environments. Genetics, **41**: 822-833.
10. **Milosevic M., Rajnprcht J., Cirovic M. and Zlokolica M.** 1994. Methods of testing seed viability in maize. Selekcija i Semenarstvo, **1**: 179-182.
11. **Kurdikeri M. B., Aswathaiah B., Mahadevappa M., Prasanna K. P. R. and Prasad S. R.** 1995. Seed invigoration on field performance of maize. Mysore J. of Agric. Sci., **29**: 208-212.
12. **Lovato A. and Balboni N**. 1997. Seed vigour in maize (*Zea mays* L.): two-year laboratory and field test compared. Italian J. of Agron., **1**: 1-6.