SHORT COMMUNICATION

HETEROSIS FOR POROMETRIC OBSERVATIONS IN MAIZE UNDER MOISTURE STRESS CONDITION

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Porometry is one of the most useful techniques for measuring leaf temperature, leaf relative humidity, stomatal diffusive resistance and transpiration rate. Stomatal behavior under water stress is an important aspect in breeding programme for drought resistance. Lower values for leaf temperature and transpiration rate and higher values for leaf relative humidity as well as stomatal diffusive resistance in maize are considered desirable under moisture stress conditions. In other words negative heterosis for former two characters and positive heterosis for latter two characters would be desirable. While the crosses, viz. Ib 1058 x Ib 1084, Ib 1088 x Ib 1100, Ib 1088 x Ib 1155 and Ib 1100 x Ib 1155 showed highly significant but positive heterobeltiosis for leaf relative humidity and stomatal diffusive resistance. Another cross Ib 1088 x Ib 1000 exhibited significantly negative heterobeltiosis for leaf temperature and transpiration rate and significantly positive heterobeltiosis for leaf relative humidity and stomatal diffusive resistance indicating its usefulness under moisture stress situation.

Key words **: Heterobeltiosis, porometry, water stress.**

Food production in the country has been oscillating among peaks and troughs depending upon the natural precipitation and environmental factors. Maize is one of the most important cereal crops in India and the World. In India, maize is grown on an area of about 6.4 m ha and over 80 per cent of which is grown under rainfed condition (Anonymous 2003). One of the most important factors affecting maize yield under rainfed condition is the moisture stress during crop season for short or long periods. Genetic variations for quantitative characters in plant populations are of prime concern to breeders . The choice of breeding methods for genetic improvement of crop depends upon the nature and magnitude of genetic variability present. The variations occurring in segregating populations of corn are attributed to three sources : additive genetic effects, non-additive effects and environmental effects. Knowledge of the relative magnitude and importance of these kinds of gene actions and their interactions with the environment aids plant breeders in the development of breeding schemes or the choice of materials from the germplasm for population improvement. Lower values of leaf temperature and transpiration rate and higher values of leaf relative humidity and stomatal diffusive resistance in maize are considered desirable under moisture stress conditions as such traits contribute to drought tolerance, whereas under optimum moisture conditions, lower stomatal diffusive resistance and higher transpiration rate are desirable as they contribute to increased photosynthesis (Kirkham *et al.* 1984).

The present investigation was carried out in the Division of Genetics, Indian Agricultural Research Institute, New Delhi (Latitude 28.38ºN, longitude 77.12ºE, altitude 228.1M) during *kharif* 1996. The experiment was carried out in 3 different environments, *viz*. normal irrigation, limited irrigation and rainfed condition. The weather

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conditions were moderate. The rainfall received during the period of vegetative growth was sufficient for crop growth (200 mm). Due to the absence of rainfall during flowering and post flowering stage the rainfed crop experienced severe moisture stress during this period.

The experimental material utilized for the present investigation was derived from 7 x 7 inbred diallel cross. Inbreds selected for diallel possessed different degrees of tolerance to drought situations. Crosses were made in diallel mating system excluding reciprocals. Materials evaluated include 7 inbred lines as parents and 21 F_1 hybrids. Parents and F_1s were grown in randomized block design with 3 replications. Parents and F_1s were subjected to RBD analysis. The trial of irrigated and limited irrigation were sown side by side separated by bund to control the water. The third trial was purely grown under rainfed condition. The irrigated trial was provided with normal number of irrigations (i.e. 5 irrigations), the limited irrigation trial was subjected to stress at flowering and post flowering stages and hence only 3 irrigations were provided. The plot size consisted of single row of 5 m length of parents and F_1s. The rows of different genotypes were kept 75 cm apart with a plant to plant distance of 20 cm within a row. Five plants were randomly selected for recording the observations in parents and F_1s.

Observations on leaf temperature (°C), leaf relative humidity (%), stomatal diffusive resistance (S cm^{-1}) and transpiration rate (µg $cm^{-2}s^{-1}$) were recorded in the leaf subtending the ear at the flowering stage in parents and F_1 hybrids, using LiCor 1600 diffusion porometer. Heterosis was expressed in percentage over better parent (BP) values. The computation of values was done as per Turner (1953) and Hays and Foster (1976).

Table 1. Percentage of heterosis over better parent for porometric observations under irrigated, limited irrigation and rainfed conditions.

Crosses	Leaf temperature			Leaf relative humidity			Stomatal diffusive resistance			Transpiration rate		
	IR	LI	RF	IR	LI	RF	IR	LI	RF	IR	LI	RF
Ib 1058×1073	0.14	-5.02**	-0.97**	-4.01	24.17**	14.96**	-11.90**	-0.56	-5.01**	-3.38**	10.38**	0.32
Ib 1058×1084	-3.35	-3.89**	-6.28**	-10.74**	30.93**	25.60**	-12.79**	9.67**	18.24**	1.43**	20.07**	20.13**
Ib 1058×1088	0.31	-4.36**	8.75**	-6.45**	20.78**	16.83**	-24.50**	-5.92**	-2.08**	-6.52**	23.53**	0.00
Ib 1058×1100	0.10	-3.85**	0.88**	-4.44**	17.45**	15.95**	-6.62**	-2.04	-7.28**	-0.97	10.38**	-7.73**
Ib 1058×1143	-1.22**	-4.24**	-5.93**	-3.48**	17.67**	11.31**	-13.41**	-2.22	-16.67**	-6.62**	15.92**	20.78**
Ib 1058×1155	-2.01**	-5.97**	-2.08**	-5.96**	27.62**	25.67**	-10.67**	-13.16**	-5.75**	-4.96**	5.83**	-6.17**
Ib 1073×1084	-0.93*	-2.53**	-1.46**	-11.49**	16.42**	5.29	-23.44**	-4.37*	3.18**	5.23**	11.50**	11.42**
Ib 1073×1088	-1.30**	-3.33**	-6.00**	2.58**	13.73**	7.20**	-9.32**	-6.41**	-5.54	3.79**	6.27**	3.53**
Ib 1073×1100	-0.58	-2.80**	3.40**	9.48**	16.46**	12.16**	-10.62**	-24.91**	-6.93**	12.94**	7.32**	-9.07**
Ib 1073×1143	-4.57**	-0.67	-1.97**	-0.07	17.79**	8.24**	-14.49**	-27.66**	-29.79**	-10.73**	-13.24**	-13.93**
Ib 1073×1155	-0.97*	-10.83**	-5.96**	3.24**	15.10**	7.53**	1.47	22.36**	-35.43**	-12.53**	-13.24**	-17.81**
Ib 1084×1088	-0.50	-6.03**	-5.18**	0.32	19.81**	36.95**	-2.38	-23.11**	-16.78**	-6.18**	5.99**	9.94**
Ib 1084×1100	-0.19	-3.96**	-1.48**	3.63**	16.41**	15.10**	7.94**	-21.48**	-6.65**	-4.28**	7.81**	-7.73**
Ib 1084×1143	-2.83**	-1.98**	-1.90**	-11.82**	17.46**	14.84**	0.36	-17.11**	-16.26**	-13.70**	-1.48	3.66**
Ib 1084×1155	-0.23	-5.23**	2.49**	-6.48**	23.13**	24.63**	-1.76	-24.80**	-29.59**	-4.96**	14.77	16.78**
Ib 1088×1100	0.62*	-2.01**	0.60**	4.79**	9.77**	5.17**	-1.83	5.28**	3.37**	3.54**	-6.34**	-10.26**
Ib 1088×1143	-1.07**	4.18**	3.10**	-2.99**	13.58**	11.86**	-1.45	-4.63**	-8.70**	-8.68**	0.51**	-4.81**
Ib 1088×1155	-1.59**	-5.71**	-4.25**	-8.62**	10.31**	39.93**	-21.39**	-14.95**	6.85**	-2.60**	0.35	-4.49**
Ib 1100×1143	-1.38*	1.68**	0.78**	0.36**	-6.40**	-2.44	-22.28**	13.32**	18.32**	-2.74**	5.58**	-6.67**
Ib 1100×1155	0.14	-0.98*	3.07**	2.33**	9.56**	8.30**	-4.16	3.49*	18.45**	0.95	5.58**	0.27
Ib 1143×1155	-0.77*	-3.04**	4.54**	-0.37	6.20**	2.55	-6.70**	-0.27	0.48	-6.16**	1.85	7.88**

*, ** Significant at 5% and 1% level, respectively.
IR-Irrigated, LI-Limited irrigation, RF-Rainfed.

Parents with low leaf temperature, high leaf relative humidity, high stomatal diffusive resistance and low transpiration rate under moisture stress condition were considered as better parents in computation of heterobeltiosis. The per cent heterobeltiosis for 4 porometric observations are given in Table 1. The heterobeltiosis for leaf temperature varied from –4.57 to 0.62 per cent, -10.83 to 4.18 per cent and –8.75 to 4.54 per cent under irrigated, limited irrigation and rainfed conditions, respectively. As many as 9 crosses exhibited significant desirable heterobeltiosis in all the three growing environments.

Heterobeltiosis for leaf relative humidity, varied from –11.82 to 9.48 per cent and from –6.40 to 30.93 per cent under irrigated and limited irrigation conditions, respectively. Under rainfed condition, it ranged from –2.44 to 39.93 per cent for this character. Five crosses exhibited significant desirable heterobeltiosis across the environments. The percentage of heterobeltiosis for stomatal diffusive resistance condition, ranged from –24.50 (Ib 1058 x Ib 1088) to 7.94 (Ib 1084 x Ib 1000) under irrigated conditions and varied from –24.91 (Ib 1073 x Ib 1100) to 22.56 (Ib 1073 x Ib 1155) under limited irrigation, while under rainfed condition, it varied from –35.43 (Ib 1073 x Ib 1155) to 19.32 (Ib 1100 x Ib 1143).

For transpiration rate, the heterobeltiosis ranged between –13.70 (Ib 1084 x Ib 1143) to 12.94 (Ib 1073 x Ib 1100) under irrigated condition. Whereas, the percentage under limited irrigation and rainfed conditions varied from –13.24 (Ib 1073 x Ib 1143 and Ib 1073 x Ib 1155) to 23.53 (Ib 1058 x Ib 1088) and from –17.81 (Ib 1073 x Ib 1155) to 20.78 (Ib 1058 x Ib 1100), respectively. Consistently desirable heterobeltiosis across the environments was observed for two crosses, viz. Ib 1073 x Ib 1143 and Ib 1073 x Ib 1155.

Lower values of leaf temperature and transpiration rate and higher values of leaf relative humidity and stomatal diffusive resistance are considered desirable under moisture stress conditions. Negative heterosis for former two characters and positive heterosis for the latter two characters would be desirable. Since, under moisture stress conditions, crop has to maintain water economy and has to give higher yield, the lower transpiration rate and higher stomatal diffusive resistance indicate reduced water loss, while lower leaf temperature and higher leaf relative indicate cooler canopy, which seems to be correlated with higher yield (Kirkham *et al*. 1984).

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