Annals of Arid Zone 27 (3&4) : 183-189, 1988

RELATIVE SALINITY TOLERANCE OF PEARL MILLET HYBRIDS AND POPULATIONS

R. P. DUA and R. K. BHATTACHARYYA

Central Soil Salinity Research Institute, Karnal-132001

ABSTRACT

Relative salinity tolerance of hybrids vs populations in pearl millet was assessed for a set of 48 genotypes grown in normal and saline soils, by scoring of the per cent reduction in yield attributes on a 1-5 scale. Populations were relatively better tolerant than hybrids for grain yield. Tall populations with long ears are better suited in saline soils. Plant height and ear length were highly correlated with grain yield. Hybrids gave higher absolute yield than populations in saline soils, indicating a scope of developing salt tolerant hybrids from inbreds of salinity tolerant populations. Bold seeded and bristled hybrids have high salinity tolerance.

INTRODUCTION

Pearl millet has been reported as relatively tolerant to salinity (Abichandani and Bhatt, 1965; Paliwal and Maliwal, 1980 and Manga and Saxena, 1981) and yields at low levels of salinity are even higher than under normal soils (Singh and Chandra, 1979; Dua, 1984). However, no information is available regarding relative salt tolerance of hybrids and open pollinated varieties or the populations. Therefore, an attempt was made to compare salinity tolerance of hybrids and populations so as to plan breeding of the tolerant hybrids or populations.

MATERIAL AND METHODS

Forty eight diverse genotypes (25 populations and 23 hybrids) of pearl millet developed at different centres in India were grown during kharif 1985 in normal and saline soils (ECe 11.0 $\pm$ 1.2 dS m^{-1}) of the Experimental Farm of Central Soil Salinity Research Institute, Karnal, in randomized block design with 3 replications. Each genotype was sown in 3 rows (3 m long) spaced 50 cm apart. Plant population of 35 plants/row was maintained at thinning done 15-20 days after germination in normal as well as in saline soils. At maturity, data for plant height, ear length, 1000-grain weight and grain yield/plant were recorded for 5 competitive plants of each genotype selected at random in each replication. Plant stand and grain yield/row were also recorded from the central row of each genotype. The data were analysed for analysis of variance, coefficients of variation and correlation coefficients. Relative salt tolerance as a reduction percentage in saline soils from that of normal soils (Shanon, 1984) was estimated for all attributes of a genotype. Scores were assigned to genotypes with

Table 1. Analysis of variance for different characters of pearl millet hybrids (H) and populations (P) grown in normal and saline soils

Source	df	Mean squares									
		Normal soils					Saline soils				
		Plant stand	Plant height	Ear length	1000-grain weight	Graisn yield	Plant stand	Plant height	Ear length	1000-grain weight	Grain yield
Replcations	2	102.65**	8056.90**	44.05**	0.70	20235.60**	102.32**	1318.13*	25.75	5.92*	101111.50**
Genotypes	47	28.00**	1240.87**	23.81**	6.63**	27871.78**	43.65*	1328.43**	32.08**	9.90**	19137.18**
P	24	30.22	818.14	19.75**	2.42**	11920.00	28.54	1182.84**	18.50**	3.07*	12629.30*
H	22	22.90	977.27	20.44**	9.76**	29459.20**	60.10**	1199.07**	43.72**	15.50**	21931.30**
P vs H	1	87.58*	17185.49**	195.50**	38.85**	375791.43**	43.45	7715.39**	101.89**	50.43**	113885.30**
Error	94	18.46	758.25	4.94	0.47	9557.7	19.87	411.12	8.65	1.66	7624.47
Genotypic coefficient of variation (%) for											
Population	—	—	—	8.61	11.48	—	—	8.29	6.91	9.70	17.09
Hybrids	—	—	—	9.68	22.00	20.57	19.41	9.06	13.95	26.03	23.39

* P = .05 ** P = .01

respect to reduction percentage for a particular attribute; score 1 for highest reduction percentage (sensitive) and score 5 for the lowest reduction percentage (tolerant) :

Score	Range of per cent decrease or increase (+) for the attribute				
	Plant stand	Plant height	Ear length	1000 grain wt	Grain yield
1	50	25	11 to 20	10	50
2	41 to 50	21 to 25	0 to 10	1 to 10	31 to 50
3	31 to 43	16 to 20	+1 to+ 5	0 to +13	11 to 30
4	21 to 30	11 to 15	+6 to+10	+11 to +20	10 to +10
5	0 to 20	0 to 10	> +10	> +20	> +10

RESULTS AND DISCUSSION

Populations and hybrids of pearl millet had significant intra-group genetic variations for all the three yield attributes viz. saline as well as normal soils except that variations in populations were non-significant for grain yield in normal soils. Variations for plant stand and plant height (Hybrids vs Population) were significant, but differences within the groups were non-significant in normal soils. Non-significant intra-group differences in normal soils became significant for some of the attributes in saline soils, indicating differences in genotypes for salinity tolerance (Table 1).

Hybrids had relatively more coefficients of variation than populations. Plant stand, plant height and ear length were significantly correlated with grain yield in populations whereas, in hybrids, 1000-grain weight was the only component having significant positive correlation with grain yield in saline soils (Table 2). Recurrent selection for plant height and ear length can thus give high yielding populations suited to saline soils. Plant growth in salinity requires extra energy for the osmotic adjustments (Stavarek and Rains, 1984). Therefore, selection of tall populations for saline soils seemed to be desirable. In hybrids, since test weight (1000-grain weight) was found to be significantly correlated with grain yield, production of bold seeded hybrids

Table 2. Correlation coefficients of different characters of pearl millet hybrids (H) and populations (P) in saline soils

Character		Plant height	Ear length	1000-grain wt	Grain yield
Plant stand	(P)	.38	.17	-.03	.39*
	(H)	-.01	-.01	-.45*	.10
Plant height	(P)		.65*	.04	.45*
	(H)		.84*	.29	.18
Ear length	(P)			.18	.44
	(H)			.34	.22
1000-grain	(P)				.29
wt	(H)				.44*

*P = .05

for saline soils would be required. Francois et al. (1984), however, found lesser effects of salinity on 1000-grain weight in sorghum but suggested improvement of grain yield through in breeding of bold seeded cultivars for saline soils.

Seed to seed screening is reported to be satisfactory for breeding salt tolerant lines (Epstein, 1976; Epstein and Norlyn, 1977). In present studies also, where a continuous stress prevailed in the soils, the overall salinity tolerance of hybrids and populations was envisaged as their average tolerance score in respect of various attributes of plant growth and maturity (Tables 3 and 4).

Table 3. Tolerance score and grain yield of pearl millet populations in saline soils

Populations	Plant stand	Plant height	Ear length	1000-grain wt	Grain yield	Total	Grain yield (g)/3m row
ICMS 7704	4	4	2	2	3	15	210.7
RHRB 363	4	5	5	2	3	19	358.3
PCB 101	4	5	2	3	3	17	230.7
ICMS 8021	4	5	3	2	3	17	222.7
NELC H 79	3	5	5	3	4	20	258.7
HC 7-82	4	4	5	3	5	21	328.0
HV 82	5	5	5	4	5	24	361.3
UCC-I	3	4	3	3	3	16	215.7
PCB 128	4	3	4	4	4	19	202.3
CZMP-2	5	4	3	4	5	21	309.0
ICMS 8010	5	3	2	2	3	15	319.3
ICMV 81111	4	4	4	2	4	18	286.3
ICTP 8203	5	5	5	3	5	23	244.7
KBP-3	3	2	1	2	2	10	224.7
WCC-75	5	5	4	2	3	19	275.7
HC-4	4	5	4	3	3	19	251.0
NELC P-79	4	5	3	3	2	17	286.0
IVSP-78	5	5	3	2	2	17	231.0
IVS 5454	3	3	2	3	2	13	189.0
CZST-II	5	2	2	2	2	13	152.3
CSP-3	4	2	1	2	2	11	202.0
CSMP-6	2	2	2	1	2	9	180.0
CSMP-5	3	1	2	2	2	10	167.0
CZST-I	3	2	2	4	3	14	153.0
CSMP-2	3	2	2	2	1	10	115.0
Mean	3.92	3.68	3.04	2.60	3 04	16.28	238.96

The mean score for plant stand, plant height, ear length, 1000-grain weight and grain yield were, respectively, 3.92, 3.68, 3.04, 2.60 and 3.04 in the case of populations, the respective scores being 3.00, 4.00, 3.57, 2.96 and 2.87 in the case of hybrids. Hybrids were relatively better tolerant to salinity with respect to plant height, ear length and 1000 grain weight and the populations were better tolerant for grain yield on the basis

of scores (Table 1). The populations, with more variability of heterogenous gametes to withstand salinity were better tolerant at flowering through population buffering mechanism (Allard and Bradshaw, 1964). Higher reduction percentage in populations (lower score) than hybrids for plant height and ear length showed that the populations with higher plant height and ear length should be selected for saline soils. The populations which had a total score of more than 20 with better tolerance for grain yield (score 5) were HV 82, HC 7-82, CZMP 2 and ICTP 8203. Therefore, these populations after testing for one or two seasons could be either utilized for producing tolerant inbreds or further improved upon through recurrent selection procedures for their higher yield in saline soils. RHRB 363, NELC H 79, WCC-75 and HC 4 were medium tolerant populations with their total score of 19-20 and 3-4 score for grain yield.

Table 4. Tolerance score and absolute grain yield of pearl millet hybrids in saline soils

Hybrid	Plant stand	Plant height	Ear length	1000-grain weight	Grain yield	Total score	Grain yield/ 3m row (g)
Ears bristled							
MBH 130	1	5	5	3	1	15	203.7
MBH 131	1	5	5	5	4	20	411.0
MBH 136	3	4	5	4	2	18	301.0
MBH 137	2	2	2	2	2	10	376.3
MBH 138	2	5	4	4	2	17	240.3
MBH 139	2	5	4	5	3	19	389.7
MBH 140	2	3	3	3	3	14	346.7
MBH 141	1	5	2	2	2	12	201.0
MBH 142	4	4	5	4	4	21	327.7
ICH 451	4	5	5	2	3	19	367.0
CMH 5-1	2	5	5	1	1	14	178.0
MBH 110	3	3	4	2	4	16	411.7
Mean	2.25	4.25	4.10	3.10	2.58	16 25	312.84
Ears non-bristled							
GHB 105	4	2	4	3	3	16	322.3
ICH 423	1	3	2	4	2	12	193.0
NB H 1	1	3	1	2	4	11	197.0
GHB 100	5	5	5	5	4	24	382.3
IARI-1	2	4	2	2	2	12	263.7
PBH 110	5	4	2	3	4	18	291.7
PBH 111	5	5	5	3	3	21	219.0
PBH 112	5	5	1	4	2	17	169.0
PNBH -1	5	5	5	2	5	22	445.3
BJ-104	5	1	1	1	4	12	277.0
HHB 45	4	4	5	2	2	17	258.3
Mean	3.82	3.73	3.00	2.82	3.20	16.55	276.23

Hybrids, relatively more sensitive at flowering, had poor grain filling and lower grain yields than the populations. Still they maintained a higher production potential than populations in saline soils. It was reflected from higher absolute yields of individual hybrids as well as the overall mean (Table 4). Thus scope of exploiting heterosis in saline soils was evident.

Among hybrids PNBH-1, GHB 100, MBH 142 and MBH 131 scored more than 20 but were moderately tolerant for grain yield except PNBH-1 which was rated as tolerant for grain yield also. MBH 139 and ICH 451 were moderate in their overall salinity tolerance. On comparison of bristled and non-bristled hybrids, it was found that although non-bristled hybrids have an edge over bristled ones for their tolerance with respect of plant stand and grain yield yet the higher absolute yield of latter in saline soils indicated that bristled hybrids should be preferred over non-bristled hybrids. Bristled hybrids had better tolerance for plant height, ear length and 1000-grain weight. To exploit heterosis for salinity tolerance, inbreds should be produced from populations showing salinity tolerance in seed to seed screening and then using these inbreds for the development of high yielding salt tolerant hybrids.

ACKNOWLEDGEMENTS

Authors thank Dr. I.P. Abrol, the then Director, Central Soil Salinity Research Institute Karnal and Dr. G. Harinarayana, Project Co-ordinator (millets) for providing necessary facilities and the seed materials respectively.

REFERENCES

Abichandani, C. T. and Bhatt, P. N. 1965. Salt tolerance at germination of bajra (*Pennisetum typhoides*) and jawar (*Sorghum vulare*) varieties. Annals of Arid Zone. 4: 36-42.

Allard, R. W. and Bradshaw, A. D. 1964. Implication of genotype environment interactions in applied plant breeding. Crop Science. 4 : 503-508.

Dua, R.P. 1984. Evaluation and breeding pearl millet varieties suited to salt affected soils. *In* Annual Report, Central Soil Salinity Research Institute, Karnal. p. 97.

Epstein, E. 1976. Genetic potentials for solving problems of soil mineral stress; Adaptation of crops to salinity. *In* M.J. Wright (ed.) Plant Adapation to Mineral Stress in Problem Soils. Cornell University Press, Ithaca, New York, p. 73.

Epstein, E. and Norlyn, J.D. 1977. Sea water based crop production-A feasibility study. Science. 197 : 249.

Francois, L. E., Donovan, T. and Mass, E. V. 1984. Salinity effects on seed yield, growth and germination of grain sorghum. Agronomy Journal. 76: 741-744.

Manga, V. K. and Saxena, M.B.L. 1981. Effect of salinity on germination and early seedling growth of different millet crops. Agricultural Science Digest. 1(2): 100-102.

Paliwal, K. V. and Maliwal, G. L. 1980. Growth and nutrient uptake relationship of some crops in saline substrate. Annals of Arid Zone. 19: 251-258.

Shanon, M. C. 1984. Breeding, selection and genetics of salt tolerance. *In* R. C. Staples and G. H. Toenniesen (ed). Salinity Tolerance in Plants-Strategies for Crop Improvement. John Willey & Sons, New York.

Singh, T. N. and Chandra, S. 1979. Salt tolerance of some hybrids of *Pennisetum typhoides*. Indian Journal of Plant Physiology 22: 181-185.

Stavarek, S. J. and Rains, D. W. 1984. Cell culture techniques: Selection and physiological studies of salt tolerance. *In* R.C. Staples and G. H. Toenniesen(ed). Salinity Tolerance in Plants - Strategies for Crop Improvement. John Willey & Sons, New York Press p. 322.