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Relative Salinity Tolerance of Pearl Millet Genotypes (*Pennisetum typhoides*)

J. D. Gundalia, M. S. Patel*, K. B. Polara and N. K. Tank

Department of Agricultural Chemistry and Soil Science,
Gujarat Agricultural University, Junagadh-362 001

ABSTRACT

A green house experiment in big galvanized pots (75 cm x 60 cm x 30 cm) containing 120 kg calcareous black clay soil was conducted to evaluate the salt tolerance of eight (V_1-GHB 81, V_2-GHB- 100, V_3- GHB-27, V_4-GHB-105, V_5-GHB-30, V_6-GHB-32, V_7-B. K. 560 and V_8-B. J. 104) genotypes of pearl millet using four levels of salinity (ECe 2, 4, 8 and 12 dSm^{-1}).

Increasing salinity decreased germination count, plant height and grain and straw yield significantly but there was increase in case of Na/K ratio in plant. The varieties B. K. 560 and GHB 105 showed better performance at all salinity levels than the other varieties.

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INTRODUCTION

Salinity is one of the important factors which limits crop production and a particular crop responds to salt as per its typical genotypes. Pearl millet is an important tolerant cereal crop and it has been reported to be relatively more tolerant to salinity as compared to sorghum (Abichandani and Bhatt, 1965) and other millets (Manga and Saxena, 1981) at the germination stage and also to sorghum, green gram and black gram in respect to dry matter yield (Paliwal and Maliwal, 1980). However the information on relative performance of commonly cultivated high yielding varieties of pearl millet in respect to their tolerance to salinity up to maturity is lacking. This paper reports the results of a green house study on this aspect.

MATERIALS AND METHODS

A green house study in big galvanized iron pots (75 cm x 60 cm x 30 cm) containing 120 kg calcareous medium black clay soil was conducted during summer 1987 to evaluate the relative salt tolerance of eight pearl millet varieties (viz, V_1-GHB-81, V_2-GHB-100, V_3-GHB-27, V_4-GHB-105, V_5-GHB-30, V_6-GHB 32, V_7 - B. K. 560 and V_8-B. J. 104) using four levels of salinity (viz., S_0 - 2.0, S_1-4.0, S_2-8.0 and S_3- 12.0 ECe dSm^{-1}) in a completely randomized design with two replications. The soil was clay in texture having pH 8.0, ECe1.05 dSm^{-1}, $CaCO_3$ 19.5 %, Organic carbon 0.75%, Olsen's available P 12.4 kg ha^{-1} and available K 323 kg ha^{-1}. The saline waters of 4.0, 8.0 and 12.0 EC dSm^{-1} were prepared by dissolving chlorides and sulphates of Na, Mg and Ca at 15:2:1 and of $Cl:SO_4$ at 2:1 ratio. The calculated amount of N and P as urea and Diammonium phosphate

* Present address : Principal, College of Agriculture, Gujarat Agricultural University, Sardar Krushinagar-35 506

was applied in furrow per pot as basal @ 37.5 kg N and 37.5 kg P_2O_5 ha^{-1} and the remaining 37.5 kg N was supplied as urea at 20 days after sowing. Following this, 50 seeds of each variety were sown in row (60 cm spacing) in each pot and they were covered with the soil. Fourty two liters of solution of different salt concentration as per the treatments were applied uniformly in each pot in order to attain slightly higher moisture (35%) than that of field capacity. The soil was allowed to attain equilibrium for 48 hrs and then it was checked whether the desired salinity levels in the soil were attained or not. The water content in the pots was mantained within 80-100% available water throughout the growth period by adding distilled water. However, the salinity levels (2, 4, 8 and 12 ECe dSm^{-1}) of the pots as per respective treatments were maintained constant throughout the crop growth period by irrigating them with respective saline waters whenever required. The fourth day after sowing, the daily germination count was recorded periodically but the final count was considered on tenth day after sowing. Finally, 7 seedlings per row (0.5 m) for each variety were allowed to grow up to maturity. The mean plant height and grain and straw yields at harvest were recorded. The soil analysis was carried out by the standard methods as described by Richards (1954), whereas plant analysis was done for Na and K as per the methods described by Jackson 1973).

RESULTS AND DISCUSSION

Germination

Effect of salinity : The periodic germination count showed that the germination of *bajra* seed started from fourth day and continued up to tenth day (Fig 1). The germination was almost 79% with ECe 2 dSm^{-1} and 46.6% at ECe 12.0 dSm^{-1} after tenth day of sowing (Table-1). The salt concentration at 8 dSm^{-1} and above showed inhibitory effect and markedly decreased the germination. The results are in accordance with those reported by Madan and Kumar (1983) and Gill (1988). The delay and reduction in germination of this crop with increase in salinity was also observed by Manga and Saxena (1981).

Effect of variety : Irrespective of salinity levels, the highest mean germination percentage (82.0) was recorded with variety B. K. 560, followed by GHB 100(80.8) and GHB 27 (73.8%) which were at par with each other but significantly superior to the remaining cultivars (Table 2).

Interaction effect : The grmination percentage was significantly affected by interaction of salinity and variety (Table 1).The highest germination percentage of 92.0, 84.0 and 62.0 was recorded with variety GHB 105 in control, 8 and 12 dSm^{-1} levels, respectively. However, GHB 100 recorded significantly highest germination percentage (91.0) at ECe 4.0 dSm^{-1}. Among all the combinations, the lowest germination of 22.0 percentage was noted with variety B. J. 104 at ECe 12 dSm^{-1}. It appeared that salinity has less harmful effect on germination upto 8.0 ECe dSm^{-1} for most of the varieties.

Plant height

Effect of salinity : As the salinity level increased, the plant height decreased significantly from 101.4 to 69.4 cm (Table 1). Similar observations were also made by Iyengar and Kurian (1971) and Dua and Bhattacharyya (1988).

Effect of variety : The plant height at maturity was also affected significantly by the varieties. The maximum mean plant height of 101.6 cm was recorded with variety B. K. 560, followed by GHB 105 (100 cm) . These both

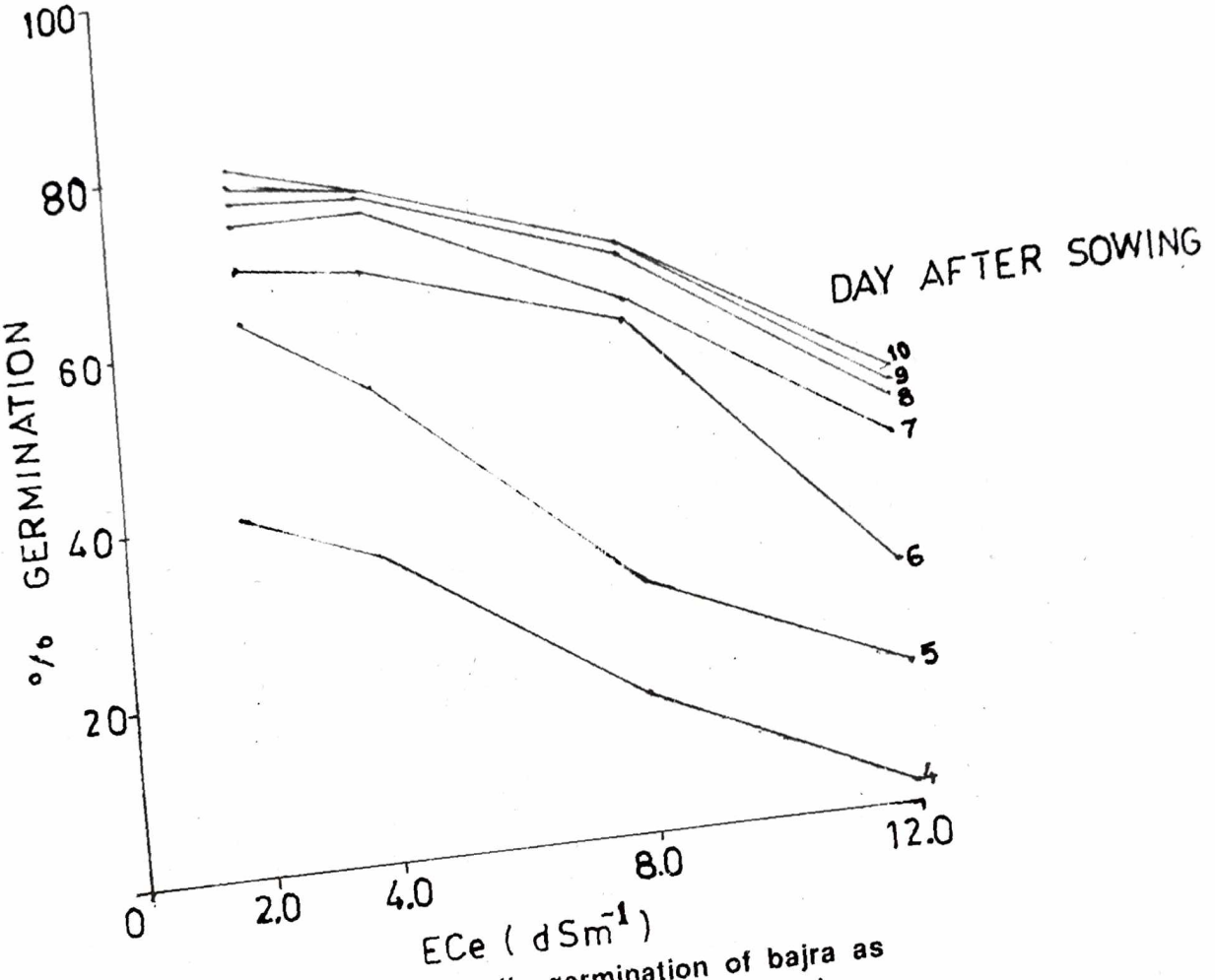

Fig. 1 : Periodic germination of bajra as influenced by salinity levels

varieties were at par with each other but significantly superior to the other cultivars, while its minimum value was recorded with variety B.J. 104 (68.2 cm).

Interaction effect : The interacting effect between salinity and variety in respect to plant height was not significant.

Grant and straw yield

Effect of salinity : Irrespective of varieties, as the salinity increased the grain and straw yield decreased significantly (Table 1). The results are in conformity with the findings of several workers (Dua, 1984 ; Iyenger and Kurian, 1971 ; Gill, 1988; Paliwal and Maliwal, 1980).

Effect of veriety : The variety B. K. 560 outyielded (79.1 g pot^{-1}) in respect to mean grain yield followed by GHB 105 (70.8 g pot^{-1}) (Table 1). The same trend was also observed in case of grain and straw yield at ECe 12.0 dSm^{-1}. The highest straw yield (107.5) was recorded with GHB 100, followed by B. K. 560 (107.3), GHB 81 (106.7) and GHB 105 (106.5 g pot^{-1}), which were at par with each other but were significantly superior to the rest of the cultivars. It is interesting to note that the overall performance of all the varieties, with some exceptions, was better a

TABLE 1

Effect of salinity levels on germination plant height, grain and straw yield of different pearl millet varieties.

Salinity levels	*Varieties*								
	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	*Mean*
				Germination (%)					
S_0	76.0	91.0	79.0	92.0	76.0	83.0	68.0	68.0	79.0
S_1	64.0	91.0	80.0	90.0	74.0	79.0	73.0	61.0	76.6
S_2	62.0	83.0	76.0	84.0	46.0	57.0	69.0	51.0	68.6
S_3	41.0	56.0	61.0	62.0	38.0	34.0	57.0	22.0	46.6
M	60.8	80.8	73.8	82.0	63.6	63.2	66.8	50.2	67.6
CD(0.05)	S=4.80		V=2.36		S x V=13.60				
				Plant height (cm)					
S_0	98.5	104.5	99.0	111.0	103.5	107.5	114.0	73.0	101.4
S_1	102.5	102.5	98.0	110.0	106.5	109.0	112.5	80.0	102.6
S_2	89.0	85.0	85.0	98.0	96.5	97.0	99.0	70.0	89.9
S_3	70.0	68.0	65.5	86.0	70.0	69.5	81.0	50.0	69.4
M	90.0	90.0	86.9	100.0	94.1	95.8	101.6	68.2	90.3
CD (0.05)	S=2.62		V=3.72		S x V = N.S.				
				Grain yield (g pot^{-1})					
S_0	76.0	69.3	73.6	98.2	88.5	88.8	112.0	76.0	85.3
S_1	63.7	66.0	74.7	101.2	84.2	76.8	113.6	68.3	81.0
S_2	34.3	27.4	36.8	62.3	40.5	46.1	63.1	31.7	42.8
S_3	13.7	13.5	13.4	21.4	12.8	15.7	27.7	14.6	16.6
M	46.9	44.0	49.6	70.8	56.5	56.8	79.1	46.6	56.4
CD (0.05)	S=2.3		V=1.6		Sx V=4.5				
				Straw yield (g pot^{-1})					
S_0	150.8	152.5	129.5	136.3	130.8	121.9	142.1	84.7	131.1
S_1	150.5	142.5	127.1	143.8	136.2	120.3	138.1	71.6	128.8
S_2	83.9	85.5	72.9	86.2	78.6	67.1	85.2	31.2	73.8
S_3	41.1	49.3	26.3	59.7	46.1	39.2	63.9	14.4	42.6
M	106.7	107.5	88.9	106.5	97.8	87.1	107.3	50.5	94.0
CD (0.05)	S=2.3		V=3.3		S x V=6.5				

TABLE 2

Relative salt tolerance of pearl millet varieties based on the grain yield.

Varieties	Mean* grain yield (g)	Mean** salinity index (%)	Reduction at ECe 12 dSm^{-1} over control (%)	ECe (dSm^{-1}) for 50% yield declined	Regression equation	Correlation coefficient (r)
GHB 81	37.2	49.0	82.9	7.8	Y=88.18 - 6.35 x	-0.996
GHB 100	35.6	51.4	80.5	7.8	Y=83.92 - 6.13 x	-0.949
GHB 27	41.6	56.6	81.9	8.0	Y=92.44 - 6.59 x	-0.973
GHB 105	61.6	62.8	78.1	8.8	Y=124.0 - 8.19 x	-0.976
GHB 30	45.8	51.8	85.5	7.7	Y=109.0 - 8.09 x	-0.987
GHB 32	46.2	52.0	82.4	8.0	Y=104.8 - 7.39 x	-0.998
B. K. 560	63.1	60.8	75.3	8.9	Y=138.7 - 9.17 x	-0.977
B. J. 104	38.1	50.2	80.8	7.8	Y=90.06 - 6.54 x	-0.986

* Grain yield across salinity levels.

** Mean salinity index = $\frac{\text{Mean of 4, 8 and 12 EC}}{\text{control yield}} \times 100$

lower salinity level (ECe 4 dSm^{-1}) as compared to that of normal soil condition (ECe 2 dSm^{-1}). The similar results were also observed by Singh and Chandra (1979) and Dua (1984) who reported that yields of pearl millet was higher under low level of salinity (5.0 dSm^{-1}) than normal soil.

Interaction effect : A significant interaction between variety and salinity indicated that the particular variety behaved differently at different salinity levels, particularly in respect of straw yield. At highest sainity level (ECe 12.0 dSm^{-1}), variety B. K. 560 recorded significantly the maximum grain (27.7) and straw (63.9 g pot^{-1}) yields. The reduction of yield may be due to lower photosynthesis and disturbed carbohydrates and nitrogen metabolism in salt stress condition leading to poor performance (Strogonov 1964).

Na/k ratio

Sodium to potassium ratio in straw has been found to be suitable parameter to judge the relative salt tolerance. The lower the value of Na/K ratio in the crop, the higher is its ability to tolerate salinity. The varieties GHB 105 and B. K. 560 have lower Na/K ratio than all other varieties at all salinity levels (Fig. 2). However, values of Na/K ratio significantly increased with increase in the salinity levels. Varieties B. K. 560 and GHB 105 gave higher yield with low Na/K ratio.

The present finding confirms the earlier work of Gill (1987) in pearl millet.

The results (Table 2) further revealed that the variety B. K. 560 recorded the better

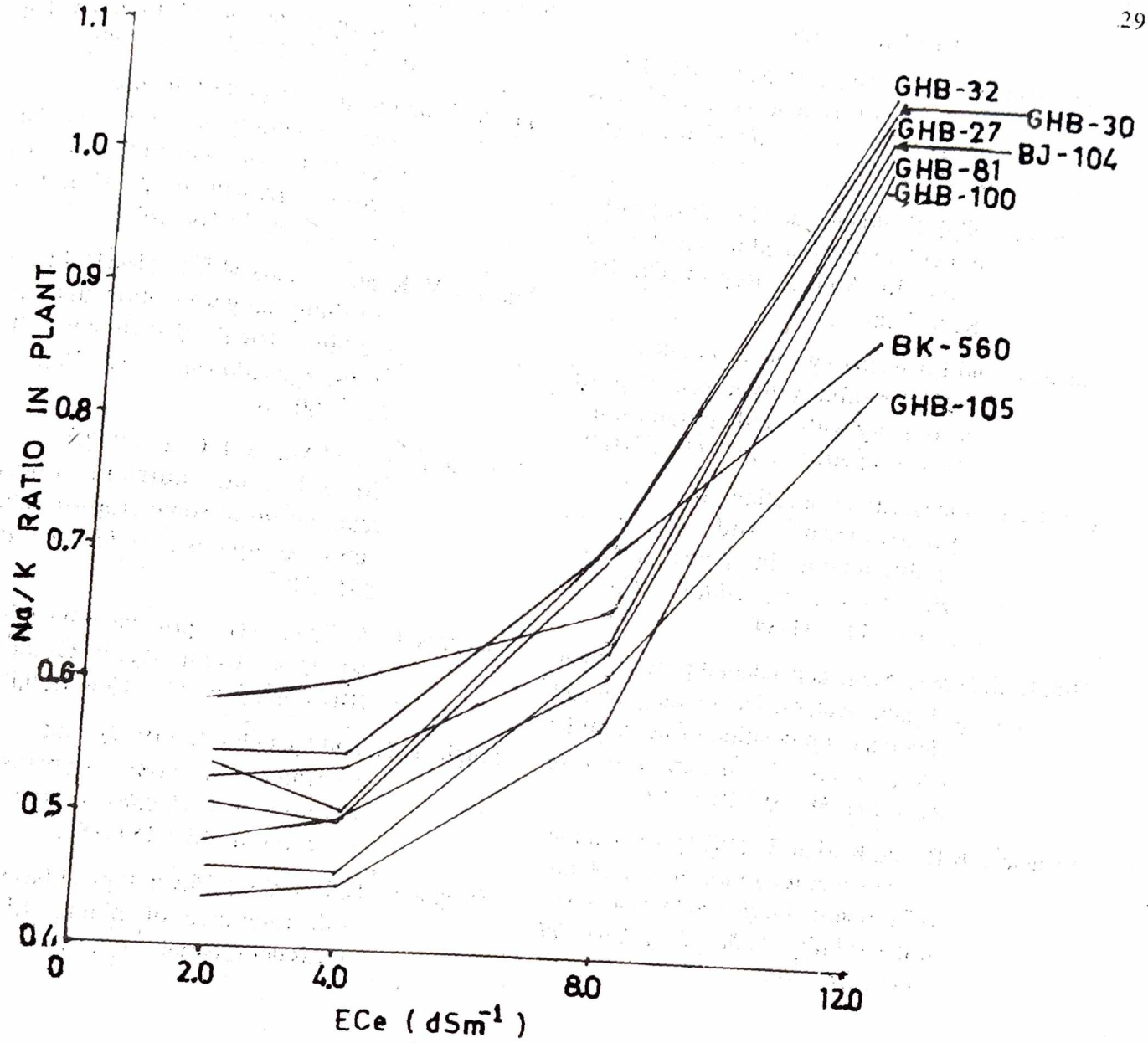

Fig. 2 : Effect of salinity levels on Na/K ratio in plant.

performance with the values of different salt tolerance criteria, like the higher values of mean salinity index (60.8%) as well as mean grain yield (63.1%) and the lower values of yield decline in high salinity level(75.3%), as well as ECe (8.9 dSm^{-1}) for 50 per cent yield decline. The GHB 105 stood the second in respect of these indices. Being the lower values of regression slope for these varieties, the yields of these varieties are least sensitive to salinity levels as compared to other varieties.

Conclusion

On the basis of the foregoing discussion, it is concluded that the variety B. K. 560 is considered as the most salt tolerant followed by GHB 105.

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