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EFFECT OF SALINITY ON GROWTH AND NUTRIENT CONTENT OF PEARL MILLET GROWN IN DESERT SAND AND GRAVEL

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Abstract

Sand or gravel culture techniques were used to study the effect of saline irrigation water on the growth and nutrient contents of pearl millet. Plant height and dry matter yield significantly decreased with increase in salinity levels. Salinity caused an increase in N,P, Ca, Na, Fe and Mn and decrease in K content of the leaves.

Introduction

The sub-soil water in Thar desert often contain salts beyond the maximum permissible limit recommended for a normal agriculture (Alam *et al.*, 1988). Chemical amendments of the available brackish water can minimize the toxic effects, lower the pH and provide essential plant nutrients. Sandy soil and brackish underground water of the Thar desert could therefore be used for growing suitable crop through the application of modern technology of saline agriculture.

In Sindh pearl millet an important crop used for grain and fodder purposes is cultivated over an area of about 285×10^3 ha. producing 106 tons of biomass (Anon., 1987). It is cultivated as a dry land crop in most of the Thar desert during rainy season. There are reports that with increase in salinity levels, the growth of pearl millet decreased (Bafna & Parikh, 1981; Maliwal & Paliwal, 1970; Patel & Dastane, 1968). Experiments were therefore conducted to explore the possibility of growing pearl millet using desert sand (Thar) or gravel (Thano Bulla Khan) under saline irrigation commonly encountered in many area.

Materials and Methods

Tube well water of Tando Jam (Table 1) was amended to give a balanced irrigation water with salinity levels from 1250 ppm to 9000 ppm of the total soluble salts (Table 2). The salinity levels were obtained by using salts of NaCl, $NaHCO_3$, $CaSO_4$, $MgSO_4$, KNO_3, NH_4NO_3, SSP (single super phosphate) and further supplemented with micronutrient salts. The nutrient solution with each salinity level was stored in a separate tank.

Pearl millet (*Pennisetum typhoideum*) seeds were sown in four beds 2 each of desert sand and gravel each measuring 11 m^2. The beds were irrigated with normal Hoagland solution. After germination they were thinned to 25 seedlings/bed and

Table 1. Ionic composition of tube-well water (dS/cm).

Na^+	K^+	Ca^{++}	Mg^{++}	N	P	Cl^-	$SO_4^=$	HCO_3^-	$CO_3^=$	pH	EC (dS/cm)
0.150	0.012	0.181	0.063	0.003	0.002	0.133	0.209	0.226	—	7.6	1.16

Table 2. Ionic composition of amended Hoagland solution (dS/cm).

EC (dS/cm)	Na^+	N	P	K^+	Ca^{++}	Mg^{++}	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$
1.95	0.17	0.273	0.188	0.25	0.312	0.078	—	0.227	0.15	0.305
4.69	0.68	0.273	0.188	0.25	0.312	0.078	—	0.781	1.30	0.843
9.38	2.69	0.273	0.188	0.25	0.312	0.078	—	0.947	3.83	0.843
14.06	4.61	0.273	0.188	0.25	0.312	0.078	—	1.420	6.12	0.843

after 10 days irrigated with salinized solution. The gravel beds were irrigated daily, while a weekly irrigation was given to beds of desert sand. Total soluble salts and pH of the solution were adjusted time to time. After 75 days of growth third leaf was harvested from 5 plants from each treatment, washed with distilled water and dried in an oven at 70°C. The whole plants were harvested at 85 days of growth, their dry weight determined and plant material digested with H_2SO_4 and 30% H_2O_2. Phosphorus was determined calorimetrically, N by micro-Kjeldahl method, while Na, K and Ca by flame photometer (Jackson, 1958).

Results and Discussion

Plant height and dry matter yield of pearl millet significantly decreased with increasing salinity levels irrespective of growth media (Table 3). The reductions in plant height and dry matter yield of 38 and 58% in desert sand and 36 and 69% in gravel beds were recorded at the highest salinity level. Reduction in growth parameters under increasing salinity may be due to the inhibitory effect of ions. Low water potential of the root zone due to high salt concentration in the growth media may also have hindered the uptake of water and associated nutrients, thereby affecting the plant growth.

Desert sand proved comparatively a better medium for growth of pearl millet than gravel. Desert sand with its fine texture retained moisture and nutrients for a longer period, whereas gravel caused rapid percolation of water. Pearl millet plants grown in gravel apparently suffered from moisture stress which was further aggravated by increased salinity levels. The decrease in growth of different plant species with increasing salinity has already been reported (Alam *et al.*, 1986; Hassan *et al.*, 1970; Singh & Chandra, 1979).

Table 3. Effect of saline irrigation water on growth parameters and nutrient content of pearl millet.

EC (dS/cm)	Plant height (cm)	Dry matter growth (Kg/bed)	% decrease over	Nutrient content (% of dry weight) N	P	K	Ca	Na	µg/g dry wt. Fe	Mn
				Desert sand						
1.95	284 a	16.08 a	0	2.18 c	0.73 b	4.40 c	0.33 c	0.60 a	325 a	72 c
4.69	239 b	9.95 b	38	2.92 a	0.87 a	5.80 a	0.39 a	0.10 b	431 b	114 a
9.38	219 c	8.82 b	45	2.88 a	0.83 a	4.68 b	0.38 a	0.14 c	455 c	122 a
14.06	192 d	6.80 c	58	2.74 b	0.87 a	2.48 d	0.35 b	0.24 d	510 d	98 b
				Gravel						
1.95	240 a	10.62 a	0	2.09 c	0.50 c	5.87 a	0.44 c	0.08 a	397 a	48 c
4.69	195 b	6.76 b	36	2.84 a	0.55 bc	4.78 b	0.45 c	0.18 b	376 b	53 c
9.38	171 c	5.44 c	49	2.80 a	0.75 a	3.95 c	0.53 b	0.26 a	253 c	61 b
14.06	118 d	3.32 d	69	2.68 b	0.57 b	3.29 d	0.59 a	0.32 d	222 d	72 a

Considerable differences in the content of nutrient elements in plant leaf were observed at different salinity levels (Table 3). With increase in salinity levels, the concentration of Na significantly increased in the leaves of cucumber and snake melon (Alam *et al.,* 1986) and castor bean (El-Shourbagy & Missak, 1975). Increase in Na content generally disturbs the nutrient balance, tissue osmotic potential, and causes specific ion toxicity to crops (Bedunah & Trlica, 1979). The Calcium, N and P contents in leaf increased significantly with increasing salinity levels which is similar to the reports of Alam & Azmi (1987), Fageria (1985) and Alam & Ahmed (1987).

Potassium content in pearl millet leaf decreased due to increase in salinity levels. The decrease in K and increase in Na content is possibly due to antagonisms between Na and K (Hassan *et al.,* 1970). The concentration of Fe and Mn in leaf increased with increasing salinity levels. These results are similar to those reported by Mass & Hoffman, (1977). There are also reports that increasing salinity levels decreased the concentrations of Fe and Mn in plant tissues (Alam *et al.,* 1986).

The results of the present study would suggest that growth reduction is mainly related to a water deficit. All nutrients remained in normal range in pearl millet but it indicates that some nutritional imbalance effect may also be involved in the growth reduction of pearl millet. This may alter the activity of some essential plant enzymes, integrity of membranes and/or the normal metabolism of organic acids. The present work demonstrates the potential use of saline water with suitable amendments for growing pearl millet in desert sand and gravel. The experiment further indicates that salinity level of 3000 ppm (0.3%) seems to be a moderate level for growing pearl millet.

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