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EFFECT OF SALINITY ON GROWTH AND NUTRIENT CONTENT OF BAJRA PLANT GROWN IN DESERT SAND AND GRAVEL

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Sand and gravel culture techniques were used to study the effect of saline irrigation water on the growth and chemical composition of bajra plant with a view to evaluate its potential use as a forage crop in desert soils. Four levels of saline irrigation water i.e. Ec. 1.95, 4.68, 9.38 and 14.06 dS/m were used. Plant height and dry matter yield significantly decreased with increase in salinity levels. Salinity caused accumulation of N,P,Ca, Na, Fe and Mn whereas K content was significantly decreased with increasing salinity levels in the growth media.

Key words: Salinity, Bajra plant, Desert sand.

Introduction

The sub-soil water in the Thar desert often contains salt and high pH beyond the maximum limit recommended for a normal agriculture [1]. Nutrients and chemical amendments can minimize the toxic effect of brackish water, lower the pH and provide essential mineral elements for the normal growth of plants. Sufficient leaching on sandy soils lessen the effect of brackish water on the root system thus minimizing its toxic effects. Sandy soils do not accumulate salts, therefore they may be acceptable for "saline agriculture".

Bajra is an important kharif crop and is cultivated both for grain and fodder purposes. In Sind, this crop is cultivated in an area of about 285 thousand hectares with an annual production of 106 tonnes [2]. It is cultivated as a dry land crop in most of Thar desert. Very small areas of bajra are cultivated under irrigation. Little information is available on the growth of bajra under saline conditions. The present experiment was conducted to study the effect of saline irrigation water on the growth and nutrient content of bajra plant.

Materials and Methods

Desert sand was collected from Umerkot and gravel from Thana Bulla Khan in the province of Sind. Salts were kept within the range of the salinity present in sub-soil water under Thar desert conditions. Tube-well water from the Atomic Energy Agricultural Research Centre (Table 1) was amended to give nutritionally balanced irrigation water covering a range of salinity treatment from 1.92 dS/m to 14.06 dS/m equivalent to 1250 PPm to 9000 PPm total soluble salts (Table 2). The salinity levels were made by using commercial grade salts of NaCl, $NaHCO_3$, $CaSO_4$, $MgSO_4$, KNO_3, NH_4NO_3, single superphosphate and supplemented in suitable quantities with micronutrient salts of zinc sulphate, molybdic trioxide, boric acid and manganese sulphate.

Gravel and desert sand were sterilized in beds with 4% formalin solution and washed with water for several hours prior to sowing the seeds to provide 25 plants/bed were sown directly in four beds of desert sand and four of gravel each measuring 11.4 m^2. The plants were supplied with normal Hoagland solution for first 10 days and thereafter the beds were irrigated with salinized nutrient solution stocked separately in four tanks. The gravel beds were irrigated daily, while weekly irrigation was given to the beds of desert sand. Total soluble salts and pH of the solution was checked regularly and ions were supplemented whenever required. pH of the nutrient solution was maintained between 6.5 and 7.0 using sulphuric acid. From 5 plants, the third leaf was taken at 75 days from each treatment, washed several times with

TABLE 1. IONIC COMPOSITION OF TUBE-WELL WATER.

EC (dS/m)	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^=$	HCO_3^-	$CO_3^=$	N	P	pH
1.13	0.172	0.016	0.181	0.078	0.148	0.305	0.226	_	0.003	0.002	7.6

TABLE 2. IONIC COMPOSITION OF AMENDED HOAGLAND SOLUTION.

EC (dS/m)	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^=$	HCO_3^-	N	P
1.95	0.17	0.25	0.312	0.078	0.15	0.305	0.227	0.273	0.188
4.68	0.68	0.25	0.312	0.078	1.30	0.843	0.781	0.273	0.188
9.38	2.69	0.25	0.312	0.078	3.83	0.843	0.947	0.273	0.188
14.06	4.61	0.25	0.312	0.078	6.12	0.843	1.420	0.273	0.188

distilled water and dried in an oven at 70 °. The whole plants of bajra were harvested at 85 days of growth and their dry weight determined. A known portion of ground plant material was digested with conc. H_2SO_4 and 30% H_2O_2. Total P was determined colourimetrically [3], nitrogen by the micro-Kjeldahl method and Na, K and Ca by flame photometrically [3].

Results and Discussion

The plant height and dry matter yield of bajra significantly decreased with the increasing salinity levels irrespective of the growth media (Table 3). It was also observed that the degree of reduction increased proportionally with the increasing concentration of salinity level. At the highest concentration, 14.06 dS/m (9000 PPm) salt reduced both plant height and dry matter yield to considerable extent, but the reduction was greater with gravel than desert sand. Reduction in growth parameters at increasing salinity may be due to the inhibitory effect of the ions. Low water potential due to higher salt concentration in the root environment may have hindered the transpirational flow of water through the roots and associated nutrient uptake thereby affecting plant growth. The decrease in growth of different plant species with increasing salinity has been reported [4-14]. It was also observed that desert sand proved to be a better medium for growth than gravel. Desert sand with its fine texture retained moisture and nutrients for a longer period whereas gravel caused rapid percolation of water. Plants grown in gravel apparently suffered from moisture stress which was further aggravated by increased salinity levels.

Considerable differences in the content of mineral elements in leaf of bajra plants were observed at different salinity levels (Table 3). The concentration of Na in the leaves progressively increased with increased salinity levels. Alam [4], Alam *et. al.* [6-8] and Lunin *et. al.* [15] with vegetable crops and El-Shourbagy and Missak [16] with three varieties of castor bean reported sodium content increased with saline irrigation. Sodium content generally disturbs the nutrient balance, osmotic regulation and causes specific ion toxicity under saline conditions [17].

We observed that the calcium concentration in bajra leaf increased significantly with increasing salinity levels. Similar findings have also been reported with cereal crops [18, 19]. The nitrogen content increased significantly with increasing salinity which agrees with the findings of Verma and Neue [19] and Heikal [20]. The opposite trend has also been reported [21, 22]. The phosphorus content increased with increasing salinity in the leaf of bajra. This agrees with the findings of Alam and Azmi [7] in wheat, Chavan and Karadge [23] in peanut and Pal *et. al*. [24] in barley. On the other hand, Fageria [25], Rabie *et. al.* [26] and Alam and Ahmed [5] observed increase in P content due to salt stress.

The potassium concentration in test plant generally decreased with increased salinity levels. The decrease in K content and increase in Na concentration with increasing salinity is possibly due to the results of antagonism between Na and K (12.27). Potassium not only participates in osmotic adjustment under saline condition but also in turgor mediated responses in plant like stomatal and leaf movements [18]. The concentration of Fe and Mn in bajra leaf increased with increasing salinity levels. These results are similar to those reported earlier [28, 29]. Contrary to this, others have reported that increasing salinity levels decreased the concentrations of these nutrients in plant tissues [6,30].

Our experiment has shown that subsoil water from the Thar desert can still be used for growing bajra plants in desert and gravel materials.

TABLE 3. EFFECT OF SALINE IRRIGATION WATER ON THE GROWTH PARAMETERS AND NUTRIENT CONTENT OF BAJRA PLANT.

EC (dS/m)	Plant height (cm)	Dry matter yield (kg/bed)	Nutrient content percent or dry weight					µ g/g dry wt.	
			N	P	K	Ca	Na	Fe	Mn
Desert sand									
1.95	277 a	14.06 a	2.14 c	0.69 b	4.34 c	0.32 c	0.05 c	320 a	67 c
4.68	226 b	7.93 b	2.88 a	0.83 a	5.76 a	0.38 a	0.10 b	426 b	109 a
9.38	206 c	6.80 b	2.84 a	0.79 a	4.64 b	0.37 a	0.13 c	450 c	117 a
14.06	179 d	4.78 c	2.70 b	0.83 a	2.44 d	0.34 b	0.23 d	505 d	93 b
Gravel									
1.95	227 a	8.60 a	2.14 c	0.46 c	5.83 a	0.42 c	0.06 a	392 a	41 c
4.68	182 b	4.74 b	2.20 a	0.51 bc	4.74 b	0.43 c	0.16 b	371 b	46 c
9.38	158 c	3.42 c	2.34 a	0.71 a	3.91 c	0.51 b	0.24 c	248 c	54 b
14.06	105 d	1.30 d	2.59 b	0.53 b	3.25 d	0.57 a	0.30 d	217 d	65 a

*Means followed by same letters do not differ significantly at 5% level of DMRT

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