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SALT TOLERANCE STUDIES ON *PANICUM ANTIDOTALE* RETZ.

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Abstract

Salt tolerance of *Panicum antidotale* Retz., was studied using gravel culture with root medium electrical conductivity (EC) levels ranging from 3 to 20 dS/m. Salinity decreased the seed germination and plant growth. A 50% relative-to-control reduction in dry mass yield was observed at EC 15.9 dS/m. Na contents in plant shoots increased whereas K contents decreased in response to increasing salinity. Ca concentration exhibited non-significant variation over control. Cl content alongwith N and protein percentage increased with increasing root medium salinity.

Introduction

Salinity and waterlogging are twin menace impairing crop productivity in Pakistan as well as in many other parts of the world. Salinity is mainly a problem of arid regions where it poses difficulty in land use. The saline soils can be brought under cultivation by the removal of excessive soluble salts through leaching with good quality water, providing drainage and use of chemical amendments such as gypsum, sulphur, acids etc. However, the problem cannot be tackled completely owing to certain limitations related to climatic and economic constraints. Alternately, the use of salt tolerant plants has been suggested for revegetation, effective utilization and improvement of salt- affected soils (Sandhu & Malik, 1975; Aslam *et al.*, 1993).

Screening and selection of salt tolerant plants is an important aspect. The present paper reports salinity tolerance in *Panicum antidotale* Retz. The species is a tall perennial grass with creeping thick root-stock and has a good forage potential.

Materials and Methods

Salinity levels of electrical conductivity (EC) = 5, 10, 15, and 20 dS/m were prepared by the addition of Na_2SO_4, $CaCl_2$, $MgCl_2$ and NaCl in Molar ratio of 10:5:4:1 following Qureshi *et al.*, (1977) to Hoagland nutrient solution (Arnon & Hoagland, 1940) that was used as control (EC = 3 dS/m). The effect of these salinity levels was studied on seed germination and plant growth of *Panicum antidotale*.

Germination studies: In the first experiment, 20 seeds were placed in Petri dish lined with filter paper soaked with 10 ml of respective solution with 4 replicates per treatment. Fresh solutions were added daily to the dishes after rinsing them with solutions of the same salinity level. Percentage germination was recorded up to 9 days. In the second experiment, 20 seeds were sown in Petri dishes filled with inert sand soaked with solutions of salinity levels 3-20 dS/m. The salinity was maintained daily by weighing the dishes and adding water as and when needed. Seed germination was recorded up to 13 days.

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Table 1. Effect of salinity on seed germination and biomass yield of *Panicum antidotale* (Means of 4 replicates).

	Germination (%)		Biomass yield (g/plant)		
Salinity level (EC: dS/m)	Filter paper	Sand	Shoot fresh wt.	Shoot dry wt.	Root dry wt.
3 (Control)	40.00a*	51.25a	28.03a	10.31a (0.37)	6.15a
5	28.75ab	40.00ab	20.10b	8.87b (0.44)	5.20a
10	22.50bc	37.50ab	15.28c	5.50cd (0.36)	3.60b
15	12.50c	25.00b	14.37c	5.72c (0.39)	3.32b
20	11.25c	22.50b	10.31d	4.29d (0.41)	3.05b

*Values in a column sharing the same letters are not significantly different. Figures in parentheses are dry/fresh weight ratios.

Plant growth: Four stubbles (root-stock) of similar size and appearance were transplanted in glazed pots (26 cm diameter 28 cm deep) filled with inert quartz gravel (2-5 cm) and saturated with Hoagland nutrient solution. The plants were allowed to establish and grow for 14 days and then subjected to salt stress. Root medium salinity was gradually raised by step-wise increase of 2.5 dS/m on every alternate day by adding aforementioned salts. After attaining the desired salinity levels (EC = 5, 10, 15, and 20 dS/m), the solutions were completely replaced with identical fresh solutions. Thereafter, the salinity levels were checked and maintained every alternate day and any loss of water was made up. The solutions were replaced after every two weeks to replenish nutrients. The quantity of solution in pots was kept such that it just soaked the gravel to avoid waterlogging and oxygen deficiency in the root zone. The plants were grown for 8 weeks and harvested. Biomass yield of shoot and root portions was recorded. Shoot samples were powdered, digested in HNO_3 and analysed for Na, K and Ca on a flame photometer. Cl content was determined by titration with silver nitrate (Richards, 1954). Nitrogen was determined by micro-Kjeldahl method (Bremner & Mulvaney, 1982).

The data were subjected to statistical analysis and significance of differences between means was determined by Duncan's multiple range test.

Results and Discussion

Germination percentage of *Panicum antidotale* seeds gradually decreased with increase in salinity both in sand and on filter paper. Maximum germination percentage was recorded in control which differed non-significantly from low salinity levels but

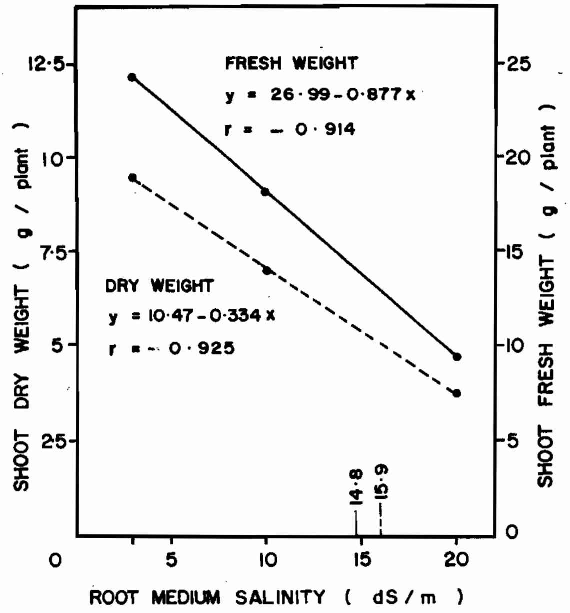

Fig.1. Relationship between fresh and dry weights of *Panicum antidotale* and root medium salinity.

significantly from higher salinity levels (Table 1). Germination percentage was relatively better in sand than on filter paper. Such responses to salinity are well known in other grass species (Aslam *et al.*, 1987; Niazi *et al.*, 1992). As mere germination of a species in a hostile environment does not guarantee its subsequent successful growth, therefore, plant growth studies are necessary to characterize the salt tolerance of a species.

The fresh and dry matter yield of *Panicum* decreased consistently with increasing root medium salinity (Table 1). However, the growth inhibition was such that more than 50% of the control yield was obtained in salinities of 15 dS/m. Shoot biomass yield exhibited negative correlation with root zone salinity. Salt tolerance limit of *Panicum* (EC causing 50% relative-to-control yield reduction), estimated with regression equations, was 14.8 dS/m for fresh weight and 15.9 dS/m for dry weight (Fig.1). Although, the species was highly tolerant, a significant decrease in yield was observed at low salinities. Reduction in biomass yield in saline treatments is a common response reported for several species having low to very high tolerance to salinity (Aslam *et al.*, 1987; Sohail *et al.*, 1991).

The reduction in growth in saline media may be due to osmotic effects or ionic toxicities due to high salt concentration leading to decreased water uptake and physiological disorders. Dry weight/fresh weight ratio is a measure of water uptake; the ratio being inversely related to water content (Naidoo, 1985). The dry/fresh mass ratios of *Panicum* plants grown under different salinity levels were only slightly affected (Table 1) indicating its ability for water uptake and osmotic adjustment.

Table 2. Effect of salinity on ionic composition, nitrogen and protein percentage of *Panicum antidotale*. (Means of 4 replicates).

Salinity level (EC: dS/m)	K/Na in Root Medium	Ion concentration (meq/100g dry wt.) Na	K	K/Na	Ca	Cl	Nitrogen %	Protein %
3 (Control)	(10.09)	18.0a	24.4	1.35	15.7	36.0a	1.10a	6.21a
5	(0.23)	55.0b	24.4	0.44	18.5	48.0b	1.55b	8.83b
10	(0.11)	66.1c	26.6	0.40	18.7	60.0c	1.98c	11.28c
15	(0.08)	72.0c	24.6	0.34	16.7	72.0d	2.51d	14.30d
20	(0.06)	89.7d	24.0	0.27	18.0	90.5e	2.55d	14.53d

*Values in a column followed by different letters differ significantly.

Na and Cl concentrations in plant shoots significantly increased with increase in salinity (Table 2). Increase in Na and Cl contents of plant parts due to increase in root zone salinity is reported in many species (Shannon *et al.*, 1981; Sohail *et al.*, 1991). However, inconsistent trends are reported for Ca uptake under saline conditions. Ca concentrations increase in response to salinity in *Sorghum halepense* (Sinha *et al.*, 1986) and *Echinochloa crussgalli* (Aslam *et al.*, 1987) but decreased in *Atriplex* spp., (Mahmood & Malik, 1987).

K uptake was not affected by salinity. Despite increased Na uptake in relation to salinity, K/Na ratios in plant tissue were always higher compared to those in respective root medium solutions (Table 2). Such selectivity for K absorption is an important factor inferring high salinity tolerance in plant species (Bhatti *et al.*, 1983; Mahmood & Malik, 1987).

N contents are indicator of protein percentage - an important characteristic for quality of crops. Nitrogen and thus protein percentages increased in *Panicum* with increase in salinity. The increase in N concentration at high salinity seems to be related to reduced dry matter yield, resulting in lesser dilution of accumulated nutrient as reported for *Sorghum* (Sinha *et al.*, 1986).

The present study has shown that *Panicum antidotale* has fairly high salt tolerance possibly owing to its ability to maintain K and water uptake and prevent Na and Cl accumulation to toxic levels under saline conditions. Reasonably high protein contents, in addition to salt tolerance, make the species a potential forage crop for moderately saline lands.

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