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Performance of *Eucalyptus camaldulensis* under different types of Salt-Affected Soils

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ABSTRACT

A pot experiment was conducted to study the performance of *Eucalyptus camaldulensis* under saline, sodic and saline-sodic soils in the wire-house of Nuclear Institute for Agriculture and Biology, Faisalabad. Salinity levels i.e. 1.25 (control), 15 and 30 dS m^{-1} SAR 0.85 (control), 20 and 30 and their combination were developed artificially by adding appropriate amount of salts i.e NaCl, Na_2SO_4, $CaCl_2$, $MgSO_2$ and/or $NaHCO_3$ in adequate ratios. One saplings of *Eucalyptus camaldulensis* was planted/pot (28x17 cm) and canal water was applied to pots as and when needed. Plants were harvested 52 days after transplanting and data on plant height, girth, number of branches, fresh and dry shoot weight were recorded. Plant height, fresh and dry weight of shoot and root, plant girth, number of branches decreased significantly with increasing salinity and sodicity or their combination. Growth of plants decreased significantly due to both salinity and sodicity levels, but it was adverse under salinity alone which showed more negative effect as compared to sodicity

Key Words: Salinity; Sodicity; Growth; Soils; *Eucalyptus*

INTRODUCTION

Salinization of soil creates extremely unfavorable conditions for plant growth. Accumulation of salts increases the osmotic potential of soil solution which in turn affects water movement and restricts its uptake by plants. Thus delayed germination, limited seedling survival and stunted plant growth are common in saline soils. Pakistan is situated in arid and semi arid regions of the world where evaporation is greater than precipitation. The magnitude of the problem in Pakistan is, therefore, high and thus about 6.3 million hectares (mha) of land is barren due to salinity and waterlogging (Khan, 1993).

In Pakistan, out of the total salt-affected area, approximately half is wastelands, and is extremely saline and saline sodic in nature. These soils are mostly unfit for agricultural crops. *Eucalyptus camaldulensis* has been identified as a tolerant tree species to salinity and waterlogging, and has more than 85% survival rate under saline soil conditions (Sandhu & Qureshi, 1986). Hence, it is the most successful tree species under a variety of saline conditions (Qureshi *et al*., 1993).

The detrimental effects of salinity on the growth of *Eucalyptus camaldulensis* are well documented in literature (Shah *et al.,* 1992; Marcar, 1993; Hafeez, 1993; Qureshi *et al*., 1993; Alkilan *et al*., 1997). However, the information regarding the effect of salinity/sodicity on the performance of *Eucalyptus* in the country is still limited. The present study was, therefore, planned to determine the effect of different salinity and sodicity levels on the growth of *E. camaldulensis* under controlled environment.

MATERIALS AND METHODS

A pot experiment was carried out in the laboratories of Saline Agriculture Research Cell, Department of Soil Science, University of Agriculture, Faisalabad and Nuclear Institute for Agricultural and Biology (NIAB), Faisalabad. A non saline non sodic soil was collected from the Research Farm of NIAB and passed through 2 mm sieve and a representative soil sample was analyzed to determine its texture, ECe, pHs, SAR. soluble cations and anions (Table I). Salinity, sodicity and salinity X sodicity levels were developed artificially.The experiment consisted of nine treatments of salinity, sodicity and salinity X sodicity with 27 replications.

Table. I. Physical and chemical analysis of soil

Property	Unit	Value
Texture		Sandy loam
Saturation percentage	%	30
EC_e	dS m^{-1}	1.25
pH_s		8.00
Cations (water soluble)		
Na^+	$mmol_c L^{-1}$	1.50
$Ca^{2+}+Mg^{2+}$	//	6.50
Ca^{2+}	//	3.50
Mg^{2+}	//	3.00
K^+	//	4.50
Anions (water soluble)		
Cl^-	//	5.00
CO_3^{2-}	//	Nil
HCO_3^-	//	2.00
SO_4^{2-}	//	1.00
SAR	$(mmol L^{-1})^{1/2}$	0.85

The following salinity and sodicity levels were developed artificially:

	Treatment (T)	EC_e dS m^{-1}	SAR
T1	Control	1.25	0.85
T2	Saline soil	15	1.25
T3	Saline soil	30	3.21
T4	Sodic soil	3.47	20
T5	Sodic soil	3.89	30
T6	Saline sodic soil	15	20
T7	Saline sodic soil	30	20
T8	Saline sodic soil	15	30
T9	Saline sodic soil	30	30

Salinity levels were developed by adding NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ in the ratio of 5:10:5:1, respectively. Sodicity levels were developed by adding $NaHCO_3$ and alternate wetting and drying cycles. While salinity X sodicity was developed by applying NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ in the ratio of 5:10:5:1, respectively.

Twenty seven uniform saplings of *E. camaldulensis* (four-month-old) were selected and one sapling was planted in each pot for 10 months. Before harvesting, different growth parameters, i.e, plant height, girth, number of branches fresh and dry weight of each plant were recorded. The data were subjected to statistical analysis and means were compared using Duncan Multiple Range Test at 5% level of probability (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

The salinity and sodicity significantly reduced plant height. Maximum plant height (Table II) was observed in T1 (38.67 cm) and minimum in T9 (13 cm). The result clearly revealed that although both salinity and sodicity depressed the plant height but it was more pronounced in salinity. Reduction in plant height could be due to high concentration of soluble salts which increase the osmotic pressure and decrease the osmotic potential of soil solution which means that the soil water is held with extra energy produced by the presence of salts (Ali *et al*., 1987; Singh *et al*., 1991) about *Leucaena leucocephala, Acacia nilotica* and *Casuarina equisitifolia*. Therefore, under these environments the plant would have to spend extra energy to get water from the salty soil solution and plant could not be able to meet the energy requirements, water uptake and plant transpiration would be reduced resulting in reduced growth which is confirmed by present study.

Table II. Effect of salinity, sodicity and salinity x sodicity on the height (cm) of *Eucalyptus camaldulensis*

EC (dS m^{-1})	SAR (mmol L^{-1})$^{1/2}$			
	0.85	20	30	Means
1.25	38.67 (100)	30.67 (79.31)	29.00 (74.99)	32.8 A (100)
15	24.00 (62.06)	21.00 (54.31)	15.33 (39.64)	20.1 B (62.5)
30	21.33 (55.16)	14.67 (37.94)	13.00 (33.62)	16.3 C (50)
Means	28.00 A (100)	22.11 B (78.9)	19.11 B (67.8)	

Means sharing similar letter (s) differ non-significantly at level P= 0.05; Values in ( ) are per cent of control; Results are average of three replications

Table III. Effect of salinity, sodicity and salinity x sodicity on the production of branches by *Eucalyptus camaldulensis*

EC (dS m^{-1})	SAR (mmol L^{-1})$^{1/2}$			
	0.85	20	30	Means
1.25	2.67 (100)	1.33 (49.81)	1.00 (38.46)	1.67 A (100)
15	0.67 (25.09)	0.00 (0.00)	0.00 (0.00)	0.22 B (13.2)
30	0.33 (12.36)	0.00 (0.00)	0.00 (0.00)	0.11 B (6.6)
Means	1.22 A (100)	0.44 B (36.1)	0.33 B (27.0)	

Means sharing similar letter (s) differ non-significantly at level P= 0.05; Values in ( ) are per cent of control; Results are average of three replications

It was noticed that different sodicity and salinity levels had siginificant depressing effect on the production of branches (Table III). Maximum number of branches were observed in T1 (2.67) followed by T4 (1.33), T5 (1.00) and T7 (1). The decrease in number of branches could be due to reduction in turgor potential and auxins synthesis. Auxin and turgor potential are necessary for cell division and cell elongation. As turgor potential and auxins were in low amount so reasonable amount of meristematic cells required for branches were not available which retarded the branching (Anwar *et al*., 1988; Ibrahim *et al.,* 1991).

Table IV. Effect of salinity, sodicity and salinity x sodicity on girth (cm) of *Eucalyptus camaldulensis*

EC (dS m^{-1})	SAR (mmol L^{-1})$^{1/2}$			
	0.85	20	30	Means
1.25	5.33 (100)	4.67 (87.62)	4.00 (75.05)	4.67 A (100)
15	3.33 (62.48)	2.50 (46.90)	2.17 (40.71)	2.67 B (57.2)
30	2.67 (50.09)	1.83 (34.33)	1.17 (21.95)	1.89 C (40.5)
Means	3.78 A (100)	3.00 B (79.4)	2.44 C (64.5)	

Means sharing similar letter (s) differ non-significantly at level P = 0.05; Values in ( ) are per cent of control; Results are average of three replications

Both sodicity and salinity had decreased plant girth but their interaction was non significant. Maximum plant girth (5.33 cm) was found in T1 and minimum in T9 (1.17 cm), which was only 21.95% of the control Table

Table V. Effect of salinity, sodicity and salinity x sodicity on fresh shoot weight (g) of *Eucalyptus camaldulensis*

EC (dS m^{-1})	SAR (mmol L^{-1})$^{1/2}$			
	0.85	20	30	Means
1.25	17.75 a (100)	11.30 b (63.7)	794 c (44.7)	12.33 A (100)
15	1.93 d (10.87)	1.07 d (6.03)	0.89 d (5.01)	1.30 B (10.5)
30	1.36 d (7.66)	0.63 d (3.55)	0.42 d (2.37)	0.80 B (6.5)
Means	7.01 A (100)	4.33 B (61.8)	3.08 B (43.9)	

Means sharing similar letter (s) differ non-significantly at level P= 0.05; Values in ( ) are per cent of control; Results are average of three replications

IV. Salinity had more severe effect on girth. Singh *et al*. (1991) reported reduction in plant girth under salinity and sodicity stress in *Dalbergia sisso, Pongamia pinnata, Araucaria cunninghamii* and *Casuarina equisitifolia* which may be due to reduction in cell turgor potential and cell division (Ashraf *et al*. 1999).

Table VI. Effect of salinity, sodicity and salinity x sodicity on dry shoot weight (g) of *Eucalyptus camaldulensis*

EC (dS m^{-1})	SAR (mmol L^{-1})$^{1/2}$			
	0.85	20	30	Means
1.25	6.18 a (100)	3.26 b (52.8)	2.42 b (39.2)	3.95 A (100)
15	0.73 c (11.81)	0.48 c (7.77)	0.14 c (6.63)	0.54 B (13.7)
30	0.52 c (8.41)	0.31 c (5.02)	0.20 c(3.24)	0.34 B (8.6)
Means	2.48 A (100)	1.35 B (54.4)	1.01 B (40.7)	

Means sharing similar letter (s) differ non-significantly level P= 0.05; Values in ( ) are per cent of control; Results are average of three replications

Sodicity, salinity and their interaction had highly significant effect on shoot fresh weight. Maximum shoot weight (17.75 g) was observed in T1 and minimum in T9 (0.42 g) and dual effect of salinity and sodicity was even more injurious for plant growth (Table V). On comparing salinity and sodicity, salinity was more severe than sodicity. It is obvious that the plants with less number of branches, girth and height may have the less weight, which is very clear from the results of present studies and also confirmed by Ibrahim *et al*. (1991) and Ashraf *et al.* (1999).

Effect of salinity and sodicity on dry shoot weight of *Eucalyptus camaldulensis* is similar to its effect on fresh shoot weight. Maximum shoot weight (6.18 g) was recorded in T1 (17.75 g) and minimum in T8 and T9 (0.14 and 0.20 g), which was only 6.6 and 3.24% respectively of their control (Table VI). Salinity is more injurious than sodicity. The reduction in plant weight could be due to lack of extra energy which is necessary for plant building material so plant could not attain its normal weight. Ashraf *et al.* (1998) and Ashraf and Khan (1993) showed that plant under salinity may have less dry weight because there was stunted growth, reduction in cell division, ion toxicity and reduction in plant turgor potential. The results are also in line with the findings of Bradbury and Ahmed (1990) in case of *Prosopis juliflora*.

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