EFFECT OF SALINITY ON GERMINATION AND GROWTH OF SOME FOREST TREE SPECIES AT SEEDLING STAGE

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ABSTRACT

Effect of salinity on growth of some forest tree species was studied at their seedling stage in nursery net house, Department of Forestry, Range Management and Wildlife, University of Agriculture, Faisalabad, Pakistan during 2007. Four forest tree species i.e. *Acacia ampliceps, Acacia nilotica, Eucalyptus camaldulensis* and *Azadirachta indica* were tested against 3.61, 6.0, 12 and 18 dS/m ECe levels. Length of root, shoot and root shoot ratio of these forest species were significantly affected by salinity. Moreover growth parameters of each forest tree species decreased as salinity increased. *Eucalyptus camaldulensis* was found as the most susceptible to salinity as its shoot length (2.76 cm), root length (2.22 cm) and respective ratio (0.37) was the lowest at 18 dS/m ECe whereas *Acacia* species were observed as salt tolerant. Maximum shoot length (11.00 cm) and root length (19.18 cm) was recorded from *Acacia nilotica* against *Acacia ampliceps* at same level of salinity (18 dS/m ECe). Germination percentage of four forest tree species decreased as the salinity level increased.

KEYWORDS: ***Acacia ampliceps; Acacia nilotica; Eucalyptus camaldulensis; Azadirachta indica;*** **salinity; seedlings; Pakistan.**

INTRODUCTION

Pakistan has been facing salinity menace since its creation. According to Siddiqui (31) sub-soil water of more than 50 percent of Indus plains was saline and rising level of this aquifer brought dissolved salts to the surface through capillary action. When water evaporated, a salt deposit was left behind in the surface soil. In addition, there were considerable quantities of salts in the Indus water which were exported to the sea before the building of head works and barrages, These are now deposited on land or seep through it to become part of shallow aquifers. Siddiqui further stated that on an average, one ton of salt is added to every irrigated acre in lower Indus plain

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every year. As a result, 40,000 hectares of agricultural land are lost to salinity and water logging annually. Irrigated agriculture is practiced over about 16.53 million hectares in the country where over 5 million hectares are affected by salinity and sodicity. His study further revealed that out of total irrigated area 8.1, 2.4, 2.0 and 3.2 million hectares are normal, slightly saline, moderately saline and highly saline, respectively (31). But according to Quraishi *et al*. (26), soils were affected to varying degrees of salinity, cover about 5.3 million hectares of which 2.8 million hectares are currently irrigated. Another report (5) disclosed that out of 20 million hectares of land available for agricultural production, 6.67 million hectares are salt affected.

Salinity adversely affects physiological and metabolic processes and finally diminishes plant growth and yield. It also affects the availability of nutrient and water, lowers the quality of aerable lands and alters the structure of ecological communities. It induces osmotic stress and physiological drought which typically reduces growth and photosynthesis in plants (1, 6, 16, 17, 18, 20, 24).

There is acute shortage of wood in Pakistan due to very small area (4.5 to 4.8%) under forests against 20-25 percent recommended internationally for maintaining ecological equilibrium (25, 26, 29). Forestry sector provides 3.5 million cubic meter wood and almost one third (15 million tons) of oil of nation's energy need. Moreover, tree cover is declining rapidly due to heavy population pressure which is growing @ 2.7-3.00 percent per year (4).

Due to tremendous increase in population of country, there is no scope to bring any productive culturable land under wood production and only marginal lands like saline soils are available for this purpose which have great potential for it. As stated by Siddiqui (31), tree growth in salt affected area exerts ameliorative effect by improving physical, chemical and biological properties of soil. Deposition of salts in upper layers of the soil is minimized through reduced evaporation from soil surface due to shading effect of trees. Trees absorb considerable quantity of water from deep portions of soil and transpire into air. The water table is thus lowered and salts do not reach soil surface. Incorporation of organic matter in the form of foliage, dead roots, etc. from the trees also brings favourable changes in physico-chemical properties and drainage of the soil.

A strong evidence exists that soil salinity affects seed germination, growth and suvivial of agricultural field crops, grasses, pasture range plants and trees to varied degree of extent. Unfortunately, as compared to agricultural field crops, a limited work on response of trees to salinity, especially at

seedling stage is available (1, 11, 14, 15, 21). In present study forest tree species like *Acacia ampliceps, Acacia nilotica, Eucalyptus camaldulensis* and *Azadirachta indica* were tested against different salinity levels for their germination and seedling growth.

MATERIALS AND METHODS

These studies were carried out under natural conditions in net house (green) located in the experimental area of Department of Forestry, Range Management and Wildlife, University of Agriculture, Faisalabad during 2006. Healthy and good seeds in all respects of four tree species were collected from recommended trees having all desired merits.

Normal soil was collected from nursery area of the Department. It was air dried, ground, passed through 2mm sieve and thoroughly mixed. Then it was analysed in Salinity Laboratory of the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad. Salinity level of nursery soil was found as 3.61 dS/m ECe. Normal soil was filled in 64 plastic pots. Each pot contained 2 kg soil. Each pot was 12.5 cm deep with 25 cm diameter. All pots were arranged in four rows and each row consisted of 16 pots. Each row was considered as replicate and each pot in each row was considered as treatment. On the basis of already determined salinity level, three salinity levels (6, 12 and 18 d S/m Ece) were developed by adding salts to non-saline soil. Nursery soil having 3.61 dS/m ECe was considered non-saline and taken as normal soil. Control treatment for developing desired levels of salinity, required extra quantity of salts based on calculation was added to normal soil (3.61 dS/m ECe) (12, 13).

All four salinity levels (3.61, 6, 12 and 18 dS/m ECe) were applied to each tree species making a total of 16 treatments. Before sowing seeds of trees under trial in pots, seeds of *Acacia nilotica* and *Acacia ampliceps* (Maslin) were soaked in boiling water for just five minutes and then soaked in cold water for one hour. No treatment was given to *Eucalyptus camaldulensis* and *Azadirachta indica* seeds. These seeds (treated and untreated) were planted in plastic pots. Tap water (free of salts) was applied to each pot continuously whenever required for seven weeks. Seeds started to germinate after two days of sowing. Germination percentage was recorded on completion of germination, whereas length of root, shoot and their ratio was recorded after seven weeks.

Net house had plastic sheets on its roof. Its sides were open. Green net saved the plants from intensive sunlight. There was no restriction for air movement, but pots were strictly protected from rainfall water throughout

investigation period. Data collected were tabulated and analysed statistically (32).

RESULTS AND DISCUSSION

Effect of salinity on seed germination

All salinity levels had a significant effect ($P < 0.05$) on seed germination of forest tree species under trial. Under each level of salinity, all species differed with one another significantly ($P < 0.05$) for this most important parameter (Table 1). Seed germination decreased as salinity increased. Response of each tree specie was different for each salinity level. *Azadirachta indica* followed by *Eucalyptus camaldulensis* and *Acacia nilotica* was highly susceptible to increasing salinity. *Azadirachta indica*, *Eucalyptus camaldulensis* and *Acacia tained* obtained only 3, 27 and 28 percent seed germination of control treatment, respectively at 18 dS/m salinity level (Table). Seed germination of these species declined to 97, 73 and 72 percent respectively as salinity level increased. In other words *Acacia ampliceps* was found comparatively more resistant to salinity as it gave 34 percent germination as compared to its control treatment against higher salinity level (18 dS/m ECe). It was concluded that salinity badly affected seed germination of all tree species under trial which decreased as the salinity increased. *Acacia ampliceps* and *Azadirachta indica* gave maximum (33.50%) and minimum (1.50%) seed germination, respectively at 18dS/m salinity level. Under non-saline conditions, same species gave 95.75 and 40 percent seed germination, respectively. It was also observed that germination delayed with increasing salinity levels.

Effect of salinity on seedling growth

Seedling growth was also significantly ($P < 0.05$) affected by salinity. Shoot and root length of seedlings of each tree species was maximum under non-saline conditions (3.61 dS/m ECe). *Acacia nilotica* gave higher shoot length (13.00 cm), root length (26.04 cm) and root/shoot ratio (2.21) whereas *Eucalyptus camaldulensis* gave the lowest shoot length (4.74 cm), root length (4.26 cm) and root/shoot ratio (0.93) (Table). As salinity increased to 18 dS/m ECe, shoot length (2.76 cm) and root length (2.22 cm) of *Eucalyptus camaldulensis* were found as the lowest as compared to other tree species.

Table. Effect of salinity on germination and growth of some forest trees at seedling stage

Tree species	Salinity levels											
	3.61 dS/m (Control)				6 dS/m (ECe)				12 dS/m (ECe)			
	Germination (%)	Shoot length (cm)	Root length (cm)	Root shoot ratio	Germination (%)	Shoot length (cm)	Root length (cm)	Root shoot ratio	Germination (%)	Shoot length (cm)	Root length (cm)	Root shoot ratio
Acacia ampliceps	95.75a	12.80a	15.52e	1.24b	86.50b (90)	11.66c (91)	14.14f (91)	1.18bc (95)	64.00d (67)	10.82d (84)	12.40g (79)	1.27b (91)
Acacia nilotica	60.50e	13.00a	26.04a	2.21a	51.25f (84)	13.12a (101)	22.82b (87)	2.17a (98)	29.00i (48)	12.20b (93)	20.22e (77)	2.11a (95)
Eucalyptus camaldulensis	93.75a	4.74i	4.26k	0.93ef	81.75c (87)	4.70i (99)	3.82k (89)	0.65gh (69)	52.75f (56)	3.90j (82)	2.78l (65)	0.49i (52)
Azadirachta Indica	40.00g	10.10i	7.90i	0.97de	27.50i (68)	9.94e (98)	6.88j (87)	0.68gh (70)	3.5l (8)	9.50f (94)	4.30k (54)	0.41i (42)
Average	72.50A	10.16A	13.43A	1.34A	61.75B	9.86B	11.92B	1.17B	37.31C	9.10C	9.92C	1.03C

	18 dS/m (ECe)				Mean values (Overall effect of salinity)			
	Germination (%)	Shoot length (cm)	Root length (cm)	Root shoot ratio	Germination (%)	Shoot length (cm)	Root length (cm)	Root shoot ratio
Acacia ampliceps	33.50r (34)	8.94g (69)	9.98h (64)	1.09cd (87)	69.94a	11.06b	13.01b	1.16d
Acacia nilotica	17.00j (28)	11.00d (84)	19.18d (73)	2.01b (90)	39.43c	12.33a	22.06a	2.12a
Eucalyptus camaldulensis	25.25j (27)	2.76k (58)	2.22m (52)	0.37j (39)	63.38b	4.02d	3.27d	0.61c
Azadirachta Indica	1.50l (3)	6.66h (65)	3.84j (48)	0.29k (29)	18.13d	9.05c	5.73c	0.58d
Average	9.31	7.34d	8.85d	0.94d				

N.B. Values given in parenthesis under each salinity level except control treatment are percent of values given in control treatment.
Means sharing similar letter(s) are statistically non-significant at $P < 0.05$

Root/shoot ratio of *Azadirachta indica* (0.29) was the lowest as compared to other tree species at higher level of salinity. Shoot length of *Eucalyptus camaldulensis* declined maximum (42%) whereas root length (52%) and root/shoot ratio (71%) of *Azadirachta indica* decreased to its maximum. The results also revealed that *Eucalyptus camaldulensis* and *Azadirachta indica* were highly susceptible to increasing salinity with respect to their shoot length, root length and root/shoot ratio of seedling, respectively whereas *Acacia nilotica* was found highly resistant to salinity as these parameters of this species growth were affected by only 16, 27 and 10 percent, respectively at highest level of salinity (18 dS/m ECe) as compared to control.

It is a well known that salinity affects seed germination and growth of plants adversely due to disturbance in physiological and metabolic processes occurring in plant body as reported earlier (1, 15, 17, 20, 22, 28). They also reported decreased seed germination and stunted growth of cereal crops and grasses due to increasing salinity. On the other hand trees can tolerate salinity to a certain degree of extent as compared to agricultural field crops and pasture grasses as observed by previous workers (2, 21, 30) while studying ipil ipil tree. Results reported herein are in line with the findings of Ansari *et al*. (3), Aswathappa *et al*. (7), Craig *et al*. (9), Marcar *et al*. (16, 17, 18), Nabil and Coudret (19), Panchaban *et al.* (22), Ramoliya and Pandey (27) and Yakoota (33) who concluded that seed germination, growth and survival of plants of *Acacia* species were more sensitive to salinity at their seedling stage. Conclusion of the same nature was also drawn by Parsons (23) for *Eucalyptus* tree species. The harmful effects of salt concentration in soil are beyond of any doubt because soil nutrients and hormones are not available for plant growth and consequently photosynthetic activity of plants is reduced or stopped. Fortunately in this desperate situation, it is very encouraging that woody vegetation especially tree reduces salinity by taking salts from soil. When trees are harvested at maturity, a considerable amount of salts can be removed from soil. Tree growth in salt affected area exerts ameliorative effect by improving soil physical, chemical and biological properties. The trees through their deep and sturdy root system, open up soil and improve its water permeability by facilitating leaching of salts into deeper layers of soil (31).

It is recommended that seedlings of trees should be grown in non-saline conditions before planting in saline areas (8, 10). Based on the results achieved in this study, *Acacia ampliceps* and *Acacia nilotica* followed by *Eucalyptus camaldulensis* are recommended for planting in saline soils and planting of *Azadirachta indica* should be avoided.

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