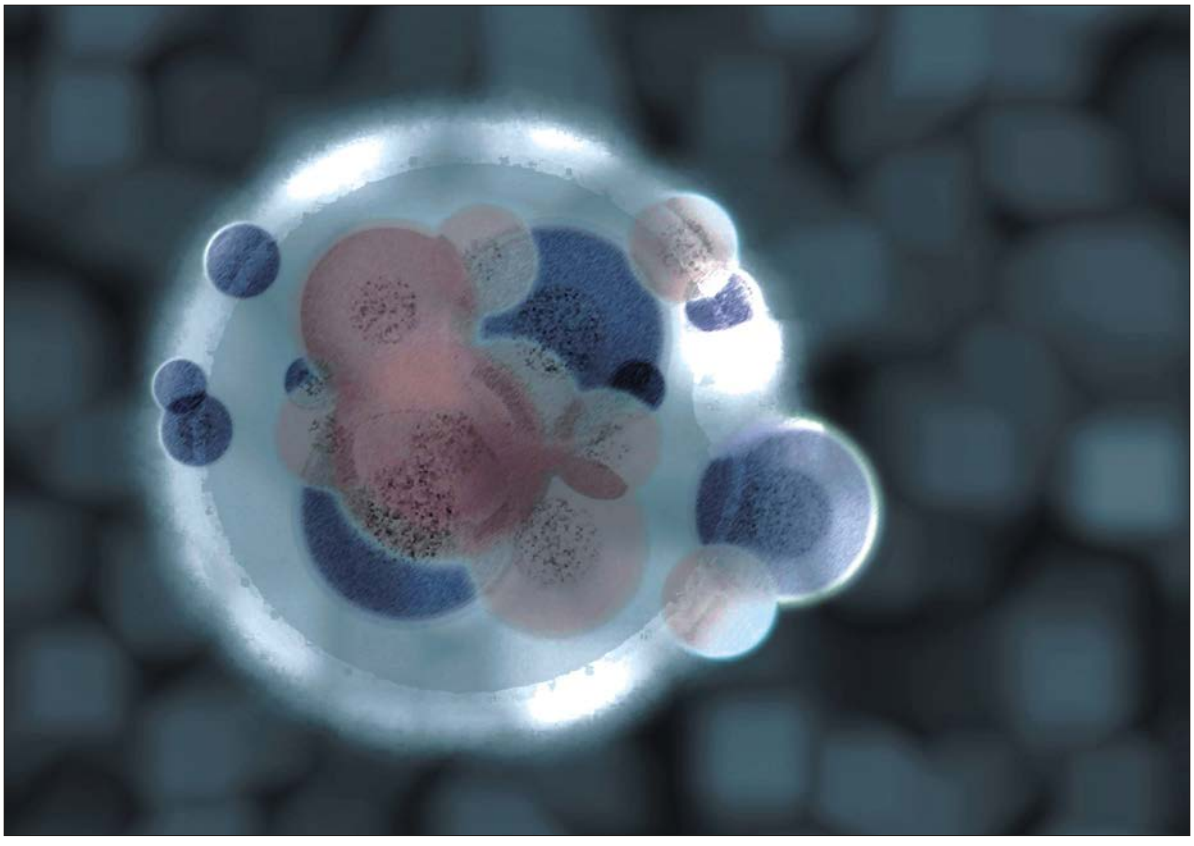

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Salt Tolerances of Some Multipurpose Tree Species as Determined by Seed Germination

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Abstract: A study of salt tolerance was carried out on seeds of six multipurpose tree species: *Acacia auriculiformis* A. Cunn. ex. Benth, *Albizzia lebbek* (L.) Benth, *Albizzia saman* (Jacq.) F. Muell., *Dalbergia sissoo* Roxb., *Leucaena leucocephala* (Lam.) de Wit and *Swietenia macrophylla* (R. Vig.) Du Puy and Labat using fresh water and salt (NaCl) solutions of 7.5, 15 and 22.5 mmhos cm^{-1}. Effect of salt on germinative energy, germination period and the reduction of germination with increasing levels of salt have been examined. It was found that germination period and germinative energy are reduced with increasing salinity and the germination trends change. Based on the observation, salt tolerance of the species has been determined and *Al. lebbek* has shown the best capacity to germinate at different salinity condition.

Key words: Multi purpose tree species, salinity, germinative energy, germination trend

INTRODUCTION

In Bangladesh the coastal zone covers 32% of the country of which 8,142 sq km (5.5% of the country) is salt affected with an increase of 146 sq km per year[1]. The effect of salinity on the bio-environment is severe and there is a significant reduction in vegetation in the salt affected areas[2]. This exacerbate the loss of forested land in a country in which this is only 0.02 ha per person[3] and the supply of wood products from natural forests are inadequate to meet demand[4]. These two problems of inadequate tree coverage and salinity intrusion have attracted the attention of the Bangladesh Forest Department and it is trying to introduce agroforestry practices in the salt affected areas with salt tolerant multi-purpose species[5-8].

In addition, the coastal zone supports the Sundarban mangrove forest, of which about 2% area is devoid of tree cover[9,10]. Trials with salt tolerant mesophytic species (e.g., *Al. lebbek, Al. saman, S. macrophylla, L. leucocephala, Acacia nilotica* (L.) Del.) have been carried out to find suitable species for raising plantation[10,11].

Against this backdrop the study was undertaken to determine the effect of NaCl on the germination of six major species with the intention of facilitating the on-going initiative of finding suitable species for plantation in the salt affected areas.

MATERIALS AND METHODS

Selection of species: The species *Acacia auriculiformis* A. Cunn. ex. Benth, *Albizzia lebbek* (L.) Benth, *Albizzia saman* (Jacq.) F. Muell., *Dalbergia sissoo* Roxb., *Leucaena leucocephala* (Lam.) de Wit and *Swietenia macrophylla* (R. Vig.) Du Puy and Labat have been chosen for study due to their multipurpose value[12-17], wide use in plantations[5-8] and proven salt tolerance at different growth stages in various environment[18-32].

To determine salt tolerance of these species the effect of different concentration of salt on germination have been tested. Presence of salt during the germination period make the seeds susceptible to altered germination capacity[33] and if they can tolerate salinity at the germination stage it is possible that they will be able to survive later on.

Plant material: The study was conducted at Khulna University Campus of Khulna District (22°12'-23°59' North and 89°14'-89°45' East) of Bangladesh. The experiment was conducted during the period of November, 2000-February, 2001 when the monthly average temperature was 23.9°C, rainfall 14 mm and relative humidity 81% (Bangladesh Meteorological Department, Pers. Com.). Fresh seeds of *Ac. auriculiformis, Al. lebbek, D. sissoo, L. leucocephala, S. macrophylla* and seeds of *Al. saman*

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stored for one year were used in this study. Seeds were sorted for sizes and large healthy seeds were selected for the study. NaCl solutions of 7.5, 15 and 22.5 mmhos cm^{-1} were prepared following the USDA manual[34] and checked using a salinity refractometer.

Germination studies: The experiment was conducted in three replications. In each replication sixty sets of petriplates (9 cm) and twelve sets of 20 cm pots (only for *S. macrophylla)* were filled with sterilized coarse sand, used as substrate for rapid water conduction and subsequent avoidance of salt accumulation on the surface. In each petridish or pots 25 randomly selected air dried seeds were placed with little pressure to give better contact with the substrate. Prepared saline solutions were poured into petriplates and pots. The petriplates and pots were always kept open. The level of solution in the containers was permanently marked and level was maintained by adding fresh water twice daily (morning and evening). Linear regression analysis has been done on the germination trends of the species at different salinity level. Germinative energy (GE), according to Melana *et al.*[35] was calculated by the following formula

$$\%\,GE = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds in the sample}} \times 100$$

RESULTS

Germination period: The germination period of all the species was reduced with increasing salinity. Initiation of germination was delayed with increasing salinity. For 1 mmhoscm^{-1} increase in salinity in *Al. saman* the initiation of germination was delayed by 0.1 days, the corresponding figures for *Ac. auriculiformis* was 0.4 days, for *Al. lebbek*, *L. leucocephala* and *S. macrophylla* was 0.5 days and for *D. sissoo* was 0.6 days.

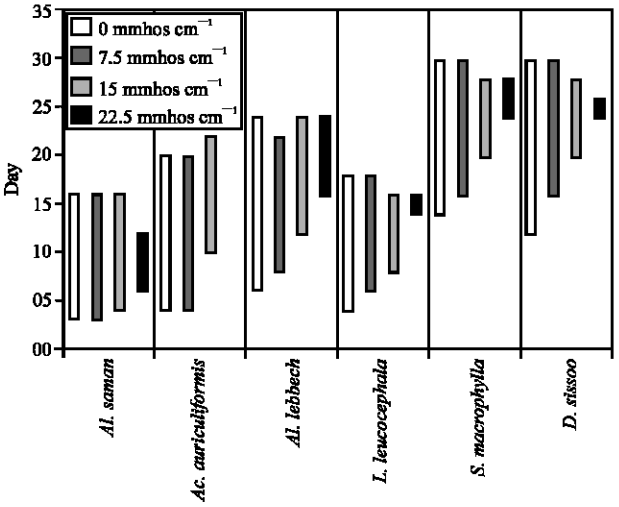

Fig. 1: Initiation and completion of germinative energy period of different species

On the other hand for a 1 mmhos cm^{-1} increase in salinity, the cessation of germination was brought forward by 0.2 days for *Al. saman* and *D. sissoo* and 0.06 days for *L. leucocephala* and *S. macrophylla.* For *Al. lebbek* no change was observed and for *Ac. auriculiformis* germination cessation was delayed by 0.06 day (Fig. 1).

Trend of germination: From regression analysis it has been observed that with increasing level of salinity the values of regression co-efficients lower (Fig. 2). For all species the values show significant difference at 95% Confidence Interval. From linear regression analysis it can be observed that *Al. saman*, *Ac. auriculiformis*, *Al. lebbek* and *L. leucocephala* germinate very quickly and at control condition within two weeks 50% of the germination is complete. Highest change is observed for *L. leucocephala* followed by *Al. lebbek, S. macrophylla, D. sissoo, Al. saman. Ac. auriculiformis* showed no germination at 22.5 mmhos cm^{-1} (Table 1).

Table 1: Value of regression co-efficients at different level of salinity

Species	Regression co-efficient at different salinity level (mmhos cm^{-1})								ANOVA of the co-efficients
	0		7.5		15		22.5		
Ac. auriculiformis	3.14	(SE = 0.40, P = 9.41E-05)	2.12	(SE = 0.11, P = 7.69E-06)	0.87	(SE = 0.12, P = 0.017)			F = 87.20; d.f. = 2,14
Al. saman	2.54	(SE = 0.34, P = 0.0003)	2.55	(SE = 0.28, P = 0.0001)	1.19	(SE = 0.07, P = 1.35E-05)	0.47	(SE = 0.12, P = 0.056)	F = 186.26; d.f. = 3,19
Al. lebbek	3.08	(SE = 0.235, P = 1.11E-06)	2.60	(SE = 0.30, P = 0.0001)	1.29	(SE = 0.13, P = 0.0002)	0.47	(SE = 0.07, P = 0.06)	F = 326.58; d.f. = 3,22
L. leucocephala	3.06	(SE = 0.13, P = 3.32E-07)	3.14	(SE = 0.32, P = 0.0001)	1.47	(SE = 0.15, P = 0.002)	0.33	(SE = 0.19, P = 0.33)	F = 456.12; d.f. = 3,15
S. macrophylla	3.83	(SE = 0.23, P = 6.96E-07)	2.41	(SE = 0.11, P = 3.41E-06)	1.73	(SE = 0.13, P = 0.0001)	0.67	(SE = 2.88E-15, P = 2.75E-15)	F = 383.17; d.f. = 3,16
D. sissoo	3.89	(SE = 0.08, P = 3.73E-10)	2.22	(SE = 0.13, P = 2.37E-06)	1.33	(SE = 0.13, P = 0.002)	0.67	(SE = 0.0001, P = 0.0001)	F = 1421.66; d.f. = 3,17

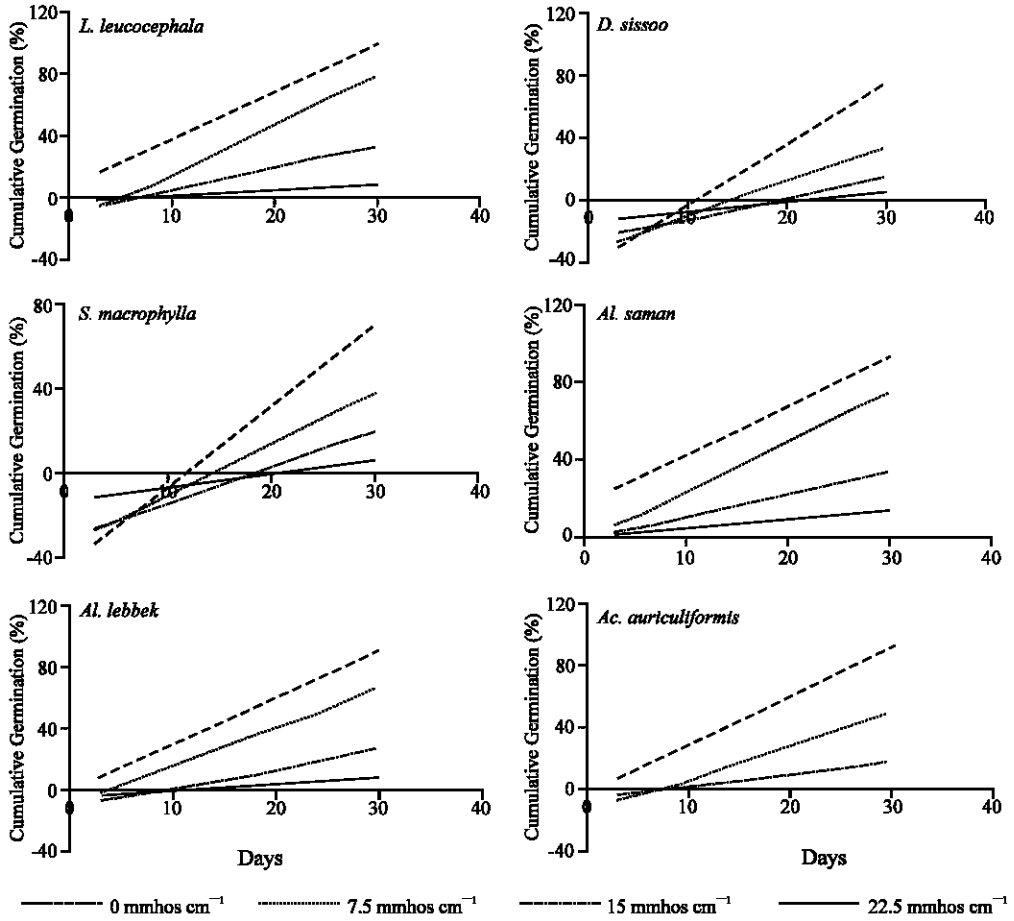

Fig. 2: Germination trend of different species

Germinative energy: In control condition highest germinative energy was observed in *Al. lebbek* followed by *D. sissoo*, *S. macrophylla* and least in *Ac. auriculiformis*. At 7.5 mmhos cm^{-1} highest germinative energy was observed in *Al. lebbek* followed by *L. leucocephala*, *Al. saman* and least in *Ac. auriculiformis*. At 15 mmhos cm^{-1} highest germinative energy was observed in *Al. lebbek* followed by *Al. saman, D. sissoo* and least *in Ac. auriculiformis*. At 22.5 mmhos cm^{-1} highest germinative energy was observed in *Al. lebbek* and followed by *Al. saman* and *S. macrophylla*. No germination was found in *Ac. auriculiformis* at 22.5 mmhos cm^{-1} (Fig. 3). Analysis of variance indicates that there is significant difference among species, among salinity level and between salinity and species, where, F= 2.506, 2.816 and 1.896 respectively at 5, 3, 15 degrees of freedom (d.f.) with an error degree of freedom 46 and $P < 0.05$.

For increase of 1 mmhos cm^{-1} salinity, highest reduction of germinative energy was observed in *D. sissoo* (2.8%) followed by *Al. lebbek* (2.7%), *S. macrophylla* (2.6%), *L. leucocephala* (2.5%), *Ac. auriculiformis* (2.4%) and *Al. saman* (2.3%).

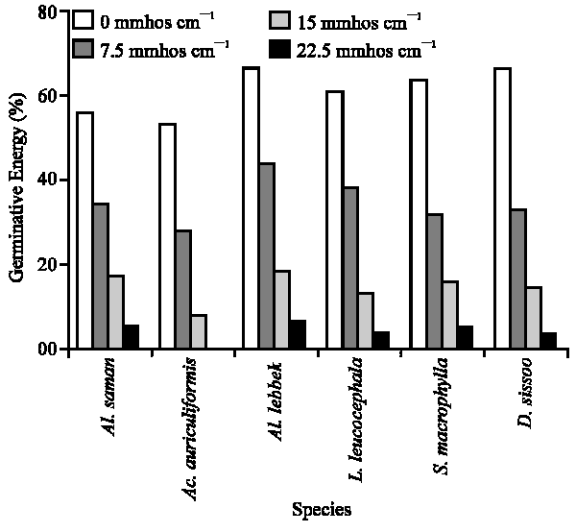

Fig. 3: Germinative energy of different species

DISCUSSION

Concentration of NaCl shows a marked effect on the germination. With increasing level of salinity, germination initiation of all the species is delayed and cessation is facilitated. But the rate varies with species. Similar type of observations has been made by Sharma *et al.*[27], Mandal and Handoo[32]. Soil salinity affect germination either by increasing the osmotic pressure of the soil solution to a plant that will retard or prevent the intake of water[36-38] or by causing toxicity to the embryo[39]. This effect may slow down or completely inhibit germination depending on the level of salt in the medium[40].

On the other hand germination energy is reduced with increasing salinity. Similar types of observations were made by authors for *D. sissoo*[27], *Al. lebbek*[20], *L. leucocephala* [20,31]. At different salinity level species shows different performances. Among the studied six species *Al. lebbek* shows highest germinative energy at all salinity levels. The next best performances were showed by *Al. saman* (at 22.5 and 15 mmhos cm^{-1}) and *Al. lebbek* (at 7.5 mmhos cm^{-1}).

The results should be considered with caution, as in the field condition the results might be different. So long term study on the effect of salinity on the germination in field condition is recommended.

REFERENCES

1. SRDI., 2001. Soil and water salinity in the coastal areas of Bangladesh. Soil Resource Development Institute, Ministry of Agriculture, Bangladesh.
2. Dutta, A.K., 2001. Effect of salinity on vegetation at Shyamnagar upazilla of Satkhira district. M.S. Thesis, Forestry and Wood Technology Discipline, Khulna University, Khulna, Bangladesh.
3 BBS., 2002. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Government of Bangladesh.
4. Iftekhar, M.S., 2001. Encroachment and degradation of forests in Bangladesh: A policy issue. M.S. Thesis, Forestry and Wood Technology Discipline, Khulna University, Khulna, Bangladesh.
5. Canonizado, J.A., 1999. Integrated forest management plan for the Noakhali Coastal Afforestation Division. Forest Management Plan Division, Forest Department, Bangladesh.
6. Islam, M.T., 2000a. Integrated forest management plan for the Chittagong Coastal Afforestation Division. Forest Management Plan Division, Forest Department, Bangladesh.
7. Islam, M.T., 2000b. Integrated forest management plan for the Bhola Coastal Afforestation Division. Forest Management Plan Division, Forest Department, Bangladesh.
8. Islam, M.T., 2000c. Integrated forest management plan for the Patuakhali Coastal Afforestation Division. Forest Management Plan Division, Forest Department, Bangladesh.
9. Runkel, M. and I.U. Ahmed, 1997. Sundarbans Reserved Forests: area, distribution and status of forest types from 1985 to 1995. Resource Information Management System, Forest Department, Bano Bhaban, Dhaka, Bangladesh.
10. Canonizado, J.A. and M.A. Hossain, 1998. Integrated forest management plan for the Sundarbans Reserved Forest (Final Draft). Mandala Agricultural Development Corporation and Forest Department, Ministry of Environment and Forest, Bangladesh.
11. Siddiqi, N.A., 2001. Mangrove forestry in Bangladesh. Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, Bangladesh.
12. Shakil, A., T.K. Nath, F.U. Ahmed and S. Akhter, 1997. People's perception and preference towards growing multipurpose tree species. Chittagong University Studies, 21: 87-94.
13. Caceres, O., 1998. Nutritive value of foliage from tropical trees and shrubs. III. *Albizia lebbeck*. Pastosy Forrajes, 21: 93-98.
14. George, S.J. and B.M. Kumar, 1998. Litter dynamics and cumulative soil fertility changes in silvopastoral systems of a humid tropical region in central Kerala, India. Int. Tree Crops J., 9: 267-282.
15. Soca, M. and L. Simon, 1998. *Albizia lebbeck* (L.) Benth. Pastosy Forrajes, 21: 101-113.
16. Tomar, J.S., S. Charan, B.P. Bhatt and C. Singh, 1998. Effect of multipurpose trees on soil fertility under woodlots in Garhwal Himalaya. Indian J. Soil Conser., 26: 35-38.
17. Kormawa, P.M., A.Y. Kamara, S.C. Jutzi and N. Sanginga, 1999. Economic evaluation of using mulch from multi-purpose trees in maize-based production systems in south-western Nigeria. Experimental Agri., 35: 101-109.
18. Bangash, S.H., 1977. Salt tolerance of forest tree species as determined by germination of seeds at different salinity. Pak. J. Forest., 27: 93-97.
19. Misra, C.M. and S.L. Singh, 1981. Seed germination studies on three predominant tree species of southern Uttar Pradesh. Ann. Arid Zone, 20: 193-198.

20. Misra, C.M., S.L. Singh and S. Behal, 1988. *Germination of tropical leguminous tree species under high pH*. Nitrogen Fixing Tree Res. Rep., 6: 13.
21. Iqbal, M.Z. and K. Rahmati, 1992. Tolerance of *Albizia lebbek* to Cu and Fe application. Ekologia, 11: 427-430.
22. Cavalcante, A.de.M.B. and S.C.J.G.de.A. Perez, 1995. Effects of water and salt stresses on germination of *Leucaena leucocephala* (Lam.) de Wit seeds. Pesquisa Agropecuaria Brasileira, 30: 281-289.
23. Cruz, M.S.D., U.E. Perez, L. Martin, A. Avalos and C. Vicente, 1995. Factors affecting germination of *Canavalia brasiliensis*, *Leucaena leucocephala*, *Clitoria ternatea* and *Calopogonium mucunoides* seeds. Seed Sci. Technol., 23: 447-454.
24. Mandal, M.P. and J.K. Handoo, 1999. Salt stress in relation to seed germination of Subabul (*Leucaena leucocephala* (Lam.) de Wit. *Van Vigyan,* 36: 66-69.
25. Mandal, M.P. and J.K. Handoo, 1998b. Presowing seed treatments for alleviation of salinity stress in Subabul (*Leucaena leucocephala* (Lam.) de Wit during germination. Indian J. Forest., 21: 204-207.
26. Saxena, A.K., O.P. Rao and B.P. Singh, 1998. Germination responses in nine multipurpose tree species on moisture gradient. Range Manage. Agroforest., 19: 69-73.
27. Sharma, A., M.U. Kukkadia, D.B. Jadeja and B.G. Vashi, 1998. Effect of different salinity levels on germination and initial growth parameters of different agroforestry tree species in nursery stage. Indian J. Forest., 21: 156-159.
28. Womgwattana C., M. Nanakorn, S. Surawattan and K. Kobayashi, 1998. Effect of sodium chloride on growth and root nodulation in some leguminous plants. J. Weed Sci. Technol., 43: 129-133.
29. Fonseca, S.C.L. and S.C.J.G.A. Perez, 1999. Effects of sowing depth, salt and water stress on germination of *Leucaena* seeds. Revista Ceres, 46: 371-381.
30. Iqbal, M.Z. and M. Shafiq, 1999. Toxic effects of zinc on different tree seedlings. Pak. J. Scient. Ind. Res., 42: 150-153.
31. Nobrega, N.G.M., J.E. Queiroz, L.M.M. Silva and R.V. Santos, 1999. Effect of salinity on germination and initial development of *Leucaena*. Revista Brasileira de Engenharia Agricola e Ambiental, 3: 257-260.
32. Mandal, M.P. and J.K. Handoo, 1998a. Effect of salt stress on germination of Subabul (*Leucaena leucocephala*). J. Applied Biol., 8: 17-19.
33. Arya, S., O.P. Toky, P.J.C. Harris, R.P. Bisht and R. Tomar, 1997. Salt tolerance of *Prosopis cineraria* (L.) druce provenances in north western India. Indian J. Forest., 20: 57-60.
34. Richards, LA., 1954. Diagnosis and improvement of saline and alkali soils. USDA Agriculture Hand Book. No., 60.
35. Melana, E.M., E.E. Melana and C.A. Arrio, 1980. Germinative study of selective mangrove species. Sylvatrop, 5: 207-211.
36. Uhivits, R., 1946. Effects of osmotic pressure of water absorption and germination of alfa seeds. Am. J. Bot., 33: 278-283.
37. Ayers, A.D., 1952. Seed germination as affected by soil moisture and salinity. Agron. J., 44: 82-84.
38. Bernstein, L., 1961. Osmotic adjustment of plants to saline media 1. Steady state. Am. J. Bot., 44: 909-918.
39. Mehta, B.V. and R. Desai, 1958. Effect of soil salinity on germination of some seeds. J. Soil Water Conser. India, 7: 101-115.
40. Ayers, A.D. and H.E. Hayward, 1948. Water quality for agriculture, irrigation and drainage. Paper No., 29, FAO., Rome, Italy.