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REGULAR ARTICLE

STUDIES ON THE EFFECT OF SALT STRESS IN *RHIZOPHORA APICULATA* BL.

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SUMMARY

The present study shows the effect of salt stress in the over all development of *Rhizophora apiculata.* The parameters used in this study were changes in growth morphology, biochemical constituents and photosynthetic pigments. From the study it was observed that the growth parameters such as root and shoot length, fresh and dry weight increased with increasing concentrations upto 400 mM NaCl. The organic compounds such as aminoacids and total sugar decreased upto optimal level of 400 mM, but protein and starch increased upto the optimal level of 400 mM of NaCl salinity. The proline and glycine betaine increased upto the extreme level of 750 mM. So it is concluded that the photosynthetic pigments are upto the optimum concentration.

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1. Introduction

Mangroves are of great ecological and economic significance in providing forestry and fishery products to a large human population, protecting coastal zones from erosion, storms, floods and also in supplying food and shelter for a large number of fishes. They are highly adapted to coastal environment, by having breathing roots, supporting roots, salt- excreting leaves and viviparous - water dispersed propagules. Soil salinity is one of the major limiting factors for crop and forage production in the arid and semi- arid regions of the world. In this situation, exploration and cultivation of salinity tolerant species often a practical solution for effective utilization of stress affected soils (Liang *et al*., 2008). Great effect have been made to improve the salt tolerance of many crops by means of traditional breeding programs and more recently, by genetic transformation (Cuartero *et al*., 2006). Consequently, searching for strategies that will generate improved tolerance to salt stress in plants is a priority (Rodriguez *et al*., 2008).

2. Materials and Methods

About 100 plants of uniform sized seedlings were collected from mangrove belt of Pichavaram, Tamilnadu. These seedling were washed thoroughly with tap water and planted in the Polythene sleeves (9" × 7"). They were filled with homogenous mixture of garden soil consisting of red earth, sand and farmyard manure in the ratio of (1:2:1). The uniform sized seedlings were selected and kept in 6 plots and treated with various concentration of NaCl ranging from 0 (control) to 750 mM. The control plants were maintained without the addition of sodium chloride. After completion of salt treatment, the seedlings were irrigated with tap water. Samples were collected on 30th and 60th days after salt treatment. They were used for the study of growth morphology and biochemical analysis.

3. Results and Discussion

Five plants were collected from each concentration and used for studying the morphological parameters. Growth stimulation at low to moderate external salinity has been reported for many halophytes such as *Salicornia brachiata* (Reddy *et al*., 1992), *Halopeplis perfoliata* (Al-Zaharani and Hajar, 1998), *Kandelia candel* (Hwang and Chen, 2001) and *Rhizophora apiculata* survived double the strength of seawater (Feller, 1995). NaCl salinity stimulated the shoot and root length upto 400 mM, at higher salinity the shoot and root length were drastically reduced. The highest increase in shoot and root was (22.46, 25.69 cm plant^{-1}) (Table1). The highest increase in the leaf production was observed at optimum level of NaCl on 60th day after NaCl treatment. The reduction in the leaf number at high salinity could be due to senescence followed by leaf fall (Feller, 1995). When the salinity reaches the maximum level, it would be metabolically less costly to drop the leaves than to overcome the stress. Growth at high salinities the old leaves become yellow green and then brown indicating marked injury of old leaves. Similar responses have been found in aquatic macrophytes exposed to saline condition (Haller *et al*., 1974; Rout and Shaw, 2001; Upadhyay and Panda, 2005). Both the fresh weight and dry weight attains high at 400 mM concentrations and decreased gradually at higher concentrations. An increase in the fresh weight of tissue can be attributed to increase in succulence (Clipson, 1987).The dry weight increase may be attributed to the organic and inorganic constituents in their tissues. However, the decrease in fresh weight at higher salinity levels revealed in the present study has also been reported in certain other halophytes (Rajendran and Kathiresan, 2000). The amino acid and total sugar decreased upto 400 mM concentration and increased at higher salinity (Table 2 and Fig 1). When the aminoacid content showed a decrease upto the optimal salinity of 400 mM, it registered a gradual increase at higher concentrations. Aminoacid accumulation in the plant tissues occured not only under salinity stress, but also under water stress in higher plants (Treichel, 1975). The decrease in sugar content could be either due to high respiration or a decrease in photosynthetic activity accompanied by reduction in growth rate. An increasing sugar content and corresponding decrease in the starch at higher salinities have been reported in several halophytes (Basak *et al*., 1995; Venkatesan and Chellappan, 1998; Prado *et al*., 2000).The accumulation of organic solutes such as sugars and amino acid do not inhibit metabolic processes, and common mechanism in maintaining intercellular homeostasis in the cytoplasm (Pagter *et al*., 2009). Protein and Starch increased upto the optimal level of NaCl salinity and decreased at higher concentration. High salinity stress can cause denaturation and days function of many proteins (Vinocur *et al*., 2005). The progressive decrease in protein and increase in the total free aminoacids under NaCl salinity was either due to the conversion of protein into aminoacids or inhibition of aminoacids incorporation into protein (Devitt *et al*., 1987). Salinity was shown to reduce the protein content accompanied by a considerable increase in the pigment and amino acid content (ABD El- Samad, 1993). The increase in starch and decrease in total sugar under salinity has been attributed to the role of sodium on the stomatal opening (Eshel *et al*., 1974). The Proline and glycinebetaine increased upto the extreme level of 750 mM sodium chloride salinity. There was three-fold increase in proline content in all the tissues at 750 mM NaCl of all the species when compared to that of control plants. *Ipomoea pes-caprae* showed an increase in proline upto the extreme level of 500 mM NaCl (Venkatesan and Chellappan, 1998). Proline is generally regarded as a compatible solute involved in cellular osmotic adjustments whose accumulation increases when plants are in salinity stress conditions (Shan *et al*., 2009). NaCl salinity promote the chlorophyll and carotenoid synthesis upto the optimal level, beyond this level both pigments were reduced drastically. The effect of salt stress on photosynthesis may depend on the changes in photosynthesizing tissue, disturbance in water balance in plants and homeostasis of Na^+ and Cl^- ions (Munns and Tester, 2008). A decrease in photosynthesis causes stomatal and non-stomatal limitations and inhibition of photochemical processes (Steduto *et al*., 2000). Decrease in chlorophyll under saline condition has been attributed to the salt induced weaking of protein-pigment-lipid complexes or decreased chlorophyllase activity (Sudhukar *et al*., 1991).

Fig: 1 – Effect of NaCl on organic components of *Rhizophora apiculata*

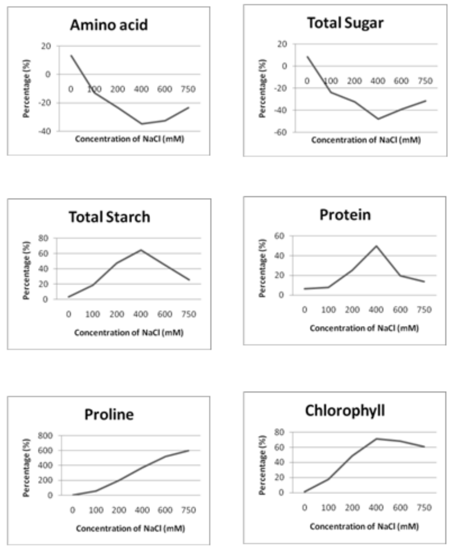

Table 1. Effect of NaCl on growth parameters of *Rhizophora apiculata* on 60th day after treatment

Concentration of NaCl (mM)	Shoot length (cm plant^{-1})	Root length (cm plant^{-1})	Number of leaves	Fresh weight (g plant $^{-1}$)	Dry weight (g plant $^{-1}$)
Control	17.08 ± 0.854	17.39 ± 0.869	6	15.968	6.500
100	19.25 (+ 12.70) ± 0.962	20.66 (+ 18.80) ± 1.033	8	18.271 (+ 14.422) ± 0.208	7.45 (+ 14.615) ± 0.079
200	20.05 (+ 17.38) ± 1.002	24.60 (+ 41.46) ± 1.230	10	20.450 (+28.068) ± 0.250	7.913 (+ 21.738) ± 0.090
400	22.46 (+ 31.49) ± 1.123	25.69 (+ 47.72) ± 1.284	14	25.936 (+ 62.424) ± 0.338	9.961 (+ 53.246) ± 0.122
600	21.20 (+ 24.12) ±1.060	23.10 (+ 32.83) ± 1.155	10	24.747 (+ 54.978) ± 0.343	9.046 (+ 39.169) ± 0.118
750	21.04 (+ 23.18) ± 1.052	22.90 (+ 31.68) ± 1.145	8	23.308 (+ 45.966) ± 0.342	8.655 (+ 33.153) ± 0.120

(+/-) Percent of increase or decrease over control are in parentheses
± Standard error

Table 2. Effect of NaCl on organic constituents (mg g^{-1} fr.wt.) of *Rhizophora apiculata* on 60^{th} day after treatment

Concentration of NaCl(mM)	Amino acid	Total sugar	Protein	Total starch	Proline	Chlorophyll
Control(0)	13.248	8.512	6.412	3.255	0.557	1.370 ± 0.068
100	11.524 (- 13.013) ± 0.122	6.49 (- 23.754) ± 0.068	6.907 (+ 7.719) ± 0.073	3.868 (+ 18.832) ± 0.041	0.873 (+ 56.732) ± 0.009	1.611 (+ 17.59) ± 0.080
200	10.13 (- 23.535) ± 0.115	5.732 (- 32.659) ± 0.065	8.036 (+ 25.327) ± 0.091	4.794 (+ 47.281) ± 0.054	1.659 (+ 197.845) ±0.189	2.040 (+ 48.90) ± 0.102
400	8.639 (- 34.790) ± 0.105	4.424 (- 48.026) ± 0.054	9.608 (+ 49.844) ± 0.117	5.353 (+ 64.454) ± 0.065	2.704 (+ 372.097) ± 0.033	2.348 (+ 71.38) ± 0.117)
600	8.922 (- 32.653) ± 0.116	5.198 (- 38.933) ± 0.067	7.675 (+ 19.697) ± 0.100	4.73 (+ 45.314) ± 0.061	3.468 (+ 522.621) ±0.045	2.310 (+ 68.61) ± 0.115
750	10.129 (- 23.543) ± 0.140	5.833 (- 31.473) ± 0.080	7.279 (+ 13.802) ± 0.101	4.083 (+ 25.437) ± 0.056	3.895 (+ 599.281) ± 0.054	2.206 (+ 61.02) ± 0.110

(+/-) Percent of increase or decrease over control are in parentheses

± Standard error

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