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Research Article

Effect of Salinity on Growth Parameters and Relative Water Content in *Rhizophora mucronata* Lam

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Abstract

The response of *Rhizophora mucronata* Lam. to salinity was studied by understanding its physiological parameters. Growth response of the plant under saline conditions were measured by monitoring the shoot and leaf length of plants grown under different concentrations of salt. Leaves are the main organ system involved in generating energy for growth and development of plants. The growth reduction caused by salt stress mainly causes changes in leaf function, so leaves were used for the study. Relative water content (RWC) was determined to observe the plant water status under salt stress **which** showed the plant's ability to tolerate salt.

Keywords: *Salinity, leaves, stress, water content.*

Introduction

During salinity stress growth inhibition is observed at the initial stage (Moussouraki *et al.*, 2019) whereas, salt-tolerant plants survive salinity and grow. Salt tolerance in a plant is brought about by many factors. Initially when a plant comes in contact with salt, it tries to prevent its entry into the cell; when salt enters the cell, the plant develop mechanisms to lower the ion concentration and protect the plant from injury, and to overcome the stress condition, the plant produces several metabolites, activate genes and proteins and finally bring about salt tolerance (Sairam and Tyagi, 2004). Previous literature reported that when a plant starts growing under salinity, changes occurs from germination until it becomes mature and there is no clearunderstanding of the mechanisms involved. This slows down the development of salt-tolerant crops. Looking into the growth patterns of a plant in response to salt, it was shown that seedlings are more affected than in germinating stage, membrane activities and its function affect the root growth. Shoot growth was also reduced at high salinity (Lauchli and Grattan, 2007). In our experiment, the plants were watered with different concentrations of saltwater, that is from 0 to 30 % salt water (30% salt water equivalent to 5M sodium chloride) and it was noticed that in plants watered with 5M salt water (high concentration) wilting of leaves were observed within an hour and finally, the leaves become dry and the whole plant was dried and dead. Photosynthetic pigments are considered as biomarkers of environmental stresses. (Rahneshan. *et al.*, 2018).To escapes from salt stress, plants produce various metabolites that help them to tolerate salt (Singh. *et al.*, 2017). Several transgenic plants were developed which are capable of synthesizing glycine betaine thereby imparting stress tolerance (Dutta. *et al.*, 2018).

RWC analysis is an important feature to analyze water balance in plants and it decreases with increasing sodium chloride concentrations (Saeed. *et al.*, 2014). This may be due to the osmotic imbalance, osmotic potential and water potential, which negatively affect plant growth during salinity (Mudgal. *et al.*, 2010). In response to salt and drought stress, free amino acids accumulate in plants and halophytes are its rich source (Nasir. *et al.*, 2010). Studies showed that with an increase in salinity arginine and asparagine

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contents were decreased in chickpea (Khan. *et al*., 2019). Phytochemicals are also involved in maintaining salinity tolerance, flavonoids and phenols are important among them and reported in many species (Annamalai. *et al*., 2015). In *Amaranthus tricolor*, *Cichorium spinosum* and buckwheat sprouts, phenols and flavonoids were increased during salt stress (Sarker. *et al*., 2018).

Materials and Methods

Taxonomic Identification and Collection of *Rhizophora mucronata* Lam.

The plant was identified based on their morphological characteristics. Plant samples were collected from the estuarine area of Melur, Thalassery. The salinity of the water in its natural habitat was measured by titration method using 0.1M silver nitrate and potassium dichromate as an indicator (Mohr method). Propagules were collected and planted in pots.

Growth Parameters

Watered the propagules using tap water for a year and one-year-old plants of *Rhizophora mucronata* Lam. were used for the study. Plants were watered using 30% saltwater at different concentrations (0 to 5M) of salt. Crystal salt was used and saltwater was given on alternate days to prevent salt build-up. Shoot and leaf length was measured using a ruler.

Relative water contents

Relative water content (RWC) was measured by the following equation (Weatherly 1950):

RWC (%) = [(Fresh weight-Dry weight) / (Turgid weight-Dry weight)] ×100

To measure turgid weight leaf samples were submerged for 24hrs in distilled water, after 24hrs a sample were blotted and was weighed. Leaves were dried in an oven and their dry weight measured.

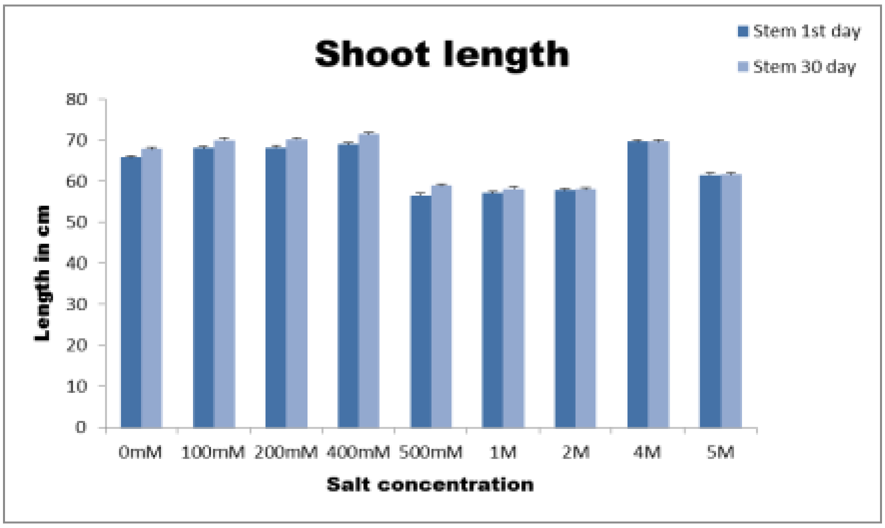
Results and Discussion

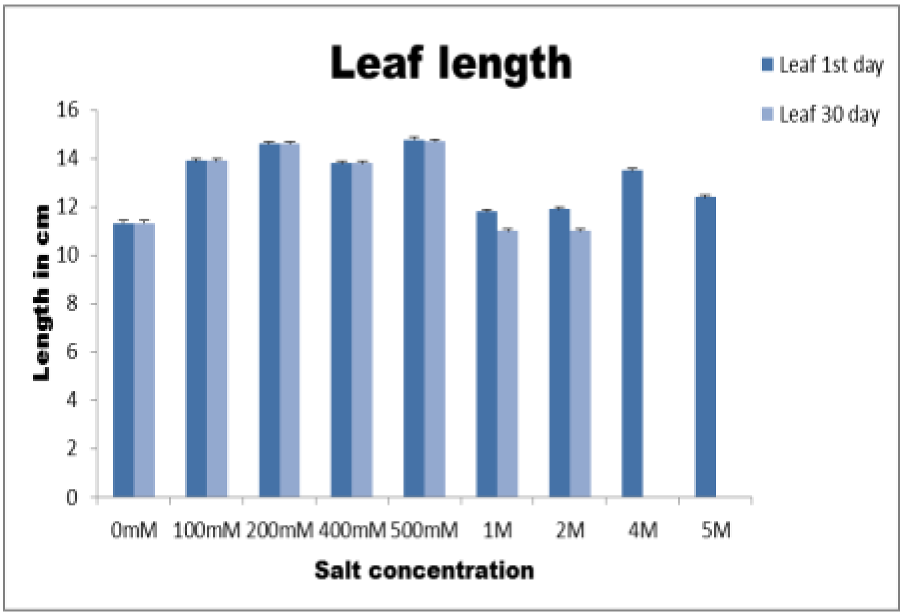
Sample Collection and Identification

Based on the morphological observations, the tree are average sized, straight, with distinctive aerial roots or breathing roots. Leaves are compact, dark green to yellowish green in color, simple with mucronate tips, arranged oppositely, elliptical, hairless, leathery, glossy, and crowded towards the end of the branches. Midrib was prominent, with distinctive black dots beneath the leaves. Flowers are creamy white in color with persistent calyx, arranged in few axillary heads, leathery with short thick stalks and seeds were viviparous, the species was identified as *Rhizophora mucronata* Lam. The salinity of the river water was measured at the time of sample collection and it was found to be 260mM. So the propagules for the study were grown at different salt concentration.

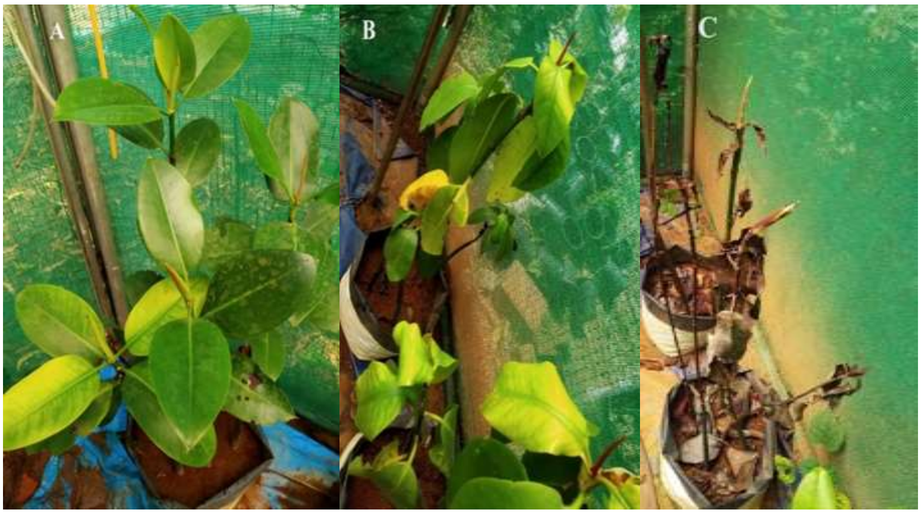
Growth Parameters

Measurement of shoot length and leaf length showed that the shoot length was slightly increased after 30 days of salt treatment and the leaf length was the same. In plants watered with a high concentration of salt (above 2M), leaves started wilting after a week and after one-month plants were completely dried. The reduction in growth may be due to the decrease in osmotic potential, change in photosynthesis and stomatal conductance. Plant's ability to absorb water also decreases with increasing salinity. The sodium and chloride ions entering into the plant may reach toxic levels and lead to the senescence of leaves (Ouhaddach. *et al*., 2018).





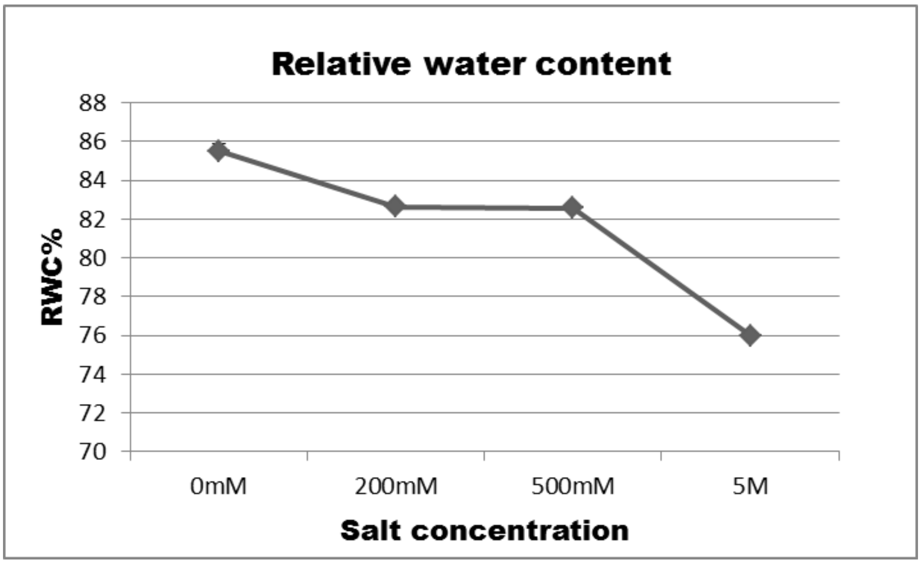
Shoot and Leaf Length at Different Concentration of Salt



A. Control Plant **B.** Salt Treated Plant **(30%Salt)**

Relative Water Content

Water status under salinity in *Rhizophora mucronata* Lam. was assessed by analyzing the relative water content (RWC). Water status is the main feature affecting plant growth and development (Qin. *et al.*, 2010). In this study, RWC of the plant leaves at different concentration of salt (0mM,200mM,500mM and 5M) were analysed and the results showed that relative water content decreases with the increase in salinity(5M) and at 500mM salt concentration RWC was similar to that of plant growing under optimum saline conditions (200mM) . Stable water status is needed for the plant to withstand salt stress (Pan. *et al*., 2016).



Leaf Relative Water Content

Conclusion

Rhizophora mucronata Lam. occurs mostly in areas where freshwater flows and they are evergreen trees. Trees are 20-25m tall and the tallest trees occur in water. Leaves are elongated with a pointed tip, hence the name "mucronata" (mucronata in Latin meaning pointed). Flowers develop as a cluster, the seeds are viviparous and the plants are classified as C3 plants.The plant is an important part of the ecosystem (Batool. *et al*., 2014). The adverse effect of salinity on plant growth was reported earlier. Under salinity plant grows slower, leaves become smaller, darker and thicker than normal plants (Berstein, 1975). The effect of salinity on plants is determined by its effect on vegetative growth, not in terms of its survival and the three factors to access the effect of salt on a plant species include – vegetative growth, survival and seed production (Flowers and Yeo, 1989). Neumann in 1997 reported that early salt-induced reduction in leaf number and size is due to the reduced transpiration and less availability of water from the soil. The sodium and chloride ions entering into the plant may reach the toxic level and lead to the senescence of leaves (Ouhaddach. *et al*., 2018). In roots, they inhibit growth and hence the function of the roots get reduced thereby leading to the death of the plant. In this way at higher concentrations of salt, *Rhizophora mucronata* plant also gets wilted and destroyed. RWC is useful for the measurement of plant water status and provides a sign of the plant's stress status (Yadav. *et al*., 2011). The result shows that the plant can tolerate salt up to a certain concentration and at higher salinity, the plant's relative water content decreases and this may be due to the decreased water potential in leaves (Gucci. *et al*., 1997; Jahan. *et al*., 2018). In sugar beet varieties, treatment with salt caused a decrease in relative water content.

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