

Comparison of Salinity Tolerance Between *Avicenna marina* and *Rhizophora mucronata* Karachi Coast, Pakistan

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Abstract. Mangrove propagule size variation is an important factor in their survival. The main aim of this study was to determine the productivity and identify the comparison between *Avicenna marina* and *Rhizophora mucronata*. However, it is less studied about the comparison of mangrove species and their salt tolerance in terms of seedling establishment of propagules. We investigated the propagules size variation of *Avicennia marina* and *Rhizophora mucronata* from the Indus delta and were grown in the polythene bags of 5x10" filled with silty soil from field nursery. We used salinity and nutrients treatments to propagules to identify the growth rate of mangrove species. The surveying technique was also used to collect the information of mangrove forest from local communities. We detected that *Rhizophora mucronata* had a higher productivity rate due to the given concentration of 50% sea water. While the *Avicennia marina* showed a lower decline ratios growth at 25% salinity level with further increases in salinity. Using diffusion porometers and infrared gas analyzers (IR-GAs), we revealed that stomatal conductance was higher in *Rhizophora mucronata*, followed by *Avicennia marina*. Moreover, our outcomes showed a higher Sodium and chloride ions with the increase in salinity and also demonstrated a higher accumulation in *Avicennia marina*. Overall, it was found that *Avicennia marina* is the most salt resistant species and it's a dominated species in littoral forest. Our outcomes can help us to better understand the green infrastructure design of mangroves, suggesting that selecting multiple techniques ensure many post-tsunami restoration initiatives are encountering problems.

Keywords: *Avicennia marina*, *Rhizophora mucronata*, propagules, salinity, stomal conductance, Hoagland solution, Seawater

1. Introduction

Mangroves are shrubs or trees that grow in coastal saline or brackish water and belong to family Rhizophoraceae. They contain a complex salt filtration system and a complex root system to cope with saltwater immersion and wave action. Mangroves are a genus of tropical and semitropical trees and shrubs that grow in the intertidal zones of tropical and semitropical coasts worldwide (Hong et al., 2018). Approximately 80 species of mangrove trees have evolved morphological and physiological characteristics to adapt to harsh coastal climatic conditions, with their genetic diversity originating from 20 plant families (Duke, 2013). Mangrove forests are unique plant communities restricted to biotopes with harsh environmental conditions such as intertidal areas of lagoons and sheltered bays in tropical and sub-tropical areas worldwide (Mukherjee et al., 2015). Mangroves forest in South Asia occurs on the sea shoreline of Bangladesh, India, Pakistan and Sri Lanka which covers 7% of the world mangroves (Giri et al., 2011). The tree species of mangrove forests are exceptional due to their better growth rate under extreme salt stress and freshwater conditions. These forests

are possibly the only plant system with wide adaptations to extreme conditions (Rajalakshmi and Parida, 2012). Along with, the mangroves are salt-tolerant trees that are known to be halophytes, and have capability to adapt in harsh coastal conditions like high temperature and high salinity (Hong et al., 2018).

Salinity is a critical abiotic factor that affects plant growth, productivity, and dispersion in tropical and semitropical intertidal areas because excessive sodium (Na^+) causes an osmotic imbalance in organisms (Krauss et al., 2008; Munns and Tester, 2008). Salinity affects approximately 20% of the world's cultivable land and 50% of its irrigated land (Tuteja, 2007). Salinity causes two forms of stress in plants: osmotic pressure (due to increased osmotic pressure) and ionic stress (due to increased amounts of harmful ions, such as sodium (Na^+) and chlorine Cl^- , resulting in ionic imbalance) (Flowers and Colmer, 2008). *Avicennia marina*, also known as gray mangrove or white mangrove, is a shrub or tree belonging to the Acanthaceae family. They are generally 10–14 m long and have light gray or whitish bark with stiff, brittle, thin flakes. Their leaves are thick, glossy, and bright green on the upper side and gray or silvery white with small hairs on the lower side. Their pneumatophores can grow up to 20 cm (Behbahani et al., 2014).

Avicennia marina is a widely distributed mangrove species that thrives in high-salinity habitats. It plays a significant role in supporting the coastal ecosystem and holds unique potential for studying molecular mechanisms underlying ecological adaptation. Because of its numerous merits, including medicinal value, this species is facing increasing pressure of exploitation and deforestation (Huang et al., 2014a,b). *Rhizophora mucronata*, belonging to Rhizophoraceae family and locally known as Asiatic mangrove, is found along the coasts of tropical and subtropical regions (Rastegar and Gozari, 2017). The tree is generally 15–25 m tall, and the stipules of leaves are yellowish in color with black tiny spots on the underside of the leaves (Naidu and Varahalarao, 2010). Plants of this genus are rich in phytochemicals and thus have high medicinal potential and are also used in traditional medicinal practice. The leaves, roots, and bark of this tree are used for treating hemorrhages, angina, and hematuria and even for inducing contractions in pregnant women. These medicinal properties are due to the rich store of phytochemicals (Seepana et al., 2016). The species of Mangroves Forest such as *Avicennia marina* and *Rhizophora mucronata* helps to cover the shoreline edges and thus useful to protect the land and ecology against natural disasters e.g., strong wave actions, stormy winds cyclones and tsunamis (Cornforth et al., 2013; Giri et al., 2007a; Porwal et al., 2012; Satyanarayana et al., 2011).

Avicennia marina has the ability to tolerate a wide range of salinity. The species is able to grow well in salinity that is close to bargain up to 90 ‰ but at extreme salinity, the tree grows stunted and the ability to produce fruit is lost (Noor et al., 2006). *Avicennia marina* collects the highest ion concentration from *Rhizophora mucronata* (Scholander et al., 1962), which means that the ability of *Rhizophora mucronata* to accumulate inorganic ions was lower than that of *Avicennia marina* (Titah et al., 2019).

The mangrove forest in Sindh extends from Korangi to the Seer creek touching Indian border with total area of almost 600,000 hectares (Ansari, 1987). The present mangrove forest is almost entirely dominated by *Avicennia marina* (95%) with few populations of *Aegiceras corniculatum*, *Ceriops tagal*, and *Rhizophora mucronata* (Saifullah et al., 1994). The aim of this study was to determine the effect of salinity on the growth of mangrove *Avicennia marina* and *Rhizophora mucronata* with artificial salinity variation of 25‰ and 50‰ and survey the local community's awareness. In this study, the following questions were addressed: (1) How to compare *Avicennia marina* and *Rhizophora mucronata* using salinity in Mangroves? (2) How to improve mangroves forests using awareness and surveying method in local communities?

2. Methods

2.1. Study area

The Indus delta region is located between 25° 50' and 24° 50' North latitude and 67° 50' and 68° 15' East latitude. It has been built up by the activity of the river Indus with its origin of the Himalayas. Its major spillway lies at Ketu Bunder. The Indus Delta covers approximately 600,000 ha with a coastline of 250 km, bordering the city of Karachi in the north-west. The Indus Delta is comprised of 17 major creeks, numerous minor creeks, extensive areas of mudflats, and 129,000 ha of mangrove forests. The dense forests are mostly located in the pockets created by the creeks. The source of fresh water is the perennial river, Indus, that flows through the Delta before reaching the Arabian Sea. The Indus Delta shelf is 150-km wide and receives scanty rainfall during the monsoon season. The average wind speed during these months varies from 12 km to 35 km. The study was conducted in institute of environmental studies where species are grown in muddy soil. The name of species is *Rhizophora mucronata*, and *Avicennia marina*. The rocks are of origin of marine and composed of clay, sandstone and limestone. The soil of mangroves area is fine alluvium comes from land drainage and erosion.

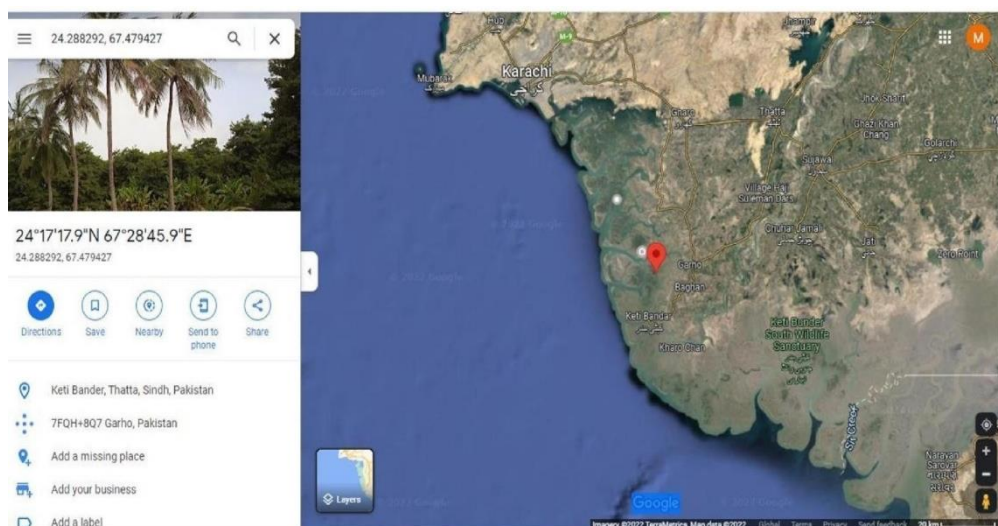


Figure 1. Ketu Bander, Thatta, Sindh, Pakistan <https://goo.gl/maps/ARmGBjPus4YadbJP8>

The relative humidity is higher throughout the year it is higher in summer than in winter the rainfall pattern is irregular, uncertain and scanty. It occurs largely during the summer monsoon season. The mean annual precipitation is annually 22.1mm recorded of 30 years. The area is subject the extreme heat and both diurnal and annual ranges of temperature are considerable. Therefore, the precipitation curve underlies the temperature curve throughout the year except for the summer monsoon period (August) and winter month (January). This may define the area as an arid zone. The average wind speed during these months varies from 12 km to 35 km.

2.2. Collection of Propagules

The propagules of *Avicennia marina* and *Rhizophora mucronata*, used in this study were collected from mother trees and forest floor of Indus Delta. The mangrove propagules species *Rhizophora*, were collected in month of July and August and rest of *Avicennia marina* were collected in the month of September. After collection of propagules those were kept in moist gunny bags and stored not more than 3-4 days in refrigerator to prevent loss of water owing to evaporation (Rasool & Saifullah., 2000). The propagules of *R. mucronata*, remains generally viable for about a week under local conditions without any pre-treatment but *Avicennia marina* should plant within 3-4 days after the collection of propagules. Therefore, it was observed by (Rasool and Saifullah.,2000) that pre-treatment of propagules has always shown better results as compared to untreated ones.

2.3 Method for Nursery Technique *Avicennia marina* and *Rhizophora mucronata*

We collected the 100 propagules of *Avicennia marina* and 100 Propagules of *Rhizophora mucronata*. The colour of propagules changes from light green to dark green with seeds maturation. They are available from August to October but mainly collected in late August and up to mid-September when they are more abundant and viable (Rasool & Saifullah., 2000). The propagules collected from tree show more viability than those of floating on to water. They were half embedded in the polythene bags filled with soil. After sowing germination starts soon with the success of 60% within 2 weeks in polythene bags It is observed that the trees above six years old produced sufficient propagules (Siddiqui et al., 1993; Rasool & Saifullah., 2000).

2.4 Surveying Technique

This surveying technique was conducted in November 2022, of the mangrove forest at Indus delta and Ketu Bander Karachi, Pakistan. The main objective of this survey was to collect the information about mangrove forest from the local community. Firstly, we approached the mangrove forest department officers to collect the information about mangrove forest. After finished the meeting with the forest department officers, our research group visited the field area. We encountered more than 50 peoples some queries about mangrove forest species. After survey, the forest department officer arranged a meeting with our research group regarding awareness of the mangrove forest. In consort with, my colleague (Muhammad Ayaz) delivered a lecture about the benefits of mangrove forest species, and consciousness about the deforestation.

2.5 Study of Experimental Parameters

The study is emphasis on investigating the effects of some ecological factors such as the area of the collection of the species, size of propagules, weight, water salinity, nutrients and the mode of sowing of propagules on the germination (sprouting) and the growth of some indigenous mangrove species of Pakistan. The propagules were collected from mangroves forest at Port Qasim (24.80° N, 67.24° E) and the observation has been conducted in the field nursery at the “Institute of Environmental Studies University of Karachi”.

2.6 Sowing Propagules in the Polythene bags

The size of 5x10 inches polythene bags have been used with 4-6 holes in the middle and sides of bags for the aeration and drainage of excess water, then these bags were filled with soil from the garden of “Institute of Environmental Studies University of Karachi”. After filled polythene bags with soil freshwater were given before sowing, the weight and length of propagules has been taken for initial study before that they were sowing in the polythene bags. Immediately upon arrival, seeds were unpacked and graded into large size (average weight is 4.32g), medium size (average weight 3.60g) and small size propagules were (average weight 3.60g). After taking initial length and weight propagules of selected specie were placed in a polythene bag which is filled with 95% silty soil and were monitor regularly. Nutrients are given to the propagule’s seawater, Hoagland solution in addition fresh water also given to the propagules to remove out excess amount of salt in polythene bags.

2.7 Preparation of nutrients

Three different solutions were given to the propagules in the spring season in March 2022. A total of two main solutions were given to the propagules such as sea or salt water on 25% and 50% and Hoagland nutrient solutions. These solutions were prepared in the lab experiment.

For the preparation of solution of sea or salt water on 25%, taken 13.5g sea salt in freshwater and diluted up to 6 liters water. Along with, for the preparation of salt water 50% solution, the sea salt of 55g was dissolved in freshwater and diluted up into 6 liters water.

For the preparation of Hoagland nutrient solution, in total components were added which are given below (Table 1).

Table 1. Components of Hoagland nutrient solutions.

Nutrients	Formula	Mol. Wt.	Per liter of nutrient solution
Macronutrients			
Potassium nitrate	KNO ₃	101.1	5 ml of 1 M
Calcium nitrate tetrahydrate	Ca (NO ₃) ₂ 4H ₂ O	236.15	5 ml of 1 M
Monopotassium phosphate	KH ₂ PO ₄	136.09	1 ml of 1 M
Magnesium sulfate	MgSO ₄ ·7H ₂ O	246.47	2 ml of 1 M
Micronutrient stock solution			1 ml of stock solution
Iron chelates	Fe-EDTA		1-5 ml of 1000 mg/l
Micronutrient			Per liters
Boric acid	H ₃ BO ₃		2.86 g
Manganese chloride – 4 hydrate	MnCl ₂ ·4H ₂ O		1.81 g
Zinc sulfate – 7 hydrate	ZnSO ₄ ·7H ₂ O		0.22 g
Copper sulfate – 5 hydrate	CuSO ₄ ·5H ₂ O		0.08 g
85% Molybdic acid	MoO ₃		0.02 g

3. Result and Discussion

Avicenna marina and *Rhizophora mucronata* were studied substantially reduced their stomatal conductance with the increase in salinity. The stomatal conductance was highest in *Rhizophora mucronata*, followed by *Avicenna marina*. In *Avicenna marina* and *Rhizophora mucronata*, a better growth response, reflects the high-water use efficiency in both species, even though one of them is salt secretor and the other is a salt excluder. Our results clearly showed that *Avicenna marina* and *Rhizophora mucronata* are highly salt tolerant and could survive full strength seawater and perhaps even higher salinity of the medium. It appears that the growth of all the species would be better if fresh water from the Indus River allowed mixing with seawater. Although all the species studied are good candidates for mangrove rehabilitation in the Indus delta, *Avicenna marina* is best equipped to deal with highly arid conditions of the Pakistani coast since this species maintains very negative water potential under saline conditions.

3.1 Patterns of surveying technique

The questioner were based on the various questions about mangrove forest species. The answers of important queries were collected from almost 50 peoples in the year of 2022. The average survey reports outcomes are listed below:

- 35% agree
- 25% disagree
- 20% no comments
- 20 % strongly agree

3.2 Comparisons of the Species

We observed that field experiment to growing propagules are not very difficult, in this observation we have set the concentration of sea salt and other nutrients for proper study of growing propagules and their variations. Observation of growth parameters were taken only for a period of six months of because older seedling doesn't perform well in polythene bags and show the signs of declining in their growth as shown in figure 3. Salt water also given to the propagules of *Avicennia marina* and recorded the results on the basis of different class size at different concentration and the estimated height on 25% is (Mean and SE, 29.568 ± 1.920) and the other range of salinity was 50% concentration which is (Mean and SE, 21.376 ± 1.44) shows better results than that of 25% concentration of seawater and the other species is *Rhizophora mucronata* and recorded the results on the basis of different class size at different concentration and the estimated height on 25% is (Mean and SE, 18.962 ± 1.057) and the other range of salinity was 50% concentration which is (Mean and SE, 15.304 ± 0.995) shows better results than that of 25% concentration of seawater.



Figure 3. Sprouting stages of *Avicennia marina* propagule

Table 2. The average growth of *Avicennia marina* and *Rhizophora mucronata* in terms of survival, plant height and number of leaves during six months period (mean $\pm$ SE).

<i>Avicennia marina</i>	Plant height (cm)
Class 1 propagules	36.45 $\pm$ 0.61
Class 2 propagules	27.66 $\pm$ 0.23
<i>Rhizophora mucronata</i>	Plant height (cm)
Class 1 propagules	18.962 $\pm$ 1.057
Class 2 propagules	15.304 $\pm$ 0.995

The initial length of the fresh propagules class 1 (Mean and SE, 3.8 $\pm$ 0.001), and class 2 propagules were measure (3.46 $\pm$ 0.04) with the weight of (4.21 $\pm$ 0.03) it is observed that large having greater weight which germinates better and faster than that of small size propagules as shown in Fig 4.

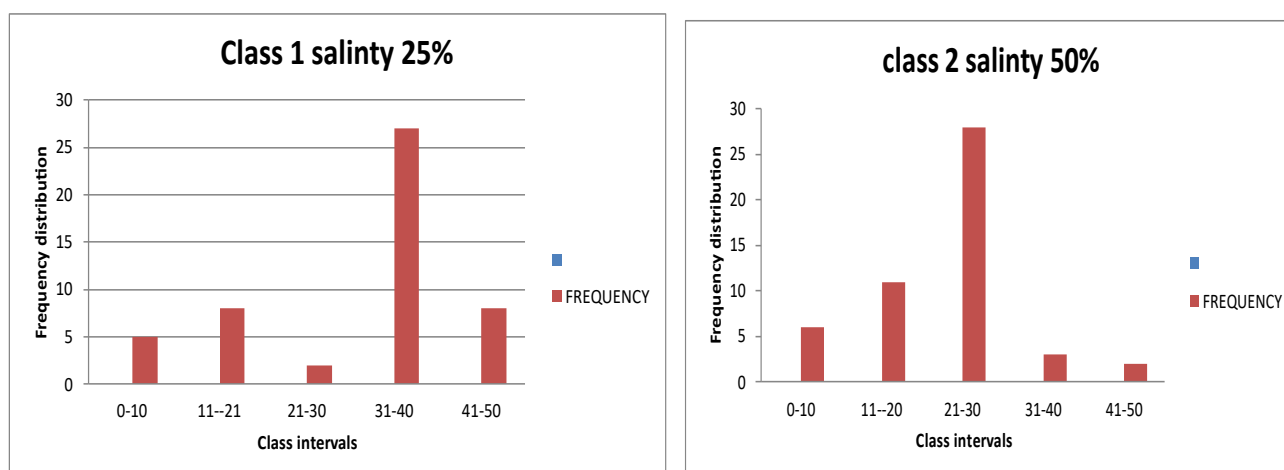


Figure 4 (a,b). Bar graph of *Avicennia marina* is showing height (H) at the level of 25 % and 50% Salinity

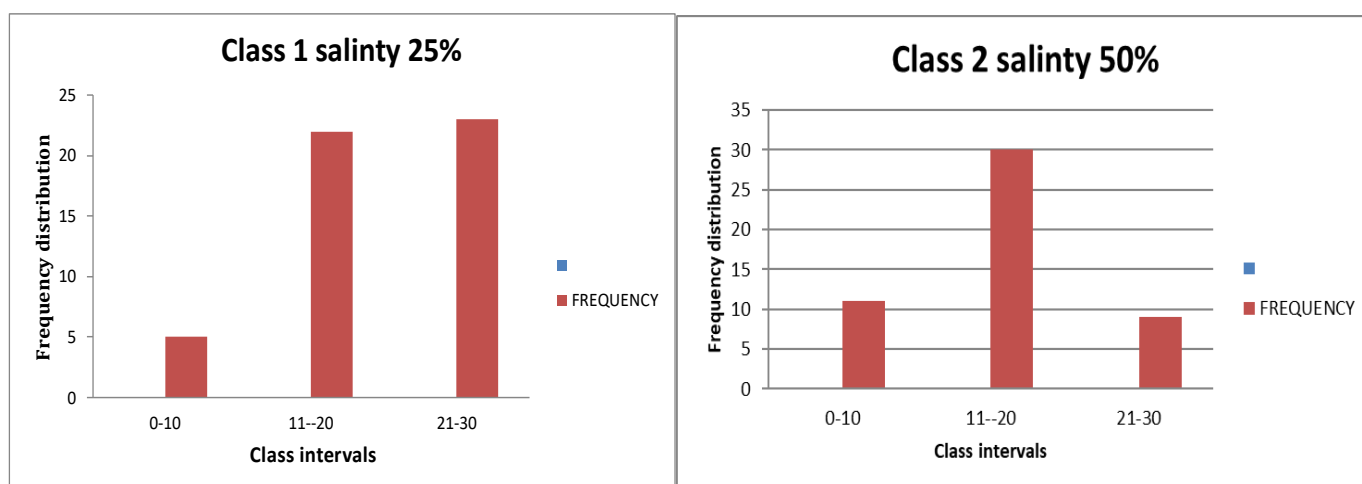


Figure 5 (a,b). Bar graph of *Rhizophora mucronata* is showing height (H) at the level of 25 % and 50% Salinity

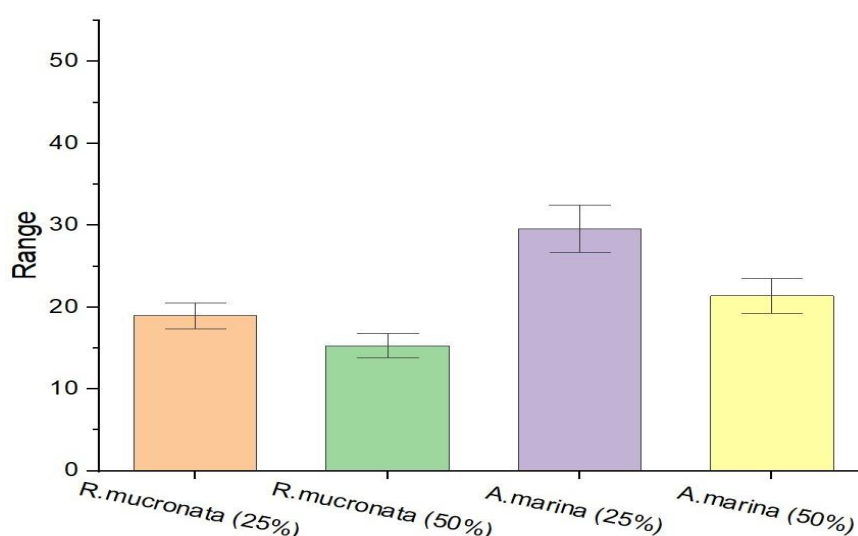


Figure 6. Bar graph is showing the differentiation between the *Avicennia marina* and *Rhizophora mucronata*. All bars are showing the plant height

Studies showed growth stimulation at 25% seawater for *Avicennia marina* and *Rhizophora mucronata* (Burchett et al., 1989). In *Avicennia marina*, and *Rhizophora mucronata*, growth was higher in 10% and significantly reduced in 50% seawater, supporting previous studies that optimum salinity for mangroves is below half-strength seawater (Ball 1988). The decline in mangrove growth with increasing salinity is primarily due to the increased energetic cost of water uptake which contributes to increased water use efficiency (WUE). Salt tolerance in mangroves is achieved by a variety of mechanisms that include salt exclusion, salt secretion, and induction of antioxidative enzymes (Takemura et al. 2000). In *R. mucronata*, the number of leaves and chlorophyll content were higher in 10% than in 50% seawater probably because these two species accumulate excess salt in older leaves that are then shed to eliminate salt from the plant. In *A. marina*, however, there were no differences in number of leaves or chlorophyll content between the 10 and 50% seawater treatments, likely because of more efficient salt regulation. At high salinities, the accumulation of Na^+ and Cl^- reduces cell expansion and growth (Parida and Jha 2010).

The clearly indicates that *Avicennia marina*, and *Rhizophora mucronata* growing along the most arid region of Karachi coast are more tolerant to salinity and have the ability to produce higher biomass when seawater mixes with Indus River discharge. In Pakistan, now only 4 mangrove species can be found in the Indus Delta region. Most stands of mangroves can be defined as monospecific forests of *Avicennia marina*, it is the most salt resistant mangrove species; and thus, its dominance is quite logical. Even under ideal conditions, *Avicennia* tree is slow growing, reaching full maturity in about 60 years with the stem reaching a girth of about 50 cm and a height of about 10 m with a canopy radius of 6 m. High media salinity affects plant growth due to low water potentials, ion toxicities, nutrient deficiencies or a combination of all these factors (Khan et al., 2000a).

Mangroves accumulate high concentrations of inorganic ions like most other salt tolerant plants that function in the osmoregulation of leaves and other tissues. Our results showed that *Avicennia marina* accumulated the highest concentrations of ions followed by *R. mucronata* and *Avicennia marina* has the ability to regulate salt content by secreting it through the glands, while *R. mucronata* have the ability to exclude salts via root ultrafiltration but do not have the ability to secrete salt through leaves. Stomatal conductance declines in salt tolerant species under drought and salinity stress (Gordon, 1993) in order to increase water use efficiency.

This also partially explains why it is the most dominant species in the entire coastal belt of Pakistan. A more recent survey showed that *Avicennia marina* the dominant species followed by few populations of *R. mucronata*, and *A. Corniculatum* (Qureshi, 1993) while other species could not be located. Mangrove populations in Pakistan are threatened because of over-exploitation, pollution, and a decline in fluvial discharge into the Indus delta (Qureshi, 1993). A decrease in fluvial discharge would result in increased salinity of seawater, which reportedly prevents fruiting, and causes senescence of immature flowers and buds (Qureshi, 1993). It is estimated that mangrove cover has decreased by 15% in past 20 years due to reduction in Indus discharge (IUCN, 1988).

Propagules of *Avicennia marina* often show growth stimulation at low salinity 25% seawater and then a decline in growth with further increases in salinity. They possess a variety of adaptations to extreme environmental stresses such

as: (i) salt exclusion by root ultrafiltration, (ii) salt recreation via glands, (iii) Ion accumulation in leaf cells, and (iv) Leaf succulence. Whereas the most common species in the Indus delta, *Avicennia marina*, is fairly well studied and known to respond as osmoregulatory (Aziz & Khan, 2000).

Among the seawater treatments the greatest increase in most of the growth parameters was observed in plants irrigated with 50% seawater. These results do not agree with some other studies in which mangrove species showed their best growth at 25% seawater concentration (Naidoo, 1987). However, (Karim & Karim., 1993) reported that best growth for *Avicennia marina* from Bangladeshi coast was obtained at 50% seawater. The coast of Karachi is regarded as one of the most arid coasts in the world and it may be that mangrove populations growing in this region have adapted to this condition by developing higher salt tolerance in comparison to the mangroves from more mesic regions in Australia and South Africa.

This study of seed size variation *Avicennia marina* in artificial environment also indicates that propagules of that species grow best under the concentration of 50% (21.376 ± 1.44) seawater rather than 25% (29.568 ± 1.9)

Table 3. Seawater concentration of Growth parameter at different percentages

<i>Avicennia marina</i>	M $\pm$ SE
25%	29.568 $\pm$ 1.9
50%	21.376 $\pm$ 1.44
<i>Rhizophora mucronata</i>	M $\pm$ SE
25%	18.962 $\pm$ 1.05
50%	15.304 $\pm$ 0.99

So, the propagules of mangroves grow under low salinity regimes and high salinity in medium causes reduction in their growth that is similar to that of other types of halophytes (Munns, 1980). In this study the growth is promoted as low salinity as 25% and 50% sea salt which were dissolved in fresh water it is observed that the length and number of leaves increased better with the treatment of 50% seawater (Ball & Pidsley., 1995) in other studies it was estimated that 75% and 100% concentration of salt water cause declining in the growth parameters of propagules.

Most of the studies that mangroves thrive that best at concentration ranging from 10% to 25% seawater (Ball & Pidsley., 1995). It proves that *Avicennia marina* are a true halophyte, characterized by enhanced growth under high saline conditions (Flowers *et al.*, 1986) and is more tolerant in semi-arid areas of Pakistan as compared to the mangroves of Australia, South Africa and Central America which live in more mesic conditions.



Figure 7. *Avicennia marina* at Institute of environmental studies, Karachi University

This project experiment suggests that large and medium size propagules germinated in a healthier way as compared to small seed size with having mean and standard error (8.65 ± 0.24) of the total number of leaves 100 propagules.

Avicennia marina can shed salt via leaf glands when supplied with salinity in the growth medium (Fitzgerald *et al.*, 1992). High internal salt concentration provides potential benefits to plants growing under conditions where soil osmotic potential is more negative than that of sea water because of high soil salinity. *Avicennia marina* accumulate large amount of glycine betaine to maintain osmotic balance. Soluble oxalate concentration decreases with an increase in salinity, indicating that it has a small role in osmoregulation. Low concentration of oxalate in leaves may also make them unpalatable, as oxalate are known to pose problem to grazing animals since they are toxic to them. The short-term experiment in which root segments were transferred from 0 to 100% seawater and vice versa for measurement produced, if anything, a slight drop in respiration rate in each case. Both transfers entail substantial osmotic shock, but such shocks are a natural occurrence in intertidal ecosystems. The responses of mangrove roots to sudden changes in external osmotic potential warrant further investigation. From the results reported here, however, it seems that there is no salt respiration in the accepted sense of the term evident in these roots. The findings on osmotic potential are in general agreement with those of *on Avicennia marina* seedlings South Australia. Downton commented on the continued accumulation of ions in the leaves with increasing salinity despite the presence of salt glands.

The drop in internal potential is more than adequate for the osmotic adjustment necessary for survival at that salinity. (Drennan & Pammenter, 1981) reported that leaf salt content as a function of substrate salinity for *Avicennia marina* showed a saturation type curve. This trend was not evidenced by the osmotic potentials measured in the present experiment.

The results from the present experiments on *Avicennia marina* are consistent with that suggestion. There is evidence that there is a continuous acclimation of ions in the leaves with increasing ion concentration in the root bathing medium. It would appear that as the concentration of the bathing medium is raised from 0 to 25% seawater, the growth of the plant responds to an increased ion uptake and subsequent increased turgor pressure with an increase in dry matter production and a corresponding increase in root respiration rate.

However, it is interesting to speculate that the increase in salinity of the bathing medium from 0 to 25% seawater may directly affect the metabolic activity of the roots and so in turn influence the growth pattern of the other parts of the plant.

According to (Critchley, 1982) reports that *Avicennia marina* shows a positive requirement for high chloride levels for photosynthetic electron transport around photosystem. There is some evidence from the present results that root growth in this species is particularly responsive to an increase in salinity in the bathing medium. It may therefore be premature to conclude that the stimulation of halophytes growth by increased levels of salt in the growth medium is primarily due to increases in turgor pressure and extension growth the decline in growth of the plant and the corresponding decline in the root respiration rate at salinities greater than 25% seawater indicates that *Avicennia marina* seedlings are not well adapted to conditions of salinity approaching that of seawater, in terms of optimal growth, although they are capable of tolerating conditions of very high salinity.

4. Conclusion

It is concluded that the mangroves species like *Avicennia marina* disperse and germinates easily in green house or artificial environment with some specific treatment measures of seawater at two different concentrations 25 and 50%, Hoagland solution and fresh water the planting of mangroves is now widely advocated as a means to increase coastline security, but planting efforts will only succeed where conditions are naturally suitable for mangrove establishment and, equally important, acceptable in the context of ongoing economic and political pressures to claim and develop valued coastal property. In fact, early evidence suggests that many post-tsunami restoration initiatives are encountering problems of this kind. The further challenge is that population and related development pressures are certain to grow along many coastlines. Compounding this, most climate change scenarios predict rising sea levels and increasingly frequent storm events which will damage and further squeeze the ecological distribution of mangroves in many areas human ingenuity will certainly be put to test in the coming years, but recent events have revealed that there is a great deal at stake if we fail. For if past economic and environmental arguments for conserving mangroves were not viewed as synonymous with human security, it is perhaps only because we did not put a human face on those whose lives and livelihoods depend on these unique and valuable forests. Tragic as it was, the Asian Tsunami of 2004 gave us this human face and, in so doing, has redefined mangrove conservation as a human security concern. Yet, the general reframing of issues like this will only get us so far. Successful mangrove restoration and management in the face of increasing human and environmental stress will ultimately depend on our understanding of the interactions between people and mangroves in particular contexts and the wider political and economic influences on these interactions. In this respect, the burgeoning literature on environment and security provides little concrete guidance for researchers, managers or policy makers.

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