MORPHOLOGICAL AND PHYSIOLOGICAL ADAPTATIONS OF SELECTED MANGROVES FOR ALLEVIATING POST-TSUNAMI EFFECTS

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Introduction

The Indian Ocean tsunami in 2004 caused damage to most of the eastern, northeastern and southern coasts of Sri Lanka. In the aftermath, it has been seen that terrestrial plants such as agricultural crops etc. have been adversely affected. However, sites with broad stretches of mangroves have experienced a low destructive impact. Thus, in this study, three selected mangrove species that are commonly found in Sri Lanka, *Rhizophora apiculata*, *Bruguiera cylindrica* and *Bruguiera sexangula* were grown under three different salinity concentrations in hydroponics with the objective of studying their morphological and physiological adaptations and assess their buffering ability to survive post-tsunami salinity conditions.

Methodology

Six month old mangrove plants belonging to species, *Rhizophora apiculata*, *Bruguiera cylindrica* and *Bruguiera sexangula* were grown in simulated saline conditions under hydroponics. An artificial sea water solution with a composition of 24.72g NaCl, 0.67g KCl, 1.36g $CaCl_2.2H_2O$, 4.66g $MgCl_2.6H_2O$, 6.29g $MgSO_4.7H_2O$ and 0.18g $NaHCO_3$ per 1 liter of distilled water was used as the nutrient solution (Johnson, 1999). The three salinity treatments contained artificial sea water solutions with 50% (control), 75% and 100% of the original of natural seawater. The experimental design applied was, Completely Randomized Design (CRD). Each species was treated with three salinity treatments separately and each of the treatment was replicated five times. Plant height, leaf number, leaf area, shoot to root ratio and number of roots emerging from the stem were measured to assess morphological adaptability. Physiological adaptability was assessed using leaf sodium percentage, stomatal conductance, transpiration rate, photosynthesis rate and total chlorophyll content.

Results

Morphological and physiological adaptations of all three species to different levels of salinity differed significantly. *R. apiculata* showed significant adaptations in terms of increase in plant height (p=0.0001) and number of roots that emerged from the stem (p=0.0001) while decrease in number of leaves per plant (p=0.014) and shoot:root ratio (p=0.015). *B. sexangula* showed significant adaptations in terms of increase in leaf area (p=0.001), stomatal conductance (p=0.0412) and transpiration rate (p=0.0168). The only significant adaptation shown by *B. cylindrica* was the increase in leaf sodium percentage (p=0.0343). In both photosynthesis rate and total leaf chlorophyll content a significant species effect was not seen (p=0.8287 and p=0.7802 respectively). Except for leaf sodium percentage which showed a significant salinity effect under 75% salinity concentration, all the other morphological and physiological parameters showed a significant salinity effect at 100% of the original of natural seawater.

All species showed yellowing and shedding of mature leaves. However, excessive leaf shedding was seen in *R. apiculata* under both 75% and 100% salinity concentrations. Though leaf yellowing was also common in both *B. cylindrica* and *B. sexangula* under 100% salinity concentration, there was no significant leaf shedding.

When all species and salinity combinations were considered, it was clearly visible that both the stomatal conductance and the transpiration rate resulted in an initial decrease followed by an increase with time Figure. 1(a) and Figure.1 (b).

Discussion

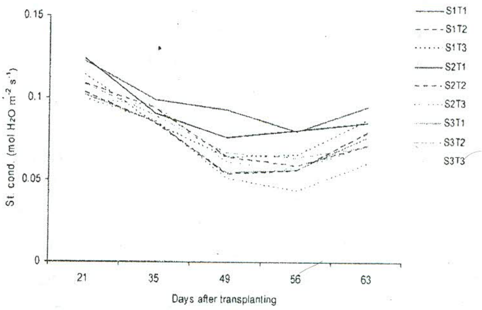
In all species, increased stomatal conductance and the rate of transpiration with time reflects their adaptability to survive in the imposed stressful environment. Thus, the plants have been able to maintain their physiological processes at an optimum level.

Even though *R. apiculata* showed a significant adaptation through excessive leaf shedding especially in the latter part of the experiment, left a suspicion about its long term survivability. This was supported by a post-tsunami assessment which has revealed that, salt accumulation in leaves of *R. apiculata* had caused the leaves to fall, ultimately resulting in death of 80% of *R. apiculata* in low saline microhabitats (Roy and Krishnan, 2005). *R. apiculata* showed better adaptability through increased shoot to root ratio and root number and plants in 50% salinity concentration showed profuse root growth. Jayatissa and Wickramasinghe (2006), have also revealed that *R. apiculata* showed a higher growth performance and adaptability under low saline conditions confirming its less adaptability to high saline conditions.

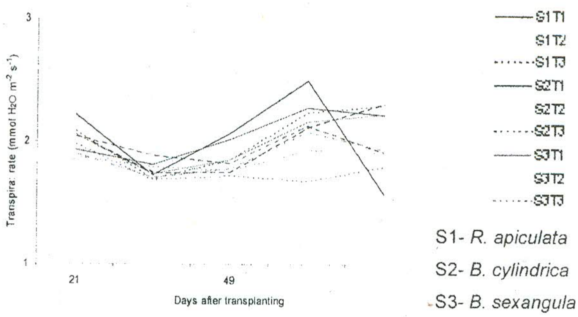
Out of the three species, *B. cylindrica and B. sexangula* showed a better adaptabilty for all of the tested parameters and left no suspicions about their long term survivability. Thus *B. cylindrica and B. sexangula* have developed necessary adaptations to withstand higher salinity conditions

Conclusion

R. apiculata, *B. cylindrica and B. sexangula* are capable of developing necessary adaptations to survive under the post-tsunami salinity levels within a duration of four months. However, *R. apiculata* may not survive after four months. *B. cylindrica* and *B. sexangula* showed similar or higher salt tolerance characters compared to *R. apiculata* via morphological and physiological adaptations. Thus, when selecting the mangrove species to be used as a natural tsunami barrier in mangrove replanting, inter-specific variations basically regarding salinity tolerance in terms of adaptability and survivability of species should be taken into consideration.



(a) Stomatal conductance



(b) Transpiration rate

S1- *R. apiculata*
S2- *B. cylindrica*
S3- *B. sexangula*
T1- 50% salinity
T2- 75% salinity
T3- 100% salinity

Figure 1. The effect of species and salinity levels on the stomatal conductance nd transpiration rateof plants.

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