EFFECT OF SODIUM CHLORIDE ON PHOTOSYNTHETIC PIGMENTS AND PHOTOSYNTHETIC CHARACTERISTICS OF *AVICENNIA OFFICINALIS* SEEDLINGS

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Abstract

The possible effect of salinity (0,-2.00% NaCl) on chlorophyll pigment content and photosynthetic activity of *Avicennia officinalis* L. were investigated. The seedlings of this species treated with NaCl above 2.00% and could not survive a month after salt treatment. The maximum accumulation of chlorophyll synthesis was observed at 0.75% NaCl, beyond this level is reduced gradually. The rate of photosynthetic activity significantly enhanced up to optimum level of 0.75% NaCl and at higher concentrations the photosynthetic activity were reduced.

Keywords: *Avicennia officinalis*; Chlorophyll; Mangroves; Photosynthesis

Introduction

Mangroves are trees and shrubs that grow at the interface between land and sea in tropical subtropical latitudes where the plants exist in conditions of salinity, tidal water flow and muddy soil. The vegetative area unique ecological environments, which host rich assemblages of species. Mangroves form unique communities in tropical region and tidal lowlands. They are considered as ecologically essential components in protecting adjacent land from wave and storm erosion (Savage 1972) while preventing terrigenous nutrients from affecting nearly reefs (Stambler and Dubinsky, 1996). There is increasing evidence that NaCl salinity is one factor leading to oxidative stress in plants cells (Hernandez et al 2000). High NaCl concentration seems to impair electron in chloroplast and mitochondria, and lead to formation of Reactive Oxygen Species (ROS) (Asada, 1999; Foyer and Noctor 2002). The aim of the present study is to examine the responses of *Avicennia officinalis* a typical mangrove species to salinity under controlled experimental condition. A detailed investigation on comparative effect of exogenous addition of various concentration of sodium chloride on photosynthetic pigments and, photosynthetic characteristics of *Avicennia officinalis* was made and salt tolerance of this species was assessed.

Materials and Methods

The plant material used for the present study was the seedlings of *Avicennia officinalis*, a dicotyledonous mangrove tree belonging to the family Avicenniaceae. This species was naturally growing in abundance in the mangrove belt of Pitchavaram, on the east coast of Tamilnadu, India (11° 24'N and 79° 44'E) about 13Km east of Annamalai University, Chidambaram. The present study was carried out in the Botanical garden of Annamalai University. Matured seeds of *A. officinalis* were collected from Pitchavaram mangrove area during monsoon period from a single tree in order to avoid genetic variability and germination.

Table salt (Tata brand salt purchased in local market) useing to prepare the NaCl concentration, 0.25mg salt dissolved in 100ml water (0.25%) followed by all the concentration. Thirty days old and fully established seedlings were treated with varying concentrations of sodium chloride. The treatment constituted 0% (control) 0. 25, 0.50, 0.75, 1.0, 1.25, 1.75 and 2.00% NaCl. A control of 25 plants was maintained without salt treatment. Twenty five plants were treated with each of the above NaCl concentrations. The treatment was continued until the completion of the experiment. First samples for various studies were collected on the 30th day after sodium chloride treatment and the second samples were collected on 60th day after NaCl treatment. The photosynthetic pigment and photo synthetic characteristics of *A. officinalis* L. Seedlings were analyzed on 30th day and 60th day after sodium chloride treatments. The chlorophyll contents were analyzed by standard method of (Arnon, 1949). Net leaf photosynthesis Li-Cor 6200 Portable Infrared Red Gas Analyser (PRGA) (Li- Cor Ins  USA).
Results
The increase sodium chloride treatments promoted chlorophyll synthesis in the leaf of A. officinalis and net leaf photosynthesis at 0.75%. NaCl concentrations, further increased in NaCl concentration in the (1.00 - 2.00%) decreased the photosynthetic pigments and net leaf photosynthesis. Salinity promoted chlorophyll synthesis in the leaves of A. officinalis to 0.75%. At higher sodium chloride concentrations there was a decrease in chlorophyll content. The maximum chlorophyll synthesis was noticed in the 60th day samples and it was 90.90% higher than that of control plants (Fig:1 and 2). Sodium chloride salinity promoted chlorophyll synthesis in the leaves of A. officinalis upto 0.75% at higher concentration there was a decrease in chlorophyll content. It may be concluded that in stressed leaves, chlorophyll concentration, can be used as an index of tissue tolerance to NaCl during the senescence process. Comparing the loss of chlorophyll and protein, it may be inferred that the latter is more stable than the former during the senescence process, when induced by NaCl-stress.

Fig: 1. Effect of NaCl on Chlorophyll 'a', Chlorophyll 'b' and Total Chlorophyll Content in the Leaf of A. officinalis on 30th day (mg/g fr. wt.)

Fig: 2. Effect of NaCl on Chlorophyll 'a', Chlorophyll 'b' and Total Chlorophyll Content in the Leaf of A. officinalis on 60th day (mg/g fr. wt.)

The effect of different concentrations of sodium chloride on the net photosynthesis of A. officinalis showed that the salt stimulated CO2 uptake with maximum rate at 0.75%. At higher concentrations, the salt decreased the rate of photosynthesis. The rate of CO2 uptake was high in the 60th day samples than 30th day samples after salt treatment at all concentrations (Fig:3 and 4). The various concentration of sodium chloride on the net leaf photosynthesis was monitored by PRGA in the leaves of A. officinalis. Sodium chloride salinity promoted the rate of CO2 uptake 0.75% and concentration beyond 0.75% NaCl decreased the CO2 uptake. Along with the increases CO2 uptake with increasing concentration of NaCl, Stomatal conductance, transpiration and inter cellular CO2 concentration also noticed a gradual increased upto 0.75% NaCl both sampling days. The effect of different concentration of sodium chloride on the net leaf photosynthesis of A. officinalis showed that the salt stimulated CO2 uptake with maximum rate at 0.75%. At higher concentration, the salt decreases the rate of photosynthesis.

Discussion
The effect of salt stress on photosynthetic pigment composition in plants depends on light intensity. In crop plants, pigment composition of barley did not change
Photosynthesis mainly through reduction of stomatal conductance of the mesophyll cell capacity to fix CO₂, an interpretation lead to increased susceptibility of photosystem II to photoinhibition and changes in photosynthetic pigment composition in halophyte Suaeda salsa grown outdoors. Plant Science, 163: 1063-1068.


In conclusion, salinity stress can decrease the photosynthetic activity of the halophytic plant by inducing partial stomatal closure, decreasing carboxylation efficiency and CO₂ saturated photosynthesis and inhibiting the light reaction mechanism (Mudrik, et al 2003). The decrease in photosynthesis (Pmax) is attributable to restriction of CO₂ access through the stomata, an interpretation strongly supported by the linear proportionality of photosynthesis and transpiration and leaf conductance (Ungar, 1991).

References


