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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 officnalis,* a dicotyledonous mangrove tree belong 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 Infra Red Gas Analyser (PRGA) (Li- Cor Ins USA).

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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:1and 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.)

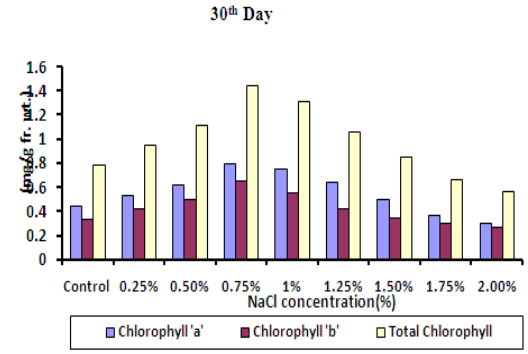


Fig: 2. Effect of NaCl on Chlorophyll 'a', Chlorophyll 'b' and Total Chlorophyll Content in the Leaf of *A. officinalis* on 60th day (mg/g fr. wt.)

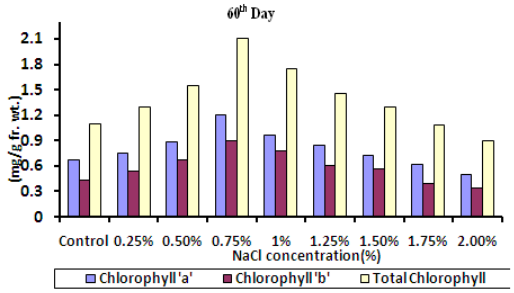


Fig: 3. Effect of NaCl on the Net Leaf Photosynthesis of *A. officinalis* (μ moles/CO_2 m^{-2} s^{-1}) on 30th day

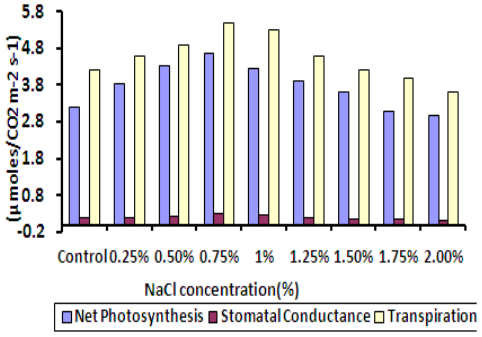
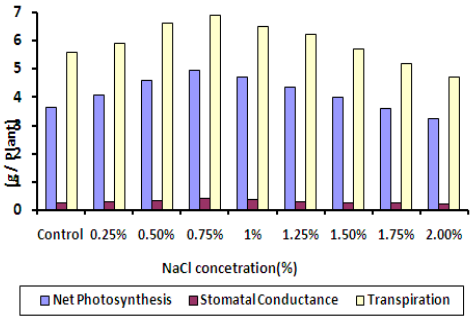


Fig: 4 Effect of NaCl on the Net Leaf Photosynthesis of *A. officinalis* (μ moles/CO_2 m^{-2} s^{-1}) on 60th day



The effect of different concentrations of sodium chloride on the net photosynthesis of *A. officinalis* showed that the salt stimulated CO_2 uptake with maximum rate at 0.75%. At higher concentrations, the salt decreased the rate of photosynthesis. The rate of CO_2 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 choloride on the net leaf photosynthesis was monitored by PRGA in the leaves of *A. officinalis.* Sodium choloride salinity promoted the rate of CO_2 uptake 0.75% and concentration beyond 0.75% NaCl decreased the CO_2 uptake. Along with the increases CO_2 uptake with increasing concentration of NaCl, Stomatal conductance, transpiration and inter cellular CO_2 concentration also noticed a gradual increased upto 0.75% NaCl both sampling days. The effect of different concentration of sodium choloride on the net leaf photosynthesis of *A. officinalis* showed that the salt stimulated CO_2 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

significantly in response to salt stress when grown under low light (Morales et al 1992). On the other hand, some studies have demonstrated that salinity in the presence of high light induced significantly changes in pigment composition in sorghum Mosojidek *et al* 1991. Photosynthetic pigment composition in *Suaeda salsa* was not affected by high salinity Basham Wang et al.,2003. Along with increase in chlorophyll content increased with increasing NaCl salinity upto the optimum level of 0.75%. The decrease in chlorophyll content at higher salinity levels might be possibly due to changes in the lipid protein ratio of pigment-protein complexes or increased chlorophyllase activity (Iyengar and Reddy 1996). Our result are agree with several reports of decrease content of chlorophyll by salinity as reported in a number of glycophytes Agaistian *et al*., (2000) and in certain halophytes such as *Suaeda salsa* Congming *et al*., (2002) and *Aegiceras corniculatum* (Parida et al 2004). A similar positive effect of sodium chloride salinity on the chlorophyll synthesis have been reported in *Halopeplis ferfoliata* (A1-Zahrani and Hajar, 1998) and *Excoecaria agallocha* (A1-Zahrani and Hajar, 1998). On the other hand, a decrease in the chlorophyll content under NaCl salinity has been reported in a number of mangroves such as *Ceriops roxburghiana* (Natarajan and Chellappan. 2004) and *Aegiceras corniculatum* (Parida et al 2004).

Water availability is the main environmental factor limiting photosynthesis and growth even in plants well adapted to arid conditions. Salinity stress may alter photosynthesis mainly through reduction of stomatal conductance of the mesophyll cell capacity to fix CO_2 (Rajesh et al 1998). Along with increase in net photosynthesis, the stomatal conductance, transpiration and intercellular CO_2 concentration were also increased with increasing sodium chloride concentration upto the optimum level. The most striking feature of mangroves is their ability to tolerate sodium chloride to sea water level (500 mM). From the physiological aspects of salinity on the photosynthesis of mangroves have been studied to some extent, mostly in relation to transpiration and stomatal conductance. Salinity stress markedly inhibited photosynthetic rate, carboxylation efficiency and stomatal conductance. Many studies have been reported that both stomatal and non-stomatal components responsible for a decrease in photosynthetic rate (Delfine 1998). At 50% reduction in photosynthetic rate of *Olea europaea* plants occurred when they were irrigated with 200 mM (Lowlor,2002). The depression of carbon assimilation that was observed in *Aegiceras corniculatum* was attributable to a reduction in stomatal opening. The likely sequence of events was thought to be increased salinity, water stress, stomatal closure, decreased in intercellular CO_2 and decrease in photosynthesis. The photosynthetic performance of sodium chloride treated *A. officinalis* was similar to that of certain previous by observed halophytes, *Kandelia candel* (Tattini 1997), *Phillyrea latifolia* (Yuan-Husun Hwang and Shun Chun Chen. 2001) and *Plantago major* (Tattini, et al 2001).

In conclusion, salinity stress can decrease the photosynthetic activity of the halophytic plant by inducing partial stomatal closure, decreasing carboxylation efficiency and CO_2 saturated photosynthesis and inhibiting the light reaction mechanism (Mudrik, et al 2003). The decrease in photosynthesis (Pmax) is attributable to restriction of CO_2 access through the stomata, an interpretation strongly supported by the linear proportionality of photosynthesis and transpiration and leaf conductance (Ungar, 1991).

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