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# Effect of salinity on chlorophyll and carbohydrate contents of *Sesbania grandiflora* seedlings

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## Abstract

The effect of NaCl salinity concentrations (viz. 10, 20, 30, 40 and 50 mM NaCl) on the contents of chlorophyll a and b and carbohydrate (soluble and insoluble) of *Sesbania grandiflora* (L) Pers. seedlings were investigated. The investigation showed significant positive influence of higher salinity concentrations on the parameters. The elevated levels of the total soluble and insoluble carbohydrates in the shoot and root are considered to be playing an important role in the osmotic adjustment.

**Key words:** Salinity, chlorophyll, carbohydrate, *Sesbania grandiflora*.

## Introduction

It has been generally recorded that salinity adversely affects seedling growth and some relevant metabolic processes of glycophytic plants (Shaddad & Zidan, 1989; Hampson & Simpson, 1990; Zidan & Al-Zahran 1994). However, the direction and magnitude of these changes varied according to the level and duration of salinization treatment as well as the plant species used. Seeman & Critchley (1985) and Sharkey *et al.* (1985) reported that salinity could seriously change the photosynthetic carbon metabolize, leaf chlorophyll content as well as photosynthetic efficiency. Carbohydrates are accumulated in plant tissues under saline stress and these substances are suspected of contributing to osmotic adjustment (Munns & Termaat, 1986; Delaumey & Verma, 1993).

*Sesbania grandiflora* (L) Pers. a plant species, a native of Malaysia is grown in many parts of India, especially Punjab, Delhi, Bengal, Assam and the Andaman's. The effect of salinity on growth and some physiological activities were studied. The present investigation aims at analyzing the effect of NaCl concentrations on the photosynthetic pigments in 50 day old plants.

## Materials and Methods

Seeds of *Sesbania grandiflora* were collected from the State Agricultural Forage Department, Coimbatore. The soils for the experimental plants were prepared by mixing red soils, farmyard manure and sand in 3:1:1 ratio. Equal quantity (W/W) of the soil mixture was taken in earthen pots of uniform size, which comprised 7kg/pot. Healthy seeds were sown after soaking in tap water for 12 hours. Five seedlings were retained. The pots with the seedlings were placed under normal sunlight. The plants were irrigated with 10 mM, 20 mM, 30 mM, 40 mM and 50 mM NaCl of AR grade along with Knop's nutrient solution. The first salt treatment (25$^{th}$ day) and the subsequent treatments were given in three stages (after 7 days of each treatment) to avoid any osmotic shock. Control plants were treated with Knop s nutrient solution.

Plants harvested on 50$^{th}$ day after salinization. Five samples were taken for each measurement. The photosynthetic pigments (chlorophyll a and b) were determined according to Arnon (1949). Chlorophyll extract was prepared from fresh leaves (100 mg) by grinding in a tissue homogenizer together with 10 ml of ice cold 80% acetone. The homogenate was centrifuged at 3000 rpm for 2 minutes. The supernatant was saved and pellet was re-extracted twice with 5 ml of 80% acetone. All the supernatants were pooled and saved. The absorbance of the extract was read at 663 nm, 645 nm and 480 nm using spectronic 1001 plus and the concentration of chlorophyll a, b and total chlorophyll was calculated using Arnon's equations. Soluble and insoluble carbohydrates were determined by the method of Fales (1951). Fresh weight (100 mg) of the leaf tissue from each sample was used using the youngest fully expanded leaf.

## Results and Discussion

The results showed that there was clear effect of salinity concentration on the leaf pigment contents of *S. grandiflora* seedlings (Table 1). It was observed that the high levels of salinization (40 and 50mM NaCl) induced a significant decrease in the contents of pigment fractions (chlorophyll a and b) and consequently of the total chlorophyll content as compared with control plants. The total chlorophyll content of the leaves of *S. grandiflora* seedlings exhibited a little increase when grown at 10 and 20 mM NaCl while the pigment contents increased at the first three treatments (10, 20 and 30 mM NaCl) and decreased at 40 and 50 mM treatments. Generally, chlorophyll contents were reduced markedly at high saline concentration treatments. This may be due to the

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reason that total chlorophyll and proportion of its components depend on the biological process and development stages of the plant and also on the type and concentration of the salt. Ahmed *et al.* (1978) in *Helianthus annus* & *Linum usitatissimum* and Hajar *et al.* (1993) in *Arachis hypogea* obtained similar findings.

*Table 1. Pigment contents at different concentration of NaCl in Sesbania grandiflora Pers. (mg/g fresh wt.)*

| NaCl | Chlorophyll a | Chlorophyll b | Total Chlorophyll |
|---|---|---|---|
| Control | 6.00 ± 0.88 | 3.4 ± 0.057 | 9.4 ± 0.52 |
| 10mM | 6.10 ± 0.057 | 3.6 ± 0.033 | 9.7 ± 0.185 |
| 20mM | 6.10 ± 0.218 | 3.7 ± 0.57 | 9.7 ± 0.088 |
| 30mM | 4.80 ± 0.152* | 3.1 ± 0.218* | 7.9 ± 0.218* |
| 40mM | 4.60 ± 0.088* | 3.0 ± 0.185* | 7.6 ± 0.185* |
| 50mM | 4.6 ± 0.120** | 2.9 ± 0.152** | 7.5 ± 0.186** |

The data are mean values± SE for five plants

*Significant at 1% level, **Significant at 5% level

It is clear from Table 1 that chlorophyll a content predominated over chlorophyll b. The ratio of chlorophyll a/b showed a reduction with increasing saline concentrations, especially 40 mM and 50 mM NaCl. The decreased levels in chlorophyll content under saline stress is commonly reported phenomenon and established that it may be due to different reasons; one of them is related to membrane deterioration (Ashraf & Bhatti, 2000).

The contents of soluble and insoluble and total carbohydrates in the leaves and roots of the treated seedlings of *S. grandiflora* plants are given in Table 2. It can be seen that the contents of carbohydrates (soluble and insoluble) in the leaves and root tends to increase with increasing salinity level (Table 2). Many plants, which are stressed, by NaCl salinity, accumulated starch and soluble carbohydrates (Green way & Munns, 1980; Rathert, 1984). This accumulation has been attributed to impaired carbohydrate utilization (Munns & Jermaat, 1986). It is apparent from the results that the soluble carbohydrate content in the leaves was higher in salt stress plants compared with control. In contrast, the total carbohydrate in the leaves was much higher than in the root of the treated seedlings (Table 2). This is strong evidence that photosynthesis is the main source of accumulating organic solutes under water stress. Meyer & Boyer (1981) showed that cutting the photosynthetic cotyledons from Soybean seedlings prevented solute accumulation and osmotic adjustment as also concluded by Kutachera & Kohler (1994). The accumulation of organic solutes (soluble and insoluble carbohydrates) might play an important role in increasing the internal osmotic pressure (Zidan & Al- Zahrani, 1994). This has been widely regarded as response to salinity stress condition. While that the photosynthesis is the main source of carbohydrates accumulation, Munns (1993) has been reported that the concentration of sugars and reserve polysaccharides always rise after plants are exposed to salinity in both growing and fully expanded tissues. This is consistent with a blockage in utilization of sugars in the growing tissues and a subsequent build-up in the rest of the plant. A reduction in photosynthesis could be due to feed back inhibition by the high sugar concentrations in the mesophyll cells.

It is appearing in the beginning of growth that *S. grandiflora* seedlings are not deficient in carbohydrates and that the supply of carbon compounds is not limiting their growth. So, after prolonged periods of exposure to salinity the levels of reserve carbohydrates increased, particularly in the leaves.

*Table 2. Effect of NaCl on the root and leaves of total, soluble and insoluble carbohydrate (mg/g/fwt) of Sesbania grandiflora seedlings*

| Parameters | Organs | Control | NaCl concentrations | | | | |
|---|---|---|---|---|---|---|---|
| | | | 10mM | 20mM | 30mM | 40mM | 50mM |
| Total carbohydrate | Root | 84.4 ± 0.03 | 101.3 ± 0.03 | 120.8 ± 0.05 | 135.0 ±* 0.02 | 151.2 ±0.06* | 164.7 ±0.03** |
| | Leaves | 85.0 ± 0.05 | 109.1 ± 0.04 | 123.8 ± 0.02 | 137.2 ± 0.01* | 151.6 ±0.04* | 165.5 ±0.02** |
| Soluble carbohydrate | Root | 21.0 ± 0.08 | 26.6 ± 0.03 | 35.2 ± 0.02 | 43.8 ± 0.04* | 51.6 ±0.01** | 57.9 ±0.02** |
| | Leaves | 21.2 ± 0.03 | 32.7 ± 0.06 | 37.0 ± 0.05 | 44.5 ± 0.02* | 51.9 ±0.04** | 58.0 ±0.01** |
| Insoluble carbohydrate | Root | 63.4 ± 0.02 | 74.7 ± 0.04 | 85.6 ± 0.02 | 91.2 ±0.01* | 99.6 ±0.04** | 106.8 ±0.05** |
| | Leaves | 63.8 ± 0.05 | 76.4 ± 0.03 | 86.8 ± 0.01 | 92.7 ±0.07* | 99.7 ±0.02* | 107.5 ±0.06** |

*The data are the mean values ± SE for five plants; * Significant at 1% level, ** Significant at 5% level*

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