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REGULAR ARTICLE

Effect of sodium chloride stress on the pigment and biochemical variation of pigeon pea (*Cajanus cajan (*L.) Millsp.)

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Abstract

In the present study, a pot culture experiment was conducted to estimate the effect on NaCl stressed Pigeon pea (*Cajanus cajan* (L.) Millsp.) the plant belongs to family Fabaceae, is a sub-tropical crop, grown worldwide particularly in south Asia for edible and fodder purposes, while little is known about its salinity tolerance. The seed were sown in plastic pots from 30 days after sowing (DAS), the plants were treated with 25mM, 50mM, 75mM and 100mM sodium chloride on 20th, 30th and 40th DAS. The plants samples were collected from 30th, 40th and 50th DAS. The leaf was collected for estimating pigment and biochemical content. The sodium chloride treatment decreased the chlorophyll-a, b, total chlorophyll and protein content. Similarly, the amino acid and proline content were increased with increasing concentration of NaCl to a larger extent when compared to control in all the treatment day.

Key words: Salt stress, Pigments, Protein, Amino acid, Proline and Pigeon pea

Introduction

Environmental stresses limit agricultural productivity worldwide. These stresses not only have an impact on current crop species. Due to the environmental stresses, the introduction of crop plants into agricultural areas where agriculture is currently not practiced seems really difficult problem to address and it gives a verity of problems to plants (Duncan, 2000).

Among the several environmental stresses, salinity is causing huge change in the plant growth and physiology and agricultural productivity. Salinity also threatens around the world. Saline soils mostly occur in the arid and semi-arid also in coastal areas (Szabolcs, 1977) in the world, the extend of saline soil ranges widely and it has been estimated that are third of which currently under irrigation are affected by salinity (Flowers et al., 1977). In India, it is estimated that 12 million hectares of lands have been affected by saline and alkaline conditions (Yadav and Gupta, 1984). Salinity can affect the morphological parameters of plants and in turn the biomass. The capacity of a plant to collect light water and nutrients is also affected by soil salinity (Locy et al., 1996).

Saline condition is mostly due to the accumulation of salt like calcium, sodium, boron and their anions like chloride and sulphate etc., soil salinity affected germination, growth of the seedling's and yield saline condition affected the plants growth in variety of way i.e., including water uptake causing toxic accumulation of sodium and chloride and reducing nutrient availability. When salinity increase the water potential around plant root decline and cells cases to divide (Bernstein, 1975).

Salinity and drought stress reduce growth and agricultural productivity more than any other environmental factors. Both salinity and

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drought can reduce the water potential of the medium outside which in turn result in growth reduction of plants. However, the physiological mechanisms that medicates the response in each case may be different (Erdei et al., 1990). It is clear from many studies, that similarities in process induced by stress that lead to the accumulation of secondary metabolites in plant cells (Mc Kersie and Lashem, 1994). The organic compounds like carbohydrates, amino acids and organic acids contribute to the alteration of growth in plants under stress depending on environmental conditions (Morgan, 1992).

Most of the legume plants have long been considered to be sensitive to salinity (Mass et al., 1986). There is variability in salt tolerance even among legumes and most of them responds to saline conditions by salt exclusion that is exclusion of sodium chloride from the leaves (Lauchli, 1984).

The pigeon pea (*Cajanus cajan*) is one among the perennial legumes of the family Fabaceae. Pigeon pea is mainly grown in tropical and semitropical regions of the world (Ahmed and Ahmad, 2016). It is an important crop of rainfed agriculture in India. Pigeon pea is capable being in symbiosis with rhizobia and there by enriches soil through nitrogen fixation (Waheed et al., 2006).

The present study is planned with the objectives to evaluate effect of sodium chloride stress on the pigment and biochemical variation of pigeon pea (*Cajanus cajan* (L.) Millsp.)

Materials and methods

Collection of seeds

Seeds of Pigeon pea (*Cajanus cajan* (L.) Millsp.) were collected from local formers and local variety of CO-1. The experiment was conducted at the Botanical Garden and Plant Physiology Laboratory, PG and Research Department of Botany, Government Arts College for Men, Krishnagiri, Tamilnadu, India.

The Pigeon pea seeds were surface sterilized with 0.2 % HgCl2 solution. For 5 minutes with frequent shaking and thoroughly washed with tap water and seeds were sown in plastic pots (300 mm diameter) filled with 3kg of soil mixture containing red soil, sand and farm yard manure (FYM) at 1:1:1 ratio ten seeds were sown per pot the seedlings thinned to five per pot on the 10 day after sowing and all the pot were watered to the field capacity with tap water up to 19 days after sowing (DAS). On 20th DAS the pot was arranged in five row, first one row is control (irrigation of tap water) and remaining rows were given 25 mM, 50mM, 75mM and 100mM NaCl on 20, 30 and 40 DAS. Pot culture experiment carried out in a completely randomized block design (CRBD) with seven replicates for each treatment and harvested and randomly on the 30,40 and 50 DAS for estimating the pigment composition and biochemical parameters were analyzed.

Chlorophyll content was extracted and estimated the following method of Arnon,1949. The protein content was extracted and estimated the following method of Bradford (1976). The amino acid content was extracted the following the method of Moore and Stein (1948). Proline content was extracted and estimated the following method of Bates et al. (1973).

Results and discussion

Chlorophyll contents

The pigeon pea plants sodium chloride treatment decreased the chlorophyll a, b and total chlorophyll contents to larger extent when compared to control on all the concentration of 25mM, 50mM, 75mM and 100mM NaCl on 30th, 40th and 50th days analysis (Fig. 1, 2 and 3). The chlorophyll content was increased in low salinity as higher salinity had adverse effect on all chlorophyll measurements which indicate its breakdown due to high Na accumulation on cytosol (Li et al., 2010; Yang et al., 2011). Compatible solutes including carbohydrates, amino acids, proteins and ammonium compounds play important role in plant water relation and cell stabilization (Ashraf and Harris, 2013: Ahmed and Ahmad, 2016; Bhuiyan et al., 2017).

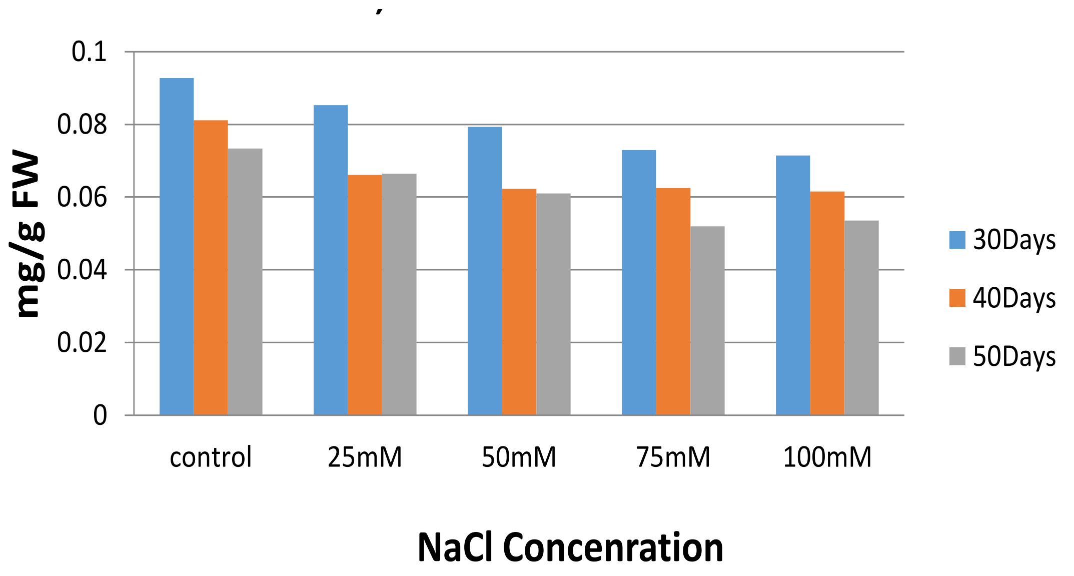

Fig. 1. Effect of NaCl stress on chlorophyll-a content of pigeon pea (values are expressed in mg /g fresh weight).

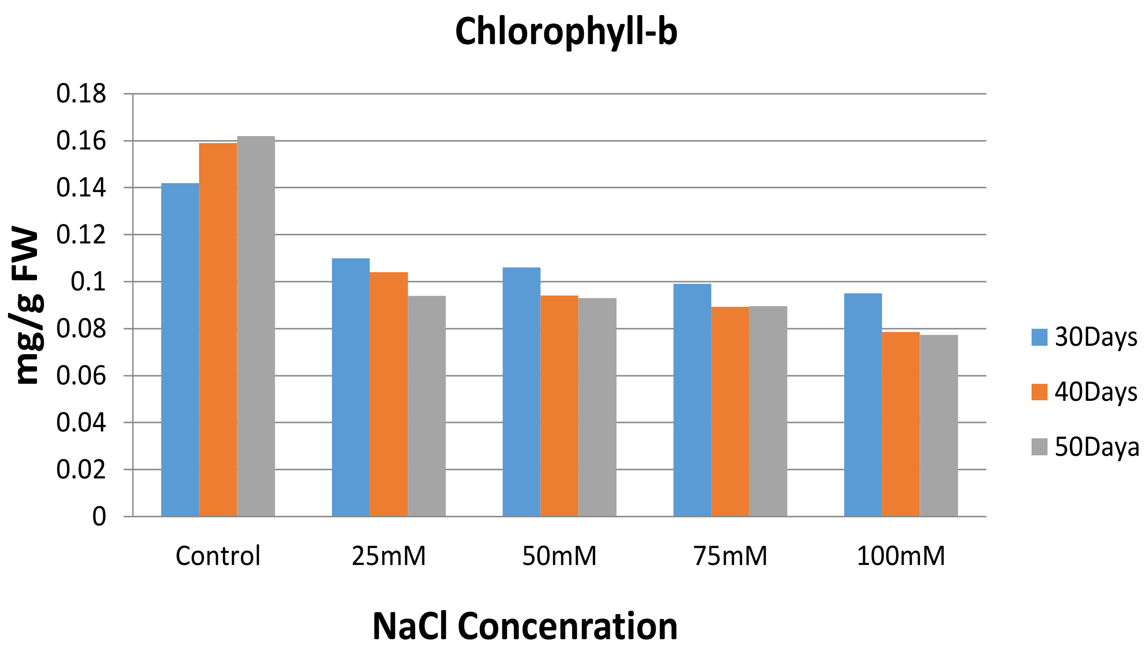

Fig. 2. Effect of NaCl stress on chlorophyll-b content of pigeon pea (values are expressed in mg /g fresh weight)

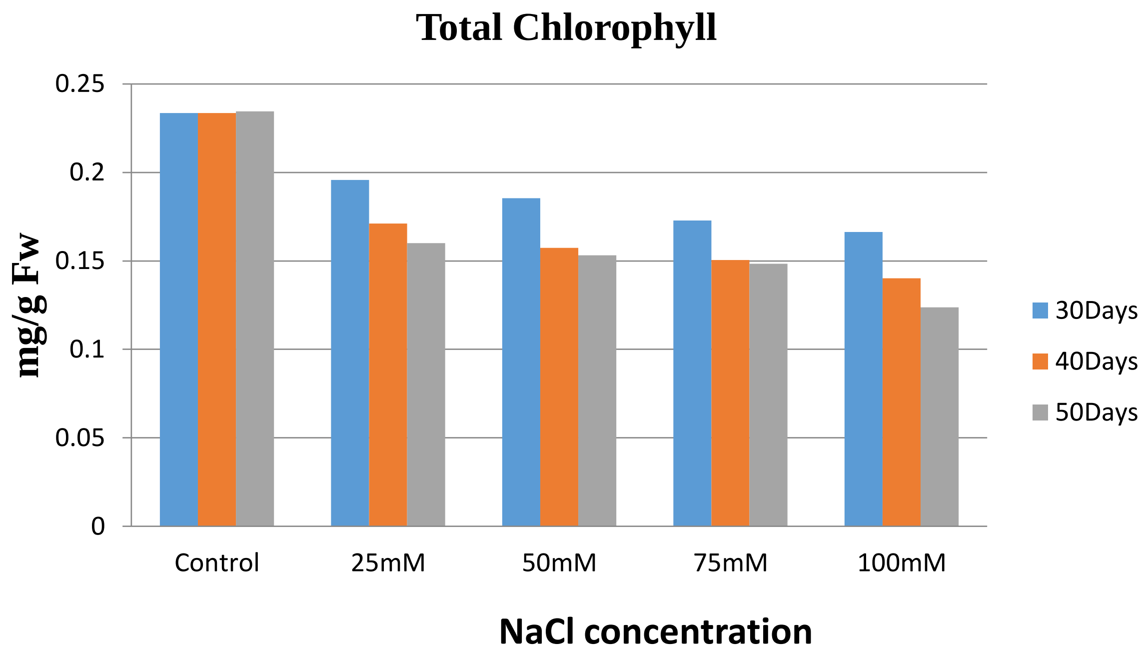

Fig. 3. Effect of NaCl stress on total chlorophyll content of pigeon pea (values are expressed in mg /g fresh weight)

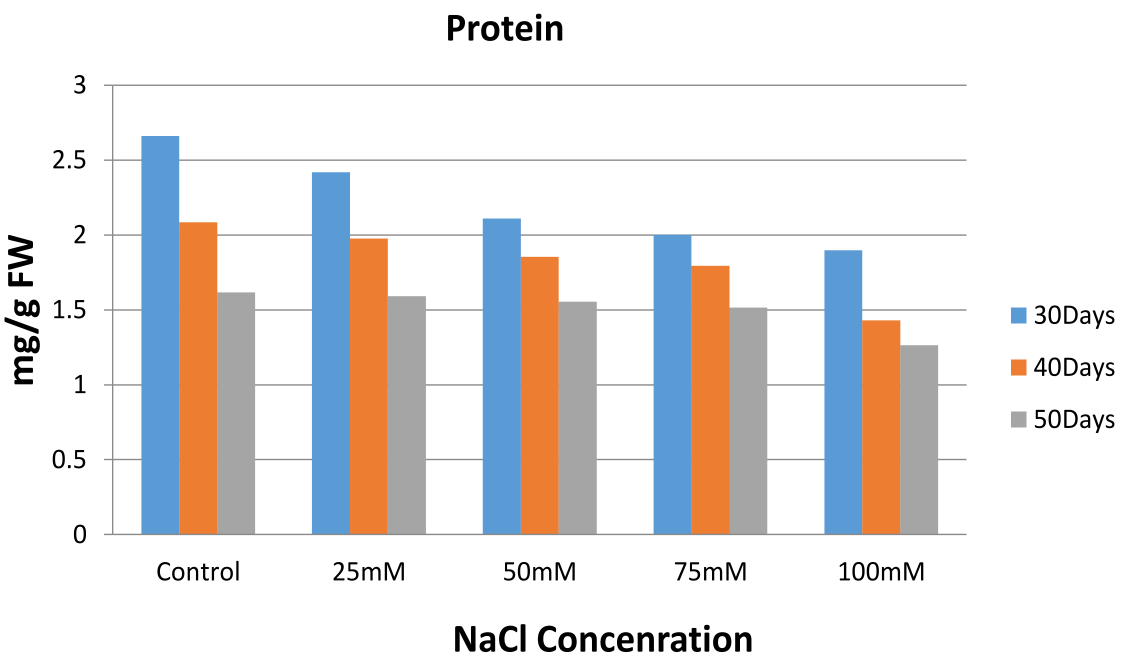

Fig. 4. Effect of NaCl stress on protein content of pigeon pea (values are expressed in mg /g fresh weight)

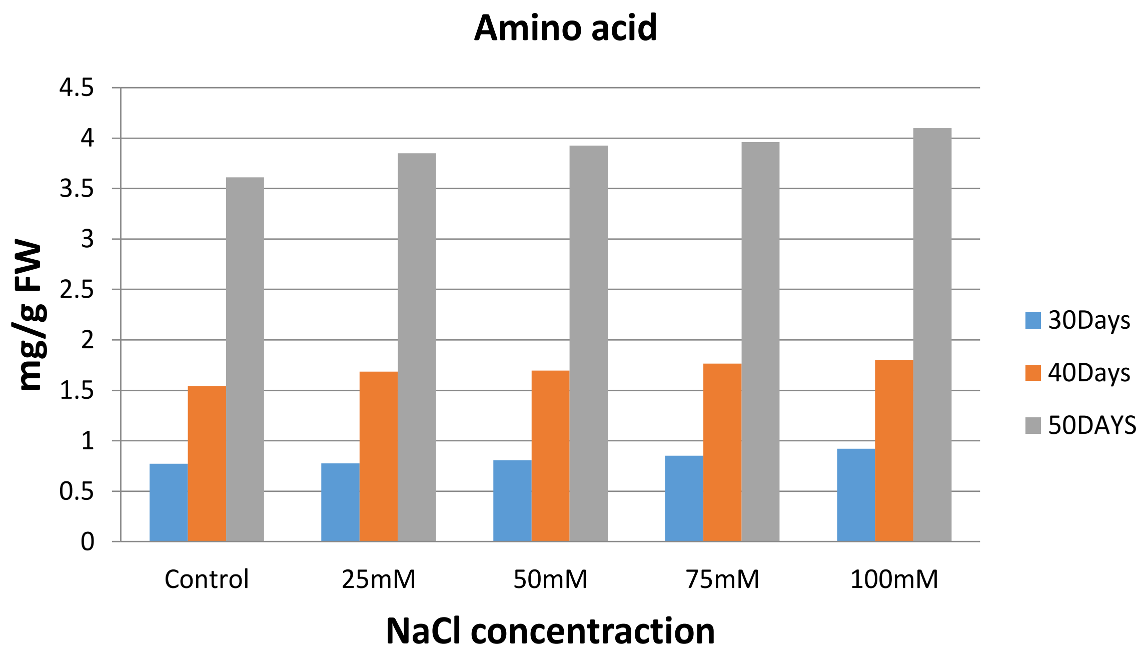

Fig. 5. Effect of NaCl stress on Amino acid content of pigeon pea
(values are expressed in mg /g fresh weight)

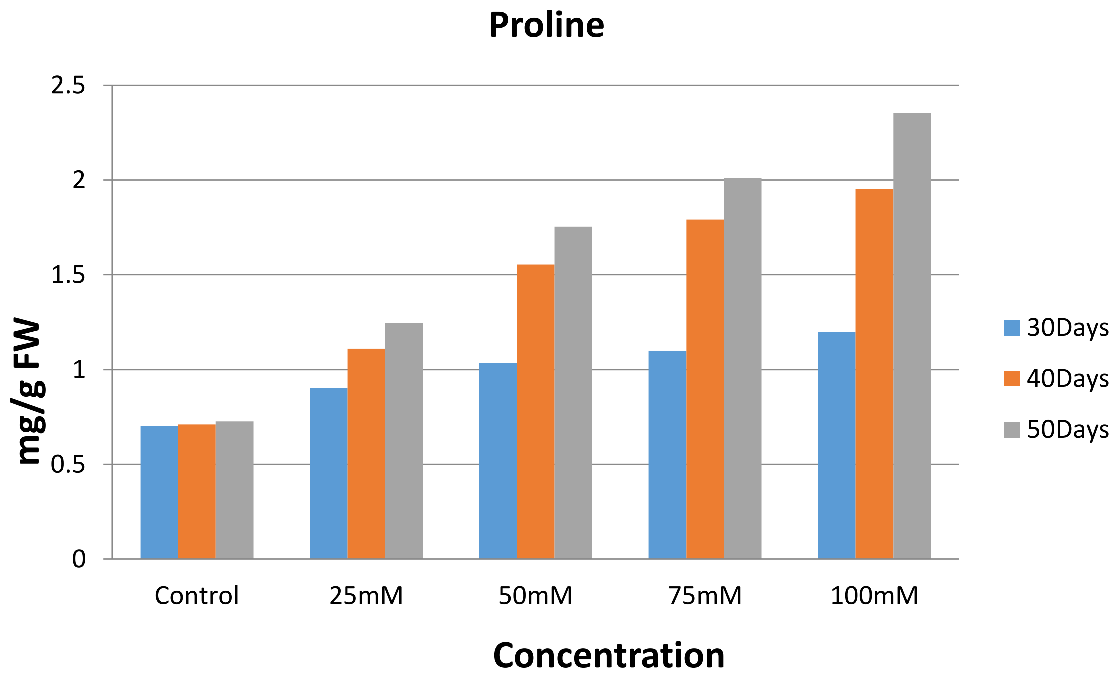

Fig. 6. Effect of NaCl stress on proline content of pigeon pea
(values are expressed in mg /g fresh weight)

Protein

Protein content of pigeon pea was inhibited by the NaCl stressed plants to a larger extent when compared to control in 30th, 40th and 50th DAS. On 25mM, 50mM, 75mM and 100mM NaCl concentration (Fig. 4). The reduction of protein synthesis in salt stressed barley and maize could be attributed to reduction incorporation of amino acid to protein and accelerated break down of protein in to amino acid fragments (Brandle et al., 1977; Gill and Sharma, 1993; Muthukumarasamy and Panneerselvem, 1997; Ahmed and Ahmad, 2016) also reported decreased protein content in *Cajanus cajan* seedlings with increasing salinity.

Amino acid

Sodium chloride treatments increased amino acid content to a larger extent when compared to control on 30th, 40th and 50th DAS. On 25mM, 50mM, 75mM and 100mM NaCl concentration (Fig, 5). Amino acid content increased with increasing salinity in bean and black gram (Kumar et al., 1996; Husen et al., 2017). Negrão et al. (2017) attributed this accumulation of amino acids to the hydrolysis of protein and this accumulated amino acid, may be occurring in response to the change in osmotic adjustment of their cellular contents (Greenway and Munns, 1980).

Proline

The proline content increased in NaCl stressed pigeon pea when compared to control in 30th, 40th and 50th DAS. On 25mM, 50mM, 75mM and 100mM NaCl concentration (Fig. 6). A similar increase has been reported in wheat cultivars by Khatkar and Kuhad (2000). The elevated levels of proline with salt stress will support the plant to tolerate the stress with osmotic adjustment (Cachorro et al., 1995, Hasegawa et al., 2000). Proline metabolism is widely studied under salt stress (Munns, 2002). Results of specific studies clearly indicated that salinity altered the chlorophyll and carotenoid contents in salt treated plants (Taffour et al., 2010: Azeen and Amad, 2011: Per et al., 2017).

Author contributions

All authors contributed equally in the study and preparation of article. All authors approved the final version of the manuscript for publication.

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