Effect of NaCl salinity on the growth and mineral nutrition of one month old *Prosopis juliflora* (Sw.) DC seedlings

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Accepted On: Mar 19, 2012; For Revision: May 14, 2012; Final Submitted: May 16, 2012

ABSTRACT

The effect of NaCl salinity on the growth and mineral nutrition of one month old *Prosopis juliflora* seedlings was studied with the help of sand culture experiment. The seedlings were treated with 100, 200 and 300 mM NaCl concentrations, respectively. It was found that there was stimulation in plant growth at low concentrations of salt, while at higher concentrations it was hampered causing a marked decrease in the fresh (60%) and dry weight (80%). The level of sodium, chloride and calcium was found to increase in the roots as well as leaves with increasing levels of salinity in the rooting medium. The level of potassium and phosphorus however, was found to decrease in the leaves and roots of seedlings grown under NaCl stress.

Keywords: salinity, growth, minerals, *Prosopis juliflora*.

INTRODUCTION

Salinity is a major environmental obstacle in crop growing areas, which limits seed germination and seedling growth.[1] Plantation in saline soil requires selection of salt-tolerant species as germination is critical in such soils.[2] According to recent observations, about 6.73 million ha land in India is saline.[3]

Prosopis juliflora is a multipurpose plant of great value. It provides timber, firewood and live stock feed. The capacity of biomass production in *Prosopis* is high and it has good ability to grow in the poorest type of soil, under very arid conditions where few other species survive.[4] According to Basavraja et al.,[5] it is an efficient tree species for reclamation of salt-affected soils. The workers from Central Soil Salinity Research Institute (CSSRI) have also noticed that genus *Prosopis* can be used for afforestation of salt-affected land. It is observed that *Prosopis juliflora* can be successfully established in a farmland of a village (M-Digraj, Dist-Sangli, Maharashtra, India), heavily affected by secondary salinisation. As Na and Cl are the dominant salts in a salt-affected area, an attempt has been made to study the effect of NaCl salt on the growth and mineral nutrition of *Prosopis juliflora* seedlings grown under salt stress in laboratory conditions.

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DOI: 10.5530/pj.2012.31.12

MATERIALS AND METHODS

Mechanically scarified seeds were used to raise the seedlings in sand culture. Seeds were obtained from *Prosopis juliflora* plants growing in the salt-affected agriculture fields in the months of April-May. After the germination of seedlings (10 days old), they were treated with increasing concentrations of salt (100, 200 and 300 mM NaCl) mixed with half strength Hoagland solution. The treatments were given twice a week alternating with watering the plants. Forty-day old seedlings were then harvested and measurements were taken for fresh weight by a digital balance. Dry weight was determined after drying the seedlings in oven at 40°C for 8 days. Acid digestion method of Toth et al.[6] has been followed for the analysis of inorganic constituents. Sodium, potassium and calcium were estimated using atomic absorption Spectrophotometer. The method of Sekine et al.[7] was employed for estimation of phosphorus from the roots and leaves. Extraction of chloride was done according to the method described by Imamul Huq and

Larher[8] with slight modifications and estimated according to the method of Chapman and Pratt.[9]

RESULTS AND DISCUSSION

The effect of NaCl salinity on average fresh weight of 40-day old *Prosopis* seedlings is shown in Figure 1. It is observed that salinity treatment has caused a marked decrease in fresh weight of a seedling at higher concentrations of salt but at lower concentrations there was an increase in the fresh weight. The fresh weight of a plant is an important parameter for the assessment of growth since it represents the total fresh biomass. In glycophytes, reduction in biomass is directly co-related with the rate of stress applied (Storey and Wyn Jones).[10] Karadge and Chavan[11] stated that low salt level increases biomass in *Sesbania*-restricted Na uptake but it decreases with increasing salinity. Fresh weight of Celery shoot was enhanced by low NaCl level (Everad et al.).[12] Venketsen et al.[13] observed an increase in the fresh weight of *Ipomea* plants up to 200 mM NaCl. Viegas et al.[14] also noticed that growth was stimulated at low NaCl levels in *Prosopis juliflora*.

In *Prosopis juliflora* also, an increase in the biomass in plants subjected to 100 mM NaCl is noticed. However, at very high concentrations (300 mM NaCl) about 60.44% decline in fresh weight is evident. But still at this concentration, the plants survive. Since *Prosopis juliflora* is a perennial tree species and the present analysis is performed at 1-month growth stage, it is quite probable that after initial hardening, the plant may become highly salt tolerant at later stages of growth and show better biomass production.

Influence of NaCl salinity on dry matter production in *Prosopis juliflora* is depicted in Figure 1. It is evident from the figure that dry weight increased in plants subjected to 100 mM NaCl while at higher concentrations it decreased. The dry weight of stem tissue also shows a similar pattern.

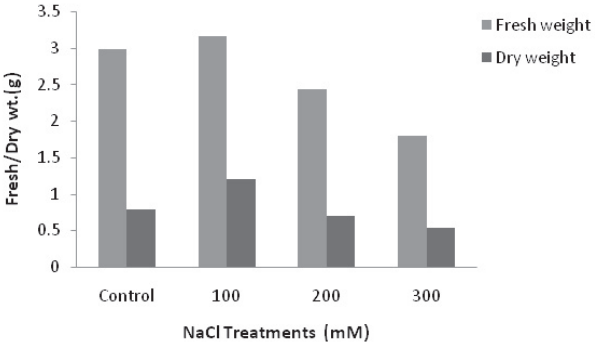

Figure 1. Effect of sodium chloride salinity on fresh and dry weights of *Prosopis juliflora* (Sw.) plants.

In contrast to shoot tissue, the dry weight of the root is higher than control in plants subjected to 100 and 200 mM NaCl and a decline is noticed at 300 mM NaCl concentration. Dry matter production in a plant represents a balance between total photosynthesis and respiration. Salinity is reported to inhibit photosynthetic CO_2 fixation in many plants (Bruria and Feigin).[15] An increase in the rate of respiration and photorespiration in salt-stressed plants is also reported (Downton).[16] Both these factors contribute to decline in dry matter production in salt-stressed plants.

According to Karadge and Chavan[11] the dry matter production in *Sesbania* was affected only at the higher salt concentration. Bottacin et al.[17] have reported that the dry matter production was stimulated up to 150 mM NaCl concentration only in *Pennisetum americanum*. Pessarakli et al.[18] reported that in saltgrass grown under salt stress, the dry weight at 200 and 400 mM NaCl was more than that of control plant. In case of *Prosopis juliflora* the dry matter production is reduced by 68.41% in 300 mM NaCl treated plants, while at 100 mM dose it is stimulated. The dry weight of root tissue is maintained above control in plants treated with 200 mM NaCl and this is certainly an important feature which may contribute to salinity tolerance of this species.

The influence of NaCl salinity on sodium and chloride contents of the leaves and roots of *Prosopis juliflora* is depicted in Figure 2a, b. From the figure, it is clear that due to NaCl treatment the level of sodium and chloride in both leaves and roots is increased. It is evident that the chloride content is increased to a greater extent than sodium.

Accumulation of sodium in plants growing in saline habitat is reported by a number of workers. Ramoliya et al.[19] have studied the mineral uptake by *Prosopis cineraria* plants exposed to salt stress and noticed that the seedlings showed greater accumulation of sodium in the leaf tissue as compared to that in root tissue. Since *Prosopis juliflora* belongs to a category of xerohalophytes (Aronson),[20] besides playing a positive role in metabolism, sodium might also be contributing to osmotic adjustment under saline conditions. NaCl salinity is related with increased contents of Na^+ and Cl^- and to a decreased availability of nutrients arising from lower uptake and the competition between nutrients such as K^+ and NO_3^- with Na^+ and Cl^-, respectively (Bottacin et al.).[17]

The chloride concentration in the root and leaves of *Prosopis juliflora* is found to increase with an increasing level of salinity. The accumulation of this nutrient is more pronounced in the leaf tissue than in the root tissue. Thus along with sodium, is possible chloride is also contributing to osmotic adjustment in this xerohalophyte species.