Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7111

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (6):** 137-143 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Salinity Induced Changes in Relative Water Content, Chlorophyll Content and Total Soluble Sugars in *Dalbergia sissoo* and *Acacia nilotica*

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Received: 6.011.2018 | Revised: 4.12.2018 | Accepted: 13.12.2018

ABSTRACT

For the past hundreds of year's trees like Dalbergia sissoo (Shisham), Acacia nilotica (Kikar), Prosopis cinneraria (Khejri) etc. have inhabited vast areas in the plains of Afghanistan, Pakistan, India, Nepal and Myanmar. These have also been widely used for afforestation in many parts of the country except in the very hot, cold and wet tracts. These have good atmospheric N_2^- *fixing ability, therefore, are extensively planted in social and agro-forestry programmes. In order to evaluate the effect of soil salinity, present investigation was conducted on two tree species i.e. Dalbergia sissoo Roxb. ex DC (Shisham) and Acacia nilotica (L.) willd. ex Delile (Kikar) growing under field conditions in Hisar district during the year 2011-2012. Mean relative water content was 57.4 % which was significantly lower than 37.6 % obtained under for the trees growing at saline sites. The mean relative water content was 60.9 % under non-saline conditions which was significantly higher than 32.5 % obtained under saline environment. The mean chlorophyll content in Dalbergia sissoo also showed significant decrease in the saline versus non-saline site trees. The mean chlorophyll content was 1.09 mg/g under non-saline conditions which was significantly higher than 1.0 mg/g obtained under saline environment. Under non saline conditions the mean total soluble sugar was 16.06 mg/g which was significantly lower than 19.08 mg/g obtained under saline the environment. The mean value of total soluble sugar in Acacia nilotica also showed significant increase in saline over non-saline site trees. Hence, the mechanism of salt tolerance is relatively better in Acacia nilotica than in Dalbergia sissoo as found from physiological and biochemical studies.*

Key words: *Acacia nilotica, Chlorophyll, Dalbergia sissoo, Relative water content, Salinity and Total soluble sugar*

Abbreviations : *Chl – Chlorophyll, RWC - Relative water content and TSS – Total soluble sugar*

INTRODUCTION

For the past hundreds of year's trees like *Dalbergia sissoo* (Shisham), *Acacia nilotica* (Kikar), *Prosopis cinneraria* (Khejri) etc. have inhabited vast areas in the plains of Afghanistan, Pakistan, India, Nepal and Myanmar.

Cite this article: Dharamvir, Kumar, A., Kumar, M. And Kumar, P., Salinity induced changes in relative water content, chlorophyll content and total soluble sugars in *Dalbergia sissoo and Acacia nilotica*., *Int. J. Pure App. Biosci.* **6(6):** 137-143 (2018). doi: http://dx.doi.org/10.18782/2320-7051.7111

These have also been widely used for afforestation in many parts of the country except in the very hot, cold and wet tracts. These have good atmospheric N_2^- fixing ability, therefore, are extensively planted in social and agro-forestry programmes.

Recognizing irrigation as a cardinal input for increasing and stabilizing yields has prompted countries throughout the world to expand their canal irrigation potential many fold. Where ever such import and liberal use of water has involved arid regions, the problem of water logging and salinity have surfaced. Presently, about one-third of the world's irrigated area of 20 million ha is salt affected[5,7,21]. In south-west Haryana about 200 km long axis of arable land comprising the districts of Jhajjar-Rohtak-Hisar-Fatehabad-Sirsa forms an inland basin with no natural drainage, is mostly underlain with saline ground water typifies this scenario[13].

Salinity toxicity normally results when certain ions are taken up with the soil-water and accumulate in the leaves during water transpiration to an extent that result in damage to the plant. The degree of damage depends upon time, concentration, crop sensitivity and crop water used, and if damage is severe enough, crop yield is reduced. The usual toxic ions in irrigation water are chloride, sodium and boron. Damage can be caused by each, individually or in combination[26].

In India Tewari *et al.*[27], observed growth responses of *Dalbergia sissoo* and *Acacia nilotica* seedlings on different levels of soil sodicity and salinity. The growth and dry weight of one-year old seedlings decreased as the level of sodicity and salinity increased in both species. However, the suppression in growth caused by sodicity and salinity was relatively greater in *D. sissoo* than in A. nilotica. A. nilotica showed wider response breadth compared with *D. sissoo* on both the gradients. Further, the response breadths were comparatively higher under sodicity levels than under salinity levels. Singh *et al.*[24], noted that *Dalbergia sissoo* in its natural and man-influenced ecosystem was being adversely affected by various abiotic stresses. Studies undertaken on the physio-chemical characteristics of soil under dead and healthy trees of *Dalbergia sissoo* and to correlate soil factors with the decline of shisham in semi-arid regions revealed that the pH, ECe, bulk density and calcium carbonate was found higher in soil under dead trees as compared to healthy trees. The value increased with increase in soil depth. The organic carbon and macro-nutrient (i.e. N, P, K, Ca, Mg and S) and micro-nutrients (Zn, Fe, Cu, and Mn) were higher under healthy trees as compared to dead trees and their concentrations decreased with increase in soil depth both in case of healthy as well as dead trees of *Dalbergia sissoo*. Bimlendra and Datta[3]. noted that out of ten provenances of Acacia nilotica, salinity was found to be more deleterious for growth, development, metabolism, water relations and nutrients in three provenances, viz., Chandigarh, Banaskantha, and Bhopal. Under saline conditions, plant height, number of leaves, leaf area, dry weight of plant parts was reduced remarkably (60-70 %) in provenances of Behrampur, Patna, Coimbatore and Banaskantha.

MATERIAL AND METHODS

The present investigation was conducted on two tree species i.e. *Dalbergia sissoo* Roxb. ex DC (Shisham) and *Acacia nilotica* (L.) willd. ex Delile (Kikar) growing under field conditions in Hisar district during the year 2011-2012. For this field surveys were made and sampling of soil and leaves was done. The soil and leaf samples were further analyzed in Stress Physiology Laboratory, Department of Botany & Plant Physiology, Central Instrument Laboratory and Soil Science Laboratory at the CCS Haryana Agricultural University, Hisar. For the determination of soil ECe and pH soil was sampled at a distance of 1.5 m in the East, West, North and South from the main tree trunk. Soil was excavated to the depth of 1 m with the help of an auger and soil from all the four samples at 20-100 cm were homogenized and sieved. Each sample was processed for the preparation of soil saturation extract in the laboratory by gradual shaking and addition of distilled water to get a water saturated soil paste. The paste was vacuum filtered and electrical conductivity of soil saturation extract (ECe) was measured by using digital conductivity meter and expressed as dS m^{-1} at 25^0 C. Soil pH of the saturation extract was measured with the help of pH meter (Elico India).

Relative water content was determined by Weatherly[29]. Chlorophyll was extracted by the method described by Hiscox and Israelstam[8]. using dimethyl sulphoxide (DMSO). Total soluble carbohydrates were determined with the method of Yemm and Willis[30]. using anthrone reagent.

Data were subjected to analysis of variance (ANOVA) using online Statistical Analysis Package (OPSTAT, Computer Section, CCS Haryana Agricultural University, Hisar, Haryana, India) and treatment means were compared by the least significant differences (LSD) ($p < 0.05$).

RESULTS AND DISCUSSION

The results presented in Figure 1 show that relative water content of *Dalbergia sissoo* was higher in range of 53.4 to 60.1 % as compared to and 33.5 to 40.0 % in trees growing under saline soils. The results presented in Figure 2 show that a similar trend was observed in *Acacia nilotica* where relative water content was again in the higher range of 26.8 to 37.5 % saline site trees as compared 55.5 to 64.8 % in trees growing under non-saline sites. Sharma *et al.*[23], also found decreased relative water content, water potential and osmotic potential of leaves in wheat grown under saline environment, while, decline in relative water content in the leaves of salt stressed barley plant was reported by Nakamura *et al.*[18]. Rodriguez *et al.*[22], observed that salt-shock caused decrease in root water potential and solute potential with a minor change in turgor potential in root of maize. Nabil and Coudret[16] observed that *Acacia nilotica* subjected to NaCl stress showed decreased water potential and osmotic pressure with salinity and concluded that lower water potential enabled the plant to maintain the turgor. Katerji *et al.*[10], in sugar-beet and Kaya and Higgs[11] in Capsicum reported that relative water content values decreased in plants under NaCl stress and there was improvement in relative water content values with additional nutrient elements application.

It is seen in Figure 3 that chlorophyll content of *Dalbergia sissoo* was on the higher side in the range of 0.90 to 0.96 mg/g fresh mass on the non-saline sites as compared to and 0.80 to 0.84 mg/g in trees growing on saline soils. In *Acacia nilotica* again leaf chlorophyll was in the lower range of 0.96 to 1.06 mg/g in saline site trees as compared 1.07 to 1.13 mg/g in trees growing under non-saline sites (Figure 4). Najafian *et al.*[17], found that chlorophyll content in bitter almond was affected by salinity. Qing *et al.*[19], studied growth and physiological adaptability of three poplars planted in different saline alkali soils and reported that saline alkali soil chlorophyll content was less affected though the annual mean decreases slightly. Various possibilities have been suggested for the reduction of chlorophyll content under the impact of salinity. Sudhakar *et al.*[25], suggested the reduction in chlorophyll content due to the influence of salt ions with the *de novo* synthesis of protein, which constitute the structural component of chloroplast. Another possibility may be associated with the increased activity of chlorophyllase which is responsible for the salinity caused breakdown of chlorophyll molecules as suggested by Rao and Rao[20] in pigeon pea.

Figure 5 depicts that total soluble sugars of *Dalbergia sissoo* that was in the lower range of 15.05 to 17.64 mg/g was found to increase to 18.02 to 19.99 mg/g in trees growing under saline soils. Again the results presented Figure 6 a similar trend was observed where in *Acacia nilotica* total soluble sugar was again in the higher range of 19.87 to 20.99 mg/g saline site trees as compared 16.28 to 18.02 mg/g in trees growing under non-saline sites. The accumulation of reducing sugars with salt stress in cluster bean has also been reported by Lahiri *et al.*[14], and Garg *et* *al.*[5]. Similarly results were observed in Isabgol[4,28], chickpea[6], faba bean[1], barley[12]. Jain *et al.*[9], reported sharp increase in proline and total soluble sugars in *Cajanus cajan cv* H77-216 subjected moisture stress. Mousavi *et al.*[15], reported that in Zard and Roghani commercial cultivars of Iranian olive total soluble sugars in leaves increased with an increase in salinity up to 80 mM but decreased further. Bimlendra[2]. also reported increase in total soluble carbohydrates in seedlings of *Acacia nilotica* derived from different Indian provenances.

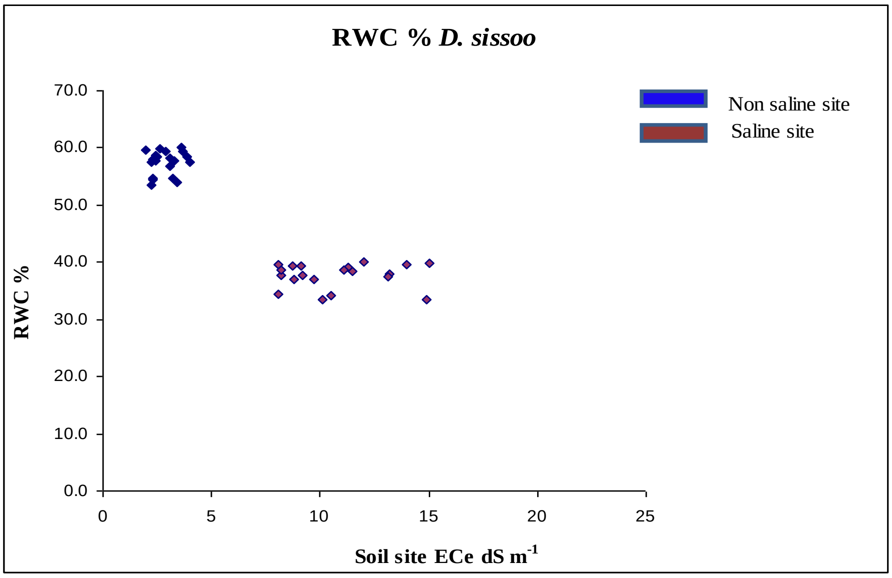

Fig. 1: Relative water content (RWC) of *Dalbergia sissoo* trees under non-saline (blue) and saline (red) sites

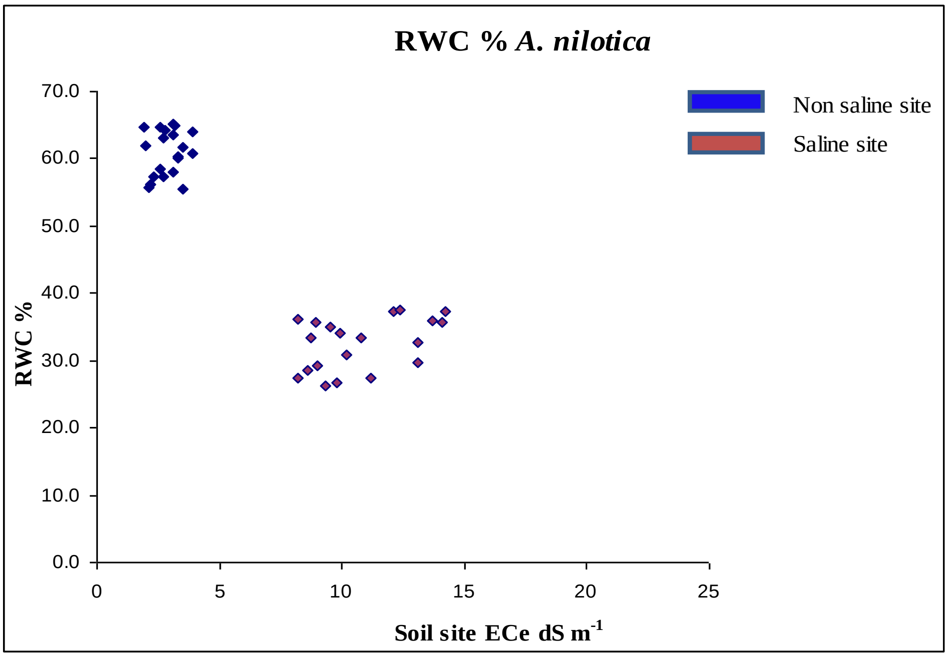

Fig. 2: Relative water content (RWC) of *Acacia nilotica* trees under non-saline (blue) and saline (red) sites

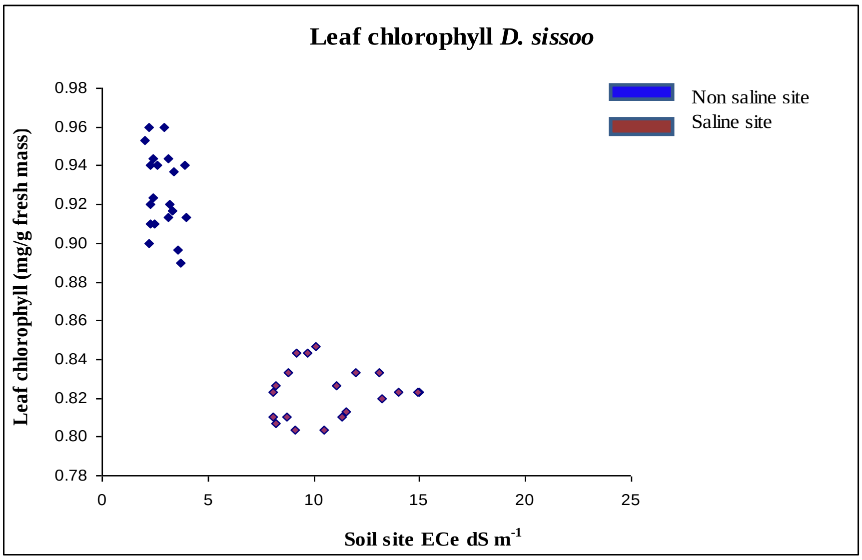

Fig. 3: Leaf chlorophyll content of *Dalbergia sissoo* trees under non-saline (blue) and saline (red) sites.

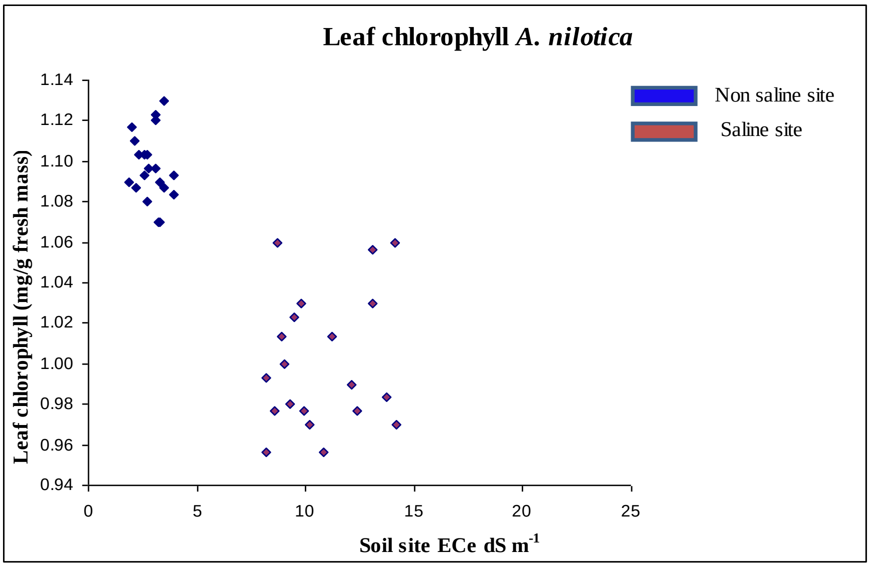

Fig. 4: Leaf chlorophyll content of *Acacia nilotica* trees under non-saline (blue) and saline (red) sites

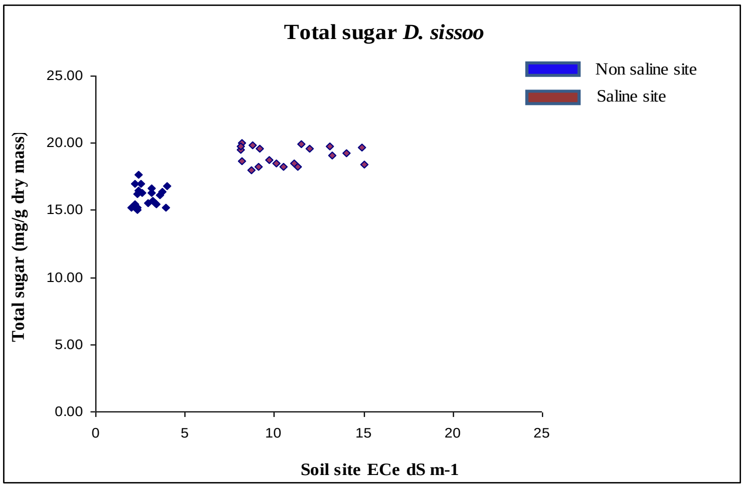

Fig. 5: Total soluble sugar content of *Dalbergia sissoo* trees under non-saline (blue) and saline (red) sites

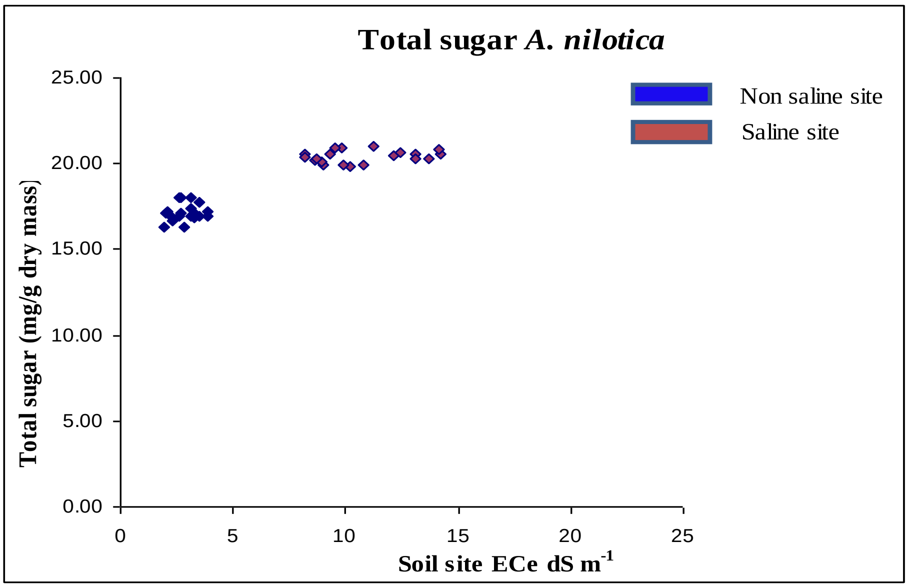

Fig. 6: Total soluble sugar content of *Acacia nilotica* trees under non-saline (blue) and saline (red) sites

CONCLUSION

Considered in totality it would appear that the salinity in the soil profile has a perpetual retarding effect on various physiological and biochemical parameters of *Dalbergia sissoo* as well as *Acacia nilotica*. This alone or in combination with other abiotic and biotic factors may lead to a slow decline and ultimate mortality of the trees.

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