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Physiological Responses of *Eucalyptus* Under Saline Environment. I: Ionic Composition in Selected Salt Tolerant and Salt Sensitive Provenances of *Eucalyptus Camaldulensis*

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Abstract: An experiment was conducted with the two provenances of *Eucalyptus camaldulensis* (tolerant = SL2 and sensitive = SL4) selected from the previous studies to scrutinize the ionic content and growth under saline environments using gravel technique. It was observed that plant height, shoot and root fresh and dry weight and stem diameter decreased with the increase in salinity levels in both the provenances upto 2% NaCl, However reduction was more clear in salt sensitive provenance of *Eucalyptus camaldulensis.* The chemical analysis for different ion showed that Na^+ increased in shoot and root in both the provenances of *Eucalyptus.* However root contain more Na^+ in both provenances under all salt treatments. The other ions such as K^+, Ca^{++} decreased with the application of salinity. The reduction was more pronounced in sensitive provenance. In case of P reduction was observed with salinity but it was not up to the deficient mark. The N contents severely decreased with salinity in shoot and root of both the provenances, however N contents are less in salt sensitive provenance under all treatment in shoot as well as root.

Key words: Repellent and residual effect of neem oil on maize weevil

Introduction

Salinization of soil creates extremely unfavourable conditions for plant growth. Accumulation of salts increases the osmotic potential of soil solution which in turn affects water movement and restricts its uptake by plants. Thus delayed germination, limited seedling survival and stunted plant growth are common in saline soils. Pakistan is situated in arid and semi arid regions of the world where evaporation is greater than precipitation. The magnitude of problem is therefore, huge in Pakistan and about 6.3 million hectares (mha) are salt-affected and is mainly located in the heart of its agriculturally the most important and productive belt, i.e the Indus plain (Khan, 1993).

The development of economical and efficient methods to combat with these problems is of paramount importance in order to feed the exponentially increasing population of the country. This can be achieved either through hydrological engineering approaches along with the use of chemical ammendments or biological reclamation of salt-affected soil i.e., saline agriculture. However, certain limitations especially insufficient supply of canal water, poor quality of ground water, huge initial investment, i.e Rs, 11,000 per hectare (Qureshi *et al.,* 1993) and poor drainage restricts the liberal use of hydrological approach while under these circumstances alternative approach of utilization of salt affected soil is "Saline Agriculture", to deal with this problem under Pakistani situation. It is both cost effective and sustainable.

In Pakistan out of the total salt-affected soils, approximately half are waste lands and are extremely saline and saline sodic in nature. These are mostly unfit for agricultural crops. It is the urgent need to use such waste land for cultivation to fulfil the food, fuel and industrial raw material requirements of even growing population of Pakistan.

However *Eucalyptus* has been identified as a tolerant tree species to salinity and waterlogging and has more than 85% survival rate under saline soil conditions (ECe of 10 to 15 dS m^{-1}) (Sandhu and Qureshi, 1986). The agronomical studies about *Eucalyptus* are well documented in literature (Marcar, 1993; Shah *et al.,* 1992; Hafeez, 1993; Qureshi *et al.,* 1993; Akilan *et al.,* 1997). However, the information about mechanism of salt tolerance are still investigating and scanty. The present study was, therefore, planed to determine morpho-physiological studies of *Eucalyptus* grown under saline condition.

Materials and Methods

Nursery of *Eucalyptus camaldulensis* was raised in sand from seeds, when the seedlings were of one month old, transferred in to plastic bags containing silt and 25% sand (mixed). Three month old seedlings were used for gravel culture experiment conducted in plastic pots in the net house of NIAB, Faisalabad. A plastic pot having hole at the bottom with diameter and length of 22×20 cm filled with washed sterilized marble gravels and this pot was placed in another plastic pot with diameter and length of 25×23 cm having no hole which is used to,collect drained solution from the first pots filled with gravel. The pots were filled with Y2 strength Hoagland's solution and three month old seedlings of *Eucalyptus camaldulensis* of tolerant provenance "SL2" (seed collected from University of Agriculture, Faisalabad) and sensitive provenance "SL4" (seed collected from Biosaline Research Station-I, Lahore) were transplanted and allowed to grow and acclimatise for 15 days. Five salinity treatment (Control, 0.5, 1.0, 1.5 and 2.0% NaCl) were created with NaCl, each treatment have 5 replications. For the appropriate growth the pH of solution was checked daily and if it was found above 7.5 then it maintained upto 6.5 by adding few drops of

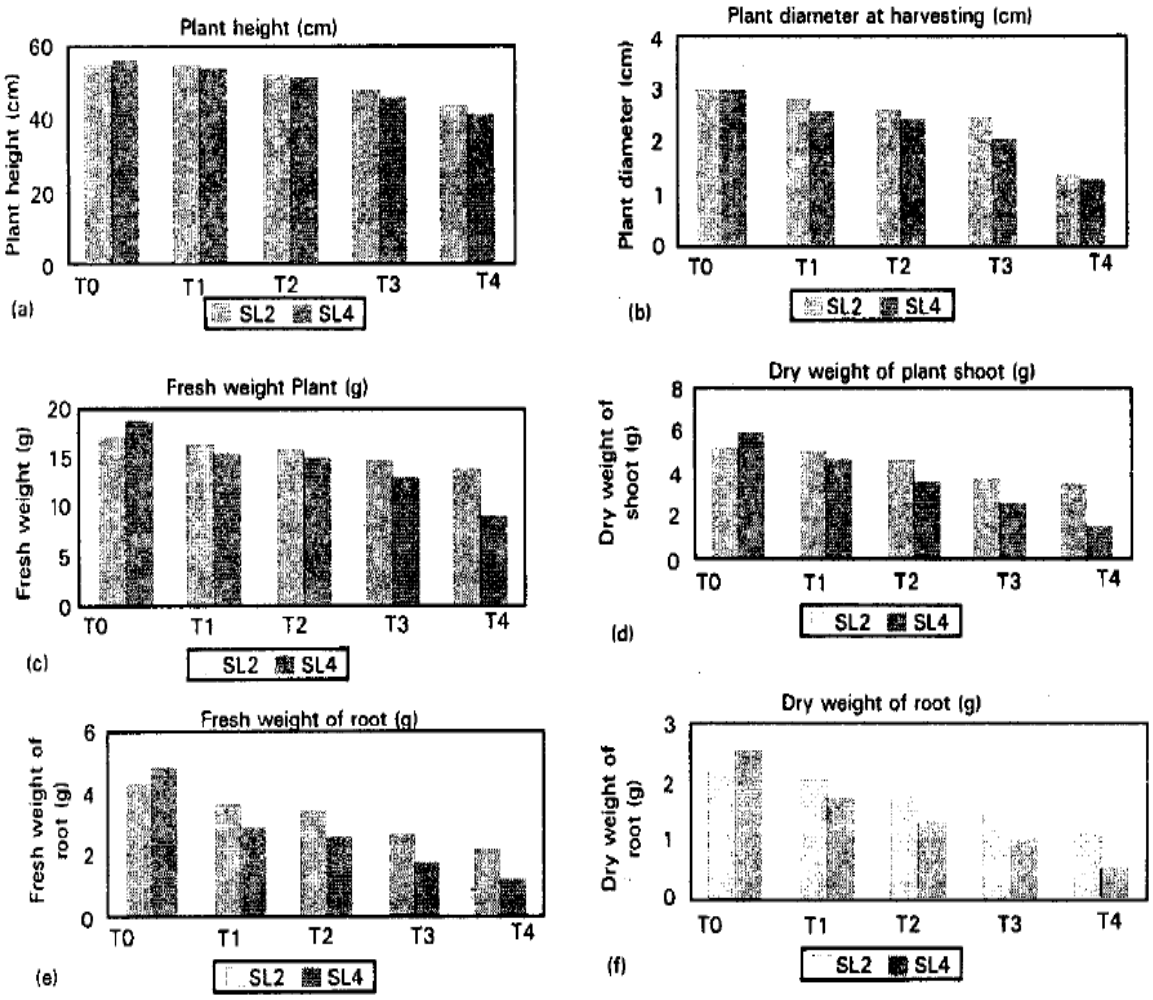

Fig. 1: Effect of salinity on plant Neigh (a) stem diameter (b) fresh weight of plant shoot dry weight (d) fresh root weight (e) dry weight of root (f) of tw provenances of *Eucalyptus camaldulensis*

concentrated H_2SO_4. The solution was changed after one week and plants were allowed to grow for a month. After one month the plants were harvested and their shoot length, root length, shoot and root fresh and dry weight were recorded. The dried material of shoot and root was used to determine ionic content. The data was subjected to analysis of variance and treatment and provenance means were compared by using DMR test (Steel and Torrie, 1980).

Results

The results showed that plant height significantly reduced by the application of salinity in both type of provenances, however reduction was more pronounced in salt sensitive provenance (SL4) at 2% NaCl. Similarly shoot length also decreased by increasing the salt concentration. The minimum root length was recorded in highest salinity level (2% NaCl) in both provenances, however the reduction in tolerant provenances was less as compared to non tolerant. The dry weight, fresh weight of shoot and root were also influenced by salinity (Fig. 1c-f). The maximum fresh and dry weight were recorded under normal conditions which reduced by increasing salt concentration. The reduction in salt tolerant provenance under highest salinity level was less than 50% while it was more than 70% in sensitive provenance of *Eucalyptus camaldulensis.* Same is the case with plant stem diameter (Fig. 1b).

The ionic content like 10 and Ca^{++} decreased by increasing salinity while Na^+ increased in both the provenances under all salt treatment. The Na^+ content was much higher in salt sensitive provenance, while K^+ and Ca^{++} were greater in salt tolerant provenance in both root and shoot. The effect of salinity on phosphorous was not much pronounced because the contents in both provinces were beyond the deficiency level (Fig. 2i, j). In other word no effect of salinity was observed in case of P uptake. N content decreased in both root and shoot in all provenances due to salinity (Fig. 2g, h). The reduction was more clear in sensitive provenance. The minimum N content were observed at highest salinity level in both the provenances.

Discussion

Although *Eucalyptus* is a salt tolerant tree plant however, in the present study the two provenances tolerant and sensitive upto 2% NaCl were screened (unpublished data)

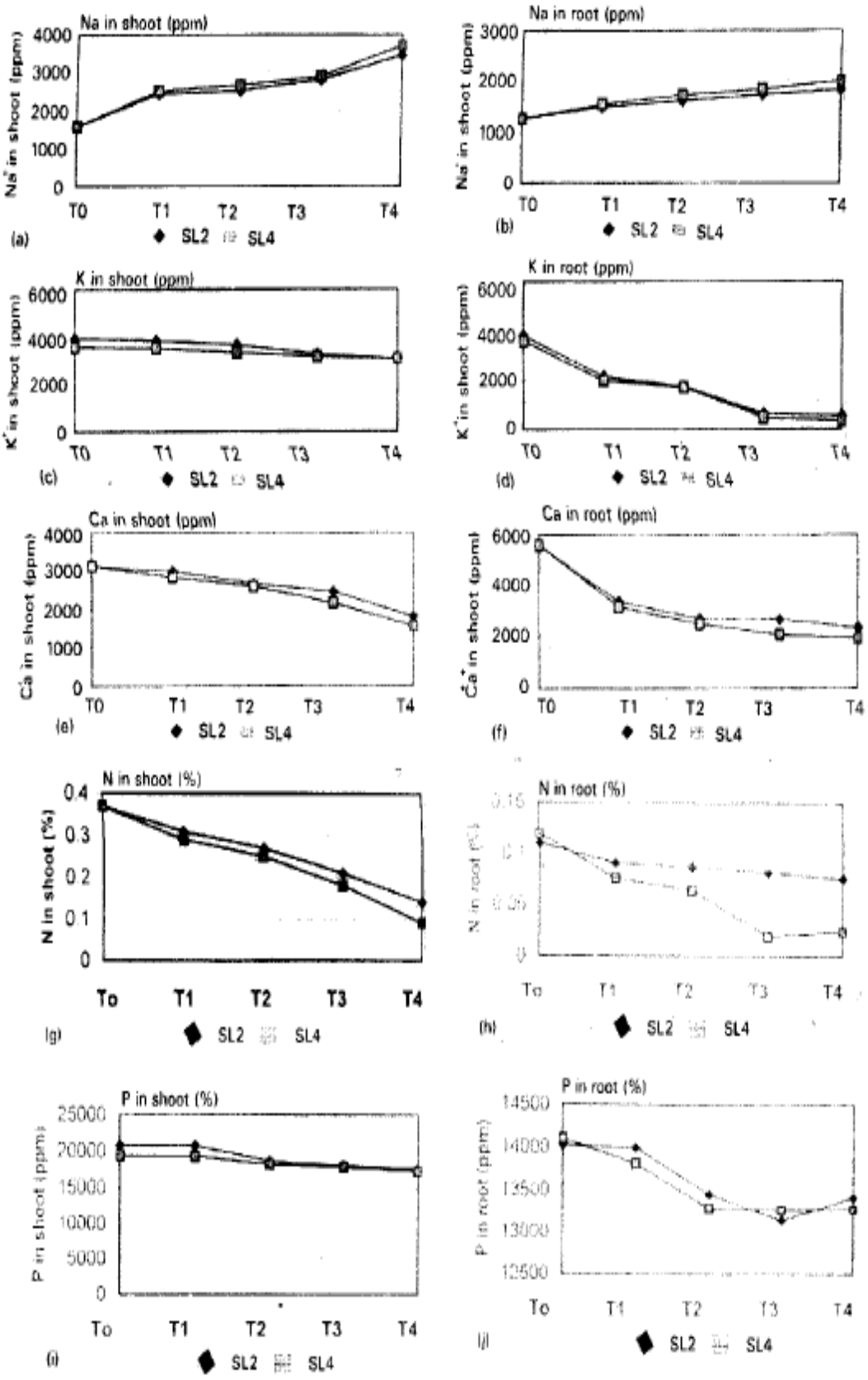

Fig. 2: Effect of salinity on ion contents in shoot and root in two provenances of *Eucalyptus camaldulensis*: Na^+ in shoot (a) Na in root (b) K in shoot (c) K in root (d) Ca in shoot (e) Ca in root (f) N in shoot (g) N in root (h) P in shoot

and used in the present study to compare for their growth and ionic content mechanism. The data on growth showed reduction due to salinity in both the provenances. However reduction was more clear in case of salt sensitive provenance (Fig. 1a). Many reports (Ashraf *et al.,* 1999; Qureshi *et al.,* 2000) indicated reduction in growth due to salinity, even in halophytic plants. The reduction in growth may be due to reduction in cell turgor Potential which is necessary for cell enlargement and elongation (Ashraf and Khan, 1994) which may be the reason in the present study for reduction in plant growth (Qureshi *et al.,* 2000). Present study confirms that tolerant provenance have longer root than non tolerant, which is a sign of osmotic adjustment with environmental conditions (Khan *et al.,* 1992).

The data on ions content showed that Na^+ content increased in both root and shoot of all the provenances (Fig. 2a, b). There are many reports (Khan and Ashraf, 1988; Khan *et al.,* 1995) showed that high Na^+ content create toxicity which Ultimately retards plant growth. The present study confirms these findings. The reduction in K^+ (Fig. 2c, d) and Ca^{++} (Fig. 2e, f) may be due to antagonistic effect of Na^+ in uptaking the K^+ and Ca^{++}. The results showed that Ca^{++} and K^+were higher in salt tolerant provenance of *Eucalyptus.* K^+ play key role in the osmotic adjustment of plant which is necessary to maintain the turgor potential (Khan *et al.,* 1992), Similarly. Ca^{++} has major role in the cell membrane stability and the plant having higher cell membrane stability were more stress tolerant than others (Ashraf *et al.,* 1992).

N contents reduced in the plants growing under saline condition (Ashraf and Khan, 1993) present study also confirms it. The literature (Khan *et al.,* 1990; Ashraf and Khan, 1993) showed that under saline condition different enzymes like Nitrate reductase, Nitrite reductase and Arnmonia-lyase activities decreased due to salt stress which effect the N metabolism of the plant and reduced the N contents. The reduction in N content in the present study may be due to above mentioned reasons.

Many reports (Khan and Ashraf, 1988; Khan *et al.,* 1995) showed that salinity did not affect the P contents however in the present study it decreased but not up to the deficient mark which showed that plant had enough P for their survival and metabolic activities.

References

Akilan, K., R.C.C. Farrell, D.T. Bell and J.K. Marshall, 1997. Responses of clonal river red gum (*Eucalyptus camaldulensis*) to waterlogging by fresh and salt water. Aust. J. Exp. Agric., 37: 243-248.

Ashraf, M.Y. and A.H. Khan, 1993. Effect of NAD on Nitrogen Status of Sorghum. In: Current Development in Salinity and drought Tolerance of Plants, Naqvi, S.S.M., M.R. Ansari, T.J. Flower and A.R. Azmi (Eds.). AEARC., Tando Jam, Pakistan, pp: 84-88.

Ashraf, M.Y. and A.H. Khan, 1994. Solute accumulation and growth of sorghum grown under NaCl and Na_2SO_4 salinity stress. Sci. Int., 6: 377-379.

Ashraf, M.Y., A.H. Khan and A.R. Azmi, 1992. Cell membrane stability and its relation with some physiological processes in wheat. Acta Agron. Hug., 41: 183-191.

Ashraf, M.Y., R.A. Waheed, A.S. Bhatti, A. Baig and Z. Aslam, 1999. Salt Tolerant Potential in Different *Brassica* species, Growth Studies. In: Halophyte Uses in Different Climates II, Hamdy, A., H. Lieth, M. Todorovic and M. Moschenko (Eds.). Backhuys Publishers, Leiden, The Netherlands, pp: 119-125.

Hafeez, S.M., 1993. Identification of fast growing salt tolerant tree species. Pak. J. For., 43: 216-220.

Khan, A.H. and M.Y. Ashraf, 1988. Effect of sodium chloride on growth and mineral composition of sorghum. Acta Physiol. Plant., 10: 259-264.

Khan, A.H., M.Y. Ashraf and A.R. Azm, 1990. Effect of NaCl on growth and nitrogen metabolism of sorghum. Acta Physiol. Plant., 12: 233-238.

Khan, A.H., M.Y. Ashraf and A.R. Azmi, 1992. Osmotic adjustment in sorghum under sodium chloride stress. Acta Physiol. Plant., 14: 159-162.

Khan, A.H., M.Y. Ashraf, S.S.M. Naqvi, B. Khanzada and M. Ali, 1995. Growth, ion and solute contents of sorghum grown under NaCl and Na_2SO_4 salinity stress. Acta Physiol. Plant., 17: 261-268.

Khan, G.S., 1993. Characterization and genesis of saline sodic soils in Indus plains of Pakistan. Ph.D. Thesis, Department of Soil Science University of Agriculture, Faisalabad, Pakistan.

Marcar, N.E., 1993. Waterlogging modifies growth, water use and ion concentrations in seedlings of salt-treated *Eucalyptus camaldulensis*, *E. tereticornis*, *E. robusta* and *E. globulus*. Aust. J. Plant Physiol., 20: 1-13.

Qureshi, R.H., S. Nawaz and T. Mahmoud, 1993. Performance of Selected Tree Species under Saline-Sodic Field Conditions. In: Towards the Rational Use of High Salinity Tolerant Plants, Volume 2: Agriculture and Forestry under Marginal Soil Water Conditions, Lieth, H. and A.A Al Masoom (Eds.). Kluwer Academic, Netherlands, pp: 259-269.

Qureshi, T.M., M. Aslam, F. Hussain and M.Y. Ashraf, 2000. Performance of *Eucalyptus camaldulensis* under different types of salt-affected soils. Int. J. Agric. Biol., 2: 45-47.

Sandhu, G.G. and R.H. Qureshi, 1986. Salt affected soil of Pakistan and their utilization. Reclaim. Reverg. Res., 5: 105-113.

Shah, B.H., A. Hussain and R.M. Omer, 1992. Effect of forest vegetation on salinity, sodicity and infiltration capacity of soil. Pak. J. For., 42: 31-36.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics: A Biometrical Approach. 2nd Edn., McGraw Hill Book Co., New York, USA., ISBN-13: 9780070609266, Pages: 633.