Exploration of desert halophytes plant for rehabilitation of saline soils through phytoremediation

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INTRODUCTION

Saline soils offer salinity stress that is among major stresses particular under arid and semi-arid climates and perhaps adversely hinders plant growth and production. Physically and chemically degraded soils comprising salinity is nearly affecting 15% of the world's total area. It had become imperative for the communities to know treating their saline soils by the natural ability of plants to eradicate salts from saline soils. Several methods have been used for reclamation and appropriate use of salinity affected soils comprising agronomic practices and using halophytes. Among these, use of halophytes (phytoremediation) can be most operative, inexpensive and ecologically sound technique for remediation of salinity affected soils. Phytoremediation is a novel approach towards dealing the problems of soil salinity. Highly saline patches are the key characteristics features particular to saline areas. The native natural vegetation can be effective for probing the adaptation mechanism associated with halophytes growth and survival to fight in the way of high salinity levels. In the area with the harsh climatic conditions biotic and abiotic stress affects plants performance adversely in all ways. Salinity is a major problem of such areas as rainfall is sporadic and uncertain. It is not yet enough for leaching down the salts. The difference between annual precipitation and evapotranspiration causes rapid salts accumulation on the surface soil during the dry seasons. As a result, in these areas planting of the native halophyte species is the effective tool to combat salinity problems.

METHODOLOGY

Two shrub species plant material one year old *Capparis decidua* and *Haloxylon salicornicum* grown through cuttings in the polythene tubes were shifted to hydroponic system containing Hoglands nutrient solution. Before the application of salinity treatments plants were irrigated after every 3 days a week with a half-strength Hoagland solution for 3 months. The nutrient solutions were altered on weekly basis to minimize nutrient accumulation. pH of solution was maintained at 5.5 to 7.0.

The data was recorded on weekly basis for the root length, shoot length and number of leaves. At the final stage of experiment the plants samples were harvested, brought to laboratory; where these were washed twice under running tap water. Leaf, stem and root portions were separated from each other after washing with distilled water. Samples were oven dried at (50° C) for consecutive 3 days to gain a permanent weight. Tubs were organized in a Completely Randomized Design (CRD) with four blocks. Each species having 4 treatments and 3 replications were subjected to different doses of NaCl salt applications at 0, 70, 140, 210 mM level (Kong, Y., and Zheng, Y., 2014).

RESULTS

Numbers of leaves are plant growth indicator. More numbers of leaves mean more foliage. More biomass will be then obtained as leaves are the photosynthetic organ; preparing plant food. Salinity adversely impacts numbers of leaves resulting reduction in biomass production. Number of leaves increased for *C. decidua* at 3 treatment levels but decreased at T4 (19) maximum at T3 (24). Number of leaves for *H. salicornicum* increased from T1 (13) to maximum at T4 (27). This shows salt tolerance is high in *H. salicornicum*.

Total fresh weight has a significant impact on total weight (root and shoot). The leaves are the photosynthetic organ of the plant thus reducing foliage production. Biomass production which is the main goal is drastically reduced by salinity. Weight is the indicator of plant health and vigor. The research was conducted to show salinity stress tolerance by the two shrub species C *decidua* and *H. salicornicum*. For *C. decidua* the minimum weight mean was at T1 (1.99g) and maximum at T3 (3.35g) but declined at T4 (2.1g). This shows weight is declined at higher salinity levels. Weight initially increased and was minimal influenced at T3 (8.33g) but then increased at higher level. This shows species is well adapted to highly saline areas. Shoot length is the total length of plant from collar region to the aerial part of plant. It determines the extent of biomass production in plants. Shoot length of halophytes greatly affected by salinity. Shoot length is the indicator of the active growth of the plant. Maximum shoot length indicates lesser effect of salinity on species and vice versa. Shoot length initially increased for *C. decidua*, maximum at T3 (140cm) and then declined. Shoot length for *H. salicornicum* however showed increased indicating not affected by salinity at 210 mM.

Root length was measured from the cutting where first root appeared and spread freely in solution. Both species root length is not affected by increasing salinity levels. Shoot fresh weight measured was higher in *H. salicornicum* (13g) as compared to *C. decidua* (2.6 g) at salinity level up to 210 mM. Shoot dry weight measured was maximum in *H. salicornicum* at T2 (11.6 g) and remained high for *C. decidua* at T1 (7.4g) Maximum shoot dry weight is shown by *H. salicornicum*. Root dry weight was increased at T4 for *C. decidua* but showed an irregular pattern for *H. salicornicum* at all levels. Root fresh weight was higher at T1 for *C. decidua* then continuously declined but showed an irregular pattern for *H. salicornicum* at all levels.

Removal of salts and other heavy metals from soil is termed as phytoremediation. It is a cheap and ecologically sound method of soil reclamation towards addressing salinity problems in degraded saline soils. Na+ uptake increased in both species at all treatment levels, maximum at T4 (50459 and 60117ppm) respectively K+ uptake decreased in both species at all treatment levels, maximum at T1 (50162 and 56632 ppm) respectively.

CONCLUSIONS

Plant biomass was higher in case of *Haloxylon salicornicum* as compared to *Capparis decidua*. Shoot length was also higher. Higher fresh shoot weight in *Haloxylon* is evident as compared to *Capparis* due to the succulence. *Capparis decidua* is suggested for planting in the Cholistan rangeland from normal to moderately saline soils and *Haloxylon salicornicum* for the highly saline areas above 210 mM concentrations of salts. Planting these species in such an area would help us in successful reclamation of salt affected areas. Reclaiming the saline areas will not only improve local dwellers economic status through rearing livestock and other products, but will also reduce deforestation thus benefitting entire ecosystem.

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