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Halophytes for Saline Lands, Their Economic Potential and Demonstration of Salt Tolerance

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ABSTRACT

Increasing land degradation is posing a great threat to the perspectives of improving food and fodder production. Salinity stress is limiting agricultural crop productivity. One of the most serious forms of land degradation is secondary salinity/sodicity (i.e. Salinity developed due to saline water irrigation), which is prevalent in arid and semiarid regions of world. The production capacity of such lands is inhospitable because of their poor physical and chemical properties, altered ecosystem, and disturbed nutrient cycling resulted from land overuse and continual addition of chemicals. Such problems are now the major determinants of global crop productivity and consequently reclamation of such soil resources is the most urgent requirement for world food production and sustainable development. However growing halophytes has been tried to reclaim such land.

Keywords: Salinity, Biodiversity, *Salsola*, *Atriplex*, sodicity.

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INTRODUCTION

Increasing salinization including secondary salinization due to irrigation water has significant and detrimental impacts on land and vegetation quality. Out of an estimated area of 173.40 million hectares total degraded lands in India, approximately 7 million hectares are affected by natural salinity. Rajasthan is the largest state of India situated in the northwestern part of the country[1]. Geographically it lies between 23˚ 3' to 30˚ 12' N longitude and 69˚ 30 to 78˚ 17 S latitude. Rajasthan is most seriously salinity-affected state of India and it is most serious problem for agriculture productivity. This substantially increasing problem needs urgent attention. Besides naturally occurring saline soil, the rate of land degradation due to secondary salinity is very high. Halophytes have special mechanisms for salt tolerance including maintenance of ion homeostasis, production and transport of compatible solutes, and the production and activation of anti-oxidative enzymes [2,5]. Halophyte have specific characteristics like thick waxy cuticle, salt glands on the leaf surface, the exclusion of salt at root surface. However recently "omics" have been developed and used to clarify complex biological systems including salinity tolerance in halophytes[6]. These approaches have allowed us to address comprehensive analysis of unique properties of minor plants including halophytes.

Decreasing water table and increasing salinity

Decreasing water table and increased use of deep wells following electrification of villages has resulted in increased levels of irrigation water salinity and increased secondary salinization. Electric conductivity of waters in such wells is very high and according to one report more than 5% of wells in arid and semi arid areas of Rajasthan contain water with EC more than 15 dS. Only in western Rajasthan, the area affected by the use of such problematic water is 880.75 km^2 where the irrigation water being used is moderate to highly saline / sodic. And it is a major contributory factor to soil degradation in India whose current rate is 3-5 million ha per year. Although, in context with the increasing population the importance of irrigated agriculture cannot be ignored but the excessive saline water irrigation may convert productive soil into unproductive salinized soil. Use of such waters does not produce sustainable yield and the cost economics of productivity of agriculture field being irrigated with such poor water is not favorable but still the farmers are forced to continue such agricultural practice because it is directly connected to their social relations and status.

Reduction in food grain production

India's current food grain production is around 200 million tonnes and shall produce annually 5-6 million tonnes extra to meet the demand of substantially increasing population. The increase in yield may primarily come from increase in arable land, cropping intensity, increase in yield per unit area of cropland, exploration for new crops for wastelands and by reclamation of wastelands including salt affected lands[1-3].

Bioremediation

Halophytes have been suggested for the bioremediation, revegetation and reclamation of such salt affected lands. They have the capacity to absorb salt and reduce the EC levels when raised before growing regular crops (Kumar and Neumann unpublished data).

Plant Species for bioremediation

Atriplex numularia, *Suaeda nudiflora* (Willd.) Moq., *Suaeda fructicosa* Linn., *Haloxylon recurvum* (Moq.) (Chenopodiaceae), *Sesuvium sesuviodes* (Fenzl.) Verdc, *Trianthema triquatra* Rottle. ex. Willd. (Aizoaceae), *Portulaca oleracea* Linn. (Portulacaceae), *Amaranthus* sps. (Amaranthaceae), and *Calotopis procera* (Ait.) R. Br. are among the main plant species studied[3].

Bio-reclamation using halophytes

Characterization of few more species for bioremediation purpose has been done only at pot level experiments. In the second phase, seeds of selected plant species will be distributed among the farmers for practical application to their salinized fields**[4].**

Halophyte Germplasm Bank

Flora of India is very rich regarding diversity and number of plant species endowed to it. It also has a rich number of halophyte plant species. It is proposed to establish a germplasm bank of halophytes. It will provide propagation and research material for the scientists besides being a prudent step in conservation of this very valuable part of flora. This will mainly have halophytes of state Rajasthan and halophytes of state Gujarat.

Demonstration Plot

A 3 hectare demonstration plot can be established at Sambhar salt lake area, which will be used for demonstration to farmers. Studies related to agro technology can be carried out at this center. It will also serve as a resource of experimental material for basic research.

Economic Potential

Halophytes are able to survive and to reproduce in saline environments like coasts, wetlands, and inland deserts with higher salinity levels. Rajasthan is well known for its indigenous knowledge; ethenobotanical surveys shall be carried out to explore the economic potential of halophytic flora of Rajasthan. Some plants like Suaeda, Haloxylon and Salsola are used to produce crude baking

soda, which is very popular in Bikaner salt dishes industry locally known as Namkeen and Papad. Adolf et al[7] reported that *Chenopodium quinoa* Willd has high nutritional value. A large number of halophytes have a potential to provide food for future besides undertaking bioremediation of saline soils [8- 11]. The naturally high tolerance to abiotic stresses together with the excellent nutritional quality of its seeds are the reasons that FAO has nominated this plant as one of the crops that might contribute to global food security during the next century[15]. Plants like *Calotropis procera* may contain 12-15% of biocrude, which can be converted in biofuel, and this plant can tolerate salinity upto 75 –100% of seawater[5]. Other biofuel yielding plants like *Jatorpha curcas* also can be important, our previous studies suggests that this plant can tolerate salt stress significantly.

Economically important plants produced in the saline area

Plants like *Rumex crispus* L could yield plants of medicinal value in the saline area. Plants of nutraceutical value can also be produced in saline area. Most of the halophytes can be used as fodder for cattle to improve their milk production [6, 7]

RESULTS AND DISCUSSION

Salinity is major factor which is limiting crop productivity world over. Improving the salt tolerance in crops is essential for sustainable food production. Schubert [3] studied mechanism of salt tolerance of crop plants and elaborated on physiological characterization of this multigenic trait. Around a billion ha of salt-affected land world wide, which is unsuitable for agriculture purposes but provides unique opportunities for "halo-biotechnologies".[4] Salinity tolerance is a complex multigenic trait showing dominance, heterosis, and additive effects[12] Salt tolerance is multifaceted physiologically and is determined by a number of sub-traits specific for each tissue[13]. Halophytes possess the unique genetic determinants for salt tolerance and hence can tolerate high salinity. However such mechanisms remain incompletely understood. However fewer than 25% of the salt-regulated genes are salt stress-specific[14].

CONCLUSION

Rajasthan has considerable saline area which can be converted as area with cultivation if proper plants are selected and bioremediation practices are followed.

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