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Root nodules of plants grown on salt–affected soils: A useful source for isolating salinity tolerant N_2–fixing non–rhizobial bacteria

Salinity is one of the most significant environmental challenges limiting plant productivity, particularly in arid and semi–arid climates. Soil salinity affects about 800 million hectares of arable lands worldwide. Therefore, there is a need to exploit the marginal lands, such as the salt–affected soil, for crop production. Salt stress impairs several major processes in plants, such as photosynthesis, protein synthesis and lipid metabolism, due to both osmotic effects that result in water deficits and specific ion effects that can cause toxicity and nutrition imbalance (decrease in uptake of nutrients). Nitrogen (N) is the most limiting nutrient for crop production in many of the world's agricultural areas and its efficient use is important for the economic sustainability of cropping systems. Leguminous plants have the ability to fix N_2 biologically from the atmosphere. These plants also help N incorporation to agricultural systems, thus reducing or removing the need to apply chemical N fertilizers. It has been found that most of leguminous plants are deficient in salt tolerance.

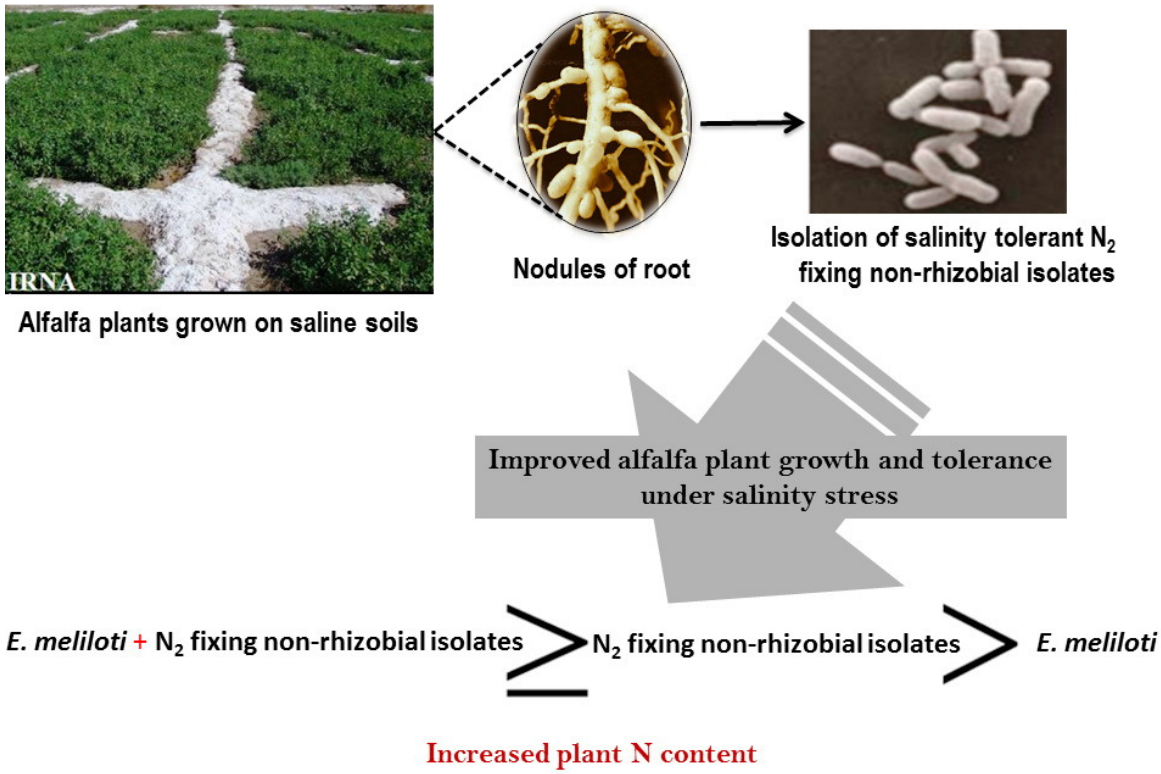

Fig. 1. Effect of non–rhizobial strains and rhizobial strain on the N content of alfalfa plant shoot under salinity stress.

Productivity and capacity of nodule formation and nitrogen-fixation of these plants could be severely affected by the saline stress. In addition, it is known that N_2 fixing legumes are more susceptible to salt stress than N_2 non–fixing plants (N–fertilized plants). An alternative strategy to improve crop salt tolerance may be to introduce salt-tolerant bacteria that enhance crop growth under salinity stress. Several studies have shown that

plant growth promoting rhizobacteria (PGPR) have a beneficial impact on plant growth and development, especially under stress conditions. Studies have also indicated that the growth and nodulation in leguminous plants were higher in the presence of PGPR. It is well known that the rhizobia are not the only nitrogen–fixing inhabitants of legume nodules. It has been known that the efficiency of bacteria is severely affected by environmental factors especially stress factors. Thus, the selection and use of salinity tolerant PGPR based on both high salt tolerance and efficiency in producing plant growth promoting (PGP) traits are potentially of enormous impact in facilitating the growth of crops in a wide range of saline environments, both natural salinity and induced salinity. It has been reported that the salinity resistant PGPR obtained from saline environments are more effective at improving the plant tolerance to salt than those isolated from salt non–affected habitats.

In a recent study, we isolated rhizobial and non-rhizobial drought and salinity tolerant bacteria from the surface sterilized root nodules of alfalfa plant (*Medicago sativa* L.), as a model plant, grown on saline soils, and evaluated the effects of effective isolates on the plant growth under salt stress. The results of this study clearly indicated that the root nodules of the alfalfa plants can be a useful source of drought and salinity tolerant bacteria with multiple PGP traits. Effective non–rhizobial N_2–fixing bacteria had the potential to increased alfalfa plant growth and N content under salinity conditions both in the presence and in absence of rhizobial bacterium symbiotic to alfalfa plant (*Ensifer meliloti*) (Fig. 1). These bacteria may be suitable candidates as tolerant bacteria in different degrees to salinity and can be used in the formulation of agricultural products as a cheaper alternative to farmers in production of leguminous plants in saline soils.

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