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Short Communication

Soil Microbes and Plant Drought Tolerance

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Among all abiotic stresses, drought is considered as one of the devastating factors limiting agricultural productivity worldwide which is likely to increase in the near future owing to continuous climate change. Drought affects the plant growth through a number of mechanisms including morphological changes, hormonal and nutritional imbalance and generation of free radicals. Under such conditions it is imperative to formulate strategies that can improve the crop production. In this regard concentrating the soil microbes in the rhizosphere has been found to have positive effect on the plant growth and chances of plant survival under drought conditions. Millions of microbes inhabit plant root system forming a complex ecological community that influences plant growth and productivity through its metabolic activities and plant interactions [1]. It has been reported that these beneficial microorganisms colonize the plant rhizosphere and impart drought tolerance by the following mechanisms.

Alterations in the level of plant hormones

Soil microbes have been found to accelerate plant growth under the drought conditions through biosynthesis of phytohormones especially IAA (Indole 3-acetic acid) which enhances the growth and geometry of the roots through increased cell division and elongation [2]. Elevated levels of IAA in wheat by bacterial treatment of different species of *Azospirillum lipoferum* resulted in increased leaf water content because of enhanced root growth and formation of lateral roots they're by increasing uptake of water and nutrients under drought stress resulting in better grain yield and higher mineral uptake as compared to untreated plants [3]. On the other hand, upregulation in the abscisic acid (ABA) biosynthetic pathway in the plants inoculated with soil microbes brings about the stomatal closure thus minimizing the water loss of the plants hence enhances the plant drought tolerance [4].

Increased levels of osmolytes

It has been observed in so many studies that soil microbes secrete osmolyte in response to drought stress which act synergistically to the osmolytes produced by the plant itself. Pseudomonas putida GAP - P45 inoculation improved plant biomass, relative water content and leaf water potential by accumulation of proline in maize plants exposed to drought stress hence adding to its existing concentrations [5]. The role of the osmolytes lies in reducing the cell water potential hence does not let the water molecules to lose in response to drought stress. Besides osmolytes can increase the stability and integrity of membranes and proteins, preventing or lessening cellular damage by water scarcity.

Increased biosynthesis of antioxidants

Drought stress causes damage to the plants especially the root hairs through the formation of reactive species like H_2O_2, O_2- and OH- , due to high susceptibility of root meristem activity to reactive oxygen species. These molecules are capable of causing damage to proteins, lipids, nuclear material as well as the cell membrane by promoting lipid peroxidation [6]. Hence the management of these molecules becomes the priority of the cells which is being made possible by the increased level of enzymatic (superoxide dismutase, ascorbate peroxidase, and catalases) and non-enzymatic antioxidants (glutathione, flavonoids, carotenoids, and tocopherols) during drought stress. Basil plants (*Ocimum basilicum* L.) treated with Pseudomonas sp. under drought stress significantly increased the catalase enzyme activity. Similarly, when treated with microbial consortia containing *Pseudomonads* sp., *Bacillus lentus* and *A. brasilense* highest activity of glutathione peroxidase and ascorbate peroxidase was observed [7] followed by lower levels of H_2O_2 and malondialdehyde (MDA) and ion leakage indicating the reduced oxidative damage to plant cells.

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