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Application of EPS in Agriculture: an Important Natural Resource for Crop Improvement

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Abstract

This unprecedented population increase would require an increased crop production, as plant sources satisfy up to 80% of humans dietary needs. The exo-polysaccharides (EPS) secreted from bacteria has shown enormous potential in the improvement of soil properties, disease suppression and plant growth. Thus, it might play a potential role in the improvement of agricultural productivity; however, it is yet highly underestimated.

Main Text

The human population, which is increasing annually by 1.4%, is expected to reach 8.3 billion by 2025. This unprecedented population increase would require an increased crop production, as plant sources satisfy up to 80% of humans dietary needs [1,2]. In this regard, microorganisms in soil can play a critical role as it plays key role in the maintenance of soil function and productivity, in both natural and managed agricultural soils. Their key involvement in important belowground processes such as soil structure formation, decomposition of organic matter, toxin removal, and the cycling of carbon, nitrogen, phosphorus, and sulphur [3] suggests its potential importance in agricultural productivity. For example, microorganisms play crucial roles in suppression of soil-borne plant pathogens, and thus help in promotion of plant growth [4]. Therefore, future exploitation of such belowground interactions for improvement in agriculture would depend on a better understanding of the biology of plant–microbe interaction [5].

The exopolysaccharides (EPS) secreted from bacteria might plays a potential role in improvement of agricultural productivity, which is yet unexplored. EPS have ubiquitous nature of alginates [6,7], which is widely known for its industrial applications [8,9]. It is used in plant tissue culture to produce artificial seeds, immobilizing enzymes by entrapment, as food and wound dressing material. EPS secreted from bacteria plays a key role in encystment of artificial seeds, which protects against desiccation and predation by the protozoon's [10], phage attack [11], and also affect the penetration of anti-microbial agents [12] and toxic metals [13]. However, its application in agriculture with respect to its role in plant growth and activity is less explored.

The exo-polysaccharides (EPS) secreted from bacteria has shown enormous effect on various soil properties and plant productivity. Some effects of EPS are mentioned in Figure 1. EPS possess unique water holding and cementing properties. Therefore, it play a vital role in the formation and stabilization of soil aggregates and regulation of nutrients and water flow across plant roots through biofilm formation [14,15]. Moreover, it helps to increase the uptake of nutrients by plant, and brings subsequent increase in plant's growth. Similarly, EPS protects nitrogenase against high O_2 concentration, and participates in bacteria interaction with plants [16,17]. Bacterial EPS bind the Na+ ion in the root, through which the plant's Na^+ accumulation decreases [18]. In that way, bacteria help to alleviate salt stress in plants. Sandhya et al. [19] reported that EPS produced by PGPR exhibit increased plant resistance to water stress. Co-inoculation of *Phaseolus vulgaris L.* with Rhizopus tropici and Paenibacillus polymyxa (which produces trehalose) has shown increased plant growth, N content, and nodulation under drought stress [20]. Plants treated with EPS-producing bacteria display increased resistance to water stress [21]. Alami et al. [22] observed a significant increase in root adhering soil to root tissue ratio in sunflower rhizosphere inoculated with the EPS-producing rhizobial strain YAS34 under drought conditions. Production of EPS by bacteria improved RAS permeability by increasing soil aggregation and maintaining higher water potential around the roots. Additionlly, the bacteria protects the seedlings from drought stress due to EPS secretion. Similar results were obtained with wheat plantlets, which was inoculated with Paenibacillus polymyxa Gouzou et al. [23] and Pantoea agglomerans [24] under salt stress. Hartel & Alexander [25] observed a significant correlation between the amount of EPS produced by cowpea, *Bradyrhizobium* strains and their desiccation tolerance. These finding indicate that it is possible to alleviate drought stress in the plants by increasing the population density of EPS-producing bacteria in the root zone. The EPS-producing Pseudomonas strain GAP-P45 acts as a plant growth promoting rhizobacteria and can alleviate the effect of drought stress in sunflower plants. It is attributed to improvement in soil structure and secretion of plant growth promoting substances. It indicates that the moisture sorption and colloidal stabilization properties of EPS are important, which could be potentially used for improved agro production. Moreover, studies on EPS should be considered in combination with other factors, such as bacterial spread along the root, physical properties of root adhering soil etc [26-31].

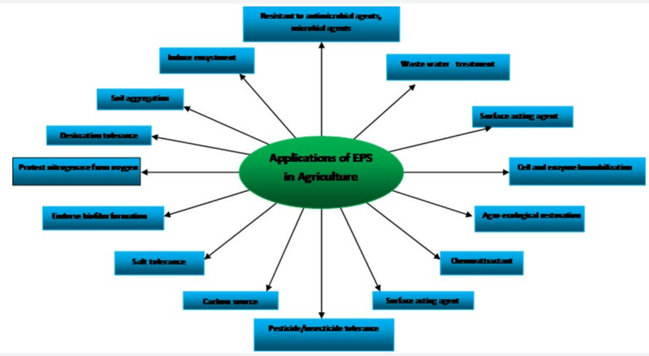

Figure 1

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