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Editorial

Microbial Biofilms as Biofertilizers

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Abstract

This review attempts to evaluate the impact of microbial biofilm biofertilizers on plant growth using studies conducted between 2020 to 2024. It was inferred that biofilm biofertilizers stimulated plant growth by promoting solubilization of nutrients (P, N, K) thus enhancing seed germination. It also increases Indoleacetic acid (IAA), siderophore, chlorophyll a and b production consequently promoting root, shoot and leaf development under stressed and unstressed abiotic conditions.

Keywords: *Microbial Biofilms; Biofertilizers; Indoleacetic Acid (IAA)*

Introduction

In natural environments, majority of microorganisms exist in polysaccharide encased consortium referred to as Biofilms, which protects them from various harsh environmental conditions [1]. Biofilms are formed by numerous bacteria (both gram positive and gram negative) [2] and could be a single/uniform (bacteria-bacteria, fungi-fungi) or mixed communities (bacteria-fungi, bacteria-algae, fungi-bacteria-algae, etc.) of microorganisms. Microbial biofilms serve as plant growth promoting agents when employed as biofertilizers [3]. Biofilm biofertilizer (BFBF) is a fertilizer that contains a healthy microbial community that has evolved in biofilm mode and has enormous potential benefits [2] which include promotion of soil structure, stabilization and solubilization of nutrients and soil water retention capacity consequently increasing plant growth and crop yield. These activities of biofilm fertilizers is particularly pronounced in marginal soils where nutrient availability and soil structure are often compromised [4].

Impact of microbial biofilm biofertilizer on plant growth

Microorganism	Plants	Study outcomes and Impact on plant growth	Author
Rhizobacterial strains; *Ochrobactrum intermedium* sp. and *Lysinibacillus macrolides*	Wheat	Increase in root and shoot wet weight *in-vitro*, maximum phosphate content was recorded in biofilm inoculated plants. Increase in nitrogen, chlorophyll a and b as well as relative water content. Significant increase in spike length and grain weight as well as Indoleacetic acid (IAA), siderophores and salt stress tolerance in BFBF inoculated plants.	[5]
Bacillus subtilis and Curtobacterium citreum, however, only *B. subtilis* produced EPS	Maize	Significantly high values of IAA production and solubilization of phosphate, enhancing plant's ability to tolerate water insufficiency and relatively improved root and shoot development.	[6]

Halotolerant biofilm forming Rhizobacteria (*Glutamicibacter arilaitensis, G. nicotianae, Enterobacter ludwigii, E. cloacae, Exiguobacterium acetylicum*, *Staphylococcus saprophyticus, Leclercia adecarboxylata*, *Pseudomonas poae*, *P. putida and Bacillus subtilis*.	tomatoes	Approximately 75% of the biofilm bacteria were able to solubilize phosphate, 26% were able to solubilize potassium, 79% produced various types of siderophores, 74% showed high salt tolerance (in 15% NaCl), 79% grew at pH 4 and all isolates grew at pH 9 and 10. There was less electrolyte leakage in seawater-induced salt stressed plant inoculated with biofilm bacteria and high relative water content in leaves. Significant levels of chl a and chl b, 21% and 11% synthesis respectively was recorded in plants inoculated with biofilm bacteria, all of which culminated to the protection of plant cells from oxidative damage in saline environment and non-stress conditions	[7]
Fungal-bacteria biofilm (*Bacillus pumilus, B. subtilis*, *Bradyrhizobium japonicum* and *Trichoderma harzianum)* with 50% chemical fertilizer	Potato	A combination of 50% chemical fertilizer and biofilm biofertilizer produced the maximum yield of potatoes as a result of enhanced soil nutrients levels. Interestingly however, there was no significant difference in the tuber yield from chemical fertilizer alone and biofilm fertilizer alone in regions where potato cultivation was not so favorable. There was also no significant difference in the soil physiochemical parameters for this region although phosphate availability in soil with the biofilm biofertilizer was significantly higher than the chemical fertilizer applied soil in the first growing season.	[8]
Bacteria-fungi biofilm with 50% chemical fertilizer	Rice	Significant increase in thousand grain weight and non-diazotrophs, increase in root and shoot dry weight, consequently increasing plant growth and grain yield	[9]

Table

Conclusion

Biofilm Biofertilizers significantly improved soil physicochemical conditions and enhanced chlorophyll, siderophore and indoleacetic acid production which are germane to plant growth and crop yield as demonstrated by several studies. The application of biofilm biofertilizers could be a key to sustainable agriculture and green farming and a major solution to the improvement of marginal soils where the microbial and soil physicochemical balance has been heavily altered by human and other environmental factors. Mostly gram positive bacteria were reported in the literatures examined as biofilm formers, with ability to stimulate plant growth promoting factors. Future research should be geared towards the isolation of gram positive biofilm bacteria as well as fungi from the rhizosphere to formulate the much needed biofilm fertilizers.

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