BENEFICIAL PLANT:MICROBE INTERACTIONS

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Overview:

The following aspects of beneficial plant:microbe interactions will be reviewed: (a) the root region environment and biology, (b) beneficial root region microorganisms, (c) commercialization of beneficial plant microorganisms, and (d) future research opportunities and directions.

Root region environment and biology:

Soils are complex three-dimensional matrices containing limited nutrient pools and therefore, are rather harsh environments for biological activity. Most soil microorganisms commonly function at subsistence levels of metabolic activity. However, introduction of seeds into this environment, which subsequently germinate and grow, provides a tremendous source of nutrient input via seed and root exudation. This tends to fuel prolific microbial growth and development, ultimately resulting in the establishment of unique and distinct microbial populations along root surfaces and in the adjacent rhizospheres.

Numerous studies have demonstrated that certain components of the root region microbiota have the ability to stimulate plant growth and development when added into root regions as inocula. These organisms are referred to as beneficial plant microorgansisms.

Beneficial root region microorganisms:

(a) PGPR: A unique group of soil bacteria, primarily pseudomonads, are able to affect plant growth and development and therefore, are referred to by the generic term, plant-growth-promoting rhizobacteria or PGPR. A number of mechanisms have been proposed for PGPR effects on plant growth including biocontrol through the production of antibiotic metabolites, physical exclusion of minor/major plant pathogens from root surfaces, production of plant growth regulators, and solubilization or mineralization of essential plant nutrients.

(b) NPR: Nodulation-promoting rhizobacteria are a subgroup of PGPR. NPR have the ability to stimulate nodulation formation and nitrogen fixation.

(c) Phosphate-solubilizing organisms: Many soil fungi and bacteria have the ability to solubilize precipated or bound phosphates into the soil solution. Phosphate-solubilizing organisms make up about 1% of the total soil microbial population. Soil bacteria seem to quickly lose their ability to solubilize phosphate after several transfers on laboratory media. Soil fungi, however, appear to retain this trait.

(d) Biocontrol: Numerous soil organisms appear to have negative effects on the growth and development of plant pathogens. The most common biocontrol organisms studied included various species of <u>Trichoderma</u> and <u>Pseudomonas</u>. Four types of mechanisms may be involved: physical exclusion of pathogens from root surfaces; production of siderophore metabolites which remove nutrients essential for pathogen growth and dvelopment; production of antimicrobial metabolites which are toxic to plant pathogens; and through direct parasitism of pathogens.

<u>Commercialization of beneficial plant microorganisms</u>:

A biological input product must have the following attributes to facilitate successful commercialization: it must be a naturally-occurring microorganism; it must not present pathological hazards to mammalian tissues or to the environment; it must be easy to use; and most importantly, it must be efficaceous under field conditions.

Commercial R & D must address and resolve the following aspects in the product development process: development of a low-cost, high-output production system; development of formulations, packaging and delivery systems that will maintain long-term product viability over a variety of storage temperatures and are amenable to current agronomic practises; product registration under the Fertilizer Act or Pesticide Act as appropriate; market analysis and development of a marketing strategy.

<u>Future research directions and opportunities</u>:

The primary research focus with plant beneficial microorganisms in the past has been product-directed, i.e., to isolate, identify and exploit microorganisms that have potential to stimulate plant growth and development. Perhaps it is appropriate to return to the more basic aspects of the interactions between these organisms and plants. Areas that should receive more emphasis are development of techniques, protocols and strategies to precisely identify and quantify individual strains in root regions and soils, determination and characterizations of the mechanisms by which microorgansisms affect plant growth and development, and development of strategies and protocols to characterize plant response to the manipulation of their root region biology.