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Microbial Interactions with Plants and Their Importance in Agriculture

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Editorial
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Editorial

Taxonomically diverse microorganisms colonize the plant system known as the plant microbiome. The plant microbiome is responsible for better plant growth and development and can possess both positive and negative interactions with plants. These interactions are symbiotic and asymbiotic, which are economically important for agricultural crop production [1]. It has been reported that microbiota in the soil/plant system promote plant growth and development, suppress plant pathogens, and increases plants' resistance to biotic and abiotic stresses, and enhance essential amino acids and protein content, and vitamins in plants [2,3]. Leaf-associated microorganisms are also involved in developing plants' growth and fitness, resistance to abiotic stresses, and pathogens [4]. Therefore, utilizing these beneficial functions of microbes has been given attention to developing them as inoculants in biotechnology research.

Beneficial microbes and their interactions with crop plants are extensively studied to harness their beneficial function in advancing agricultural crop production. Soil or foliar application of these economically important microbes following the formulation as microbial consortia (biofilms), or mono or mixed culture forms has proven their efficiency in biotechnology research [5-7]. Co-culturing of beneficial microbes has been shown to enhance the production of secondary metabolites of plant growth-promoting microbes [8]. Biofilm formation of beneficial fungi and bacteria in fungal bacterial biofilms has also been shown to enhance indole acetic acid production, reduced weed growth, and reduction of chemical fertiliser usage by 50% [5,9-11]. However, factors involving the enhanced performance of beneficial microbes and the disease progression of pathogenic microbes are needed to be investigated for the understanding of molecular mechanisms of these interactions. This editorial gives an insight into microbial interactions with plants and the utilisation of various molecular tools and their prospects.

Molecular approaches: ensuring enhanced crop production

Plant microbiome studies provide insight into the interactions between plants and microbes. These interactions occur through the transference of molecular and genetic information [12], which is known as molecular communication. This involves the synthesis of specific chemical compounds from both plants and microorganisms during their interactions. These chemical constituents are volatile compounds and a range of other chemical compounds such as hormones and hormone mimics, carbohydrate- and protein-based signals [13] of plants and microbes. With the advancement of cutting-edge technologies for metabolomics, genomics, transcriptomics, and proteomics, recent studies have identified these chemical constituents, and genes expressed from both plants and microbes during their interactions [14-18].

Plant miRNA has been reported to be involved in establishing plant-microbial interactions [19] during symbiosis and pathogenesis [20]. miRNA regulates the expression of genes and transcription factors that controls hormone signalling, and nutrient homeostasis. For instance, in pathogenesis, miRNAs express disease-resistance genes, regulate the production of reactive oxygen species (ROS) and secretory pathways such as exocytosis [21]. Although, omics data enable researchers to find new information about chemical communication of plants with microbes [15], the way this information can be deployed in crop advancement is pivotal to investigate.

Several reports have shown that the knowledge of these techniques is applied in achieving agricultural benefits, especially in the formulation of microbial inoculants. Yang et al. (2021) have mentioned the application of miRNA in future breeding programmes for developing pathogen-resistance in plants [21]. Genome-wide association studies have been used in selecting desirable plant traits and in the manipulation of plants and their beneficial microbes [1]. Transcriptomic studies identify which gene/s are up/downregulated, what factors, especially inducers are involved and what developmental stage of the host/pathogen interaction [14,16,22-26]. As such, when the underlying mechanisms of plant-microbe interactions are properly investigated, modulation, manipulation and inoculation strategies can be developed to meet crop growth, increased yield and pathogen control. When transcriptomics analysis investigates the expression of virulence genes of pathogens and their induction during disease development, control strategies can be developed to reduce or suppress the induction of enzymes and metabolites involved in pathogenesis for ensuring no/less attack of microbial plant pathogens.

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