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New Insights in Plant Microbes Interaction, Different Immune Responses and Novel Approaches

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Abstract

Different types of microbes playing important role in soil fertility, increase the food production both agricultural and economical point of view. Plant activities such as phytoremediation efficiency in the form root symbiosis formation by assisting the removal the toxic metals for the formation of rhizosphere. Once the pathogen enters into the plants through different routes, different immune responses elicited as plants show a variety of immunological behavior as a result of microbial attack. Plant growth-promoting rhizobacteria most commonly beneficial for promoting the plant growth as a result of nutrients uptake by plant and readily available to the nodule formations. Many of the green algae also involved in making the beneficial relationship to the microbes. These are blue-green algae and a host of other beneficial microorganisms. Fungi also show the symbiotic association with different plants mostly in hyphae formation. For example, the chitin-derived lipo-chitooligosaccharides. Transferring the some characters from plants and microbes to the different organisms helpful to establish the relationship among various food chain animals.

Keywords: Nodule formation, bacteria, plant-microbe interaction, defense mechanism.

INTRODUCTION

Different types of microbes playing important role in soil fertility, increase the food production both agricultural and economical point of view [1, 2]. They are also used for the production of plant varieties via interacting the plant metabolism through series of events. They are also utilized for biofuels production at large scale due to the biocompatibility. Detrimental relationships involve pathogens including fungi, bacteria and viruses [3, 4]. The chemical fertilizers that directly applied to the plants are not reliable due to high cost and side effects on the growth of plants. Plants and microbes have evolved detrimental and beneficial relationships. Due to the complexity of microbe–host interactions, systems biology will have to play an essential role in understanding of these complex inter-organismic relations. Plant host relationship can be establish through nitrogen fixation via the nitrogen fixing bacteria that increase the soil fertility [5].

While on the other hand, useful microbes can be grown at certain conditions to enhance the agricultural yield and protection against the different pests. The chemicals based fertilizers are used in large concentrations accumulate in the roots of the plants causing the chlorosis. Beneficial association in plants and microbes include symbiosis, diazotrophic endophytes that supply the plant with fixed nitrogen and other endophytic associations that promote plant growth by producing phytohormones, volatiles, defense compounds, and enzymes. Therefore, current advances

have been made in the fields of agriculture and plants sciences to grow useful bacterial that promote the plant growth, development even during the stress conditions [6-8].

Table-1: Shows the natural phenomenon's of plant-microbe interaction and biological significance

Plant-microbe interaction	Benefits	Importance	References
Major significance Plant-microbe interaction	Different types of microbes playing important role in soil fertility	Increase the food production both agricultural and economical point of view.	[1, 2]
Major significance Plant-microbe characteristics	High cost, beneficial relationships	Biocompatibility	[3, 4]
Plant-bacteria interaction	Nitrogen fixing bacteria, symbiosis	They are involved in nitrogen fixation by increase the soil fertility. They are also helpful for agricultural yield and protection against the different pests., signaling molecules that maintain the cyclic activities.	[9, 10]
Plant hormones as regulators	Auxins, cytokinins, gibberellic acid (GA3), abscisic acid	Nutritional supplements and time to growth the seasonal crops	[11, 12]
Microbes-host interaction	Horizontal immunity	Block the entry of further entry of different pathogens and parasites	[18, 19]
Rhizobia species	Carbon fixation	increasing the soil fertility	[21,22, 23]
Fungal species	Symbiotic association	Different plants mostly in hyphae formation, chitin-derived lipo-chitooligosaccharides	[28, 29]

Mutualistic interaction between plant-microbes

Availability of the different types of nutrients that applied in the form of solid or liquid form increase the crop cultivation, promotes growth accelerating factors and crop sustainable development. Growth promoting bacteria increase the plant metabolic pathways such as production of photochromic pigments and degradation of toxic metabolites from different tissues such as leaves. The most important plant regulators that maintains the different activities such as seedling, microbial growth, production of genetically engineered fruits and vegetables, and increase the growth of nutritional metabolism in plants. While on the other hand, excess concentrations of the plant hormones leads to stunt growth that affected the plant bioactivities and increase chances of attack of lethal pathogens that can cause the accumulation of microbial wastes in plant tissues. In order to resolve this issues, plant hormones such as auxins, cytokinins, gibberellic acid (GA3), abscisic acid acting as the signaling molecules that maintain the cyclic activities [9, 10].

Auxis are applied to the soils according to the nature, nutritional supplements and time to growth the seasonal crops such as winter, autumn or summer. It regulates the cellular processes in plants such as light, dark reactions and photoperiodism under the influence of quality of light applied to the plants for growth under specific conditions of temperature and light. There are different aspects of auxins supplementation to plant developments. It also regulates the seedling, fruits and promotes the growth of plants under environmental harsh conditions. Excess concentrations of the auxins to plant developments can inhibit the growth at optimum level. Therefore, optimum concentrations of auxins can increase the plant activities. They affect which tissues grow upward and which grow downward and even plant death. Therefore, genetic modifications in plants have been made through advances in in agricultural biotechnology, agricultural microbiology and soils biology [11, 12].

Gibberellins are the plants promoting growth factors that playing different roles in plants such as root developments, germinations of different types of seeds under stress conditions. Excess concentrations of the gibberellins to plant developments can inhibit the growth at optimum level. Therefore, optimum concentrations of gibberellins can increase the plant activities. Ethylene is plant hormones playing important roles such as promoting the growth of leaves, roots, flowers, vegetables, fruits and senescence. Ethylene is the fruits promoting hormones in order to increase their shelf life at extreme level. It also regulates the seedling, fruits and promotes the growth of plants under environmental harsh conditions. Excess concentrations of the ethylene to plant developments can cause the damaging to fruits. Therefore, optimum concentrations of ethylene can increase the plant activities [13-15].

There are different factors affecting the plant growth while applying the different chemical regulators in plant development. These are long periods of seed germination, increase rate of pests attack on the crops due to their resistance against the specific chemicals. Strong acids like sulfuric, hydrochloric and nitric acids will have a highly detrimental effect, as will strong bases like lye and potassium hydroxide. There is need to such kind of chemicals or biofertlizers that genetically targeted the pests in order to prevent their

attacks on growing parts of plants. CRISPR technology is the most widely used for controlling the plant diseases through genome editing. Through this technology, different plant diseases have been controlled in appropriate manner [16, 17].

Mechanism of Plant-microbe interaction

There are different mechanism approaches for immunity in response to plant and microbes entry into the different tissues. One of such kind is the hallmark of pathogenic interactions due to suppression and interference with plant immune responses. Once the pathogen enters into the plants through different routes, different immune responses elicited as plant show a variety of immunological behavior as a result of microbial attack. There are two pathways activated in to support the evidences about the microbes-host interaction. One of the pathways is the microbial or pathogen associated molecular patterns horizontal immunity and other one is the effector-triggered immunity (ETI). Plants show adaptive responses and releases different types of chemicals and peptides that block the entry of further entry of different pathogens and parasites [18, 19].

Plant growth-promoting rhizobacteria most commonly beneficial for promoting the plant growth as a result of nutrients uptake by plant and readily available to the nodule formations. Their action to make nutrients such as nitrogen, phosphorous, etc., available to plants by acting as the balancing nutrients between plants and microbes. Biofertilizers are the microbial preparations that when applied to the soil, plant, or roots provide or enhance the nutrients and increase the fertility of soil. One of the best example is the Rhizobia species that symbiotically shows beneficial relationship to the plants. Rhizobia species and plants both getting benefits in this relationship that plants provide a niche and fixed carbon to bacteria in exchange for fixed nitrogen in different ways through increasing the soil fertility [20-22].

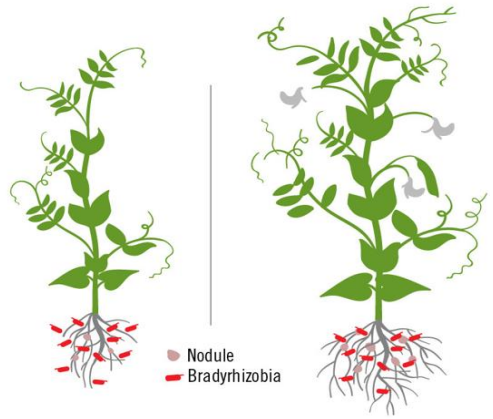

Fig 1: Shows nodule formation in the bradyrhizobia that activates the uptake of nutrients

There are also many other types of plant growth-promoting bacterial endophytes that can colonize some interior tissues and cyanobacteria. They colonize the plants tissues by promoting the growth factors. Many of the green algae also involved in making the beneficial relationship to the microbes. These are blue-green algae and a host of other beneficial microorganisms. Biofertlizers that directly applied to plants increase the plant and microbe interaction. Bio fertilize is a misnomer and the term microbial inoculants better suit these plant growth-promoting organisms, which are capable of exerting beneficial effects on plants. These biofertlizers can be applied in the form of sprays with sometime liquid emulsion that enhanced the plant prompting bacteria for fixing the nitrogen [23-27].

Fungi also show the symbiotic association with different plants mostly in hyphae formation. One of the best example is the chitin-derived lipo-chitooligosaccharides have been effective and mediate the mutualistic interactions in the molecular crosstalk with plants that mediate the symbiotic accommodation of the fungus. They can associate with the plants by forming the different types of hyphae thus ultimately in involved in stimulating the hyphal branching. Fruiting bodies that developed during the formation of the hyphae, which then develops further to form the mycelium. This type of relationship held the plants to survive under water tolerating conditions [28, 29].

Many of the pathogens show different responses as a result of chemical treatments such as bio control in the form of sprays. Different approaches have been proposed for increasing suppressiveness and methods for biocontrol more successful that can be associated with several antagonistic agents through synergistic modes of action different pathogens. There are varieties of bacteria that produced in plants roots and other oarts. Sometimes, their excessive activities in the plants tissue leads the deaths of plant tissue as they obtained the energy from plants. Pseudomonads are well known for their ability to act as biocontrol agents through the production of various substances such as *Pseudomonas syringae* that produces chemical toxin coronatine, for one or more of the growth regulating jasmonates, disrupting growth. These bacteria sometimes can cause the poor growth of roots formation as they start damaging from young roots [30-32].

Different bacteria in the roots also playing important roles in plant development processes. Root exudates that comprised of lots of compounds that directly stimulate or suppress the growth of soil-borne plant pathogens. Overall the general rhizosphere effect could help the plant by maintaining the recycling of nutrients, through the production of hormones, helping to provide resistance to microbial diseases and to aid tolerance to toxic compounds. One of the example is the

A. euteiches isolated from pea roots is stimulated by pea root exudates compared with exudates of other crop plant [33, 34]

Transferring the some characters from plants and microbes to the different organisms helpful to establish the relationship among various food chain animals. This can be achieved through the genetic determinants that can be genetically modified in crops, probiotic competence can become a target for breeders. Various biotic and abiotic factors also affecting the plant and microbes interaction through different routes. This can exemplified by the action of the probiotic cocktails on the field. Transgenic technology also helpful to improve the interaction among plants and microbes [35, 36].

CONCLUSION

Plant and microbes interaction can be useful for providing the useful products that have been sued as source of foods. Different beneficial plant activities such as phytoremediation efficiency in the form root symbiosis formation by assisting the phytoremediation for the formation of rhizosphere. While on the other hand, microbes increase the growth of plant with soil enrichments of micronutrients by leaching to the different parts of plants organs. Molecular biology and scientific research also leads for the improvement growing beneficial microbes that can increase the yield, and no harmful effects on the plants.

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