Improving Root Development for Young Plant Production

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Producing your own young plants is a good way to save money and control the quality of your plants from the start. Seedlings and/or cuttings are typically grown in individual small cells filled with a limited amount of growing medium. In the greenhouse, growers can control the greenhouse and can have total control over their growth by manipulating the environment. Consequently, using more efficient resources can translate into savings for higher-quality plants.

These savings in horticultural inputs can be even higher with the use of Plant Growth-Promoting Microorganisms (PGPMs) in growing media. Furthermore, plants protected and stimulated by PGPMs can grow and develop at a faster rate, increasing the quality of flowers and fruits, and higher yields, which generate higher profits for the grower.

In a greenhouse, the aerial environment can be controlled by using heating, cooling, supplemental light and irrigation technology. In terms of root environment, young plants grow in high density and in finite volume of substrate with minimum to no microbial activity; therefore, it's beneficial to add PGPMs to produce a healthy root environment and, consequently, a healthy root system. The substrate must be designed to support healthy and strong roots to survive transplant shock and to reach a plant's maximum genetic potential.

Using PGPMs really saves you money

In nature, plants have evolved to live with microorganisms that can be beneficial, pathogenic or saprophytic. In general, they include bacteria, fungi, nematodes, protists and viruses. Unfortunately, pathogens are ubiquitous and they're always looking for a food source. In a healthy soil, beneficial microorganisms are typically higher in numbers than pathogens, keeping them in check so plants can grow without any restrictions. Transplants with newly developed roots are exposed to biotic and abiotic stresses. Therefore, young plants need to use their energy to grow and to resist stress. By using PGPMs, plants have an opportunity to produce higher yields naturally.

Root exudates are the major source of carbon and a food source for root microorganisms, including PGPMs, which can benefit the plant by means of biostimulation and/or biocontrol. This first group of microorganisms helps to enhance plant growth and nutrient availability. The second group of microorganisms is classified as microbial pesticides because they produce antagonistic organic compounds that suppress pathogens.

Generally, plant losses can be attributed to poor water and nutrient management, and plant diseases. PGPMs in the rhizosphere can help plants to increase water and nutrient uptake, to regulate hydric and nutrient deficit, and they can act as biocontrol agents.

Nutrients acquisition

Nitrogen, phosphorus and potassium are used by the plant in greater relation compared to the other essential nutrients. One way to be more efficient in the use of these nutrients, as well as the other nutrients, is by using PGPMs. These microorganisms can acquire most of the nutrients that plant roots cannot obtain by themselves.

In legumes, nitrogen fixation by certain PGPMs can be done by symbiosis or by free living bacteria. In this process, PGPMs help to convert nitrogen to a usable form for plant root uptake. Potassium can be solubilized with organic acids secreted by other PGPMs, which also can be taken up by the plant.

Certain PGPMs can help make phosphorous more available, transport it and translocate it into the plant roots. PGPMs can make potassium available by secreting organic acids that transform organic phosphorus into a soluble form. PGPMs can also mineralize phosphorous by the production of phosphatase, an enzyme that extracts usable phosphorous from organic matter and inorganic forms.

Iron is an essential element for photosynthesis and serves as a food source for microorganisms. PGPMs produce siderophores, which are iron chelating compounds with a high affinity to Fe3+. These chelated compounds allow iron to be taken by the plant.

Phytohormone production

Phytohormone production is another benefit that PGPMs can offer. Phytohormones control plant growth and development, and play an important role in plant defense. The main phytohormones are auxin, gibberellins, cytokinin, ethylene, abscisic acid and jasmonic acid. PGPMs enhance the beneficial attributes of phytohormones. For example, *Bacillus pumilus* PTB180 produces an auxin, which results in a stimulated root system.

PGPMs as biocontrol for root diseases

Direct mechanism

Enzymes produced by certain PGPMs can be used to hydrolyze pathogen cell walls, therefore inhibiting fungal hyphae growth. Some examples are chitinase and glucanase.

Production of antibiotics by other PGPMs are used as biocontrol agents because they suppress the development of plant pathogens. Antibiotics are low weight molecular compounds that have inhibitory and antagonistic effects against plant pathogens.

Production of siderophores can be used as another mode

Pepper seedling in PRO-MIX FPX BIO-FUNGICIDE.

Celery seedling eight weeks after seeding.

Tobacco seedlings at third true leaf, with a competitor's (left) and PRO-MIX BX BIOFUNGICIDE + MYCORRHIZAE (right).

of action to control root pathogens. PGPMs secrete siderophores that bind Fe3+ and convert it into available form for the plant so there's less available for pathogens.

Indirect mechanism

Competition for nutrients and space is a way in which PGPMs can win the fight against pathogens, especially in the root system. PGPMs can colonize the root system faster because plant roots send signals that they're welcome to live in the vicinity of the roots for protection and biostimulation. In a healthy root environment, beneficial microorganisms are going to be in greater quantities than pathogenic microorganisms. This is why it's important to inoculate the root system as soon as the seed germinates or the cutting starts to develop roots.

Strawberry (Cv. Monterey) cutting production in PRO-MIX HPCC 10 weeks after transplant.

PGPMs elicit Induced Systemic Resistance (ISR), a term that refers to defense priming when a beneficial microorganism colonizes the root system. In other words, ISR elicited by PGPMs enhances a plant's defensive capacity. This defense isn't specific to any pathogen and the plant will be on the alert for any pathogen attack for the whole plant. When compared to active defenses or immunization, this kind of defense requires negligible energy by the plant.

It's recommended to use more than one PGPM, but they must have different modes of action and they must be compatible with one another. A good example is the tripartite association between the plant, bacteria *Bacillus pumilus* PTB180 and the mycorrhizal fungi *Glomus intraradices* PTB297. The mycorrhizal fungus colonizes the root system producing hyphae, which serve as root extensions for more efficient absorption of water and nutrients. In return, the plant gives carbohydrates to the mycorrhizal fungus to grow so the hyphae can reach and explore more substrate volume. The bacteria colonize the root system, including the mycorrhizal fungal hyphae, resulting in enhanced root protection and biostimulation, compared to a root system without mycorrhizae.

Finally, remember to use products from professional and reliable companies that offer technical support and warranties. This is another way to use resources and money more efficiently!

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