insideGROWER

FEATURES

11/1/2024

Maximizing Plant Potential: Substrate Innovation Explained

Jose Chen Lopez

Over the last century, most of the research around Controlled Environment Agriculture (CEA) was focused on the aerial part of the plant, with attention to environment, light quality and quantity. For the root system, research was focused more on the physical and chemical properties of the substrates and their interaction with plant needs for water absorption, nutrient uptake and avoidance of phytopathogens. Fortunately, the current century has brought new technologies to study the interaction between plants and their microbiome, especially in the root system.

Below the surface

CEA is an intensive method to grow plants that maximizes their genetic potential to produce ultimate yield, therefore, it's crucial to mimic its natural environment.

Long ago, bryophytes evolved from algae, and since then, plants have benefited from microorganisms that help them acquire water and nutrients. Vascular plants continued to take advantage of beneficial microorganisms for biocontrol, biostimulation and to help with nutrient absorption. The root system is the other half of the plant, and yes, plants still need microorganisms.

During seed germination, the first part of the plant to come in contact with the environment, the growing media, is the root's radicle. This fragile organ needs humidity, oxygen and beneficial microorganisms to develop naturally. Humidity and oxygen are given by choosing a substrate that fulfills plants' requirements and growers' preferences. But the last component must be integrated.

Substrates can be organic (peat moss, bark, coconut coir …) inorganic (perlite, stone wool, expanded clay …) or a combination of them. The use of inorganic substrates may be preferred for specific applications, however, they contain no or limited microorganisms. This lack of beneficial microorganisms can be a disadvantage for the roots to work naturally to fulfill plant needs since phytopathogens are looking for the right moment to colonize a plant organ—in this case, a vulnerable, newly developed root and its exudates are a good place for them to thrive. This is why to maintain a balanced nutrition for the plant with fertilizers many growers use excessive agrochemicals: fungicides to avoid disease and pesticides to avoid insect pests. Adding beneficial microorganisms like *Bacillus* spp. and mycorrhizal fungi species before seed germination minimizes the potential damage of pathogens by growing plants with natural protection and stimulation.

Making the right choices

Choosing the right substrate for a particular application can be a challenge. Choosing the right beneficial microorganisms for a specific plant, mode of action and ensuring compatibility with other beneficial microorganisms can be excruciating.

When choosing and adding beneficial microorganisms to the substrate, growers must ensure that they're viable, that the carrier is compatible, that the application rate is uniform and homogenous within the whole volume of the substrate, and that they're from a reputable company. At the time of mixing, when a substrate is over-manipulated, the physical properties can change drastically. Figures 1 and 2 show how a substrate can be altered in less than one minute in a pot-filling machine.

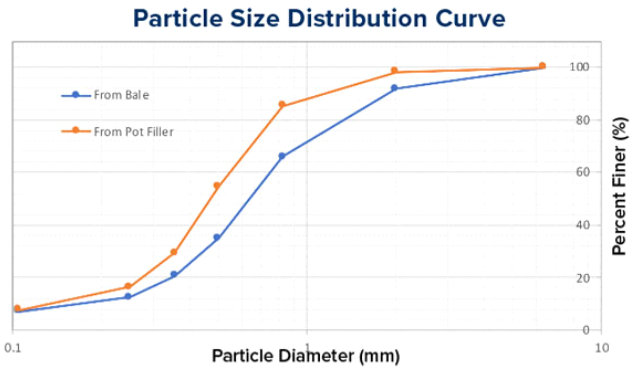

Figure 1. Particle size decreases when mixing beneficial microorganisms in-house.

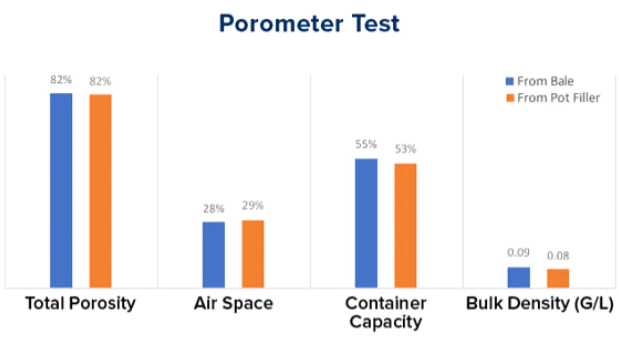

Figure 2. Expected physical properties of a mix change after mixing beneficial microorganisms in-house.

Adding beneficial microorganisms into the mix is expected to help plants grow and develop without any negative effects from biotic or abiotic stress. Yet, by having pots with heterogeneous physical properties and potentially with uneven microorganisms' concentration, the potential problem of water-holding capacity will impact plant growth and development due to uneven drying. For these reasons, it's recommended to buy a substrate with beneficial microorganisms already included.

Premier Tech has been investing in the addition of beneficial microorganisms (active ingredients) to the substrates to save time and effort in the busy lives of growers. By having active ingredients in the substrates, the grower can have peace of mind on homogeneity in terms of beneficial microorganisms' concentration and chemical/physical properties of the substrate.

Beneficial microorganisms/Active ingredients

Bacterium—*Bacillus pumilus* PTB180

Bacillus pumilus PTB180 comes as an endospore that withstands harsh environmental conditions. After its germination, it helps to accelerate seed germination in a favorable root environment. This bacterium is labeled to control specific root rot diseases Pythium, Fusarium and Rhizoctonia; it can colonize a wide range of plant species in 24 to 48 hours.

As a biocontrol agent, it will indirectly compete for nutrients and niches, and outcompete for food and space to avoid pathogen infection, and trigger-induced systemic resistance and prime the whole plant to be alert against pathogens and pests. *Bacillus pumilus* PTB180 produces enzymes, antibiotics and siderophores and secretes a biofilm, preventing cell wall degradation and excluding pathogens.

The use of *Bacillus pumilus* PTB180 is highly recommended for microgreen production because it's a fast colonizer and the benefits can be seen in a short period. Since the plants are protected and stimulated, more

crop cycles are expected per year, which translates into higher ROI. In addition, the grower will have higher yields, better produce quality, more uniform crops and savings in resources such as electricity, water and fertilizers.

Mycorrhizae—*Rhizophagus irregularis* PTB297

The mycorrhizal fungi inoculum *Rhizophagus irregularis* PTB297 forms a symbiotic relationship with the roots in which the fungal hyphae absorb water and nutrients for the plant and the plant gives sugars to the fungi. During this interchange, the net energy usage is positive in favor of the plant. It can be used for a wide variety of applications from plant propagation to long-term crops like tomatoes.

When adding mycorrhizal fungi, the inoculum viability is important because it ensures the germination of the spores. Moreover, the use of viable spores is preferred because it has the longest shelf life compared to propagules that contain hyphae and vesicles. Furthermore, the spore wall helps to withstand harsh environmental conditions and doesn't need a plant to exist. It's important to expose the root system to the mycorrhizae as soon as possible, as the colonization will be more efficient.

Rhizophagus irregularis PTB297 expands the root system up to 10 times, which increases nutrient acquisition and uptake, especially N, P, K, Cu, Fe, Mn and Zn; it also produces phytohormones like auxins and cytokinin to promote growth, thereby mycorrhizae improve overall plant performance.

Combining bacteria and mycorrhizae

After several years of research on the synergies of different beneficial microorganisms, scientists at Premier Tech concluded that the bacteria *Bacillus pumilus* PTB180 and the fungi *Rhizophagus irregularis* PTB297 are fully compatible. This interaction between the beneficial microorganisms and the plant is called the tripartite association. The plant gives carbohydrates to the fungi, the fungi explore the substrate exuding carbon, the bacteria absorb this carbon and multiply along the hyphae and liberate lipopeptides and hormones, protecting and stimulating the plant.

With this tripartite association, the plant benefits from both microorganisms in the following ways:

- Via a protective barrier around the extended root system
- Protection against certain root rot diseases
- Increased plant growth survival and productivity

Those active ingredients are produced in an aseptic production facility under rigorous quality assurance by Premier Tech under the AGTIV brand and are integrated into PRO-MIX growing media. These solutions allow growers to save on labor, energy, agrochemicals, etc., while increasing the yield, quality and quantity of fruits and vegetables resulting in higher ROI and healthier, high-quality produce.

Jose Chen Lopez is a Horticulture Specialist at Premier Tech. Jose holds a bachelor's and master's degree in Soils and Irrigation, as well as a Ph.D. in Agricultural and Biosystems Engineering, specializing in Controlled Environment Agriculture. His academic background informs his technical demonstrations, coaching sessions and problem-solving approach, all focused on delivering optimal solutions to help customers overcome their specific challenges.