

A quarterly publication for growers

# BOTANICARE® GROW GUIDE

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The unseen world of  
**Microbes**  
in grow media

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A quick guide to taking a cutting

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Q and A on mycorrhizae fungi



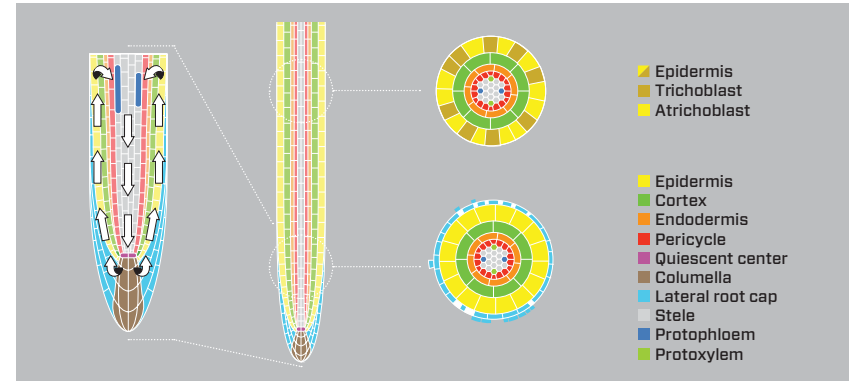
# AUXIN & ROOTS

Auxin's importance in root stimulation from plant cuttings by Brandon Jewell

Auxins are a class of plant hormones that are involved in all phases of plant growth and development, but are most commonly associated with the stimulation of roots from plant cuttings.

The majority of naturally occurring auxin in plants is indole-3-acetic acid (IAA) produced in the new growing points, hence the word “auxin” is derived from the Greek word “auxein,” meaning “to increase” or “to grow.” Other than the initiation of new roots, auxins are also responsible for cell expansion and division and have shown to be involved in shoot elongation, adventitious root development, fruit and flower development, and tropisms (plant movements).

The amino acid tryptophan is the precursor for indole-3-acetic acid and other indole derivatives known as auxins. The most common forms of synthetic auxins are indole-3-butyric acid (IBA) and naphthalene acetic acid (NAA). While there are naturally derived auxins, such as IAA, they are generally chemically unstable once extracted from the plant and thus are not typically used in rooting compounds. The effective exogenous application rate of IBA or NAA has been shown to be between 500-2000 ppm for herbaceous cuttings up to 10,000 ppm for difficult to root hardwood cuttings. When calculating the percentage of IBA or NAA simply multiply the percent of auxin on bottle by 10,000 to convert from percentage to ppm. So for a product that shows 0.3% IBA, the product would contain 3000 ppm IBA in solution.



When a cutting is taken from a plant, the auxin (mostly IAA) that was stored in the new growing point of the cutting (apical meristem) is transported towards the freshly cut end to begin the process of cell differentiation to initiate root cell development. While the plant contains small amounts of auxins stored in the newly expanding tissues of the plant, adding an auxin compound directly to the cut portion of the plant where new roots will increase rooting potential. This is why growers who propagate plants from cuttings will utilize rooting gels, powders, and dips that contain auxin to increase root initiation and vigor of root formation.

# CUTTING 101

by Douglas Marvin

A cutting, also called a clone, is a genetically identical plant produced asexually from a parent plant.

Identifying a plant with a desirable trait that you would like to reproduce is the first step.

Once you've identified a trait you would like to preserve, it's time to take a cutting, but first make sure you have all the right tools for success!

## The ABC's of cuttings

**A** Always keep all equipment fully sanitized before, during, and after taking clones. Cuttings are vulnerable to plant pathogens which out-compete the plants for nutrients, and can infect and kill the cutting.

**B** The maximum length of the cutting should be 5".

**C** Use a razor or shears with a very sharp blade(s) to limit the stress on the plant. Always disinfect the blade before each use. Never use dull scissors. They can bruise or damage the cells that are being cut, which causes unnecessary stress. The less stress the better!



Equipment Checklist:

Blade (do not use dull scissors)

Rooting gel or liquid clone solution

Cut kit tray or aeroponic cloner (both with or without a dome)

Medium (peat plugs, Rockwool, coco plugs, neoprene inserts, perlite)

Sealable watering container

Spray bottle

Seedling mat, with automatic thermostat

## ✚ Caring for your new cuttings

- If using an aeroponic cloning machine, the pump should run 24/7. Do not use a cycle timer to turn the pump on and off.
- Use a vented clone dome to allow for better air flow, and to help prevent overheating.
- At least once per day spray the leaves of the clones with pH adjusted water (5.8-6.2) to keep them well hydrated. Cuttings do not yet have roots therefore they cannot uptake enough water to keep up with their demands.
- If growing in a kit tray check your cloning substrate daily to make sure it stays moist.
- Monitor reservoir pH regularly and adjust as necessary.
- Roots should form in approximately 2 weeks.
- When a fibrous root system has formed transfer clones into your grow substrate.

## MAKING THE CUT

1

Start by selecting a healthy, vigorously growing region of the mother plant, ideally below an internode.

2

Slide the blade along the stem lengthwise in a slicing motion at a 45 degree angle to ensure the cleanest possible cut.

3

Apply a rooting hormone such as a gel, solution, or powder to the freshly cut end of the plant material.

4

Immediately place the treated clone into your cloning substrate (Rockwool, Aeroponic cloner, Peat plug, Cocogro® Plug).

**Rockwool-** presoak and pretreat the cubes prior to use.

**Peat or Cocogro plugs-** moisten prior to use.

**Aeroponic cloners-** (Power Cloner®)  
•Sanitize entire unit prior to use.

•Fill unit with a solution of Botanicare Power Clone solution or other cloning product, start unit and carefully place one cutting in each neoprene insert.

•After approximately 10 days replace with fresh Power Clone Solution if cuttings are not ready for transplant.

5

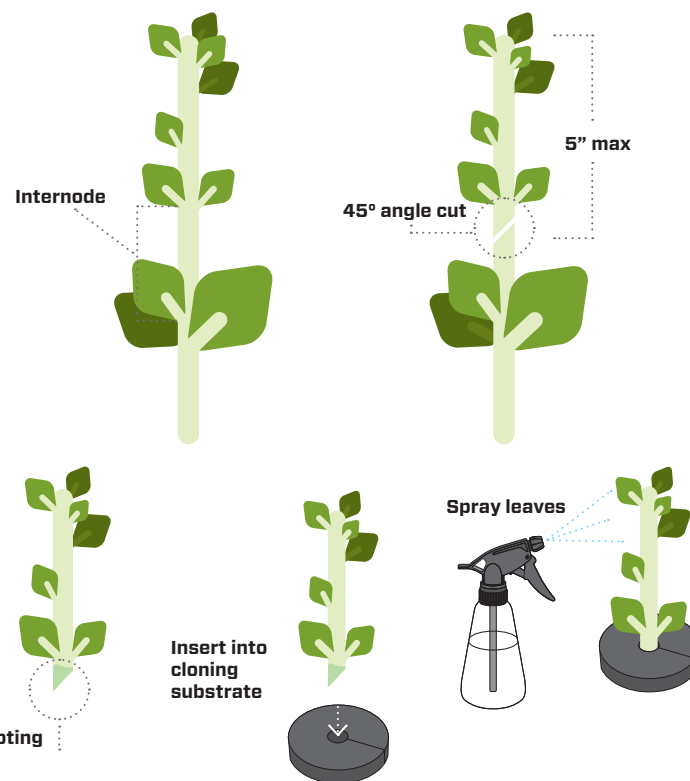
Spray the leaves of the clones with pH adjusted water (pH of 5.8-6.2).

6

Place the cut kit tray, with the clones, on top of the heat mat and set the temperature at 78 degrees and add solution accordingly.

7

Place dome over cuttings.







# The Unseen World of Microbes in Grow Media

by Perry O. Gooch, PhD

**This community of living organisms is essential to maintaining soil and plant health.**

**In one tablespoon of healthy soil there are as many organisms as there are people on the Earth.**

Soil microbes perform many functions in maintaining fertile plant grow medias including; storage of nutrients, filtering and buffering contaminants, regulating water usage, protection from pathogens, recycling plant wastes, formation and stabilization of soil aggregates and providing a habitat for beneficial micro flora and fauna. This microbial community has often been called the Microbial Food Web and, when in balance, it protects plants from diseases and pests and stimulates plant growth functions.

## What makes up this microbial community?

Grow medias contain a large variety of microorganisms which include; bacteria and fungi, protozoa, nematodes and other microbes. However, the largest group of these microorganisms are various bacteria and fungi. They have been classified into several functional groups depending upon their main activity. Microbial functional groups include; Aerobic and Anaerobic Bacteria, Fungi, Actinomycetes, Pseudomonads and Mycorrhizae Fungi.

There are many other specific types of microbes that are specialists such as cellulose degraders, nitrogen fixers, denitrifiers, pathogen inhibitors and hundreds of thousands more.

### Examples of microbial functions in the soil:

*Plants cannot function properly without help from some of these microbes.*

- 1 Heterotrophic bacteria** make up a majority of the microbes in growing systems. They are responsible for many functions including; storage of nutrients and water, the breakdown of simple carbon compounds into plant available forms, formation of soil structure, release and stimulation of plant growth compounds to name a few. They are a major indicator of Grow Media health.
- 2 Mycorrhizae fungi** attach to plant root systems. They are essential for helping the plant uptake certain minerals such as Phosphates and Calcium as well as protecting the plant from diseases. These fungi are also responsible for breaking down more resistant organic compounds like cellulose, lignin, lipids and pectin materials. Fungi, along with earthworms, are some of the main aggregate builders in soil systems. Mycorrhizae fungi are very important for root development and growth. They usually colonize the root systems of plants and help store nutrients for the plant.

There are thousands of different types of Mycorrhizae fungi and they are generally specific to each type of plant. In addition to collecting and storing nutrients, they also protect the plant from many pathogens and predators such as nematodes and root feeding bacteria and fungi. A plant will often send more than 50% of its photosynthetic sugars to the roots to attract these important fungi.

**3 Actinomycetes** produce plant antibiotics. They are agriculture's main plant protectors. They produce and release antibiotics and other compounds that inhibit the growth of plant pathogens. Actinomycetes give soils their "earthy" smell. If you grab a handful of soil and it has a good earth smell, this is an excellent indicator of a strong, healthy microbial system.

**4 Nitrogen-fixing bacteria** Like *Azotobacter*, *Azospirillum* and *Rhizobium* are examples of bacteria that convert atmospheric nitrogen into nitrogen compounds used by plants to synthesize proteins. They are often associated with plant roots although there are many genera of nitrogen fixers in good grow media. They are an essential part of the nitrogen cycle, which keeps plants growing.

### 5 Pseudomonads

These organisms are nutritionally versatile and capable of degrading many natural and synthetic organic compounds. Pseudomonads are typically aerobic and contribute to the decomposition and nutrient release process by attacking a wide variety of organic substrates including humic acids and synthetic pesticides. Certain pseudomonads have been linked to the biological control of plant pathogens.

## Checking your Grow Media's microbial health.

You can check the diversity and strength of your grow media's microbial balance by having a microbial bioassay done. Bioassay laboratories such as MBS (Mineral Bio-Science), A&L Labs or Midwest Laboratories will check your medium for microbial species strength and classification by functional grouping. It is as important as nutrient balance to know your grow media's microbial content to understand what is needed to generate bio-active mediums for maximum plant growth and health.

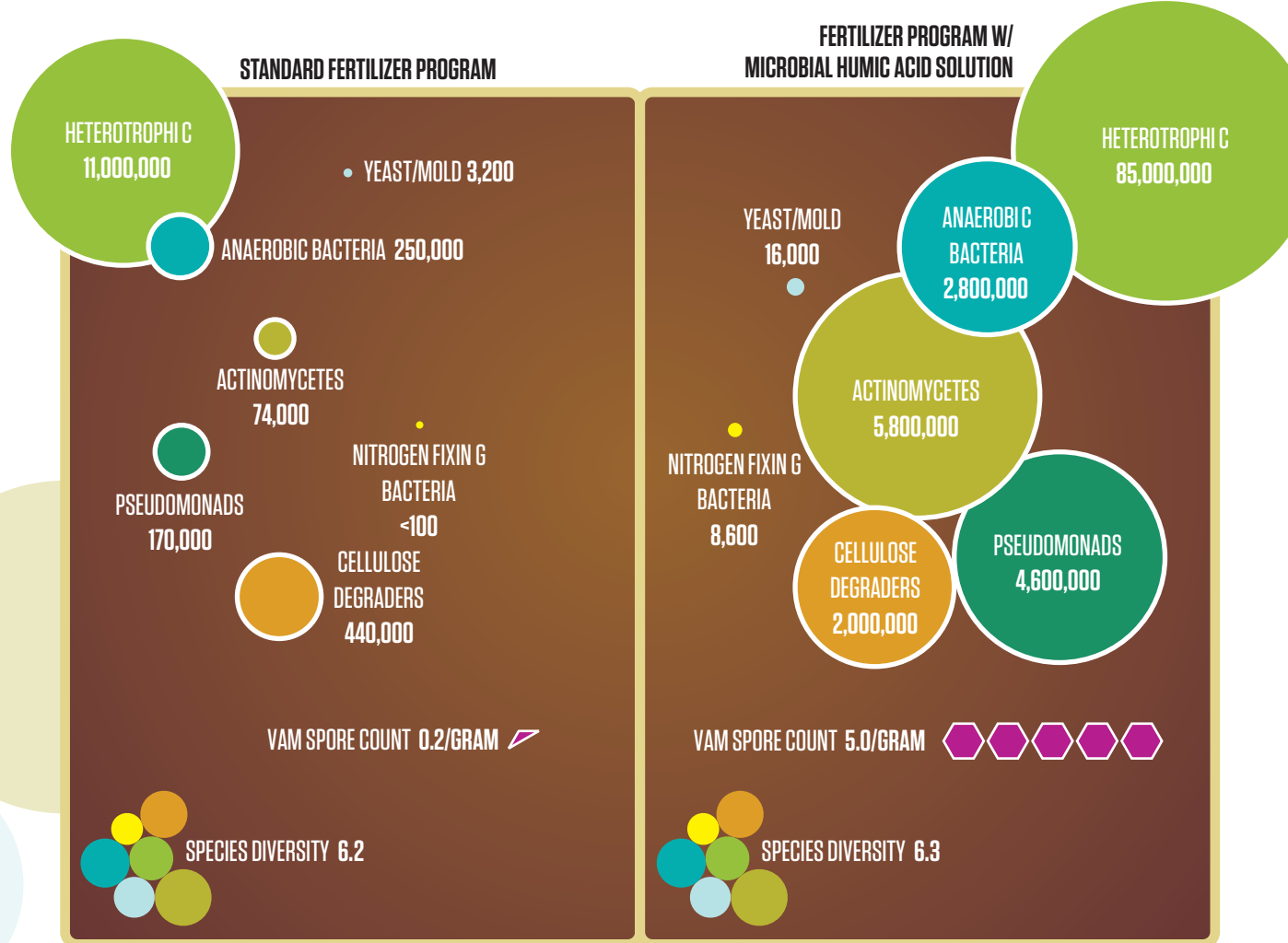
## How do you increase microbial diversity and strength?

Microbial organisms are what produce an environment that will make your grow media perform to highest level. Beneficial microbes are essential to any plant growth environment. It is important to continually stimulate the growth of beneficial microbes. Some of the foods microorganisms need are simple sugars, proteins and carbohydrates, which can come from molasses, fish emulsions, seaweed compounds, organic acids, composts and compost teas and other organic materials. Beneficial microbe populations can be best inoculated by adding to your grow media the above mentioned materials, which stimulate the indigenous populations rather than add foreign microbial inoculants. External microbial inoculations sometimes do not work as well as just building up the indigenous microbial populations. Inoculants often merely become food for the local microbial populations who have acclimatized to the existing grow media.

## Increasing microbial diversity.

Recently, Parson/Pavich Consulting conducted a research project on vegetable fields in Salinas, CA. The researchers selected two large fields and set up a control field and a test field. A bioassay microbial count in colony forming units (cfu) by functional groups was done prior to planting and after harvest. The control field was treated with a conventional fertilization program, which included high levels of nitrogen and phosphorus applications. In the test field the chemical NPK fertilizers were reduced by 50% and the researchers added a microbial based humic acid and seaweed application. Once the harvest was completed the researchers found some dramatic results. The microbial counts in the test area showed increases of 10 to 100 times higher than the standard fertilizer program (see graphic). In addition to increased microbial counts they found no disease in the test plots versus high levels in the conventional NPK fertilized field. The test area produced larger plants at a much lower cost due to the reduction in synthetic chemical NPK fertilizer and pesticide application.

As growers, we should be aware that by enhancing the diversity and strength of the microbial communities in our grow media, we will have healthier plants, less disease and increased utilization of nutrients applied to our crops.



# Magic Myc

Q and A on beneficial fungi by Brandon Jewell

## How do mycorrhizae help with availability and uptake of essential plant nutrients?

Mycorrhizae help increase the availability of essential plant nutrients in the plant root zone by producing organic acids and enzymes that chelate minerals from an insoluble form, into a form that plants can easily uptake. The small size of mycorrhizal structures when compared to plant roots, allow them to penetrate smaller particles, and colonize spaces in the growing media that roots could otherwise not occupy nor be able to penetrate. Mycorrhizae act as an extension of the plant root network which increases the ability of the plant to take up water and nutrients. Mycorrhizae also produce enzymes and organic acids which can break chemical bonds such as phosphorus, iron, zinc, and calcium, making them more available for the plant.

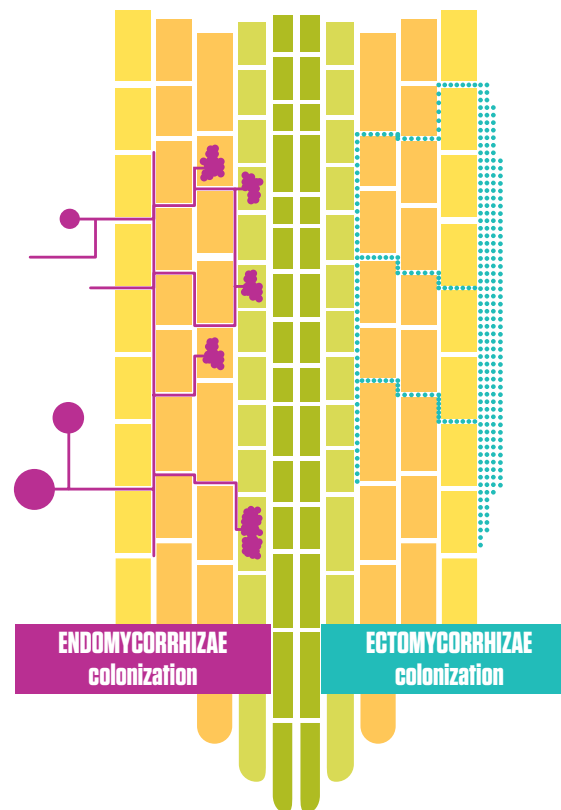
## Ectomycorrhizae vs Endomycorrhizae- What's the difference and what should we be using?

To better understand Mycorrhizae, it is important to learn more about how each type interacts with the plant. There are two main groups of beneficial mycorrhizae, **ectomycorrhizae** and **endomycorrhizae**. Each group has a very specific type of plant that it can interact with. Ectomycorrhizae, from the Latin meaning “outside fungi”, forms a sheath on the outside of the plant root and are most often found on woody plant species such as trees or shrubs. Endomycorrhizae, from the Latin meaning “inside fungi”, will physically grow into the plant root and become an extension of the root itself. The endomycorrhizae members are most often found on herbaceous plants such as flowers, fruits, leafy greens, and grasses. Studies have shown that more than 90% of all plants will form a relationship with

endomycorrhizae. In short, this means that for those growing fruits and flowers, endomycorrhizae are a much more desirable inoculant to increase yields, and overall plant health.

## How do the properties of growing media (composition material, organic matter %, and pH) affect the colonization of beneficial mycorrhizae?

The composition of the growing media affects the rate and success of mycorrhizae colonization based on percentage of organic matter, pH, temperature, CO<sub>2</sub> concentration, and available moisture. Higher percentages of organic matter in the growing media will increase the rate of colonization growth by the mycorrhizae. At a high pH, low pH, or a pH that is outside the range of the host plant, the growth of the



mycorrhizae will be decreased. In addition, the lower the temperature of the growing media the slower the mycelium growth, while higher temps increase the rate at which mycorrhizae multiply. There is also a correlation between the concentration of CO<sub>2</sub> in the atmosphere of the host plant and the rate of mycorrhizal growth due to the accelerated rates of photosynthesis by plants in enriched CO<sub>2</sub> environments (>400 ppm). The amount of free water in the root zone will also effect the growth of mycorrhizae which thrive in moist media.

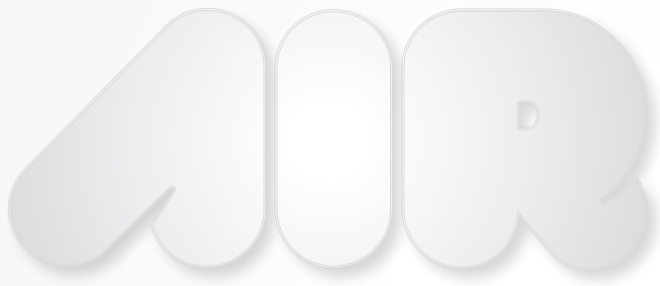
## Why are amino acids so effective when used in combination with beneficial fungi?

Amino acids, such as glycine, are sometimes blended with mycorrhizal inoculants to increase their effectiveness when applied to the plant. All amino acids contain organic nitrogen which acts as a food source for endomycorrhizae, giving them a “starter food” until they can expand their threadlike structures called mycelium, to acquire free nitrogen in the root zone.

## Are Endomycorrhizae compatible with *Trichoderma*, *Bacillus*, and other species of bacteria/fungi, or are certain types overly dominant?

In nature, different types of fungi and bacteria play specific roles and work in synergy with each other, and their environment. While mycorrhizae do have some ability to contribute to disease resistance, they cannot legitimately be classified as biocontrol agents against plant pathogens. This is where other beneficial microbes, such as the fungal species *Trichoderma* or the bacterium *Bacillus*, become important to also incorporate. These organisms have a targeted purpose against pathogenic fungi and bacteria and are generally more aggressive than mycorrhizae for disease suppression in the plant root zone.





## The Invisible Key to unlocking your plants' potential

by Alex Schroeder and Brandon Jewell

More often than not, growers focus on the basic necessities for plant growth that are easily controlled: light, water, temperature and plant nutrients. Just because air cannot be seen, does not mean that it is not a critical element in the growth and development of plants. The benefits of increasing carbon dioxide (CO<sub>2</sub>) levels for the leaves, flowers, and fruits of plants is well understood, but often overlooked are the air levels in the form of oxygen (O<sub>2</sub>) that can drastically affect plant growth and development.

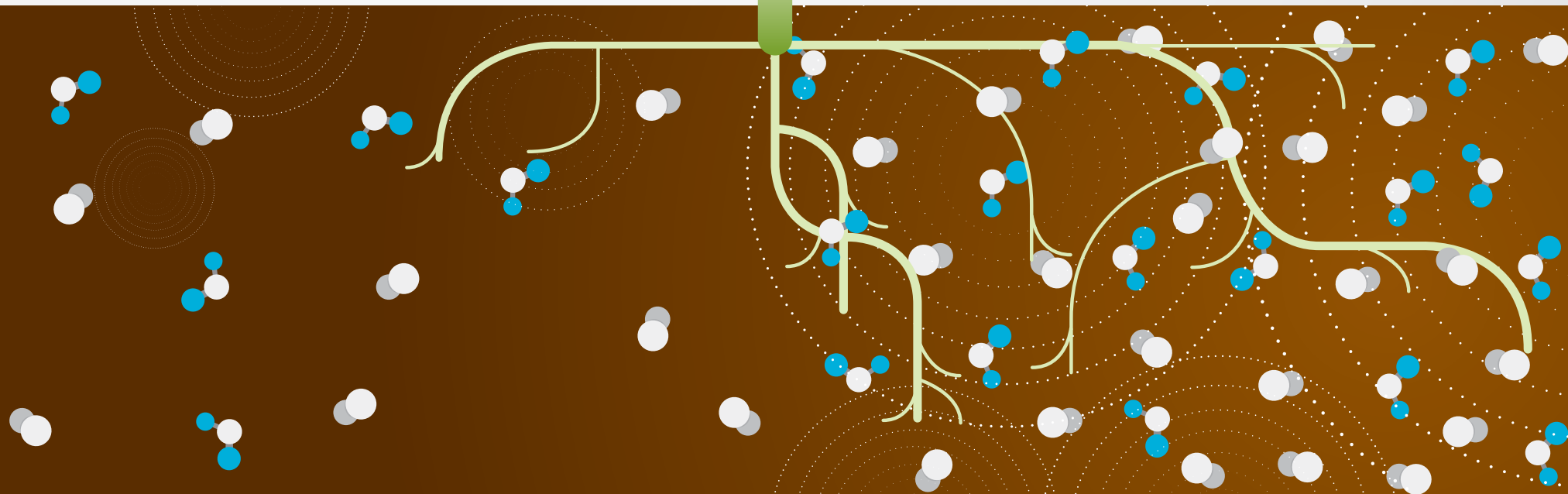
Factors that contribute to oxygen levels in the plant root zone can be affected by the physical characteristics of the growing substrate, the temperature of the root zone or nutrient solution, and the frequency of irrigation (watering).

The primary physical characteristics that can influence the oxygen levels of a growing substrate are water holding capacity and particle size determining pore space. If the water holding capacity is very high, such as in a peat-based substrate, the growing medium will retain higher than optimal levels of water versus available oxygen essentially suffocating the plant roots. The particle size of a growing media will determine the amount of space between the particles, which affects the amount of free oxygen in the rhizosphere (root zone). The more compacted and moist the growing media is, the less oxygen the plant roots have the potential to absorb.

*Just because air cannot be seen, does not mean that it is not a critical element in the growth and development of plants.*

The temperature of the root zone or the nutrient solution will affect the amount of free oxygen for plant roots. While there are various plants that thrive in different environments, most cultivated plants have an optimal root zone temperature between 65-75° F. At temperatures above and below this optimal range, the uptake of both water and plant nutrients is decreased due to limited oxygen to the plant roots.

The frequency and amount of nutrient solution or water applied to the plant root zone is also related to oxygen availability for plant roots. Determining the optimal amount and timing of irrigation is a balancing act that is dependent on the water holding capacity of the growing medium, the size of the plant being grown, and the temperature of the growing environment. Keeping an eye on these factors will allow a grower to maximize oxygen levels and increase plant growth.





Rhizosphere root inoculant

# ZHO<sup>®</sup>

For seedlings &amp; transplanting in coco, soil, and hydroponic applications



ZHO is a unique, proprietary blend of beneficial Endomycorrhizal fungi, Trichoderma fungi and highly available L-Glycine amino acids. ZHO was formulated specifically for fruit bearing and heavy flowering plant types. ZHO promotes new root growth, and improves plants' ability to uptake water and nutrients.

**Benefits:**

- Improves rooting
- Improves soil structure
- Increases nutrient uptake
- Increases root mass
- Water soluble

**Use for:**

- Seedlings
- Transplanting in coco, soil and hydroponics

**Directions:**

For best results reapply ZHO to each plant site using the appropriate method every 2-4 weeks after the initial treatment.

**For seedlings & transplanting:** Apply 1/4 teaspoon of ZHO at the base of each plant site. Place plant or seedling directly on top and replace soil or media to cover roots or seedling.

**Coco/Soil topfeed application:** Mix recommended amount of ZHO with a small amount of water and drench soil or coco with the liquid mixture.

**Hydroponic application:** Mix 1 tsp per 10 gallons of nutrient solution.

Note: Use protective equipment as needed (glasses, gloves, and dusk mask)

DO NOT USE in conjunction with Hydrogen peroxide.

Bacillus root inoculant

# HYDROGUARD<sup>®</sup>



Hydroguard's unique formula, available exclusively from Botanicare, contains an isolated form of Bacillus bacteria known as *Bacillus amyloliquefaciens*. This scientifically isolated bacterium was selected for its superior ability to amplify root mass and vigor, especially in hydroponic gardening, when compared with the more common and well known Bacillus Subtilis species. Upon application, the highly concentrated and pure culture of Bacillus bacteria contained in Hydroguard rapidly colonize the rhizosphere. These highly specialized rhizobacteria assist in the breakdown of organic materials, and increase nutrient availability.

**Benefits:**

- Hydroguard helps maintain a clean system 100% naturally.
- Helps reduce and prevent the buildup of slime and toxins near or on the roots.
- Hydroguard breaks down nutrients and makes them readily available for the plant.
- Roots will uptake nutrients more easily as needed, reducing the likelihood of excess nutrients.

**COCOGRO<sup>®</sup>**  
**CLONING PLUGS**  
 Premium coco coir plant starters



Cocogro<sup>®</sup> Cloning Plugs naturally maintain the ideal air to water ratio for accelerating rooting time and establishing vigorous clones.

**Benefits:**

- Available exclusively from Botanicare<sup>®</sup>
- Ideal for transplanting into coco, soil and hydroponics
- Ready to use and pH balanced
- Contains no peat
- Made with premium, high pith, double washed, buffered coconut coir

**Cocogro Cloning Plugs vs the competition:**

- Clones need air to form roots quickly. Cocogro Cloning Plugs provide 10% more oxygen to the root zone than competing plugs which can become easily over saturated. This increased air to water ratio decreases rooting times and promotes explosive growth of new roots.
- Due to the natural strength of coco coir and the unique binding agent used in Cocogro Cloning Plugs, they retain their structure and won't degrade and fall apart like competing rooting plugs.
- Completely peat free. Peat based products commonly harbor mold and pathogens. The excessive moisture content in competing peat based plugs creates an anaerobic (oxygen deprived) environment which leads to the growth of algae and stem rot.
- Cocogro plugs are 100% coco coir based, so they will not become water logged like competing plugs.
- Cocogro Cloning Plugs are fortified with worm castings, to establish strong and vigorous clones.
- Cocogro Cloning Plugs are easy to rehydrate, even if they completely dry out. Other plugs become deformed and shrink when this occurs.