



MAINTAINING A HEALTHY ROOT ZONE

Plant roots have two basic functions: they anchor plants and they extract water & minerals. The roots are arguably the most important part of a plant as root mass is directly proportional to the size and yield of a plant. This is one of the most easily damaged parts of a plant. It is crucial to practice good preventative care - it is much harder to eradicate an existing problem. If you want to maximize the the health & ultimate yield of your plants, it is wise to have a clear picture of the crucial activities occurring at the root zone.

Root-Microbe Symbiosis

A plant actually grows its own garden of microbes along the surfaces of the root. To do this, the light energy captured from photosynthesis in the leaves is channeled down the stem through the phloem vessels and out through epidermal cells to the external root surface. Up to 80% of the total plant energy is exuded as mucigel into the *ectorrhizosphere* as carbohydrates, amino acids, and other energy-rich compounds. Billions of bacteria, fungi, algae, actinomycetes, protozoa, and other microbes feed upon this exudate.

Those Phenomenal Mycorrhizae

Especially important are the mycorrhizal fungi which extend their thread-like hyphae from inside root cells out into the soil for several millimeters. They extend the feeding volume of a root by 10 to 1,000 times or more bringing nutrients back to the root. There are two types - *ectomycorrhiza* and *endomycorrhiza*.

Feeding On Exudate

In return for the release of nutritional substances from plant roots, microbes produce chemicals that stimulate plant growth and/or protect the plant from attack. This large array of substances include auxins, enzymes, vitamins, amino acids, indoles and antibiotics. These complex molecules are able to pass from the soil into the plant, with minimal change to chemical structure, where they stimulate plant growth, increase metabolic functions and enhance plant reproduction. As these molecules are released into the rhizosphere, they serve as food and growth stimulants for a healthy mix of microbes.

The rhizosphere is always functioning for the plant whether it is growing in a field, in a planter, in a hydroponic media, or even in a lake or ocean. The details of function may differ somewhat, but the principles are the same in order for the plant to survive.

General Root Tonics And Stimulators

Advanced Nutrients B-52: Formulated to give plants a boost of energy by raising the rate of metabolism, **B-52** increases nutrient uptake by providing naturally occurring hormones and vitamins which are missing in macro / micro hydroponic nutrient formulas. **B-52** can be used during a plants' entire lifetime from seed to harvest. **B-52** is ideal for hydroponic, soil or any other growing medium.

CANNA Rhizotonic: An organic root stimulator, **Rhizotonic** is suitable for both soil and hydroponics. This is a powerful, organic stress-reliever which provides hormones and vitamins to help stimulate new fuzzy, white root development, increase resistance against disease and improve the vigor of plants.

Roots Excelerator: The strongest product we have for preventing and combating Root Disease. Comprised of Beneficial microbes and a proprietary blend of other beneficial molecules, nothing works as well as Excelerator. It will blow roots - WAY OUT - within 3-5 days and keep them Super Healthy the entire cycle.

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Root Health and Pathogen Control

In a healthy root environment, "microherd" groups of microbes colonize the *rhizosphere* of the plant. Most are beneficial bacteria and fungi; they do not damage living plant tissue and are critical to making essential minerals available to the plant. These microbes retain large amounts of nitrogen, phosphorous, potassium, sulfur, calcium, iron and many micronutrients in their bodies, preventing these nutrients from being leached or removed by water runoff. Mycorrhizal fungi form an almost impenetrable physical barrier on the surface of plant roots - Ideally, they out-compete pathogenic species. It is usually only when the beneficial species are killed by toxic chemicals that pathogenic species have an advantage.

In hydroponics we can promote a plant's rhizosphere capability by insuring it has the proper minerals, as well as a well aerated root zone to allow for good air and water movement. We strongly suggest using **Roots Excelsior**, the strongest Root Tonic that we have ever come across - not only does it create a HUGE amount of roots - it keeps them extremely happy and healthy as long as you use it. It is a powerful, organic stress-reliever which stimulates new root development, increases disease resistance & improves plant vigor.

Root Rot and Pythium

"Root rot" is a generic name for several common opportunistic waterborne diseases that can seriously affect indoor and outdoor crops year round. "Pythium" is the name of one of these diseases and is also used as a generic term for several different root rot and stem rot fungus species (including *Pythium*, *Verticillium*, *Phytophthora*, and *Fusarium*). The term "damping-off" is also often used and usually applies to disease in seeds, seedlings and clones. Whatever you call them, these diseases attack the roots of a plant and can rapidly infect crops in all stages. Damage includes reduced yields and crop failure. Pythium is particularly damaging in recirculating hydroponic systems as the reservoir provides ideal conditions for rapid growth and spread of infectious spores; a single infected plant can breed and send spores to all the plants.

The best thing is to prevent root rot from ever taking hold in the first place. It is an opportunistic disease which means that it is looking for sick, injured or weakened plants. Pythium is almost impossible to 100% eradicate from an infected system; this would involve starting completely over. It is probably present even if undetected... just waiting for its chance to get a foothold. This can be why a previously successful grower has suddenly started experiencing problems.

Spotlight on Enzymatic Formulas

Small, yet amazingly powerful -- enzymes have a variety of important benefits for the grower. There are two types of enzymes that we are most concerned with: There are those that accelerate sugar/ resin production, creating flavor and aroma. Then, there are those that break down dead plant proteins (leaves and roots) into amino acids, lipids and smaller molecules which can be reabsorbed by the plant and the beneficial microbes, thus preventing those proteins from being food for pathogens.

Hygrozyme: This is a great enhancing enzymatic formula. It prevents the formation of pythium and algae, and facilitates chemical nutrient assimilation. It will also create healthy white root growth in your plants. Hygrozyme is not a digestive enzyme solution, rather a plant growth & metabolism stimulant.

SensiZym: This is a super concentrate of over 80 different enzymes, each having specific functions that enhance plant and root growth. Great for soil or hydroponics, SensiZym is made to work with all beneficial microbes (Pirahna, Tarrantula, Vermi-T, Great White, and Voodoo Juice) SensiZym not only breaks down plant proteins, but also provides enzymes that are a catalyst for total plant and root development.

Cannazym: simply put, is the strongest digestive enzyme product on the market. It digests dead or dying root matter like no other can (which in turn greatly helps at keeping your root zone healthy and strong.) Use with Hygrozyme for a explosive combination!



Some of the main Beneficials at the Root Zone

Bacillus

Certain forms of Bacillus are known to inhibit *pythium* and other pathogens. One of these is *bacillus subtilis* and is found in **Aqua Shield**, **Tarantula** and **Great White**. Several varieties of *Bacillus* have been found to play a role in the conversion of unavailable forms of phosphates into plant available forms. In natural settings they can provide near 10% of the available phosphorous in the soil solution. *Bacillus* can function as a back up, providing hungry blooms with phosphorous if they should become otherwise unavailable. *Bacillus* actually cleans the roots & disinfects them, also helping to synthesize hormones & enzymes.

Mycorrhizal Fungi

These fungi colonize the outer cells of plant roots and extend long fungal threads, or *hyphae*, far out into the rhizosphere, forming a critical link between the plant roots and the growing media. Mycorrhizae produce enzymes that decompose organic matter, makes phosphorus and other nutrients from inorganic rock, much more soluble, and convert nitrogen into plant available forms. They also greatly expand the area from which a plant can absorb water. In return for this activity, mycorrhizae obtain valuable carbon and other nutrients from the plant roots. This is a win-win mutualism between both partners, with the plant providing food for the fungus and the fungus providing both nutrients and water to the plant.

Nitrosomonas Bacteria & Nitrobacteria

Nitrosomonas is a species of aerobic bacteria which converts ammonia to nitrite. *Nitrosomonas* is one of the critical bacteria in the nitrogen cycle. *Nitrosomonas* eat ammonia, they absolutely LOVE it. They convert plant available ammonium (NH₄) to unavailable nitrite (NO₂). *Nitrobacteria* then convert the nitrite (NO₂) into nitrate (NO₃-), an important form of highly absorbable nitrogen that all plants need.

Trichoderma

Trichoderma fungi have been observed physically attacking and destroying pathogenic fungi. Strains of trichoderma are found naturally occurring in many soils and play a role in the prevention and control of root pathogens. *Trichoderma* can degrade chitin, a structural component found in pathogenic fungi and in insects. Many forms of coco coir contain *Trichoderma* naturally, such as **CANNA's Coco Growing Media**. If a healthy root environment is maintained, the bacteria will continue to colonize the roots and multiply.

A note about Colonizing Growing Media:

If you are using beneficials, you will want to use one of the growing media that is hospitable to inoculation, such as coco or rockwool or Soil. Although rockwool works, It is not as aerated as the coco. Coco also has naturally occurring enzymes which are GREAT! for roots, and is a natural habitat for *Trichoderma*. There are great coco net cup liners which can be filled with a combination of perlite/pumice and coco coir.

How to Avoid a bad case of Root Rot

- Monitor plants and roots frequently
- A clean system – change the reservoir regularly. Preferably run “Drain to Waste”(See **-Info Sheet**)
- Keep reservoir **between 66 - 68 deg F** to maximize root growth, O₂ levels & inhibition of pythium
- Constant aeration – maintaining high dissolved oxygen levels inhibits pathogens & accelerates roots
- Keep a lid or black plastic cover over your reservoir to keep plant matter and light out
- Use Ro Water with a UV sterilizer. This will ensure a pathogen free water supply
- Use prevention!! Use tank additives to give your roots the edge they need
 - Enzymes: **Hygrozyme, SensiZym, Cannazyme, or MultiZym**
 - Beneficials: **Fungal - Piranha & soluble root enhancer, Vermi-T, Voodoo juice, Tarrantula**
 - Tonics: **Roots Excelerator, Liquid Karma, or Rhizotonic**

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Using Good Microbes to fight the Bad Ones

There are countless beneficials and they have a vast variety of functions, ranging from the breakdown of nitrogen into useable forms, to cleaning the roots, to warding off negative microbiological pathogens. These good microbes also activate, enrich & stimulate the roots - **They help to create beautiful fuzzy white root growth like you have never seen before.** The new array of products on the market can be confusing and misleading. We sell products that we have personal experience with and really believe in. Some of them can be mixed and matched:

Vermi - T - This is a powerful blend of over 30,000 microbes, including Mycorrhizae, Trichoderma, Beneficial bacteria, Ciliates, Protozoa, and nematodes. It is very effective at building a healthy root zone and warding off pathogens, synthesizing a cornucopia of hormones & enzymes for faster, fuller, stronger and BETTER growth.

Plant Success Soluble Root Inoculant: A soluble blend of humic acid, endomycorrhiza and ectomycorrhiza. Also has a host of beneficial bacterium. A fine powder that dissolves. For soil or coco.

Piranha: Colonizes the root zone with 26 beneficial fungi. These fungi are 8 species of trichoderma and 18 species endo and ecto mycorrhizal. These are very aggressive colonizers that enhance root mass, and provide excellent control from root rot, pythium and phytophthora. Use with **Tarrantula & Voodoo Juice**. Increase root mass by up to 700% This is the only form that can be used in a reservoir with hydroponics.

Tarrantula: A bacterial blend of 57 microorganisms. This rich blend contains *Bacillus*, *Streptomyces*, *Actinomycetes*, and *Pseudomonas* for massive plant growth. Forms a symbiotic relationship with root zone.

Voodoo Juice: A liquid solution consisting of five strains of microbes, one which is a nitrogen fixer. Also contains *Bacillus subtilis*. These microbes colonize the roots, facilitating the conversion of nutrients.

Great White: Excellent product that combines very fine (weaponized) mycorrhizae, and trichoderma fungus with a wide assortment of Beneficial bacteria. Can be used in a Hydroponic Reservoir or hand watered with Soil / Coco.

Roots Excelsior: This is the strongest all around product we have at preventing and combating Root Disease. It will blow roots WAY OUT within 3-5 days and keep them Super Healthy throughout the cycle.

Gleco – a blend of root stimulating fungi that “coats” the root system. This blend facilitates nutrient uptake while simultaneously providing protection from many groups of root pathogens. The active compounds are known as Gliotoxins. The Gliotoxins have superior resistance to root decay in a variety of plants.

SCD Efficient Microbes (EM)TM The microorganisms in EM produce bioactive substances, vitamins, hormones, enzymes, amino acids, and antibiotics, which enrich and detoxify the soil. The organisms and processes within the EM culture enhance plant growth and produce high yielding crops, which are drought, frost, pest & disease resistant.

The Other Route: Keeping the Reservoir Sterile

Some growers rely on sterile growing environments, strong disinfectants and products that sterilize the reservoir.

Zone: Comprised of monochloramine and essential oils. This is the strongest sterilizing agent that we sell. It is easy to use and works well at combatting disease. Can be used at 2-3x strength to fight an infection.

SM-90: A root disease inhibitor and effective preventative treatment for pathogens including fusarium, pythium, rhizoctonia, phytophthora, etc. Wards off root infestation as it encourages new root growth.

Hydrogen Peroxide: Creates ozone in water, killing bacteria and adding oxygen to the system. Elevated levels of oxygen in water have proven to dramatically increase the speed of plant growth.

UV - Filter: Use of a UV Filter can greatly help win the battle against pathogens. As long as the nutrient solution is clear when it runs across the filter, (i.e. no organics,) all microorganisms DNA will be torn apart.

PLEASE NOTE!! Both SM-90, Zone and Hydrogen Peroxide offer protection and benefits. But they do not work well with organic additives in the reservoir. We DO NOT recommend using them with Liquid Karma, SuperThrive or anything similar. Keeping your reservoir totally sterile can work very well, but once you get a population of icky badness it can keep coming back again and again. Some pathogens such as pythium are almost impossible to get rid of completely. More and more innovative growers are moving toward a more holistic approach of using good microbes and beneficial enzymes in the reservoir.

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