Put Nature's Invisible Army to Work on Your Crops Building Bigger Roots for Bountiful Yields

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CONTINUING A SERIES OF WHITE PAPERS BASED ON RESEARCH AND FACT

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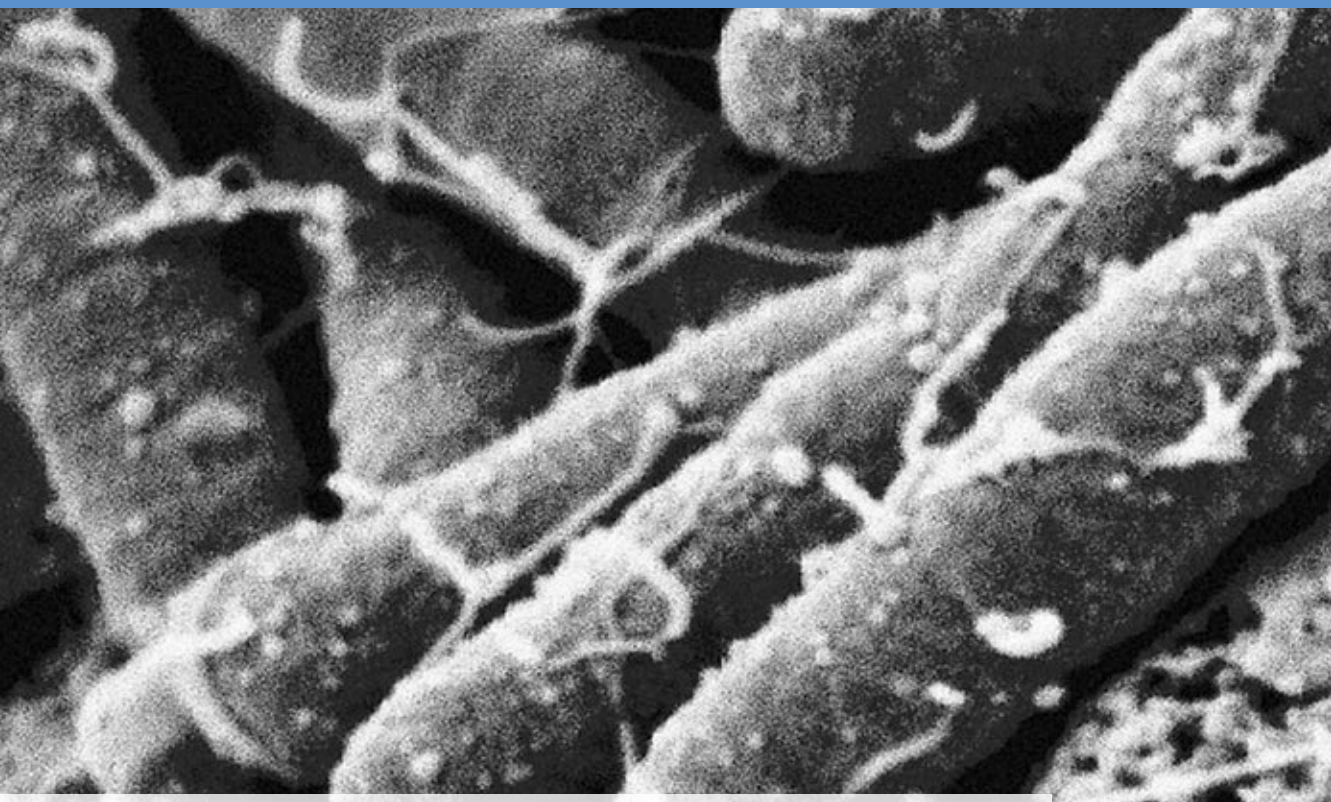
Use natural microorganisms for a happier harvest.



Put Nature's Invisible Army to Work on Your Crops Building Bigger Roots for Bountiful Yields

In the white paper that follows, we'll explain the secret behind bigger roots—and one of nature's most abundant yet misunderstood growth and bloom stimulators: an invisible army of beneficial microorganisms that lives symbiotically with plants, creating healthy, big, vibrant root systems and ensuring maximum nutrient absorption for optimal yields.

You've done it all…or so you think

You've given your plants the base nutrients they require for a decent grow. Come flowering time you've applied a premium bloom booster with ample phosphorus, potassium, and amino acids, and other beneficial company to really boost your yields. You're on the right track, and you expect a stellar harvest.

But wait! Are you sure you're doing everything possible to help your crops achieve their full genetic potential?

Even though you've provided plenty of superior ingredients, will your plants be able to absorb them all? Probably not. That means wasted resources, both of time and money, and perhaps a disappointing harvest.

The root of the problem is exactly this: the roots.

Imagine putting your face in a pond for a drink of water. The amount you can swallow depends on the size of your mouth, not on the size of the pond. A hippo, with its huge month, could take in quarts or liters, while you could only manage sips.

The same thing applies to plants. It's a crude analogy, but it holds true: giving your crops a larger root mass is like giving them a larger mouth. It enables them to absorb far more nutrients and water than crops with an average size root zone of.

So, there's really no use loading more and more into your nutrient solution or growing medium. Additional P and K, and other mineral or organic additives are useless if your plants lack sufficient root size, mass, and expanse to gobble them all up. It's often overlooked that bigger roots equals bigger buds—precisely because the bigger roots increase both the rate and the absolute volume of nutrient absorption.

In the white paper that follows, we'll explain the secret behind bigger roots—and one of nature's most abundant yet misunderstood growth and bloom stimulators: an invisible army of beneficial microorganisms that live symbiotically with plants, creating healthy, big, vibrant root systems and ensuring maximum nutrient absorption for optimal yields.

Billions of microorganisms live in a shovelful of rich soil but few to none are found in untreated hydroponic growing media. So, how do you correct this problem and assure your plants of a healthy, vibrant root system?

Read on for the answer.

Nature's invisible army

Pick up a handful of rich soil and inhale its aroma. What is the source of that wholesome "earthy" smell? Beneficial microbes! Billions of them. Or, more precisely, the fragrance you inhale is from organic materials that are being broken down and released as natural compounds geosmin and 2-methylisoborneol.

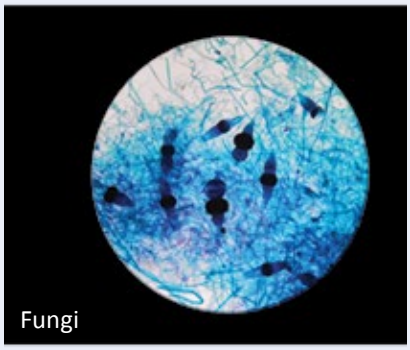
Even before farmers knew about microbes, they depended on those same microbes' presence. They knew that the stronger the smell, the more fertile the soil and the higher the yield. What they didn't know was that fragrance and fertility were associated with this thriving secret army of tiny living things (Becker B., 1995).

Beneficial microbes live in a close relationship with roots, helping to strengthen and increase their mass and reach—sometimes severalfold. This, in turn, increases the plant's ability to absorb nutrients, thus directly contributing to greater vegetative growth and bigger yields.

However, hydroponic nutrient solutions and growing media typically lack beneficial microbes. This is a huge loss for you, the experienced grower. Hydroponic horticulture, in most ways much more efficient and productive than soil-based horticulture, can be taken to the next level by bringing the very best of the soil—nature's invisible army—into your hydroponic garden.

As it was said earlier, root systems are usually not big enough to take up all the nutrients you feed them, leading to waste, higher costs, and suboptimal yields… despite all your efforts.

Beneficial microbes lives in soil



Most growers focus on bloom boosters. Adding phosphorus and potassium does increase yields, but the limiting factor, especially in hydroponics, is the root size. Plants can take in only as much as the roots can handle; the rest goes to waste.

By adding billions of beneficial bacteria and fungi to the reservoir, you create a growing environment that duplicates the success potential of rich, vibrant, life-imbuing soil.

In addition, these tiny microorganisms not only increase root size, mass, and vibrancy, but also stand guard against disease and help increase the production of essential oils. By enabling plants to absorb larger volumes of nutrients, they waste less fertilizer—and money!—causing less chemical runoff, which is better for the environment.

What exactly are these tiny life-forms that fill the ranks of such a powerful army?

Find out in the next section.

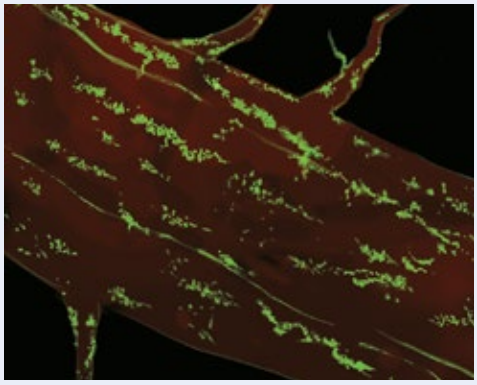
Getting closer to beneficial microbes

There are two types of beneficial microbes: bacteria and fungi. They are so small they can only be seen through a microscope. However, millions can be found swimming in a single drop of water.

Their relationship with plants is one of the oldest on earth. Over millions of years they have evolved to provide plants and their roots with the following benefits:

- Create a bigger root mass which expands the root surface and enables a considerable increase in the absorption of water and nutrients
- Protect against disease by decomposing old, decaying roots, thus enabling crops to reuse them as food
- Increase the health of a plant by maintaining the correct pH level within the rhizosphere
- Break down nutrients into forms that are more readily available to the plants
- Establish a healthy, ecological balance within the rhizosphere
- Increase nutrient transport to and into plants
- Secrete growth cofactors and bloom factors directly into plants, thus increasing the production of essential oils

Beneficial microbes colonize plant roots.



Under floorescent light microbes (in green) are clearly visible on root surface..

Beneficial bacteria live in patches along the root, ultimately covering between 15 and 40% of the total root surface. Common sites for bacterial colonization are at epidermal cell junctions, root hairs, axial groves, cap cells and sites of emerging lateral roots. (See Figure 2) This colonizing activity increases root mass and provides the plant with the ability to absorb extra volumes of extra nutrients.

But all of this happens only when a wide variety of the right microbial strains are introduced into the ranks. Just as any human army needs specialized individuals who perform hundreds of different jobs, the microbe army needs specialized individuals for their unique tasks.

The result of having the right combination of microbes is readily apparent in the illustration to the right. The roots were all grown from the same celery seed. But obviously, some combinations of beneficial microbes produced considerably better results.

Beneficial microbes guard against attack. Not all microbes are beneficial. Some attack plants and cause plant disease. But many beneficial microbe strains have developed strategies to protect their host plants.

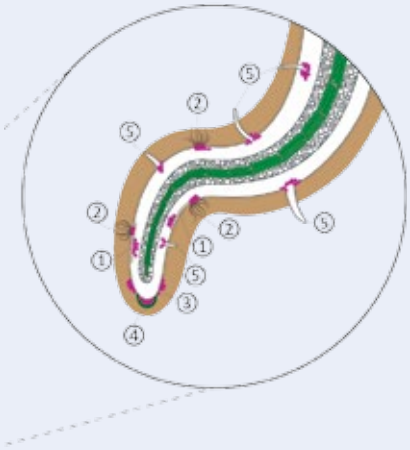
A typical example is the tiny Bacillus thuringiensis. This microscopic organism produces a powerful toxin that kills plant-eating insects but is perfectly safe for humans, animals and beneficial insects that pollinate plants. Because of this, B. thuringensis is used as a natural biopesticide (George and Neil Crickmore, 2012).

Research continues to find and isolate new bacterial and fungal strains that fight plant pathogens, some of which have the potential of helping sick plants recover from an infestation. Not only do the beneficial microbes maintain the ecological health of the root zone but also benefit the plant in general.

Microbial colonization sites

1 Epidermal cell
2 Root hairs
3 Axial groves
4 Cap cells
5 Emerging lateral root

Microbes



Beneficial microbes improve plant health by reducing pH swings.
Beneficial microbes thrive best when the pH of a growing medium is between 5.5 and 6.3. (Link to pH W.P.) However, unwanted pathogenic microbes prefer a much lower pH and work to bring down the pH to their comfort zone. Beneficial microbes resist this effort and thus help keep the pH level in a range best suited for both themselves and your growing plants. This not only provides plants with the proper growing environment, but by stabilizing the pH in a narrow window, renders pathogens too weak to cause trouble.

Beneficial microbes convert nutrients into forms that are more readily absorbed by plants.
Microbes need the same basic nutrients and micronutrients as plants. When converting these nutrients for their own use, they make them more accessible to plants.

For example, Bacillus bacteria and Trichoderma fungi make phosphates and micronutrients found in most fertilizers more available to plants. (Marschner, 2008). This is done by the production of many different enzymes and chelators that extract nutrient ions. (Link to chelation w.p.)

Also, when microbes die, their cells decompose, freeing amino and other organic acids. This provides even more nutrients to both the microbes and plants (Marschner et al., 2011).

Imagine the benefit of having a wide variety of microbial strains creating a multitude of chelators that attract different nutrient ions. This enables plant roots to absorb a number of different micronutrients more efficiently, stimulating healthier plants and more abundant harvests.

Beneficial microbes release plant growth stimulators directly into the plants.
Several bacteria release plant growth and bloom cofactors, such as powerful cytokinins, directly into the plant sap. These boosters aid the production of lateral branching, adding more budding sites, greater girth and more weight to your plants. They are also helpful in increasing the number of flowering sites.

Beneficial microbes increase production of essential oils.
For millions of years, essential oils have been used by plants to fight diseases. Moreover, the

volatile aromatic organic chemicals found in essential oils are toxic to many pathogenic microbes.

What was not understood until recent years is that microbes can increase the essential oil production in plants. For example, rhizosphere microbes stimulate stems, leaves and flowers to produce more essential oils (Alam et al., 2011; Banchio et al., 2009). By adding the right microbial strains to the fertilizer used on medical plants, both the aroma and medical value are increased.

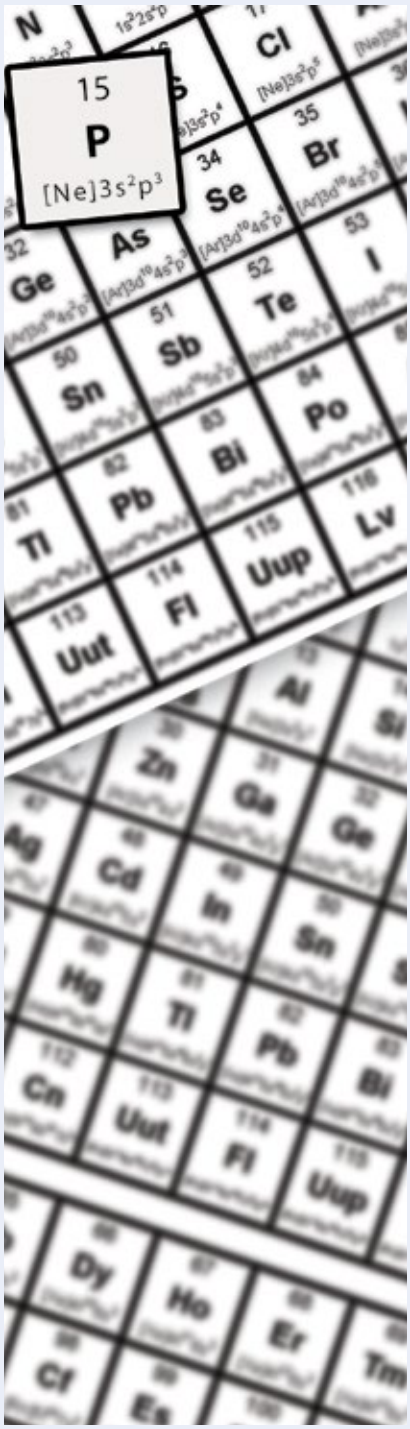
Specialized beneficial microbes even protect the environment! It is well known that the excessive use of fertilizers causes pollution and toxic conditions in groundwater, streams, rivers and eventually our oceans. The proper use of microbes can help stem this pollution problem.

For example, because plants cannot readily absorb phosphates, the mineral is excessively used to avoid a deficiency in crops. Much of this excess ends up as waste, causing numerous environmental problems. However, when using selected strains of microbes that help plants absorb phosphates, far less of the mineral is needed.

Protection of the environment is only one example of why some hydroponic companies are spending huge amounts of research and development dollars on improving our understanding of and the very use of microbes.

Understanding beneficial microbes and the wonderful things they can do for your plants, leaves one important question unanswered. How can you put nature's army of microbes to work creating larger root mass and increasing the ability of your plants to absorb more nutrients?

The following section answers this very question.



The picture is taken from our scientists reports. Whene developing Vodoo Juice, they have tested different strains to find which ones stumulate most root growth.

Using microbial supplements to enhance hydroponic gardens

The obvious answer to the question about how you can put nature's army to work in your hydroponic garden are microbial supplements. But what to look for when buying these supplements? How can you be certain of getting a quality product that will provide the benefits we've been talking about?

What to look for in a top-quality microbial supplement

To reap all the benefits that we have discussed, it is important to have the right microbial supplements for your plants The criteria for the top microbial products are following:

The right strains/species in the right ratios and for the exact kind of crops you grow: As we have seen, there are hundreds of strains of beneficial bacteria. The right microbial supplement for you will need to have the right combination of strains and species of microbes and they should be chosen carefully, to bring maximum yields for the crops you grow. Also, the right ratios of these strains need to be used, so that the ecological balance in your rhizhosphere is maintained and no "harmful" microbes dominate. In fact, no species should be predominant. If the right rations are maintained, you will get the benefits of all of them equally.

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- **Each strain grown in the right way:** It is crucial that each microbe strain is grown properly and cultured individually not in a big bouillabaisse (a French stew that has a little of everything). If manufacturers grow several strains in the same vat, you will end up with a skewed microbial population, which is not the ideal one for your crops. Watch out for companies that simply batch-breed their microbes, making an unstable stew of bacteria and fungi. We don’t do that; we breed each strain separately before bottling species together; so that they can cohabitate even in concentrated solutions.

- **Incompatibles bottled separately:** Microbial supplements contain numerous strains that are often incompatible if put into a concentrated solution and need to be bottled separately to sustain viable populations. Just as numerous animals that can generally coexist in nature should not be housed together in one cage, certain strains of microorganisms fail to coexist in close proximity. If they are bottled together in one product, their numbers will drop with time. We have noticed that this happens with many companies who sell all-in-one microbe supplements. Keeping the microorganisms housed separately before setting them free in your much more diluted nutrient solution gives these same microbes a long shelf life without risking that any one strain dominates the others.

- **Maximum number of live microbes at time of use:** Microbial supplements have to contain live microbes when you use them, in order to be effective. To achieve this, they have to be bottled in such a way that microbial populations are sustained and do not die. Certain precautions need to be taken to ensure the right results.

Are there products that meet all these criteria? Yes! See the next section.

The fabulous four: Voodoo Juice, Piranha, Tarantula, and Bud Candy

Each of the above microbial supplements meets the quality standards discussed in the previous section. Even though some bacteria in these products are incompatible in concentrated solutions, and thus contained in separate bottles, when diluted they work together providing the important benefits described throughout this white paper. But at the same time each product also has its own special function.

- Voodoo Juice is noted for its ability to increase root mass
- Tarantula's most outstanding feature is plant protection and combating plant enemies
- Piranha improves the plant's health by keeping the roots clean and maintaining a balance between different microbial strains

When combined, each product is enhanced by the presence of the other two. Together they provide:

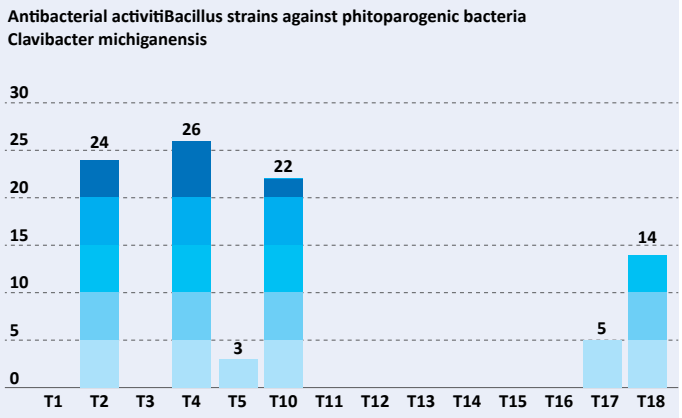
- Bigger root mass
- Healthier plants
- Increase in essential oils
- More stable pH
- Protection against disease
- Increased absorption of nutrients and water

Advanced Nutrients produces top-of-the-line microbial supplements. The aforementioned criteria, which are difficult to meet for many producers, are considered as the standard at Advanced Nutrients®. The enormous popularity and high satisfaction with Advanced Nutrients' products among you – the growers, speaks for itself.

Let's show you why Advanced Nutrients microbial supplements are so successful.

Beneficial bacteria	Scientific evidence
Arthrobacter globiformis	(Casida and Liu, 1974; Gobbetti and Smacchi, 1999; Morris, 1960)
Bacillus amyloliquefaciens	(Correa et al., 2009; Idriss et al., 2002; Kloepper at al., 2004)
Bacillus brevis	(Asaka and Shoda, 1996; Singh and Shukla, 1986; Udaka and Yamagata, 1993)
Bacillus cereus	(Chen et al., 2012; Liang et al., 2013; Stabb et al., 1994)
Bacillus coagulans	(Iyengar et al., 1998; Quintelas et al., 2008; Uma and Sandhya, 1997)
Bacillus laterosporus	(Arulmani et al., 2007; O'donnell, 1997; Zouboulis et al., 2004)
Bacillus licheniformis	(Brunetti et al., 2012; Gutiérrez-Mañero et al., 2001; Ramos et al., 2003)
Bacillus macerans	(Halsall and Gibson, 1985; Seldin and Dubnau, 1985; Seldin et al., 1984)
Bacillus megaterium	(Lian et al., 2006; Raja Sekar and Karmegam, 2010; Vary et al., 2007)
Bacillus polymyxa	(Gouzou et al., 1993; Mavingui et al., 1992; Robert, 1947)
Bacillus subtilis	(Crecchio and Stotzky, 1998; Graham and Istock, 1979; Van Elsas et al., 1986)
Bacillus thuringiensis	(Saleh et al., 1970; Shu et al., 2011; Stotzky, 2002)
Paenibacillus polymyxa	(Lebuhn et al., 1997; Timmusk et al., 1999; Timmusk et al., 2005)

This picture is taken from our Advanced Nutrients's R&D team reports. Our scientists have tested different microbial strains to find the best ones.



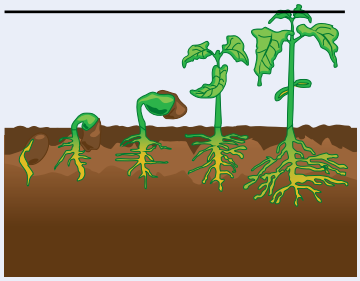
We grow bacterial strains and species of fungi individually and properly considering their specific requirements.

We use the right and the most effective strains and species for plant growth based on scientific research.

Beneficial fungi	Scientific evidence
Glomus aggregatum	(Duponnois et al., 2001; Johnson et al., 1992; Ultra Jr et al., 2007)
Glomus etunicatum	(Huang et al., 2009; Pawlowska et al., 1999; Purakayastha and Chhonkar, 2001)
Glomus intraradices	(Koide and Kabir, 2000; Mathimaran et al., 2005; Subramanian et al., 2009)
Glomus mosseae	(Ames et al., 1983; Azcon-Aguilar et al., 1986; Vivas et al., 2005)
Pisolithus tinctorius	(Marx and Bryan, 1975; Marx et al., 1982; Rodríguez-Tovar et al., 2005)
Rhizopogon amylopogon	(Bidartondo et al., 2001; Molina and Trappe, 1994; Rusca et al., 2006)
Rhizopogon fulvigleba	(Ersek and Lange, 2011; Harisundan et al., 2010; Woods and Divers, 2012)
Rhizopogon luteolus	(Strzelczyk and Pokojska-Burdziej, 1984; Theodorou 1971a, Theodorou 1971b)
Trichoderma harzianum	(Ahmad and Baker, 1987; Elad et al., 1980; Elad et al., 1982)
Trichoderma kongii	(Manhong et al., 1997; Shuocheng, 1991; Xi et al., 2003)
Bacillus subtilis	(Crecchio and Stotzky, 1998; Graham and Istock, 1979; Van Elsas et al., 1986)
Bacillus thuringiensis	(Saleh et al., 1970; Shu et al., 2011; Stotzky, 2002)
Paenibacillus polymyxa	(Lebuhn et al., 1997; Timmusk et al., 1999; Timmusk et al., 2005)

We bottle them separately, depending on their compatibility with each other. Due to this crucial strategy, some bacterial strains are specific for Voodoo Juice and some others for Tarantula. Mycorrhizal species are exclusively represented in Piranha.

All products are specifically bottled and so that the maximal vitality of microbes in the company's product is ensured.



Quality requires revitalizing 'foreign' microbes.

After a few months of intensive growth, microbes from foreign locations tend to degenerate. In order to keep the quality of a microbial product high, the foreign microbes must be replaced.

Constant testing and checking is required to spot the first signs of degeneration, triggering the order for a new batch from the country of origin.

All root mass expanders Voodoo Juice, Piranha Liquid, Tarantula Liquid are included together with the bud enhancer Bud Candy in both the Bigger Yields Flowering System® and the Fabulous 4 PakTM.

Buy. Apply. Observe the results.

Are you risking your money? Not if you buy Advanced Nutrients products. Every one of our products is backed by a 100% guarantee. If they don't provide the benefits outlined in this white paper, return the product to your hydro dealer for a total refund.

Remember, claims are easily made. Words are often exaggerated. But the results you get with quality microbial supplements are the truth you can depend on.

You've never used microbial supplement root expanders? Today is a great day to begin. You've used a microbial supplement in the past and got disappointed? Why not try switching to Advanced Nutrients? Proof is in the using.

Root mass expanders Voodoo Juice, Piranha Liquid and Tarantula Liquid are included together with bud enhancer Bud Candy in both the Bigger Yields Flowering System® and the Fabulous 4 PakTM.

Whether used separately or (better) together or (best of all) in conjunction with high-end bud bulkers such as Big Bud® Liquid and Overdrive, they are guaranteed to give growers bigger yields of the highest quality.

To learn more about how these supplements give you bigger harvests, dial this

Advanced Nutrients Tech Support at **1-800-640-9605** or visit the Advanced Nutrients website.

Read more white papers and special reports in our Hydroponics Research Website at http://www.hydroponicsresearch.eu/.

Share this white paper now with friends, coworkers, and family. **References**

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