

Advanced Nutrient Management for hydroponic growers

by Lawrence Brooke

Check your nutrient IQ

To the skilled hydroponic grower, nutrient management represents an opportunity to enhance plant growth. To the novice, it represents a challenge to be dealt with. The difference is in knowledge, understanding and equipment. Consider the following questions to test your nutrient IQ:

- What temperature is your nutrient solution, what is the range during a day and during a season?
- What is the “dissolved solids” content of the water you use to mix your nutrient and does this content vary greatly from season to season? Does your water supplier provide you with good water from one reservoir at one time of the year and bad water from a different reservoir at another?
- Are there any components in your water that could affect the availability of nutrients to your crop?
- What is the “EC” or strength of your nutrient?
- Do you mix special nutrient blends for different kinds of plants and for each stage of the crop's life-cycle?
- Does the pH of your nutrient stay within a reasonable range?
- Are there any pathogens in your nutrient from a contaminated water supply or from sick plants that may spread disease to the rest of your crop?
- Do you change your nutrient often enough to prevent excesses from salt accumulation or deficiencies from nutrient exhaustion?
- Did you know that an important reason to change your nutrient solution is to eliminate the wastes your plants discard into the nutrient? Did you know that as plants transpire, moisture and nutrient levels drop in your reservoir and the EC or strength of the nutrient can rise to dangerous levels?



Advanced Nutrient Management (continued)

Those were just a few basic questions that may help you better realize what you already know, and what you may need to learn to achieve outstanding crops every time. This discussion is especially for the advanced grower who wants to achieve the highest yields and is seriously interested in being at the leading edge of plant growing technology. Hobby growers generally don't have to worry about all of these questions, but don't stop reading just yet. When problems arise and a crop isn't growing as well as it should, the problem can often be traced to nutrient management. Once you know what can go wrong, it's easier to recognize a problem when it happens.

The root environment is what separates hydroponics from soil cultivation. In soil, plants await rainfall or irrigation, and their roots search out essential nutrients. With good, fertile soil and abundant water plants thrive.

In hydroponics, the plant roots are constantly provided with water, oxygen and nutrients- no searching for available nutrients or waiting for the next rain. The challenge for the grower is to keep up with the plants' needs and to avoid damaging plants with excesses or deficiencies of minerals, extremes in pH and temperature, or a lack of oxygen. A few simple tools and techniques can make the difference between success and failure.

What's in Your Water?

The first question to consider is water quality. With good, soft water it's easy to succeed. Just add the right combinations of nutrients to the water and you're off and growing. If you have very hard water, or water contaminated with sodium, sulfide, or any number of heavy metals, you may have to filter your water using "reverse osmosis."

So, what's in your water anyway? The most complete answer comes from having an analysis of your water done by a lab. If you're on a municipal water system, call your water district and request a copy of their most recent analysis.

Another approach - highly recommended - is to check your water regularly with a dissolved solids meter, also called an electrical conductivity (EC) or parts per million (PPM) meter. These instruments are one of the most important tools for a grower to have and use regularly.

All of these instruments work in essentially the same way. They measure the electrical conductivity of the water. It is the dissolved salts in most water that allows it to conduct electricity. Pure water is a poor conductor since there are none of the conductive salts found in impure water. Purified water will show no, or very low, salt content (conductivity) when tested with a dissolved solids meter.

It is not uncommon to find high levels of salts in well water or municipal water supplies. Calcium and Magnesium carbonates are among the most common ingredients in tap water and in well water. In fact, water "hardness" is defined as a measure of the water's content of calcium and magnesium carbonates.

Since calcium and magnesium are important plant nutrients, water with reasonable levels of these elements can be just fine for hydroponic cultivation. However, even a good thing can become a problem if the levels are too high.

Generally, a calcium content of more than 200 PPM, or 75 PPM for magnesium, are on the verge of excessive for most hydroponic applications. An excess can cause other important elements in the nutrient solution to "lock-out" and become unavailable. For example, excess calcium can bond with phosphorous to make calcium phosphate, which is not very soluble and therefore not available to the crop. The key is to start with decent water and add the right combination of nutrients.

Too Hot, Too Cold

Water temperature is another important factor. If your solution is too cold, seeds won't germinate, cuttings will not root and plants will grow slowly- or stop growing and die. If it's too hot, the same seeds won't germinate, cuttings won't root, and plants will die from oxygen deficiency or simply from temperature stress. Most plants prefer a root zone temperature range of between 65 degrees (18 C) and 80 degrees (27 C), cooler for winter crops, warmer for tropical crops. When adding water to your reservoir, it is a good idea to allow it to come to the same temperature as the water in the reservoir.

Remember, plant roots have evolved in a soil environment where temperature changes occur slowly, tempered by the thermal mass of the earth. Plants do not like rapid temperature changes, especially in the root zone!

Frequently Asked Questions

Q: Why are there three parts to the General Hydroponics Flora Series Nutrients?

A: The concept behind the Flora-series is simple: Different kinds of plants have significantly different nutrient needs, and these needs change during each plant's growth cycle. By using different combinations of FloraGro, FloraBloom and FloraMicro, the grower is able to fulfill the exact needs of the plant at each stage in the plant's life cycle. As the crop grows, the grower is able to precisely adapt the nutrient formulation to meet the crop's changing requirements.

Q: Can you explain the purpose of each component of the Flora Series?

A: In hydroponics, the plant roots are constantly provided with all the water, oxygen and nutrients they need. The challenge for the grower is to keep up with the plants needs, and to avoid damaging it with either excesses or deficiencies of minerals. As a general rule, a plant consumes more nitrogen during the formative or vegetative stage, and more phosphorus, potassium and magnesium as it flowers. Throughout its growth cycle, the plant will also consume calcium, sulfur and micronutrients such as iron, manganese, boron, molybdenum and copper. FloraMicro, the foundation or "building block" of the Flora Series system, provides nitrogen and calcium as well as trace minerals, which are essential for a comprehensive hydroponic plant diet. By adding FloraGro to FloraMicro, the plant will receive additional nitrogen and potassium, which stimulates structural and foliar growth. To stimulate flower and fruit development, FloraBloom is added to provide the necessary phosphorus, potassium, magnesium and sulfur.

Q: How do I mix the Flora Series?

A: Always start with a reservoir filled with water, then add the concentrated nutrients one at a time. Never mix the nutrients together in their concentrated form, as this will cause nutrient "lock-out" making some minerals unavailable. It is best to begin by adding FloraMicro, stirring well, and then adding FloraGro and/or FloraBloom one at a time, stirring well before adding the other nutrient.

Q: What is a general purpose nutrient recommendation?

A: The proper ratio of each Flora Series nutrient depends on the crop and the stage of growth (see www.generalhydroponics.com for specific recommendations for different crops).

Q: What TDS or EC readings should I expect when combining the Flora Nutrients?

A: Using distilled water for our preparations and adding teaspoon(s) per gallon of each nutrient.

FloraGro:FloraMicro:FloraBloom:

Nutrient	EC (microS/cm)	TDS meter (ppm)
3:2:1	2.6-2.7	1300-1350
2:2:2	2.5-2.6	1250-1300
1:2:3	2.4-2.5	1200-1250

Q: Why is conductivity of the nutrient important?

A: Conductivity is a measure of the strength of the nutrient solution. The higher the conductivity, the more dissolved solids there are in the solution. Delicate plants, cuttings, and seedlings can experience fertilizer burn if the conductivity is too high. Once the plants begin growing, they need a stronger nutrient solution, so conductivity must be increased by adding concentrated nutrient. Some plants prefer a milder nutrient strength, while others grow better and produce better quality fruit with a higher concentration. Generally, nutrient strength should run between 500 and 1500 parts per million (ppm). If you want to measure ppm you will need to purchase an EC or TDS meter. Before using your meter, calibrate it with General Hydroponics Standard Reference Solution. If you find that ppm is too high, add water to bring to a safer level. If you find the ppm is too low, add nutrient to increase ppm. When in doubt, remember that it is always better to apply too little nutrient than too much.

Q: How does conductivity effect plant growth?

A: Conductivity is really a measure of the nutrients in the solution. Low conductivity implies a low nutrient concentration, which usually results in nutritional deficiencies and slow growth rates of your plants. One can look at the situation as a higher conductivity is more food for your plants. However, be careful of very high levels as this can burn and or kill the plant.

Q: How important is water quality?

A: Water containing too much calcium and magnesium (called "total Hardness") may create serious problems. Contact your municipal water supplier who can provide you with an analysis of your water supply. If you are using well water, there are many laboratories that can provide you with an analysis if you send them a sample. If the dissolved salts in your water supply measure 200 PPM or more, we strongly recommend that you obtain a water analysis to determine calcium content. Excessive calcium is the main factor in determining if your water is hard. If an analysis of your water supply reveals that the Calcium content is greater than 70 ppm (mg/liter) you should use Hardwater FloraMicro. Hardwater FloraMicro provides rapidly growing plants with a combination of chelated micronutrients uniquely formulated for hardwater conditions. Other options are to collect rainwater, install a reverse osmosis filtration system, or use purified water. Do not use mineral or "spring" water, which can unbalance the nutrient solution or even be toxic to plants.

Q: Can I turn my system off at night to conserve energy? Should I run it continuously or cycle it at intervals?

A: All systems can be left off at night once the plant roots are long enough to reach the nutrient level in the reservoir. Longer cycles depend on the type of system you have:

AeroFlo Systems: The cycle can be set to run continuously during the day and coming on once or twice during the night for 15 to 30 minute intervals.

Euro Grower Systems: Set the timer to come on for 15 to 30 minutes every 90 minutes during the daylight cycle once the plant has a good root system. These systems use cocopeat that holds moisture and nutrients in the root zone.

WaterFarm & PowerGrower: Set the timer to come on for 1 hour and then off for 1 hour during the daylight cycle.

RainForest Systems: These units are run continuously, especially if you are trying to root cuttings. If you are growing plants, they can be shut off in the evening once the roots have grown into the nutrient solution.

Q: What pH is best for growing plants hydroponically?

A: The ideal pH range for most hydroponic crops is between 5.5 and 6.5.

Q: How does pH level affect plant growth?

A: pH is important because it affects availability and absorption of several of the 16 atomic elements needed for plant growth. Maximum absorption of these elements is found at pH readings 5.5 to 6.5. When pH falls below this range many of the macro elements (N, P, K, etc) have less availability, and absorption of the micronutrients can reach toxic levels.

Q: How do you change the pH?

A: pH is adjusted by using an acid to lower it or an alkali to raise it. General Hydroponics' pH Down and pH Up are designed for this purpose. Many acids and alkalis are extremely corrosive and dangerous, so care should be used if you are not using a product labeled for hydroponic use.

Q: What is the desired temperature range for the nutrient solution?

A: The optimal temperature of the nutrient solution should be in the range of 65 to 75 degrees Fahrenheit (18 to 24 degrees Celsius). Before adding water to your reservoir, it is a good idea to allow it to come to the same temperature as the water in the reservoir. Plants dislike rapid temperature changes, especially in the root zone.

Q: How important is fresh air?

A: Ventilation is often overlooked as a problem. Plants absorb nutrients when the water molecules in the leaves transpire. Increased ventilation improves transpiration rate, which correlates with increased nutrient uptake. Remember that ventilation means exchanging the air, not just circulating it around the room.

Q: Do I ever need to drain the reservoir and refill it with fresh water and nutrient solution?

A: Yes. The reservoir should be drained and rinsed every 7-14 days, depending upon plant size and nutrient usage. It is a good idea to rinse off the growing medium each time the reservoir is cleaned with fresh water for a short period prior to refilling with new nutrient.

Q: Between cleanings, how often should I check the reservoir level?

A: Fast-growing crops can consume large amounts of nutrients and water so it is important to keep an eye on the reservoir every couple of days. Plants will also use more water under longer light cycles and lower relative humidity.

Q: When the reservoir level begins to drop, should I top it off with fresh water or nutrient solution?

A: As plants consume nutrients and water, the nutrient strength in the hydroponic reservoir will change. If you drain, clean and remix the nutrients every 7 to 14 days, it's okay to top off with fresh water daily. If the concentration(ppm) in the reservoir decreases 500 ppm, you can add nutrients in the same ratio that were initially used to raise the ppm to the level you started with in the reservoir. Don't do this more than twice between complete nutrient changes to avoid buildup of some elements.

Q: How do I clean my hydroponic system between crops?

A: The easiest way to clean your system is to drain all the water and remove any accumulated organic matter from the previous crop. Refill the unit with fresh water and add a 1/8 cup bleach per gallon of water and allow the unit to run for several hours. If you have any salt buildup you can start with citric acid or vinegar and warm water to help dissolve accumulated salts. Drain the reservoir and flush with fresh water until the bleach is removed. If you have an AeroFlo unit it is a good idea to remove the plugs at the end of the sprayline to remove any accumulated solids.



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Water pH

A subject that is often discussed but rarely understood by many growers is nutrient pH. Generally, we worry about pH and its affect on nutrient availability. For example, if pH is too high, iron may become unavailable. Even though your nutrient solution may have an ideal iron content, your plants may not be able to absorb it, resulting in an iron deficiency. The plant's leaves will yellow and weaken.

On the other hand, advanced hydroponic plant foods contain special "chelates" that are designed to assure iron availability at higher pH ranges. The result is that your crop will grow reasonably well, even at higher pH levels. Nonetheless, high pH can damage plants in other ways.

The cause of a high solution pH can be fairly complex. Most city water supplies contain added calcium carbonate to raise the pH of the water and prevent pipes from corroding. As a consequence you are starting with water that has an abnormal pH, typically 8.0 for city water.

The best way to deal with this is to mix fresh nutrient with your water, let it stand for a while to stabilize, then test and adjust the pH. With city water supplies you will often have to add a bit of pH down (usually phosphoric acid) to lower the pH to the range for most plants, between 5.8 and 6.2.

As the plants grow, it is a good idea to occasionally test the pH and adjust it if needed. You can safely allow pH to drift between 5.5 and 7.0 without adjustment. In fact, constantly dumping chemicals into your system to maintain a perfect pH of 5.8 to 6.0 can do a lot of damage. It is common for pH to drift up for a while, then down, and up again. This change is an indication that your plants are absorbing nutrient properly. Adjust pH only if it wanders too far.

A pH below 5.5 or above 7.0 can mean trouble, but don't over-react. An apparently sudden and dramatic shift in pH can be the result of a malfunctioning pH meter. If in doubt, double check with a reagent (color match) pH kit before adjusting your solution. Also remember that all pH measuring methods are temperature dependent. Read and follow all of the instructions that came with your meter or test kit.

Media Culpa

Another cause of unstable pH is poor quality growing media. Industrial grade rockwool and gravel are notorious for having very high pH levels that cause your nutrient pH rise, often to constantly rise, often to dangerous levels.

A simple way to test a new growing medium is to put some of the medium - rockwool, gravel, soil - into a clean cup, then immerse (soak) the sample in distilled or "de-ionized" (chemically pure) water. Let this sit for a little while and then test the pH of the water, note the pH and continue to let the sample sit. Test the pH occasionally for about a week until it has stabilized. Has the pH risen to 8.0, perhaps 9.0? Construction grade gravel can go as high as 10.0 - torture to roots, death to plants!

Never underestimate growing media as a source of pH problems. This is one of the primary reasons that "water-culture" hydroponic methods are gaining popularity over "media-based" hydroponics. This less media you use, the fewer problems you will encounter with pH instability and salt accumulation. Plus the water-culture systems require less water and nutrient than media-based methods due to higher efficiency and reduced evaporation.

Time for a change?

How often should you change your nutrient solution? That's one of the most common questions asked, and one of the most difficult to answer. Many people have tried to come up with a simple, easy-to-follow rule - once a week, every two weeks - but they're all wrong! They're wrong because there is no simple answer. It all depends on the species, the number and size of your plants, the capacity of the reservoir, the kind and quality of nutrient you use, water quality, environmental conditions such as temperature and humidity, and the type of hydroponic system used. Instead of a simple answer, what we need is a procedure that takes many of these variables into account and is responsive to changing conditions.

It sounds complicated, but it's actually quite simple. All it takes is a little monitoring and some basic record keeping. Start with a fresh reservoir of nutrient and make note of the date, pH, and EC or PPM of the solution. As you run the system, the level will drop in the reservoir. Note the EC/PPM level, then top-up the reservoir with fresh water. Test again for nutrient concentration. If the nutrient strength has dropped significantly, add a bit of nutrient to bring it back up to spec.

Be sure to record how much water you added to top-up the reservoir. Repeat the procedure every time you top-up the system, carefully recording the amount of water added. When the total amount of water added equals the capacity of your reservoir, it is time to drain and replace all of the nutrient solution.

For example, imagine a hydroponic system in a cool, spring greenhouse with 24 strawberry plants and a nutrient capacity of 20 gallons. Typically, such a system would require about 5 gallons of added water each week. After four weeks the plants will have transpired 20 gallons—the capacity of the reservoir. You need to completely drain and replace the nutrient every four weeks in this example.

Nutrient Pathogens

The problem of pathogens or disease in the nutrient solution can be a serious one. It is not uncommon for this to be a regional and seasonal problem. For example, in Holland during the winter, fungi thrive in the cool and damp environment, the air is full of spores. All kinds of soil-borne diseases become endemic in the Dutch winter and growers have to work hard to avoid infestations. One of the reasons Dutch growers adopted hydroponics so readily was to avoid soil-borne diseases.

Keep your growing area clean. Never allow soil to get into the nutrient stream. If soil is accidentally kicked into the reservoir, the entire crop can be at risk. Some growers will place a sponge-mat, soaked with disinfectant, at the doorway of the greenhouse. Everyone who enters must clean their shoes on this mat before entering. This is an effective and practical way to prevent disease organisms from entering the greenhouse and endangering the crop.

If an infected plant is introduced into a hydroponic system, the disease can race through the entire crop. By the time a problem is noticed, it may be already out of control. Plant diseases are beyond the scope of this article, but the best advice is to avoid problems by working clean, planting only healthy disease free plants, and closely monitoring the crop.

If you see evidence of disease in a single plant, remove and destroy it quickly before the disease spreads. Watch the crop closely and destroy any other plants that show signs of disease. It is better to lose a few sick plants than to risk an entire crop.

If you do encounter disease problems, it is a good idea to completely drain and renew your nutrient after removing the sick plants. If it is possible there is nothing better than to flush the system by running fresh water without nutrient for a day. Then drain and refill with fresh nutrient. Flushing between every three or four nutrient changes can help maintain cleanliness in the root zone and in the hydroponic system. Periodic flushing is especially helpful for gravel systems to remove salt accumulation in the medium.

To the Limit

To some hobby growers, especially those who come to hydroponics from the “U-plant-em-and-pray” school of outdoor gardening, the techniques described above might seem too difficult and time-consuming. Remember, hydroponics offers great control over the health and quality of plants to the grower with the interest and the skill to exercise that control. That’s what this article is all about- pushing it to the limits. Remember, too, that it is possible to produce a hydroponic garden that will out-perform any soil garden by simply following the manufacturers’ instructions on system operation and nutrient changes, and paying attention to the condition of your plants. But even the most casual grower can benefit from an understanding of a few basic concepts.

Quality water is a great advantage, poor water is a challenge. Use only the highest quality plant food- designed specifically for hydroponics. Low grade plant foods and common fertilizers offer your plants poor and incomplete nutrition, cause pH drift, and sometimes contain impurities that can become toxic to hydroponic plants. Only high-quality plant food can grow superior plants. Healthy plants grow faster, generate higher yields and are resistant to disease and insect infestation. When you mix fresh nutrient always measure carefully.

Keep notes on your observations of EC drift, pH drift, total water usage, temperature range, and comments on crop health and progress. Keep an eye on pH, and an especially close watch on nutrient strength (PPM, EC, dissolved solids). Look out for diseases and remove and destroy sick plants immediately.

To control your nutrient temperature, use high quality aquarium heaters to warm nutrient in the winter, and look for “chillers” to cool your nutrient in the summer if high nutrient temperature becomes a problem. The aquaculture or fish farming people have developed excellent chillers. Fish don’t like water that’s too hot or too cold either.

Don’t be overwhelmed or intimidated

Plants can tolerate quite a lot of stress and still produce well. On the other hand, the grower who knows the questions, and how to find answers, is the one who will have consistently good crops. It is far easier to avoid problems through knowledge and proper technique than to fix them after they arise.