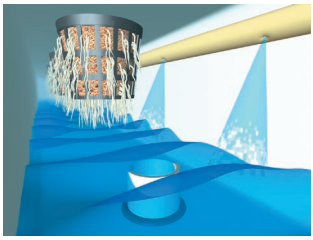
WHAT'S IN YOUR WATER?

By Noucetta Kehdi - Co-manager at General Hydroponics Europe

In soil-less, as well as in soil cultivation, water is the main factor.

In soil, bacteria will decompose organic matter into nutritive elements that plants will absorb, but only in the presence of water. Without water there is no absorption and plants will die.



Root environment in an AeroFlo

Of course, water is the main ingredient in hydroponics. It is indeed the most perfect vector to convey the essential elements the plants need to thrive. This is why the quality of the water you use is of the utmost importance.

Water quality varies from source to source. Most generally people use municipal water from the home tap, or well and pond water when they live in the countryside. Each water source has separate issues and water qualities are measured by several properties, all of which affect the growth and health of plants.

For the skilled professional, nutrient management represents an opportunity to enhance plant growth. To the novice it represents a challenge to be dealt with.

The following text will interest the advanced as well as hobby growers as it gives you the main conditions for a well-managed hydroponic operation. Needless to say that good water and nutrient management is essential in soil too, if you want to attain quality.

Whichever category you fall into, water quality management is quite an easy task once you know which are the issues to be dealt with.

In hydroponics it is important to know what is in your water. The most complete answer comes from having an analysis done by a laboratory or, if you are on a municipal water system, call your water district and request a copy of their most recent analysis. If you have difficulties interpreting it, your supplier, the manufacturer of your nutrient, or "Frequently Asked Questions" sections in magazines, will help you with comments and advice.

There are several essential factors to keep in mind when using water as a substrate:

1. Soluble salts and EC
2. Water hardness and pH
3. Oxygenation and water temperature
4. Filtration methods, rain and purified waters

On a general basis, and concurrent with the original quality of your water, you must check your solution regularly, as several factors will interfere to modify its quality. What you want to achieve is a well-equilibrated nutritive solution, with

the right amount of dissolved mineral salts, so your plant gets all the elements it requires, in the right quantities. What you need to control are all parameters that will induce deficiencies or excesses and worse, toxicities.

To do so, you need 2 essential tools for hydroponics: digital EC and pH digital meters - or a liquid pH test indicator. (photo d'un EC & pH meters et du pH Test Kit). It is always good to read the manufacturer's instructions before use.

SOLUBLE SALTS AND EC

The amount of soluble salts in water is measured by Electrical Conductivity. It is the dissolved salts that allow water to conduct electricity. *(Pure water has no conductivity since there are no conductive salts).*
It is important to know that this reading will not tell you all of what is in your water: some elements, like magnesium for example, offer very poor conductivity and are practically invisible to conductivity meters. But it will indicate if your general level of salts is sufficient, and this is basically the information you generally need.

It is not uncommon to find high levels of salts in well water or in municipal water supplies. Most waters will indicate an EC of 0,5 to 0,8. In some cities, it may indicate levels that are much higher still.

Calcium carrbonate and magnesium carbonate are among the most common ingredients generally found in water. 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 and an excess of some elements 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 soluble and therefore not available to the crop.

The key is to start with decent water and add the right combination of nutrients to always make sure your solution does not exceed the plant's tolerance for dissolved salts. When in doubt, remember that it is always better to apply too little than too much.

Depending on their variety and on their life cycle plants will absorb more or less fertiliser. The faster they grow the more they will absorb the nutritive solution. As plants consume nutrients and water, the nutrient strength will change in the reservoir, so

When it is hot, plants will transpire lots of water, and you will find that your EC tends to rise. It is recommended at that stage to top off your reservoir with plain water (with adjusted pH) to bring the EC back to reasonable levels.

it is important to regularly check your EC levels.

Adjusting the EC to the right levels is quite a simple task. You will generally find complete application charts on your fertilizer's label, as well as nutrient management directions with the instructions of all quality hydroponic growing systems.

WATER HARDNESS AND pH

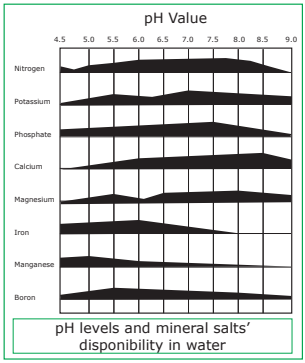
Water hardness is defined as a measure of the water's content in calcium and magnesium.
pH is the abbreviation of "potential Hydrogen" and refers to the positively charged hydrogen ions (H+) relative to negatively charged hydroxyl ions (OH-). The pH scale goes from 0 to 14; 7 being neutral (equal number of H+ and OH-).
Generally speaking, hard water will have high pH, and soft water low pH. Some brands of fertilizers offer hard and soft water nutritive formulas to best adapt to your water.

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.

Usually well waters tend to fluctuate in pH and in EC as the water table rises and falls over the seasons, but generally the same minerals will always be present. Even municipal waters may fluctuate from time to time, although much less than well.
Most often municipal waters will indicate a pH range of 8 to 9, which is way too high for your plants, as most of them will grow within a pH range varying between 5.2 and 6.5.

Why is it so important to have the right pH?

The pH directly affects the availability of most elements, especially the micronutrients. See the table shown here.
Too low of a pH can result in increased micronutrient availability that can lead to phyto-toxic responses in some plant species.
Too high a pH will lock out some elements that become non available to the plant:



pH levels and mineral salts' disponibility in water

Problems associated with "out of range" pH:
Low pH causes:
Toxicity in iron (Fe), manganese (Mn), zinc (Zn), copper (Cu)
Deficiency in calcium (Ca), Magnesium (Mg)

High pH causes:
Deficiency in iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), Boron (B).

For example, if the 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, a high quality hydroponic plant food will 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 many other ways. So the best way to deal with pH adjustment is to adjust your water's pH, mix in the nutrients, let it stand for a while to stabilize, then test and adjust the pH again.

Why adjust the pH before and after? Adding the nutrients in a well-adjusted pH will allow the very precious chelates not to brake down. And adjusting after again, when needed, allows you to make sure your roots will bathe in the most harmonious and complete nutrient solution, an environment where you know they will thrive.

Like for the EC, adjusting the pH level is quite a simple task:

- When the level is too low your solution is too acidic, and you have to add a base to raise the pH. It may be helpful to know that normal tap water has a level of pH high enough so that you can add a little of it and raise your pH at little cost.
  But when working with Reverse Osmosis filtration, it is highly recommended to use a good quality pH Up.
- When the level is too high, it is too alkaline, and you have to add acid to lower the pH.

Which acids to use? There are many brands on the market, as this is quite a simple product to manufacture. Generally they are the result of a diluted high concentrations of nitric or phosphoric acids that you can use either for the growing or for blooming stages of your plant's life.

And there are other acids that are balanced formulations with added buffers that will adjust your pH while stabilizing it at the same time. The same bottle is needed during the plant's whole life cycle.

As plants grow, check EC and pH levels regularly. 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 down for a while, then up again. This change is an indication that your plants are absorbing nutrient properly. Adjust pH only if it wanders too far.

An interesting information for shop owners who do mail orders: it is not safe to send acids by postal mail, but there exist excellent acids in powder form that stay totally harmless as long as they are dry, and can be shipped harmlessly anywhere you want.

EC and pH meters are quite accurate (when properly calibrated) and fast. But they are slightly sensitive to temperature and won't give the same reading at different temperatures, although some of them include an Automatic

Temperature Compensation, which corrects the reading. So ideally it is good to keep your environment as stable as possible.
pH and EC values are only as good as the last calibration. Calibrate your meters regularly as they do fluctuate. As much as the EC meter is essential, the pH meter may be replaced with the liquid pH test indicators that are cheaper and totally dependable. In fact, when you are not sure about your pH digital meter, you can always double-check with the liquid pH test indicator, as these ones will not alter.

In any event, and to prevent from salt accumulations and pathogen invasion, it is good to change your nutritive solution regularly. More or less often depending if your plants are young cuttings or mature plants.

TEMPERATURE

Water temperature is another important factor. If your solution is too cold. If its too hot, the same seeds won't germinate, cuttings won't root and plants will grow slowly.

Most plants prefer a root zone temperature range of between 18 and 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!

Oxygen solubility and Temperature

One of the key-words in hydroponics is "oxygenation". Generally a good hydroponic system will provide the best amount of oxygen in your solution thanks to its pump and several other "manufacturer's tricks".
But it is imperative to know that temperature will influence the oxygen content of your solution. Here are a few numbers of saturation level of water with oxygen in mg/l of O_2 at different temperatures:

Degree C°	O_2 saturation	Degree C°	O_2 saturation
10	11:36	22	8:85
14	10:39	26	8:22
18	9:56	30	7:67

As you see, the higher the temperature, the less oxygen will remain in your solution. And without oxygen, although your plant's roots bathe in water, your plant's will asphyxiate and drown…

Without oxygen all kinds of diseases and pathogens will thrive, including the much dreaded pythium. So make sure to always keep your water at ambient temperature, as close from 18 to 22 °C as possible.
More information about water oxygenation in hydroponics, is available on www.eurohydro.com click on "to know more".

FILTRATION METHODS, RAIN AND PURIFIED WATERS

Some waters will contain more or less contaminants, sometime high levels of poisonous elements like excessive salts, sulphides, chlorine, fluorides, or even heavy metals.

Most municipal waters contain chlorine. While tiny amounts of oxidant chlorine can have beneficial effects on some plants, frequent, or excessive chlorination must be reduced, which is quite easy. Just fill a container with tap water, and let it stay for 24 hours. Chlorine will evaporate over night.

But most contaminants are not so easy to remove. In this case it is necessary to purify or replace your water source. A variety of methods have been developed:

- The easiest is to cut your tap water with purified or rain water. In small containers this is an easy and economic task.
- Distillation comes to mind too. Except for the most advanced multistage distillation technology found in large installations, it is quite energy intensive. In addition, distillation produces a product that for our purposes is unnecessarily pure.
- Reverse osmosis is an excellent method, but a little expensive still although many small scale systems exist now on the market. With RO you get totally pure water.

A disadvantage for RO filtration is the percentage of pure water obtained versus the quantity of original tap or well water. This proportion is quite high indeed. But pure water is not recommended for plants and it is often advised to cut it off with “normal” water, to the ratio of 2/3 pure water with 1/3 normal water. This is an excellent way to reduce dumping. The remaining waste water can still be used for outdoor plant irrigation, car cleaning or other home chores.

There is still a lot more to say about water and hydroponics. These 4 basic parameters are all you need to follow to ensure healthy plants and beautiful crops. If you start growing with this method, you will soon realize that water as sole environment is a very efficient substrate. Of course one needs to have the right tools and information at hand. Once you do, follow the instructions and prepare to be amazed.

But understanding water while growing in soil is important too as nothing replaces a good quality water, and a well-balanced nutritive solution is the key to success wherever you grow.

Attention Debbie:
TEXTS WITH PHOTOS

Page 2 : 1 - *EC digital meter*
2 - *Liquid pH Test Indicator*

Page 3 : pH chart:
An example of the influence of pH on the availability of essential nutrients in a soilless substrate.

Page 6 :
Roots of an Iboza riparia plant in a Dutch Pot System (Aero-hydroponics)