FAQ – controlling, adjusting and knowing pH in Hydroponic Gardening

Even though there has been great effort by many people to show hydroponic growing as something that can be done by anyone with little knowledge, it has come to my attention that many novice and commercial gardeners fail because of their inability to properly interpret the chemical phenomena around them. One of the variables that is primordial in hydroponic culture and that is grossly oversimplified in most literature about hydroponic gardening is the treatment of pH. For this reason, I decided to create this pH FAQ post in order to answer (in a basic but scientific way) the questions most people have (or should have anyway) about the science of hydroponics.

What is pH anyway ?

This is the most basic and important question. In layman terms, pH is a measure that tells you if a solution is acid or basic, with values of pH over 7 being basic, and values below 7 being acid. Going a little bit deeper into detail, pH is just the result of applying the operator "p" over H (which symbolizes the concentration of $H_3O(+)$ ions within a solution). The operator "p" is just getting the negative decimal logarithm of a number. Since $H_3O(+)$ concentrations appear usually in really small magnitudes, like 0,00000001 M, using the logarithm let's us express this in more humanly understandable numbers, like 9.

Why is 7 the neutral pH ?

Seven is the neutral pH value because the concentration of $H_3O(+)$ ions in solution is determined by the self dissociation constant of water which is 1x10e-14 and equals the product of $H_3O(+)$ and OH(-) concentrations. If $H_3O(+)$ concentrations are equal to OH(-) concentrations you have that $H_3O(+)$

concentration should equal 1x10e-7 which after applying “p” turns into 7.

Why is pH so important in hydroponics ?

This variable is very important in hydroponic gardening because it determines the form in which nutrients are present inside the solution. In pH values which are too acid or too basic, nutrients assume forms which are different from the ones which plants can assimilate. Therefore, an adequate pH value needs to be maintained in order to ensure that all nutrients are present as the right species.

How do I measure pH correctly ?

First of all, pH meters need to be calibrated prior to each measurement. In order to calibrate any pH instrument, at least two different buffer solutions must be used, one with pH 7.0 and the other with any other known pH value. The measurement should be taken with enough time for the reading on the instrument to stabilize.

How can I correct pH changes ?

Bases or acids can be added to hydroponic solutions in order to increase or decrease the pH value of a solution. Bases and acids should be added as solutions and the amount added must be recorded in order to know how nutrients are changed. For example, if a potassium hydroxide solution is added to increase the pH of a solution, the amount of solution added needs to be recorded in order to know how much potassium was added to the solution (since this is a nutrient). Common acids to lower nutrient solution pH values are nitric acid, phosphoric acid and citric acid. I would recommend the use of citric acid to reduce pH and potassium carbonate to increase pH.

What is the ideal pH value ?

It depends on the specific plant you are cultivating. Most crops grow very well with pH values between 5.5 and 6.0, although there are some plants which require more basic or slightly more acid pH values.

How can I stop pH from changing ?

Please refer to the article I wrote about controlling the pH of your nutrient solution with buffers in order to effectively prevent pH variations inside your hydroponic nutrient solution.
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FAQ – Electrical Conductivity (EC) in Hydroponics

Amongst one of the few properties that hydroponic growers use to control their nutrient solutions is electrical conductivity (EC). The main problem with the measurement of the EC, is that few growers really understand it’s meaning and more often than not, grossly overestimate the amount of information it can give them. Therefore, I decided to create this FAQ in order to better explain electrical conductivity, it’s limitations and it’s uses.

So, what is electrical conductivity ?

Electrical conductivity measures the easiness in which an electrical charge can flow through a certain length of a certain material. It is usually measured in S/cm which just means that the material has a certain conductance in S (Siemens) per centimeter. A material with a higher electrical conductivity let’s charge flow more swiftly (it offers less resistance to the movement of charge).

Why is this useful in hydroponics ?

It is useful in hydroponics because the conductivity of a solution is directly proportional to the amount of salts (in this case, the salts are our nutrients) dissolved inside it; so, if a solution has more salts dissolved, it has a higher conductivity. Therefore, measuring EC can give you an idea of how many nutrients are left in your solution.

What are the limitations of EC in hydroponics ?

The first limitation arises because of the chemical character of the property we are measuring. Since EC is proportional to the amount of dissolved salts in each solution, you could suppose that measuring EC would always allow you to calculate nutrient concentrations within your nutrient solution. This is wrong ! Salts increase conductivity but each different ion present inside the solution has a different specific conductivity (they contribute differently to the overall EC) so you could in fact be deceived because you could just have a small amount of an ion that conducts a lot or too much of an ion with a small conductivity. Of paramount importance are the ions that determine pH which have conductivities hundreds of times larger than other ions.

What are some common mistakes when measuring EC ?

Given the above mentioned conditions, EC should always be measured at a constant pH. An EC measured at pH 5 and an EC measured at a pH of 7 will be completely different given that the ions which determine pH have a very large effect on the EC value. Another important fact is that the conductimeter should be calibrated using a solution of known conductivity. If it is not, comparison between measurements can be meaningless.

What is EC useful for ?

The electrical conductivity can tell you if your solution has lost nutrients or water due to evaporation, if measurements are done at the exact same pH value. The EC should be measured when the solution is prepared and three times each day after

then. If your solution's EC becomes too high, you can add water to lower it to the original value. If EC becomes too low (70% of original value), you should not add nutrients. This means that your solution has been substantially changed in composition by the plant and it needs to be disposed off and a fresh one needs to be prepared.

Why can't I add nutrients to a solution with low EC ?

You cannot do this because you don't know which nutrients the plant took up. By adding nutrients to the solution you could be putting too much or too little of any given compound. Of course, you could always do some fancy atomic emission analysis to know the exact ionic composition of the solution but the safest (cheapest and easiest) thing would be to adequately dispose of your nutrient solution and start a fresh batch.

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FAQ – Growing media in hydroponics

In this section I will answer some of the questions that I have already answered in mails that have been sent to me, and that I believe will be helpful to most of the people interested in developing hydroponic crops. This FAQ covers the essential part about the hydroponic growing media and some advice based on my experience and personal knowledge.

What is the aim of the growing media in hydroponic crops and what is it?

The growing media is the substance over which the roots of the growing plants are supported. The plats can grow in either

solid support media or simply over water. The function of the growing media in hydroponic crops is totally different from the one achieve by soil in traditional cultivation, because in this case the growing media is just the plants' mechanical support and it's not involved in any other growing process.

Which is the ideal growing media for hydroponic crops?

The ideal growing media is the one that can supply the plant's necessities of air, water and support; the media has to have a favorable interaction with water in order to maintain the humidity for a long time and it also has to have particles big enough to let the air flow and therefore, allow the oxygen to dissolve in the nutrient solution.

The ideal growing media has to be chemically inert for both the nutrient solution and the plant, and it shouldn't modify neither the pH nor the solution's nutrient balance. Additionally, the media shouldn't have a significant reaction with any of the substances excreted by the plant.

The media should also be biologically inert, which means that it shouldn't contain any organism that might alter the solution's composition (like algae) or damage the plant (like pathogen micro organisms).

Which growing media are available?

There is a great variety of growing media available in today's market. The fist criterion to choose a growing media is the kind of plant that will be cultivated. The second criterion is the price, because even though the media isn't ideal for the plant, the lower price and the fact that it is more available locally are also important. Some of the most popular media are described as follows:

Perlite is a type of amorphous volcanic glass with a high content of water. For this media to be usable in hydroponic crops it has to be heated to 900°C so the water contained in

the crystalline structure liberates and therefore the commercial perlite is obtained, also known as expanded perlite. This type of perlite has a great water retaining capacity, leaving enough space for airflow. The size of the particle in this media is also ideal for big plants' support. The only problem with perlite is the fact that in most of the cases it has to be imported, limiting its use.

Vermiculite is a clay that expands in a limited way with heat. Once expanded, it provides the ideal conditions to be used on hydroponic crops. Nonetheless, this material also has a high cationic exchange capacity which may cause alteration of cation concentrations in the nutrient solution. This could be positive or negative, depending on the hydroponic formulation and on the plant.

Sand is a granular material, generally obtained from any mineral that has been finely divided. This type of material is ideal for hydroponic crops when combined with other materials that can provide a good airflow, because sand by its own can't provide enough space for airflow and therefore the plants could easily die.

Rice husk is an organic substrate obtained from rice plants. The advantage of this material is that it doesn't have a fast decomposing, due to its high silicon content. Nonetheless, it has a high water resistance, although it can provide a great airflow. A mixture between rice husk and sand is ideal for hydroponic crops, taking into account that the proportions can vary according to the plant's necessities. To prevent the rice seed from growing or fermenting and cause a drastic change in the solution's temperature, it's important to wet the rice husk before growing the hydroponic plants. The idea is to maintain the rice husk for at least a day under water before using it.

Gravel. The word gravel refers to any mineral or rock which has particles of a size between 5mm and 2cm. Gravel provides

an excellent airflow and drain, but a bad water retention. When mixed with sand it could provide an ideal growing media, although it’s also ideal for NTF systems because it doesn’t block pipes or moves as easily as the rice husk does.

How do I choose a growing media?

Choosing the growing media mostly depends on the particular experience. For drop irrigation systems I recommend to use a mixture of rise husk and sand, or to use perlite. For NFT systems I recommend gravel or vermiculite. When choosing a growing media it’s important to take into account the necessities of the plant for it to have the best possible development.

For how long can I use the growing media?

This depends on the nature of the media. Non-organic media such as perlite or gravel can be used many times, while organic media such as rice husk need to be renovated once or twice a year.

What treatment should the growing media receive between different crops?

Between crops the media should be washed with disinfectant. Personally I prefer to use hydrogen peroxide because it can be lately removed by the own plants. The system must be irrigated during a whole day with the hydrogen peroxide solution at 3%. After this, the system must be irrigated for two more days with common water and it will be ready to use again.

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