Preparing a Hydroponic Nutrient Solution

Every hydroponic grower should know how to prepare his or her own solution in order to save money and improve crop results. Preparing a nutrient solution is an exact science involving some basic chemical knowledge that is in fact, not so hard to do. One of the main problems in preparing hydroponics solutions (besides knowing the formulation) is knowing how much to weight of each available nutrient salt in order to achieve the desired concentrations.
In order to solve this problem, you can use the hydroponic nutrient calculator I created called Hydroponic Buddy. The hydroponic calculator is located here.

It is fairly easy to use, the calculator includes links to tutorials you can find within this blog which will tell you how to do many things, from the calculation of simple formulations to the creation of A+B+C concentrated solutions, the copying of commercial nutrients, etc.

And that's it ! Press the calculate button and you'll be shown the final concentration results coupled with the amount of grams you should weight of each salt in order to obtain the concentration results you desire. Now you just need to go to your local supplier and buy each one of the salts in order to prepare your hydroponic solution. This let's you experiment with different nutrient concentrations as well as with recommended and optimum nutrient concentrations for different plant species.

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.

—

Hydroponic Nutrient Solutions for Lettuce

Most hobby and some commercial hydroponic growers often get their nutrient solutions from stores that sell “generic” hydroponic nutrients. In some cases, this standard solutions are “compensated” with the aid of some additional help coming from additive solutions that are formulated to add certain qualities that the original standard solution is missing.
Well, the sad thing here is that by not preparing his or her own nutrient solution, the hydroponic grower is wasting his main edge in soiless culture. The composition of the nutrient solution.
In the particular case of lettuce, different nutrient solution compositions have varying effects on the plant, this, of course, because the particular chemistry of your nutrient solution must be fitted for your plant in order to achieve optimum results. The use of generic solutions to feed your plants will more often than not end with some loss in product quality (dry weight, nutrient content, marketability, etc).

In a peer reviewed study published in 2004, M.S. Karimaei *et al* [1] compared different nutrient solutions for lettuce cultivation under hydroponic conditions. Amongst their conclusions, was that the Hoagland solution offers the best conditions for lettuce cultivation amongst the solutions they tested. They also found some important factors such as the electrical conductivity being inversely correlated to dry

weight and K concentration. This shows the utmost importance that using the correct and not the “generic” nutrient solution has on your lettuce growing potential.
_

[1] Karimaei, M.S., Massiha, S. and Mogaddam, M. 2004. COMPARISON OF TWO NUTRIENT SOLUTIONS’ EFFECT ON GROWTH AND NUTRIENT LEVELS OF LETTUCE (*LACTUCA SATIVA* L.) CULTIVARS. Acta Hort. (ISHS) 644:69-76

Hydrogen Peroxide in Germination

As I published earlier, the use of hydrogen peroxide is extensively known in hydroponic cultivation as a disinfectant. However, this little molecule has far more uses and some of them also pertain to plant grow. For example, as it was discussed in the fourth International Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops; Translating Seed and Seedling Physiology into Technology in February 2008, the use of hydrogen peroxide has been studied as an agent to aid the germination of seed.
Indeed, the chemical qualities of hydrogen peroxide make it ideal for the replacement of the stratification of certain seeds. In a peer reviewed article published about the use of hydrogen peroxide for the germination of eastern gamagrass seeds, the authors discovered that the use of hydrogen peroxide 15% for 18 hours indeed helps the seeds germinate by “dissolving” the outer coat of the seeds and therefore facilitating water’s access to the seeds embryo.
In fact, hydrogen peroxide is so effective at this, that the above mentioned treatment substitutes a four week period of stratification at 4°C. The seed containing cupules treated with Hydrogen peroxide effectively germinated after only 2 weeks, when such a time was impossible before the treatment.

The article mentions that hydrogen peroxide was the “most effective” mean of breaking up seed dormancy and effectively carry out germination. (Below a picture of eastern gamagrass)
_

Using Hydrogen Peroxide in Hydroponic Crops

As we all know, hydroponic growers face the challenge of maintaining pure and innocuous solutions that should be free of any type of bacteria, algae or any other microorganism. The growth of any of these organisms inside the nutrient solution carries with it the imminent possibility of plant disease as well as an increased risk of malnutrition and of course, nutrient deficiencies.

—

Algae, in particular, are one of the most troublesome organisms as they are found everywhere and they grow ecstatically inside a hydroponic nutrient solution (after all, they are photosynthetic organisms !). These little creatures love to colonize plant roots (depriving them of food) and also consume a large proportion of the nutrients present inside a hydroponic solution.

—

So what should a concerned grower do about the incredible problem of algae growth ? Nature has given us part of the answer in the form of a powerful oxidant called hydrogen peroxide. This molecule, whose formula is basically H_2O_2 decomposes forming molecular oxygen and water. It also reacts with organic matter in a redox reaction to oxidize it. In other words, algae and hydrogen peroxide cannot coexist.

—

However, there is an important problem that arises when using hydrogen peroxide. It does not discriminate between roots and

algae so using more than the optimum amount leads to plant root death caused by the same quality that kills algae. So what is this optimum amount ?
–
I would love to show you a peer reviewed article that studied this issue but, as a matter of fact, no one has actually studied the levels at which these conditions are right at a scientific level. Most of what we know is currently empirical. Nonetheless, I have – from personal experience- verified that the application of 1mL of hydrogen peroxide (3% v/v) per liter of nutrient solution every week does seem to prevent algae and does not damage plant roots.
–

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.

—