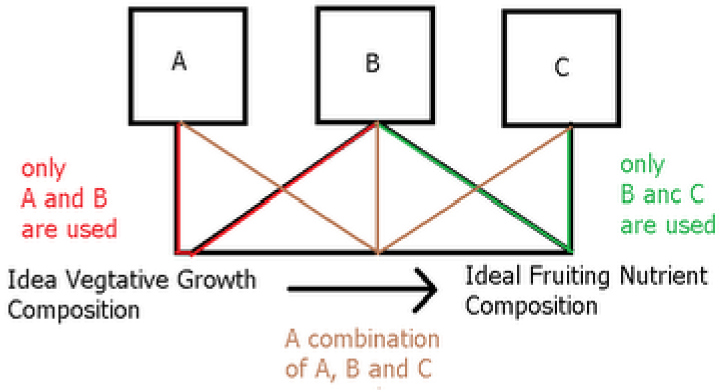
Preparing A, B and C (three part) Concentrated Nutrient Solutions, a Tutorial for my Hydroponic Nutrient Calculator

On the last tutorial dealing with my hydroponic nutrient calculator we learned how to prepare A and B concentrated nutrient solutions for any given formulation we would like. We learned about the different incompatibilities that need to be avoided and why this leads to the creation of two separate solutions. After learning how to prepare these solutions many of you may be interested in knowing how to make the three part formulations commonly made available by most hydroponic nutrient sellers. For example, companies like Advanced Nutrients and General Hydroponics offer three part formulas which are meant to be combined to ensure adequate nutrition during a plant's whole growing cycle. Today I am going to explain to you the main objectives of a three part formula, the difference with a two part formula and how you too can prepare your OWN three part nutrients to feed your hydroponic plants through their whole vegetable, flowering and fruiting cycles. As with the past two tutorials you will need to download my hydroponic nutrient calculator available here for free.

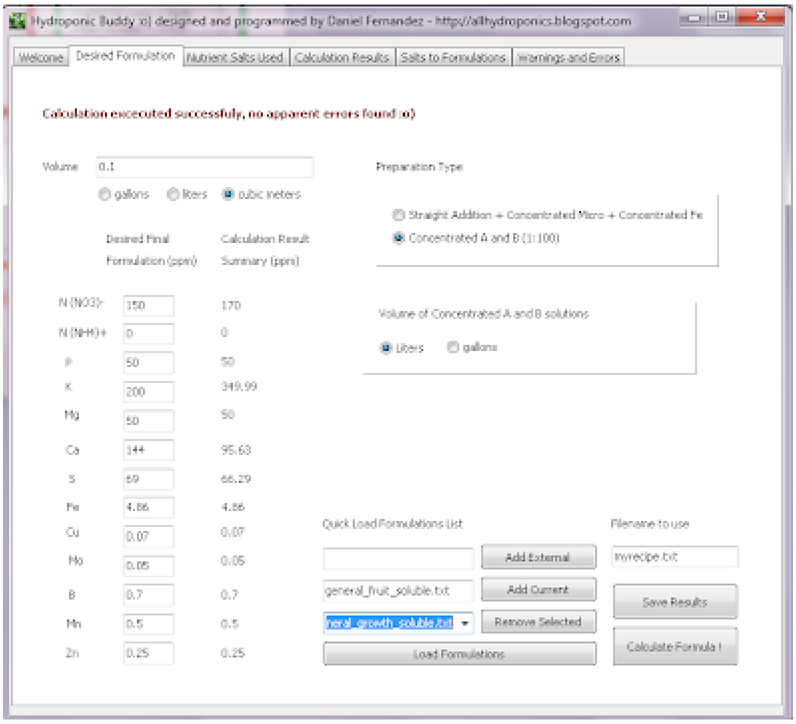
What is the difference between a 2 and a 3 part formulation ?

What we need to understand here is that plants usually have different needs through their whole life cycle and therefore they require different nutrient ratios as they grow older and face different stages of their development. With a two part concentrated nutrient based formulation we can only vary this ratios in a certain way and doing any variations outside this scope will not be possible. With the default approach in my calculator you can vary nutrient ratios by varying the "desired formulation" every time you prepare your reservoir again (since most nutrients are added directly) but with the A and B concentrated solutions you are bound to “stick” to a certain set of concentration values for each nutrient.

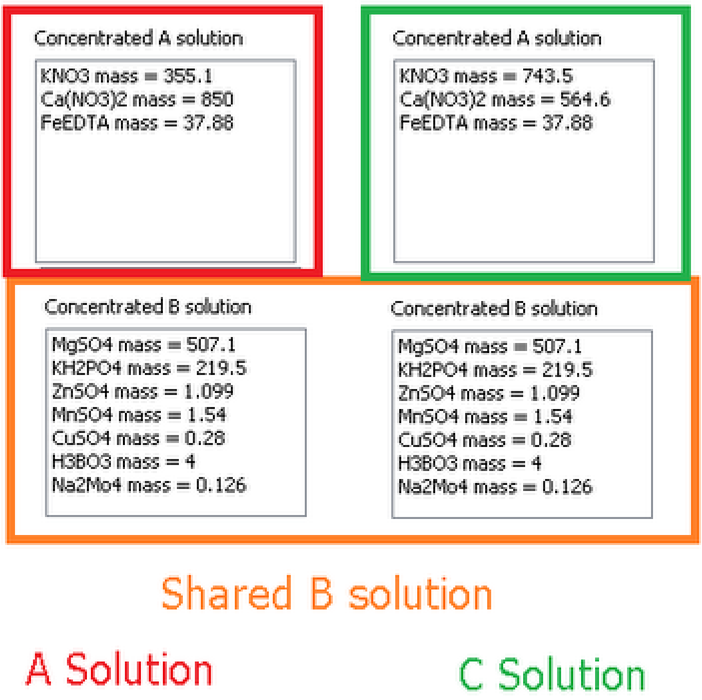


The solution to this problem is quite simple and this is what most commercial fertilizer sellers have come up with. You have two solutions with the same salts but varied nutrient ratios and a third solution that remains constant. What we have then is two possibilities of final compositions A-B and C-B and a whole new possibility for nutrient ratios by combining A-B-C. What is done most of the time is that A-B becomes an ideal formulation for vegetative growth while C-B is an ideal formulation for fruiting. When you start to grow you generally do so with A-B and then you move towards C-B by increasing C and decreasing A as reservoir changes happen.

In my program this sort of solution scheme is easily achieved. What you need to do is simply to have two desired formulations, one for ideal growth and one for ideal flowering and then you just need to make two sets of A and B calculations where B is shared amongst the two. To do this we will first load the general_growth_soluble.txt and general_fruit_soluble.txt desired formulations as indicated on the tutorial for the preparation of A and B formulations (you can download them [here]() and [here]()). After loading the general_growth_soluble.txt composition you should have the formulation composition displayed below.



Then follow the same procedure outlined on the “A and B solution tutorial” to arrive to the salt-weight compositions of the A and B formulations (save the results using the “save results” button) . Now load the general_fruit_soluble.txt formulation and repeat the calculation, also saving your results. A summary of the results of both calculations is shown in the image presented below. You will notice that both calculations share the same weights for the B solution (meaning they use the same B solution) while the composition of the A solution changes. What you have now is a basic three part formulation. You could now think about a regime to change from an A-B growth solution to the C-B fruiting solution in the amount it takes your plants to bear fruit.



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For example, if your plants took aproximately 5 reservoir changes you would then use different quantities of A and C to go from a 100% A feed to a 100% C feed during that time. A timeline if it takes your plants 5 reservoir changes to get to fruiting is shown below. Note how in the beginning we use 10mL of A per liter and then in the end we use 10mL of C per liter, meaning that we have done a full gradual change from a growth to a fruiting formulation.

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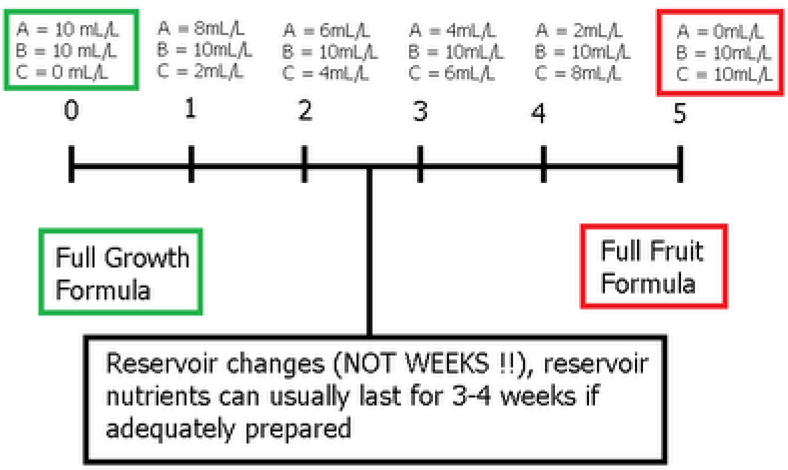

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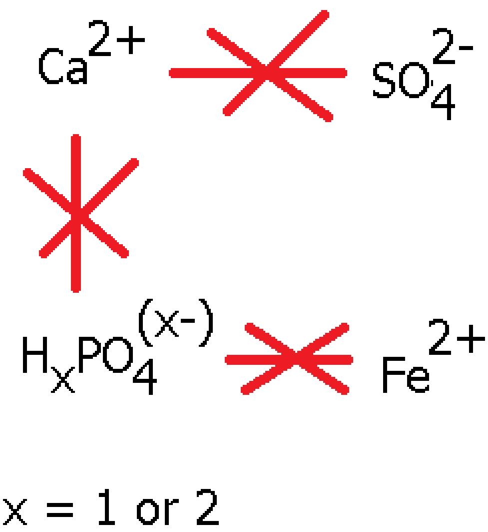
As you see from the above, you can easily use my hydroponic calculator to prepare your own three part concentrated nutrient blends which you can use to build your own nutrient schedule to go from vegeative growth to fruiting. However if you are currently using a fixed composition of a three part commercial nutrient blend then you can easily prepare an A and B solution to replace it, three part nutrients are ONLY needed when you want to do a varying schedule like the one introduced above, using three part nutrients without doing this is simply an overcomplication since a fixed composition can be prepared using just two custom concentrated solutions.

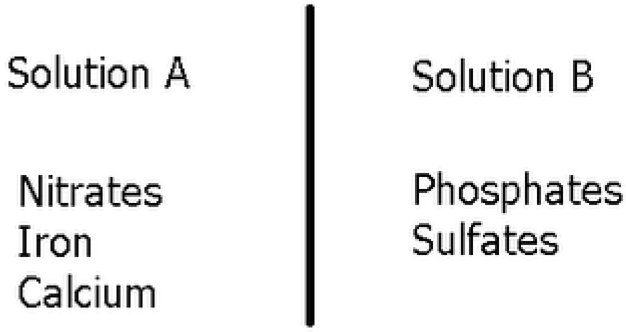
Preparing A and B Solutions Using My Hydroponics Nutrient Calculator

The default way in which solutions are prepared using my hydroponic nutrient calculator involves the direct addition of some component in your nutrient reservoir plus the preparation of some micro nutrient and iron concentrated solutions from which 10 and 100mL are added per batch. This way of preparing solutions is especifically suitable for people with large reservoirs and commercial hydroponic growers since when reservoir levels go above 4 cubic meters all nutrients can be added directly to the reservoir, saving the time and cost of preparating any concentrated solutions. The approach is also good for people with small reservoirs since you can prepare the micro and iron concentrated solutions, dissolve other salts directly and in the end you will have a very accurate amount of micro and macro nutrients prepared with your own custom formulation. However upon the request of several people I implemented an approach that allows people to prepare traditional formulations using an A+B concentrated nutrient solution approach in which two concentrated solutions at a 1:100 ratio are prepared and then simply diluted to prepare

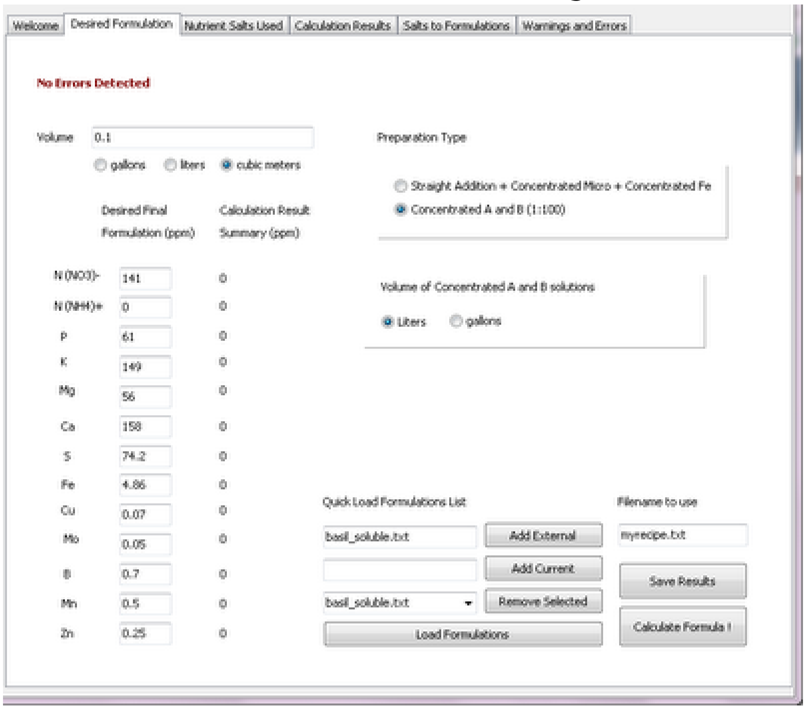
the final hydroponic reservoir’s contents. On today’s post I will discuss this approach and how you can use it if you have the appropiate nutrient salts. Please download my hydroponic nutrient calculator [here](#) to follow this tutorial.
Before we go into the main aspects of the preparation of concentrated solutions we must first understand the incompatibilities that are present within concentrated solutions that restrict the salts that can be used. The program checks for these incompatibilities automatically when using any of the saved salts and for this reason custom salts cannot be used for the A and B custom preparation. The main incompatibilities are shown on the image below. Mainly what we want to ensure is that certain ion pairs that would precipitate insoluble salts are never present together. For this we should avoid putting calcium and sulfate ions together as well as calcium and phosphate species and iron and phosphate species.



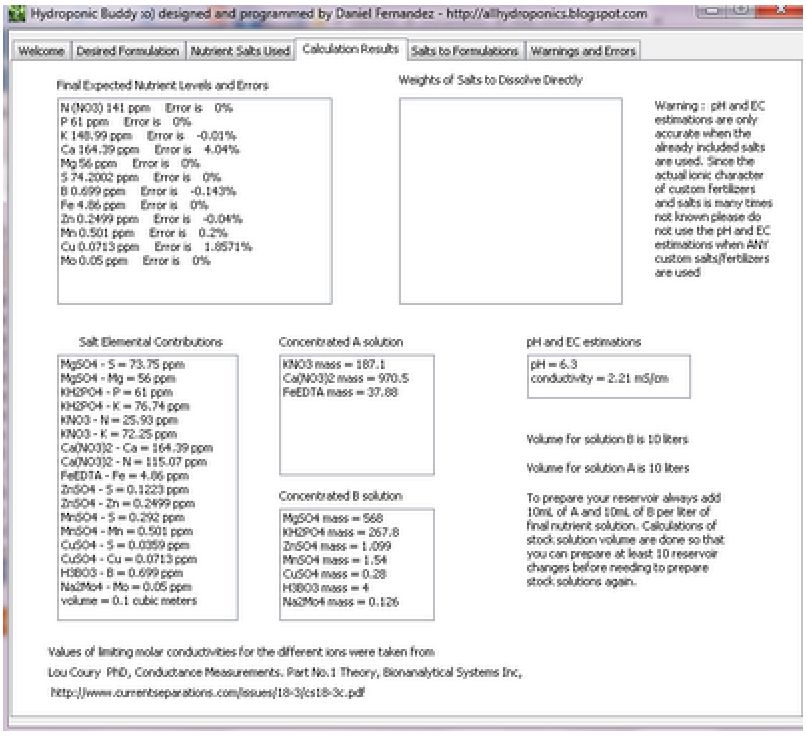
What we have left is the layout shown below that describes the general distribution of ions relevant to solubility of an A and B hydroponics formulation makeup. As you see what we achieve by dividing the concentrated solution into two is to keep away the ions that would precipitate when put together. This of course also restricts our ability to use iron sulfate and a different source of iron, either a chelate (FeEDTA, FeDPTA, etc) or iron nitrate must be used. It also restricts our sources of Calcium to calcium nitrate and therefore our sources of phosphate and sulfate are reduced to potassium salts.



Now let us use our basil_soluble.txt example to calculate the composition of the given A and B solutions needed for this formulation. Unzip the calculator and txt files to any given directory and input basil_soluble.txt under the field next to the “add external” button in the “Desired Formulations” tab, then click the “add external” and “Load Formulations” buttons and select the basil_soluble.txt formulation from the drop down menu. The end result of this process is shown on the image below. Also make sure you check the “Concentrated A and B” option so that the program calculates the results for these solutions instead of the regular method.



After doing this go to the “Nutrient Salts Used” tab and uncheck Calcium Monobasic Phosphate and Iron Sulfate and check Iron EDTA, Potassium Sulfate and Potassium Monobasic Phosphate. Now go back to the “Desired Formulations” tab and click the “Calculate Formula!” button. The program will now calculate the volume of A and B solutions you should prepare so that it will last for 10 reservoir changes of the volume you have input under the “Desired Formulations” tab. So for this case in which we left the input as 100L the final concentrated solution volume is 10L since it will last for 10 changes of the 100L nutrient reservoir, adding 1L per reservoir change. It should also be clear that the concentration ratio of 1:100 cannot be increased due to solubility limitations of salts. The results of the calculation are shown below.

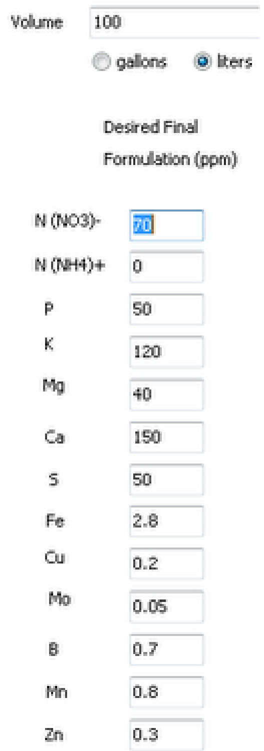


Hopefully with this tutorial you will be able to prepare any A and B solution for any final formulation you would like. It is also clear that this approach has less flexibility than the “default” since it restricts the character and distribution of the salts used, making the use of very cheap fertilizers like calcium monobasic phosphate effectively impossible. However it also provides an “easy way” to make reservoir changes since concentrated A and B solutions only need to be prepared once every 10 times this happens. So it is clear that both approaches have their advantages and with the help of my calculator you’ll be able to choose whichever approach fits you best :o)

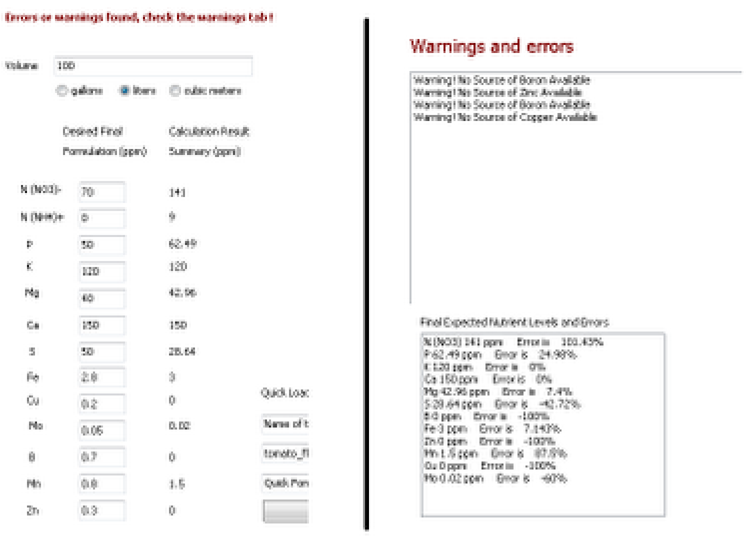
Using my Nutrient Calculator with Commercial Fertilizers : Part No.2

On the last part of this tutorial series I talked about how you could use my hydroponic nutrient calculator to figure out the ppm values of a commercial fertilizer. Today I am going to talk about how you can achieve a given ppm formulation using a commercial preparation figuring out what additional salts you would need to arrive at an adequate composition. I am also going to show how you can figure out the final concentrations of nutrients when using combined commercial fertilizers and salts and how this approach can be used to arrive at full, accurate and complete formulations for your hydroponic reservoir. In the end you will see how my hydroponic calculator (hydroponic buddy) is a great tool for the preparation of your hydroponic nutrients even if you rely solely on commercial formulations. You will need my hydroponic nutrient calculator to follow this tutorial, you can download it here.

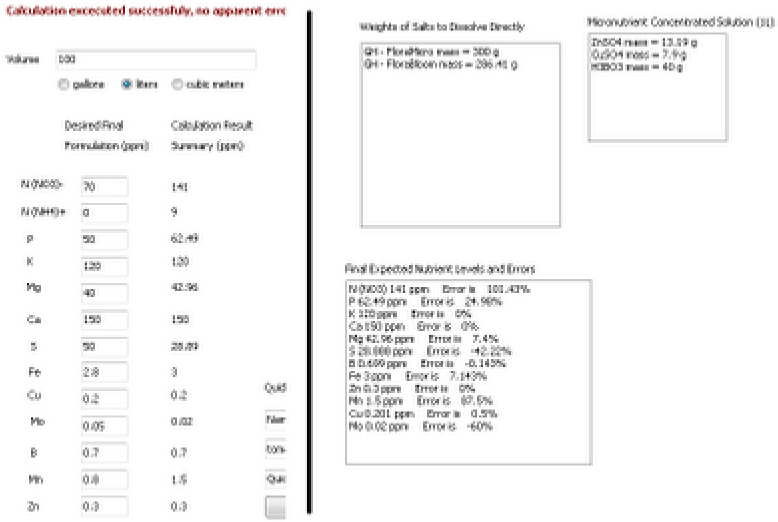
Today we are going to use a few commercial fertilizers from General Hydroponics and Advanced Nutrients as well as a hydroponic formula to grow tomatoes. The formula – applied for tomato growth in Florida for the first cluster growth stage – can be found here. We are going to use the FloraBloom and FloraMicro nutrients from General Hydroponics (labels here and here) . As with yesterday's tutorial the first thing we are going to do is add all the custom fertilizers within the "Nutrients Salts Used" tab by using the "Add New Salt" button by entering the composition percentages found on the label and composition pages of the above mentioned fertilizers. After doing this we input the desired tomato formulation under the "Desired Formulation" tab like it is shown below.



Once we have the formulation we select the custom fertilizers, uncheck all other salts and input a volume of 100 liters. After doing this we press the “Calculate Formula !” button which produces hte results shown below. The software also warns us about errors so we need to go to the “Warnings and Errors” tab where we see that certain nutrients are missing from the formulation. In particular we see that we are missing Zn. B and Cu. You will notice that many combinations of hydroponic fertilizers miss one or several essential nutrients for plant growth (even micro-grow-bloom combinations often miss B, Zn and Cu).



So right now we need to add sources of these elements to have an adequate formulation. Go to the “Nutrient Salts Used” tab and select Zinc Sulfate, Boric Acid and copper sulfate and press the “Calculate Formula !” button again. This now produces the results shown below where all elements are present and the program tells us to prepare an additional 1L concentrated solution of Zinc Sulfate, Copper Sulfate and Boric Acid.



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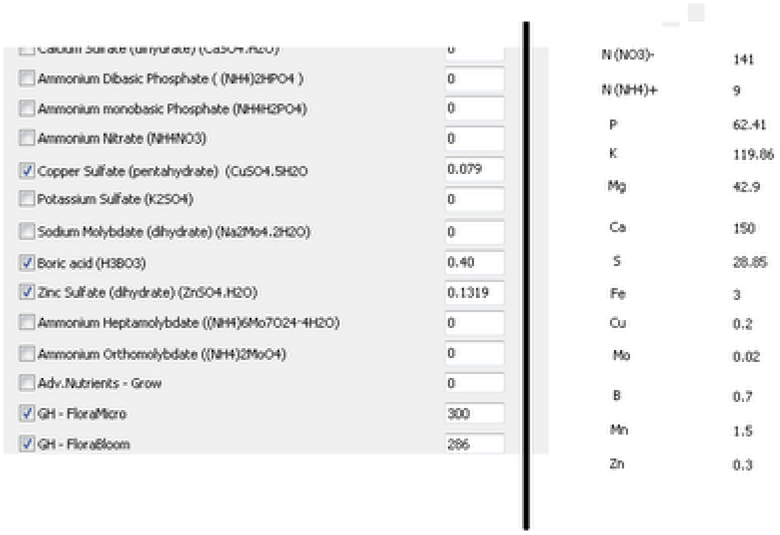
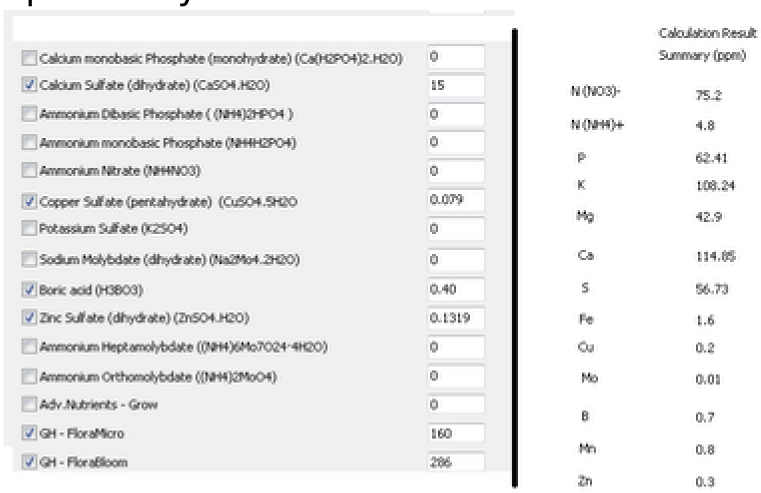
However we see now that the formula is not very well balanced since we have a 100% excess of N and a defect in S so to achieve the desired composition it might be necessary to tweak the results slightly in a manual fashion and use some additional salts like Calcium Nitrate. To do this tweaking you should input the weight values obtained on the “Mass” boxes next to each salt’s name (the mass of Zn, Cu and B salts is the mass of the concentrated solutions divided by 100 since the 1L concentrated solutions are prepared with a 1:100 dilution factor taken into account). The input and the results of the “salts to formulation” calculation are shown below.



Now we need to increase S and decrease N. To decrease N we need to reduce the amount of the most important Nitrogen source (FloraMicro) to about half. Since this reduces the amount of Ca significantly we can now add calcium sulfate to the formulation to make up our now acquired Ca and S deficiencies. Select calcium sulfate and give it a value of 15g. After doing this you will notice that Ca and S concentrations will be much closer to the desired end values given by the original formulations. The final result is shown below. Eventhough the amount of nutrients are not absolutely the same as the ones on the formulation we were able to achieve the same "global ratios" for all important nutrient levels and the solution will now contain ALL the necessary nutrients for adequare plant growth and – in this case – especially for the first cluster development of tomato plants.



I hope that this tutorial allows you to understand better how my hydroponic nutrient calculator can be used for the preparation of a wide array of formulas and the correction of commercial nutrient fertilizers that lack some essential nutrients for plant growth. It also shows you how you can modify the results of the automatic calculator to further correct a formula if you believe that better results and pairings can be achieved. As you see, the calculator gives you tremendous flexibility and makes the preparation of hydroponics nutrients with precise ppm nutrient values a simple exercise.

Using my Nutrient Calculator with Commercial Fertilizers : Part No.1

One of the main reasons why I wanted to develop a nutrient calculator for hydroponics was to allow people to understand the amount of nutrients they are adding to their solutions and to use the calculated amounts to either use common salts to achieve the same nutrient percentages or to understand which salts are needed to adequately compliment the nutrition achieved by their hydroponic nutrients. On these posts I intend to show you how you can use my hydroponic nutrient calculator with your commercial hydroponic nutrient composition, figure out the amount of nutrients given by a certain amount of the fertilizer, adapt your fertilizer to a given formulation you want, supplement your nutrient with other salts and get a similar composition yourself with easily available salts (which are used to make your hydroponic nutrients most of the time). **For this tutorial you will need my hydroponic nutrient calculator available here.**
First of all, lets learn how to add a given nutrient commercial fertilizer to your list of hydroponic salts/nutrients. After you open the program go to the "Nutrient Salts Used" tab and select the "Add New Salt" button. A screen will pop up in which you can input the percentage composition values of your fertilizer. As an

example, let us use the FloraBloom fertilizer from general hydroponics and add it to our fertilizer list. The fertilizer composition given on the product's label is available here. Below you can see an image of the added percentages on my nutrient calculator, note that the K2O, P2O5 check box is used as the percentage values on the label are given as oxides for K and P. After finishing the addition the "GH – FloraBloom" item becomes available in the bottom of the page.

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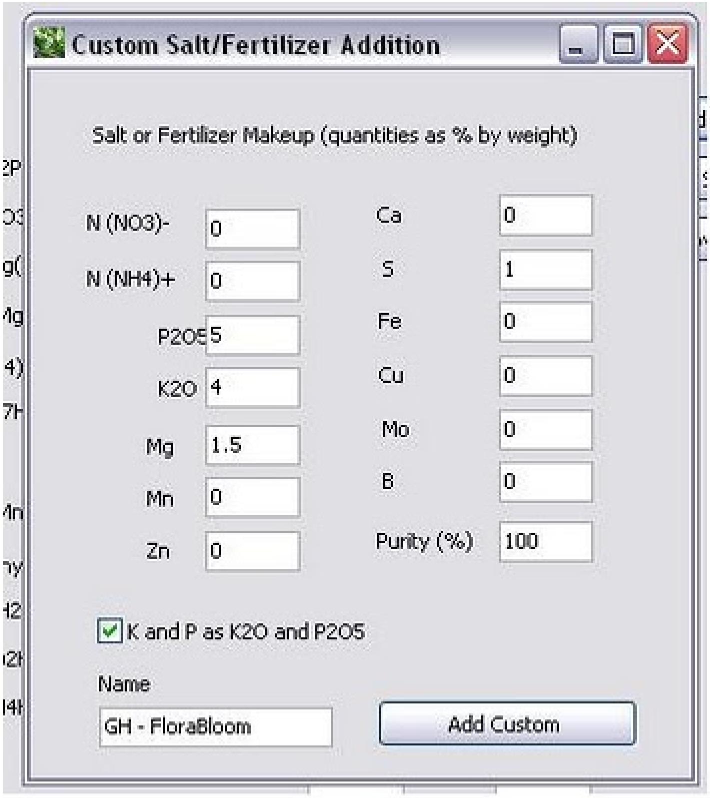

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We are now going to calculate the ppm values for the different nutrients we would get for the recommended addition of 1 tbsp/gallon for regular growth. Since 1 tbsp is 15 mL and we assume the fertilizer density to be 1 g/mL we get an addition of about 15g per gallon of solution. We input 15 in the field next to the fertilizer name, leave the purity at 100% and go to the "Salt to Formulation" tab where we input a volume of 1 gallon. We then get the results shown below. You can see that this preparation would give us around 87 ppm of P, around 131 ppm of K, 60 ppm of Mg and 40 ppm of S. Now that you know how to get these values it becomes easy for you to know the amount of nutrients you are getting for a given amount of any commercial fertilizer simply by using the composition values available on the label.

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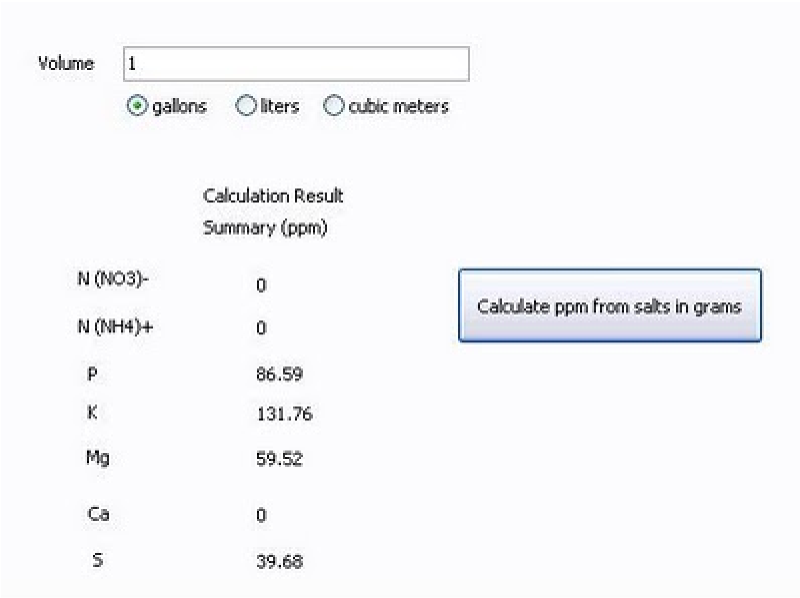


Getting these values is only the first and easiest thing we can do with commercial fertilizers using my calculator but you will see within the next few tutorials that much more powerful things are possible. Right now you can also get the ppm values of different mixes of commercial fertilizers as well as current ppm values you are getting with any custom regime you are using. For example you could upload the whole General Hydroponics series to the calculator and see the different ratios you can achieve with different proportions of their products.

On the next tutorial we are going to use the above mentioned fertilizer as well as a predetermined formula to determine which salts are needed to compliment the above solution and obtain a well-balanced custom formulation. After that we are going to see how we can use the above obtained ppm values to makeup our own copy of this fertilizer as well as how we can improve it. I hope you are enjoying my free hydroponic calculator and that you leave any comments you may have :o)

Possible New Features for my Hydroponics Calculator

A few days after the release of my hydroponic calculator free software implementation I can tell you that I am absolutely happy with the results. The calculator had some resolution problems at first but these problems where easily fixed. After changing to a tabbed interface and by including the ability to save and load nutrient recipes I think that the calculator is on its way to become one of the most important tools for serious hydroponic hobbyists and small business owners. Right now the calculator allows you to get precise weights of different nutrients to prepare your own hydroponics solutions something which no other free software available online does. This allows people to save great amounts of money and achieve very good results around their hydroponic crops, at least when dealing with nutrients. However I believe that there is still a lot to do and for this reason I will be writing today's post about my ideas for the calculator and it will also be great to know what you have in mind :o)

There are several things I want my calculator to be able to do in the future but first of all my focus will be on everything dealing with hydroponic nutrients. The first important additions I am working on mainly deal with the ability to add custom salts to the program and obtain results of ppm concentrations achieved by placing certain amounts of salts within the solutions. Certainly being able to go from a given weight of salt or commercial fertilizer (with known percentage element compositions) to a ppm concentration will allow people to know how adequate their recipe is and – moreover- it will allow people to play with different levels of salts if they feel that the currently "automatic" salt quantity selection is not doing the best possible job. It will also allow people to "reverse engineer" their commercial hydroponic solutions by figuring out their ppm contributions, later using those on the nutrient design tab to obtain salt weights to arrive to those concentrations. By using different sources people will also be able to pinpoint with good accuracy the nutrient sources used by their favorite commercial blend.

The next big feature I am looking forward to add is a “water quality” section which will help people adjust their nutrient solution to their water quality parameters. Things such as hardness, carbonate levels, magnesium, calcium, pH, EC, nitrogen and QOD (chemical oxygen demand) might be important parameters I will take into consideration within this section. A pH and EC prediction module – which is almost finished – will help people calculate an estimate of what their final solution properties for a given formulation might be.

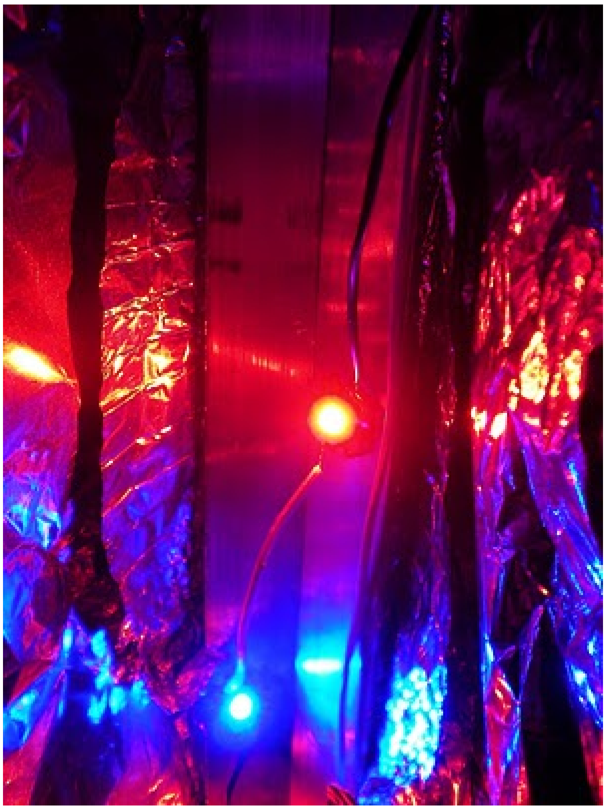
Even though these features are bound to add great flexibility to my calculator, I believe that right now this is only the “tip of the Iceberg” of the potential the software has. After doing this I will attempt to put all my chemical knowledge regarding hydroponics crops into practice by inputting “optional additions” that people will be able to choose when preparing their formulations. For example, you might want to choose the “hydrogen peroxide regime” option and a summary giving you usage instructions as well as detailed explanations of how much peroxide to add and when to your reservoir will be shown. Similar options ranging from “potassium silicate treatment” to “cobalt supplementation” might become available as the calculator progresses.

As you see, there is a lot in storage for this little calculator program which I am hoping to rename to something like “hydroponic buddy” once version 1.0 comes out. Right now I am working on all the features and relearning a lot of Delphi programming which I honestly haven’t done extensively for almost 10 years. Do you have any suggestions for my hydroponic nutrient calculator ? Do you have any suggestions about what you would want to do with it ? Please leave any comments, questions or suggestions below ! By the way, you can get the latest version of the calculator here.

Building Your Own High-Power LED Grow Lights for Hydroponics

You will often hear in the world of hydroponic growing that Light emitting diode (LED) lights simply do not work as well as the traditional HPS (high pressure sodium) or Tungsten Halide lamps when growing large plants. The truth is that this belief is centered around the fact that most of the commercially available LED fixtures are built with low-power cascade LEDs that simply do not give your plants enough light intensity to grow properly. The fact that people do not know how to distinguish one from the other, coupled with the problems of getting a genuine, high power LED lamp makes the use of LED fixtures in hydroponics limited and almost never considered a serious option for modern growers. On today's post I want to talk a little bit about how you can build your OWN high power LED lamp and how this way you can get a cheap, low-energy, highly-efficient device to make your plants grow.

The first thing you need to consider here is the amount of LEDs you will be using (the amount you will require for your plants) and the power supply you will need to feed those little hungry fellows. From my experience I can tell you that the lumens measurement of high power LEDs does not give you an accurate estimation of how many you need since LEDs have a highly centered light spectrum that is more accurately measure in micro Einsteins (the appropiate measurement unit for these devices). In this case I advice an empirical measurement of 5, 3W high power LEDs for each plant you wish to grow and 1 blue LED for every 10 red LEDs. (below you can see a picture of one of my LEDs, the LED was dimmed to get a better picture)



The second thing you want to do is buy the LEDs, just google red or blue 3W high power LED on ebay and you will find several chinese or US providers who will sell you these great artifacts for a small price. When you get your LEDs make sure you buy at least 3-5 more than what you will need since these LEDs are sensitive and they will burn easily if you wire them incorrectly. Since the power requirements of these LEDs are also pretty high they will get VERY hot (however much cooler than traditional lamps) and they will need to be mounted on aluminimum rails with at least one 6 inch fan for each 5 LEDs (or a BIG rail than can dissipate all the heat).

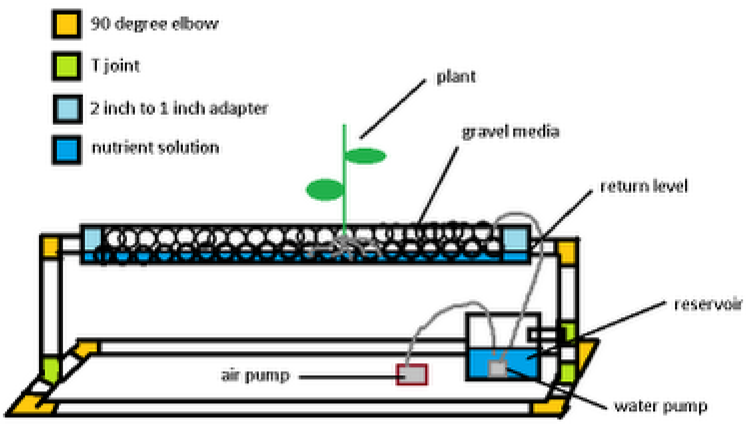
The next part – which is the most difficult – is the building of the power supply and voltage regulator side of the device. You can use a laptop supply to power up some LEDs but you need to calculate their power requirements so that you know how many you can power up for the power supply you will be using. A very good guide I used to create my LED assembly can be found here. Of course you should change the setup and LED number to fit your needs but the tutorial shows you exactly how you can choose the power supply, calculate LED needs and build the voltage regulator with a simple electronic circuit.

Finally, after I finished I hooked the power supply of my LEDs to a regular appliance timer which sets them on and off at certain times of the day. Making sure that my basil plants get enough light for their growth even when I am not at home. It is very worth noting that before I installed this LED fixture my basil plants were extremely leggy, etiolated and just dying. A few days after the LEDs where in place they started to grow like crazy :o) **Do you have any questions, comments or suggestions ? Have you also built your own LED fixture ? Leave a comment below !**

A Simple Home-Made PVC Hydroponic Growing System

When I moved into my new apartment I wanted to build a small hydroponic system I could use to grow basil just next to a window. Since I absolutely love to cook Italian food and fresh basil is a key ingredient this seemed like the best solution to enjoy my cooking to its fullest and practice the building of a new hydroponic system. I finally decided to build a very cheap and simple PVC system which currently hosts 6 beautiful basil plants that give me more than enough basil for all the Italian cooking I could possibly want. On todays post I want to share my system's design and description with you as well as some picture of my basil plants, showing you how they are doing under this great – yet very simple – PVC hydroponic growing system.

The system I built can be classified as a continuous Ebb and Flow system. It basically has a 2 inch PVC pipe with a horizontal cut on top, a reservoir, an air pump, a water pump and a 1 inch PVC framework that also acts as a secondary reservoir for the nutrient solution. The system is filled with river bed gravel as a growing media and it can be used for the growth of almost any type of plant. Of course, any rocky media that easily allows nutrient solution flow can be used and a larger pipe diameter can be used to grow other plants such as tomatoes, cucumbers, etc. For larger plants a 4 inch diameter PVC pipe and a 2 inch frame work would be required. A diagram of the system is shown below (sorry for the poor drawing skills ;o)).



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As you can see, the pump constantly sends solution from the reservoir below to the gravel bed inside the 2 inch PVC pipe located above it. The solution recirculates and goes down to reenter the reservoir. Even though the actual passage of the solution may seem "biased" towards once side, the truth is that a small part of the solution actually flows through the whole pipe and ends up draining through the other side as I have not noticed any difference in development between plants in opposite sides of the tube. Since there is a level that has to be filled within the tube before a return of solution is established there is a constant feeding of aerated solution

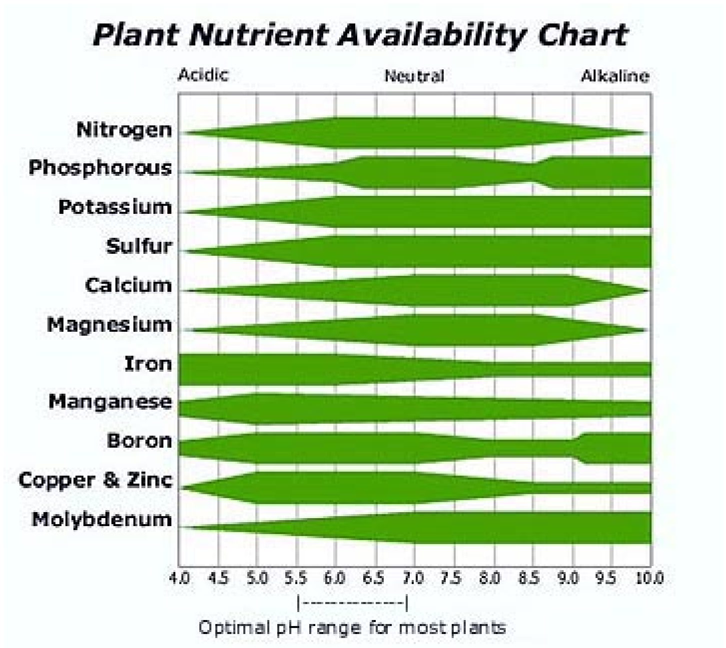
for the plants.
This system is very cheap to build and it can be made with 6 – 90º elbow joints, 3 – T joints, 2- 2′ to 1′ adapters, 5 feet of 2 inch PVC piping and about 10-15 feet of 1 inch PVC piping. You also need a container that can hold enough nutrient solution volume, a water pump and an air pump. The system provides very good growing conditions for plants and the gravel media provides adequate support for a wide host of vegatable varieties. This system is also great for strawberries and similar crops. Several improvement over this design are obviously possible and many will be featured on future blog post articles as I implement and test them.

The above picture shows you my setup with the basil plants currently growing vigurously (they are currently about 60 centimeters high). Above the system you can have a small look at the high power LED fixture I built myself to provide these plants enough light (as hardly any light gets through the window). I hope you have enjoyed this article and decide to build your own simple home-made PVC hydroponic growing system. Make sure you leave any comments with questions or suggestions you may have :o).

Understanding pH in Hydroponics – Part No.2

Yesterday – on the first part of this article – we talked about the nature of pH, the origin of pH changes in hydroponics growing and why these changes happen with time within a hydroponic culture, I also talked a little bit about how to prevent pH changes by building a balanced solution with a given percentage of nitrogen given as ammonium. On the second part of this article I am going to talk about the adaptation of plants against pH changes, why certain pH levels are needed and why there is an important over-focus on the importance of pH which does not need to be maintained in ranges as narrow as most growers believe.

What is the ideal range of pH for plant growth ? The fact is that plants can grow ideally from a pH of 5.5 to about 7.0. Above or below these values certain changes start to happen within the chemistry of the solution that makes nutrients less available to the plant. The large importance of adequate – yet not excessive – control of pH values is to maintain an optimum absorption of nutrients for your plants. When we go below a pH of 5.5 certain nutrients like iron become very readily available while nutrients like phosphorous and nitrogen become much less available. This lack of availability has two main causes. The first one is the overall change of chemical species within the solution, with the newly generated species being difficult or impossible to assimilate by the plant while the second one is that species that become extremely available generate a strong antagonic effect against some nutrients. For example, iron is antagonic with phosphorous and with a pH decrease below 5, the absoprtion of iron becomes extremely easy and therefore the aborption of P becomes more difficult, the overall formation of acid phosphate species which are also not so readily available by the plant further reduces P availability. An image shown below gives you a good idea of the availability of nutrients for plant growth as pH changes.



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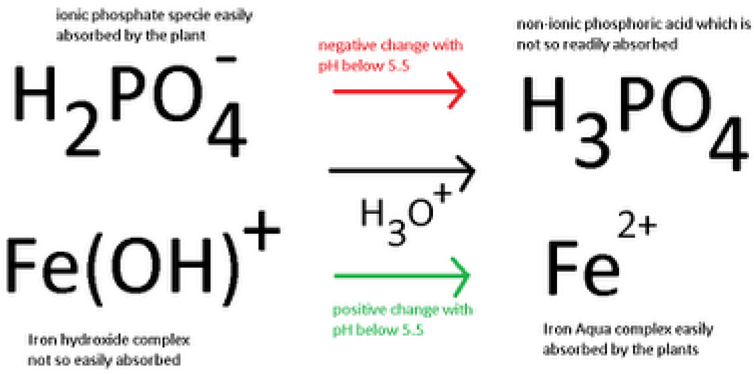

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However most growers tend to believe that the pH level of their nutrient solution is the pH level that plants have around their roots, something which is actually not correct in the sense that plants have evolved local pH adaptation mechanisms to survive to changes in soil pH. When you measure the pH of your nutrient solution you are measuring the pH of the “bulk” while the pH of the actual root-zone of your plants might be within the ideal zone for nutrient absoprtion. Therefore growers usually underestimate the actual capacity of their plants to correct pH and spend an enormous amount of time tinkering with pH to make it “ideal”.

The fact here is that plants do not like abrupt pH changes like those that happen when you add pH up/down to continuously adjust your nutrient solution’s pH levels. Plants can deal perfectly with a slow pH increase caused by nutrient absorption from 5.5 to 6.5 but when you – in a matter of seconds – revert the pH back from 6.5 to 5.5 in a matter of seconds you are causing your plants significant levels of stress since they are simply not used within their natural environment to such quick pH changes.

The easiest way I have found to deal with pH is to simply not obsess with it. Most solutions that are well balanced and contain about 10-15% of the nitrogen as ammonium and about 20-40 ppm of phosphorous will adequately contain pH within the 5.5 to 7 pH region from the beginning of your nutrient cycle to the time when the nutrient solution has to be changed. As a matter of fact – beyond the initial adjustment – the changing of pH can be avoided if the nutrient solution is adequately formulated and given in a quantity of at least one gallon per plant. Plants develop well around these pH levels and the improvement you gain from obsessing about perfect pH zone levels will be lost by the stress you put into your plant roots with pH corrections. Of course, there are easy and almost perfect solutions to pH control like the method using ion exchange resins I mentioned in a previous post. A method that mimics the way in which pH is naturally buffered within soil.

Therefore if you want to have a great hydroponic crop with little maintenance and a very good yield I would advice you to prepare your own nutrients taking pH-self balancing and adequate nutrient ratios into account. Certainly this method will give you a lot of control over your composition and a great saving in solution costs.

I hope that after reading these two posts on pH in hydroponics you have now grown a much better understanding of how pH is, how it works and how it evolves in a hydroponic culture. It is very important for you to understand that pH plays a vital role in nutrient absorption but that obsessing with strict pH zones is not beneficial for your plants in the sense that constant additions that cause quick changes in pH values cause stress to their root zone. Adequate nutrient design and a good understanding of how nutrient interact is therefore important for the correct use and low maintenance of a hydroponic crop.

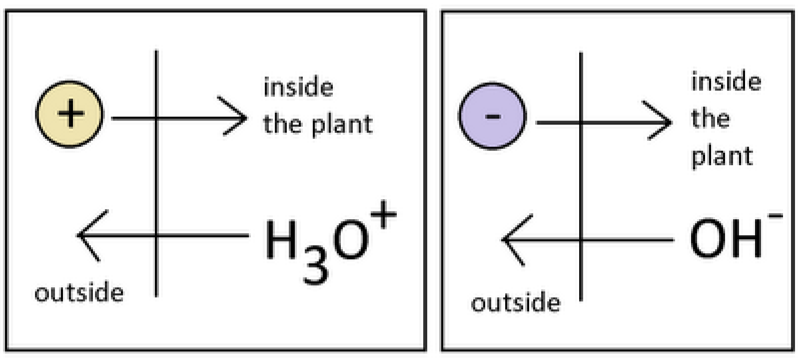
Understanding pH in Hydroponics – Part No.1

When water reacts with itself to create the H3O(+)(hydroxyl) and OH(-) (hydroxide) species, one of the most fundamental and important characteristics of aqueous solutions is generated. The reactivity of a solution and its interaction with living organisms is determined in a great extent by the concentration of these two species, a variable usually measured as pH which is nothing but the negative value of the logarithm of the concentration of the H3O(+) ion. In hydroponic culture – where our plants are in great contact with aqueous solutions – the understanding of the role of the H3O(+) and OH(-) ions and their measurement as pH becomes very important if an in-depth understanding of what is going on wants to be attained. On today's post I will attempt to guide you into this micro world of pH and how and why pH changes within a hydroponic crop. Tomorrow -on Part No.2 – I will try to explain to you how plants adapt to pH changes and what a pH change actually means for a living organism.

What determines pH ? This variable is inversely proportional to the concentration of H3O(+) ions and directly proportional to OH(-) ions, the more hydroxil ions you have the more acidic your solution will be (the lower the pH) while more hydroxide ions will increase your pH and give you a higher pH reading. It is important to understand here that hydroxyl and hydroxide ions determine each other's concentration. Since water's self-reaction equilibria must be maintained, the sum of pH and pOH must always be equal to 14 (a neat consequence of chemical equilibrium theory). When the concentration of hydroxyl and hydroxide ions is equal, pH and pOH contribute equally to the solution and they are therefore both 7, reason why the pH of a neutral solution has this value.

Now that we know a little bit about pH we can understand better what happens when plants interact with a nutrient solution. When a plant is put within a given solution it wants to absorb the nutrients it needs to grow. These nutrients are avilable as ions that have a given charge. For example, nitrogen is absorbed as the nitrate ion (NO3(-)) while potassium is absorbed as the K(+) ion. When a plant takes potassium in, it depletes the solution of a positive charge. Since the solution must remain neutral the plant gives the solution an H3O(+) ion to compensate. The plant has therefore decreased the pH of the solution by absorbing a potassium ion. When nitrate is absorbed – an ion with a negative charge- the plant does the opposite and exchanges the nitrate for an OH(-), the pH of the solution is increased.

Plants absorb nutrients and change pH !



If plants absorbed nutrients in a perfectly symmetrical fashion, they would not increase or decrease pH as overall charge changes would be compensated. However – as no one is perfect- plants absorb nutrients at different rates and they therefore create a “pull” towards a certain pH region. If a plant absorbs nitrate heavily it will start to contribute far more OH(-) than H3O(+) ions into the solution and the result will be a net increase in pH. Depending on the composition of the nutrients and the overall growth stage of the plant, different net movements in pH can be achieved by the plant.

The most influential factor in the changes of pH within a solution is generally the composition of the nitrogen component of the solution. When plants absorb ammonium ions NH4(+) they tend to decrease pH while nitrate – as mentioned above – tends to increase pH when absorbed. If you contribute a percentage of the nitrogen in your solution as ammonia the net effect will be a beneficial "absorption pH buffer" since plants will take nitrogen in both forms, effectively delaying the onset of important pH variations. Of course, the ratio of nutrients also performs a vital role since plants' nutrient absorption mechanism are largely non-specific and they are greatly influenced by the different concentrations of nutrients within the solutions. Having a nutrient solution designed to provide an adequate balance will be vital in helping you control pH fluctuations.

On part two of this "understanding pH in Hydroponics" post I will talk about the range of pH plants can live in, how they adapt to changes in pH and other interesting aspects that will help you better understand the role and true importance of pH within a hydroponic crop. I hope that today you have acquired a rough idea of what pH represents, the nature of pH changes and some basic things that can be done to improve the pH balance within your hydroponic culture.

Growing a Hydroponic Garden Without a pH or EC meter

So you have decided you want to start a hydroponic garden but you do not want to use a pH or an EC meter. It is fairly common for people to feel this way when they are starting their own hydroponic gardening due to several reasons. Maybe you are not very familiar with the technical side of

hydroponics, you don’t want to get into all that stuff in the beggining or perhaps pH/EC meters are terribly hard to get or expensive where you live. Does this mean that without a pH and EC meter you won’t be able to run a successful hydroponic venture ? No. On today’s post I am going to talk to you about how you can grow hydroponic crops without a pH or EC meter and yet get good results, sometimes even better than people using all those technical gizmos :o).
As a chemist I think like a scientist and part of this way of thinking is the controlling of variables. I like to control pH and EC because I feel that this allows me to have a record of what is happening within my nutrient solution, without these measurements I would be “blind”, so to speak. However when I was beginning my major I started my first hydroponic ventures with absolutely no control over pH or EC. I didn’t do this because the cost of an EC/pH meter where I lived was prohibitive so I said, “what the hell” and went for it. I have to say that I got some very satisfying tomato crops after having some significant failures due to both rookie mistakes and disease. I managed to get full, 2 meter high tomato plants filled with delicious vibrant tomatoes and this happened without ever checking my pH or EC.

How did I manage to do this ? After time went by and I got an EC/pH meter, I started to monitor how my crop evolved with time to know what I should or should not do to improve my corp’s yields. I found out that the pH of my crop increased steadily – and sometimes came near 8 – before I usually changed my nutrient solution. The EC oscillated widely but my reposition of the initial “level” of solution with water was enough to keep the EC at a good level. So if you want to be successful with hydroponic crops, it is not absolutely vital for you to have a pH or an EC meter, you just need to follow some simple guidelines to have a wonderful hydroponic crop.

1. Have one gallon of nutrient solution per plant. Having this volume of solution in your reservoir per plants allows you to have enough nutrients so that each plant will take a significant amount of time to absorb them. Having less solution is troublesome since your EC will change wildly and your nutrient solution changes will have to be more frequent. A one gallon per plant rule of thumb seems to be the best choice.

2. Add fresh water to recover the initial level of your solution . This is one of the easiest things to do. By adding fresh water -without any nutrients- to top off your reservoir to its initial level you will keep the EC near its initial value for the whole time. This simple technique ensures that your EC remains within rational levels and your plants stress-free.

3. Change your solution every 4 weeks. After 4 weeks, in a hydroponics system where there is one gallon per plant and the solution is continuously topped off (at least once a day) you will find that your plants have used about 40% of the nutrients at most (this is what I got from full production tomato plants and an atomic emission analysis of the nutrient solution). This means that your solution is now deprived of nutrients and it is time to use the solution to water your soil-garden and prepare everything again.

With this simple guidelines, anyone will be able to grow a hydroponic garden without using a pH or an EC meter. Of course, in the beginning you may find some problems while you find the adequate level of nutrients your plants need (if you do not prepare them yourself) but after a few trial and error runs you will be able to grow full hydroponics gardens without having to constantly monitor either pH or EC. Certainly, better results are achievable when you are monitoring these variables but it is possible to grow a beautiful hydroponics crop without the slightest monitoring of these aspects of a hydroponic nutrient solutions. People usually underestimate the ability of plants to adapt to changing conditions, something that they are able to do beautifully if you only follow the above advice. **Do you have any advice or suggestions**

to help people grow without an EC or pH meter ? Feel free to leave a comment :o)