Crazy pH Swings – How Media and Bacteria Affect pH in Hydroponics

I usually get an email from time to time from someone who is experiencing wild pH swings in their hydroponic reservoirs. Growers usually tell me that their pH was around 6.2 one day and then 8.0 by the next morning or some similar story. This situation becomes a little bit frustrating as the grower does a huge effort to keep the solution at a certain pH level only to realize that after a certain time the pH of the solution simply starts to swing wildly between very odd values. In order to help new and experienced growers better understand the nature of these swings, what they mean, and how they can be eliminated for good I decided to write this small article on hydroponic pH swings and how variables different to plant feeding affect pH levels.

Let's suppose you got home from work, prepared a new batch of nutrient solution and set your pH level at a very comfortable level of 5.7. By the next day, when you wake up in the morning to check your plants you find that the pH of your solution is 7.5. You start to argue with your pH meter, recalibrate, readjust your solution and leave for work. When you come back – to your surprise – your pH level is now around 7.3. What ? – you ask yourself – What could be wrong if you set the pH to 5.7 again and it again went up to 7.3 ?

The answer to these wild pH swings comes from an understanding of the chemistry behind everything within your hydroponic system. Generally these swings towards high pH values are caused by media which has surface-active basic sites which act like "buffers" and readjust the pH of your nutrient solution to their own "preset" pH level. This is very much like the mechanism used by soils to naturally control pH, only that this time the minerals are playing against you. Substrates

that have been made at high temperatures which have basic potential – such as rockwool – show this kind of behavior. Other media such as river bed gravel also show strong pH buffering effects due to their natural mineral composition.

How do you end this problem ? The easiest way to end this problem is to pretreat your media before starting your crop. Place your media in a bucket and then add 1 liter of vinegar for every gallon of water. The media will attempt to neutralize the acetic acid and in doing so it will lose the proton capturing ability of its surface basic sites. Using a weak acid like acetic acid is better than using a strong acid – like nitric acid – because this ensures that residual acids within the media won't lead to other extreme pH fluctuations. After the media is soaked in the vinegar solution measure the pH, wait a day and measure it again. If there is no difference between both readings then you can now wash and use the media – if there is – then you need to wait another day and remeasure.

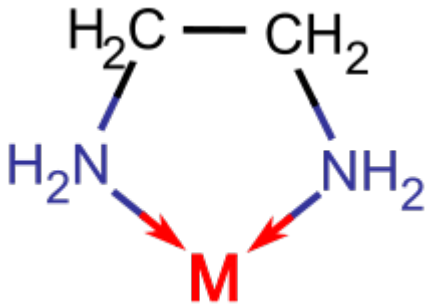
Now basic media is not the only problem around. There are also wild swings to acid values which are usually a consequence of bacterial growth or dying organic matter. When organisms die or when they are being decomposed by bacteria organic acids – which lower pH – are released into your nutrient solution. Wild swings into the 3.5-4.5 region usually mean that the problem is not media but related to root disease. You should do a hydrogen peroxide treatment (check my articles on peroxide for more on this) and wait to see if pH levels stabilize after a while. In extreme cases, physical removal of dead root material may be necessary to correct the problem.

Last but not least, the problem can also be related with plant feeding from a very scarse volume of solution. If you are handling less than 1 gallon per plant of solution in your reservoir then it is likely that plants themselves – through the absorption of nutrients – are causing the swings. This is easily fixed by placing a larger reservoir and ensuring that

you are always recirculating at least 1 gallon per plant of nutrient solution. Hopefully with the above guide you will be able to better understand “wild” pH swings and take corrective action whenver you see this behavior happening within your hydroponic crop.

Preparing your Own Chelates – Improving Your Hydroponic Nutrients

If you have already read my free ebook for preparing hydroponic solutions and you have already seen many commercial and other standard formulations you may be asking yourself if you will have problems with iron due to the unavailability of any chelating agents. The truth is that I have used formulations without any chelating agents several times and I haven’t had any problems when they are prepared by the ebook. However many of you may be interested in the addition of chelating agents and you may wondering how you may modify the spreadsheet or what you should add in order to generate the adequate chelates. On this post I want to explain a little bit how you can add chelating agents to your reservoir to chelate the salts mentioned on my ebook and how this can easily generate all the chelated metal complexes you need to avoid any solubility problems.



Simple metal chelate model representation

What is exactly a chelate and what are they good for ? A chelate is simply an organic molecule that “wraps” itself around a metal ion and prevents its precipitation, increasing its solubility. Chelates also diminish the amount of available metal ions to plants and therefore they slowly release the quantities of micro nutrients available for plant growth. There are many available pre-made chelates on the market such as Fe-EDTA. However, the cheapest way to generate chelates once you already have a standarized formulation based on simple inorganic salts is to add a chelating agent.

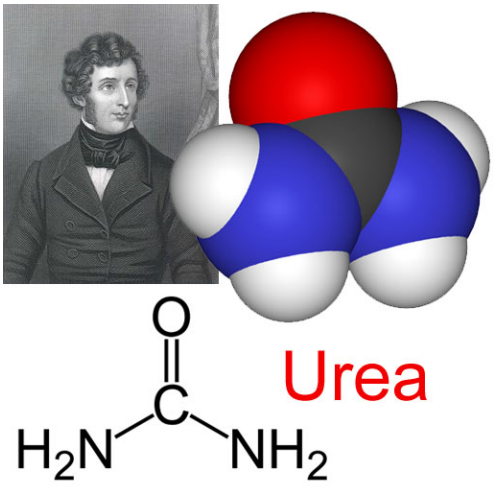
The most common of these agents is called Ethylendiamintetraacetic Acid (EDTA), a tetraprotic acid which is able to chelate most metals with a particularly high afinity for Fe. However, when you add only chelated iron, the fact that other metals start to compete makes the iron complex destabilize and the chelate is eventually destroyed. However, when we add the chelating agent we can make sure that we add enough to “wrap” Fe and other metals in such a way that the stability of the iron complex is guaranteed.

When we add the chelating agent we do not add EDTA (the acidic form) but we add it as a salt of another element, usually K-EDTA. Once this is added to the solution the EDTA quickly gets rid of K and goes for another metal – such as Fe – for which it has a much higher affinity. The chelating agent quickly forms complexes with all the metals it loves and you end up with a solution that is highly stable and not prone to any micro nutrient related precipitation. How much do you need to add ? Depends on your formulation. The spreadsheet download

with the ebook shows the amount of chelating agent (K-EDTA) you need to add to the END solution after all micro nutrient concentrated solution additions have been done (this amount fully complexes Fe, Mn, Zn and Cu).

Urea in Hydroponics – Positive or Negative ?

When we supply nitrogen in our hydroponic solutions there are always a several ways in which we can fulfill our plants' needs for this nutrient. The traditional way is to supply nitrogen solely as nitrate (NO3-) salts, something which is well proven to give good results, high yield crops and better than soil growth. However it is always good to ask if a combination or the use of additional nitrogen sources may improve the outcome of our hydroponic experience. Particularly since plants in soil absorb nitrogen as nitrate and ammonia it becomes worth asking if a slow releasing source of ammonia- such as urea – would improve the yields of our hydroponic system. On this post I will write a little bit about the use of urea in hydroponics and the scientific evidence that there is to support or reject its use.



Model of a urea molecule

Urea is an organic molecule which slowly decomposes in water to yield ammonia and carbon dioxide. If the media is slightly acidic, the ammonia released will get protonated to form ammonium, a form of nitrogen which can be readily assimilated by most plants. Moreover, this form of nitrogen can also be processed by bacteria to yield nitrate, providing us with an additonal – slow release- mechanism for nitrate supplementation. Several research groups have asked themselves if urea would bring any significant benefits to hydroponics crops. Of particular interest was a study published by Oda *et al*, dealing with the effects of Urea and nitrate fertilization in hydroponics crops using both organic (peatmoss and baggasse), inorganic (rockwoll and sand) media and pure NFT systems.

After doing a study with several concentrations of Urea and Nitrate -both by themselves and combined – this research group found out that Urea does not improve crop yields in NFT systems and indeed pure nitrate does the best job when no media is in place. When media is introduced, organic media shows a faster Urea to Ammonia conversion but Ammonia to nitrate conversions are faster in inorganic media. However, the effect of Urea remains poor in the sense that nitrate-only crops outperformed almost all crops except for some plants grown with small quantities of Urea which proves to be beneficial in the same way as small additions of ammonia are

already known to be.

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So in the end, is it worth to add Urea to a hydroponic formulation ? The scientific evidence says that Urea does not have any clear beneficial effect that could not be gained by a small addition of ammonium salts, something which has already been confirmed by several studies done on different plant species. If you are planning on starting a new hydroponics crop adding about 5-10% of your total nitrogen as ammonium may prove to be beneficial but any addition of Urea seems completely unecessary.

Of course, further research on this subject would be needed to know the effect of nitrate/ammonium/urea combinations to know if the beneficial effects are a sole consequence of the presence of small quantities of ammonia or a virtue of the “regulatory” effects introduced by Urea as a slow release ammonium fertilizer.

Hydroponic Tomato Formulations – Nutrients for Every Growth Stage

One of the most interesting things that can be done once you know how to prepare your own hydroponic nutrients (check out my free ebook on the right hand menu) is to make formulations for the different growth stages of your crops. Certainly the variation of several nutrients along the different stages of a plant's life will guarantee optimal production with better than average results. In the beginning it certainly isn't very clear how you should vary nutrients and careful care about the amounts – particularly the ratios between nutrients – have to be taken into account in order to have the best possible results. On today's post I want to talk a little bit about hydroponic tomatoes and how we can design a very specific "feeding schedule" with small modifications in our nutrient formulations for the whole growing process of this plant.

When you are growing plants, their needs are obviously not the same along all their growing stages. In a similar way as a 5 year old human doesn't need the same nutrients as a 16 or 52 year old, plants that are just germinating and plants that have been flowering or have just begun their fruiting have different nutritional needs. In tomatos, these differences manifest themselves as different demands for the different nutrients. For example, demand for magnesium, nitrogen and potassium increases as the plant grows older as more nutrients are needed to develop more live material. However some needs – such as those of micronutrients – remain fairly constant as the demand for most of these ions is not increased radically as the plant grows.

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Of partiular usefulness to understand how to improve your tomato crop by developing a formulation schedule is a study done by the university of Florida by Hochmuth *et al*. The study shows the design and application of a feeding schedule to

tomato crops from transplant to fifth cluster development, changing nutritional input as the plant develops. You can access this study here and look at all the different formulations developed for different stages of tomato growth. By using the ppm values provided on this study you can easily prepare nutrient solutions using the spreadsheet provided with my nutrient preparation ebook (available freely).

When you analyze the nutritional formula given above you can see how some nutrients are increased gradually while some are increased in large steps. You can also see how some ratios – like the N/K and Ca/K relationships – vital to the development of healthy tomato fruits, develop as the plants reach a more mature stage. In the beginning, small quantities of nitrogen (< 70 ppm) are available while in the end this quantity is increased to 150 ppm falling in line with the demand of a much larger fruit-producing plant. Hopefully with the above guidance and reasearch article you will be able to start some customized nutrient scheduling for your tomato crops to improve their yields, making sure that your plants get the most out of the nutrient formulations they are using.

Making Your Own Hydroponic Solutions – Download my Free Ebook

Many of us have always dreamed about making our own hydroponic solutions to stop buying all those expensive solutions from the hydro fertilizer companies. Sadly, most people do not have the necessary knowledge to prepare solutions and coming up with an adequate formulation seems to be extremely difficult for almost everyone out there. As a chemist, I have the

fortune of having the knowledge necessary to prepare hydroponic solutions and the initiative to teach you how to do this by yourselves in an understandable way. Through the past 6 years I have worked as a hydroponic consultant, lecturer and avid gardner and I believe this experience allows me to teach all of you how to design your own hydroponic solutions.
How do you make your own final solutions ? The first thing is to get away from the notion that doing this is extremely difficult. Certainly there are a lot of technical aspects that need to be known but I have taken them all and simplified them so that everyone can actually make their own hydroponic fertilizers with little or no practice. Within my ebook – which you can download freely at the end of this post – you will find detailed instructions on how to prepare your own hydroponic solutions using a spreadsheet I made that makes the preparation of these solutions extremely easy.

My ebook gives you the ability to take any formulation and easily translate it into the real amounts of chemicals you need to weight in order to prepare your final hydroponic nutrient reservoirs. All the chemicals I have included within the ebook are extremely easy to find – as they are very common fertilizers- allowing you to prepare ANY formulation you may want. You can now fulfill your dreams of preparing one solution for each separate growth stage controlling the exact

amount of each single nutrient you add into the solution.
What you will find here is a very easy to use solution – made by a proffesional in chemistry – that will help you prepare fertilizers in the most cost effective yet flexible and satisfying way there is. You will now know exactly was is inside your hydroponic formulations and you will be able to pin-point and solve any nutrient related problems that may arise within your crop. You will also be able to easily discard problems as not being nutrient related since you KNOW the exact quantities of each nutrient you are putting into the solution.

So are you ready to embark yourself in the journey for total freedom and independence in the world of hydroponic nutrient solutions ? . Please leave any comments with any suggestions, questions or doubts you may have :o) Also if you want to share this ebook with anyone please direct them to my website so that they can download it themselves.

I have also recently made a great move forward by coding my own windows application to calculate hydroponic nutrient formulations. If you would like to learn more about this program and download it absolutely for FREE please follow the link shown below.

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This EBOOK is NO LONGER AVAILABLE as it was replaced by HydroBuddy.

I want to learn more about your new free hydroponic calculator app

Hydroponic Nutrients… Why Solid is Better than Liquid

One of the most important decisions you can make when buying hydroponic nutrients for your plants is the way in which the nutrients are prepared. Fertilizers for soil-less culture are available both within solid and liquid presentations and it is very likely that you have been buying the liquid once up until now since these are the most well-known and easiest to prepare. However, you may not be realizing that by buying liquid fertilizers you are putting an enormous burdden on your hydroponic growth wallet. The fact is that by buying solid hydroponic nutrients you could be saving 5 to 10 times your hydro-food costs. Within today's post I will explain to you the difference between solid and liquid fertilizers and why buying solid nutrients is always a better choice for your hydroponic garden.

Liquid fertilizers available for hydroponics are generally prepared by dissolving an array of salts and additives in water. After these additions are done the concentrated solution is prepared and ready to be sold. When you get it the only thing you need to do is to take a given measure of volume from the liquid and poor it into your hydroponic reservoir. What you may not be realizing is that – due to the fact that salts need to be dissolved in water – there is an inherent limitation in the amount of nutrients you are getting and most of what you are buying is actually water. There is also the

added cost that in order to make up a concentrated nutrient solution, compatible salts have to be used. This limits the chemicals that can be purchased and makes the cost of the fertilizer higher.

When you purchase a solid hydroponic fertilizer you simply buy a mixture of salts which you then need to weight and dissolve in a given volume of water. Since there is actually no water and the salts don't need to be predissolved in a concentrated solution, the array of salts that can be used are a lot wider and much cheaper costs can be achieved. Added to that is the fact that packing is a lot simpler and much more efficient since the need to bottle solutions is unecessary. In the end you will see that with 2 pounds of solid nutrients you will be able to prepare more than 300 gallons of nutrient solution while you would probably need much more (about 10-30 gallons of concentrated solution) to prepare the same amount using concentrated liquid fertilizers.

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You will definitely see that most hydroponic fertilizer companies are simply charging you a lot for liquid fertilizers when you could as easily be buying bulk solid fertilizers at a fraction of the cost. Premixed solid hydroponic fertilizers are also widely available commercially and easily made up with some basic chemistry concepts (more on this on a later article!). So next time you are planning to buy more hydroponic fertilizers think about cost efficiency and look for some solid premixed hydroponic nutrients which are bound to give you as good – or better – results than your previous liquid mix.

The Hoaglands Solution for Hydroponic Cultivation

This hydroponic nutrient solution was developed by Hoagland and Snyder in 1933 and it’s one of the most popular solution compositions for growing plants (in the scientific world at least !). The Hoagland solution provides every nutrient necessary for plant growth being appropriate for the growth of a large variety of plant species. The solution described by Hoagland in 1933 has been modified several times (mainly to add iron chelates and the like, but you can use the salts you normally use for preparing your solutions as long as you append to the concentrations given for each element) but the original concentrations for each element are shown below.

N 210 ppm
K 235 ppm
Ca 200 ppm
P 31 ppm
S 64 ppm
Mg 48 ppm
B 0.5 ppm
Fe 1 to 5 ppm
Mn 0.5 ppm
Zn 0.05 ppm
Cu 0.02 ppm
Mo 0.01 ppm

As you may notice, the Hoaglands solution has a lot of N and K so it is very well suited for the development of large plants like Tomato and Bell Pepper. However, the solution is very good for the growth of plants with lower nutrient demands such as lettuce and aquatic plants with the further dilution of the preparation to 1/4 or 1/5.

Also remember that the amount of iron you use should be in proportion with the amount of phosphate placed inside the solution, when used at higher strength, there exists the

possibility of iron precipitation if non adequate chelates are used. If possible, try using DPTA instead of EDTA (which is not so good a chelating agent for hydroponics).