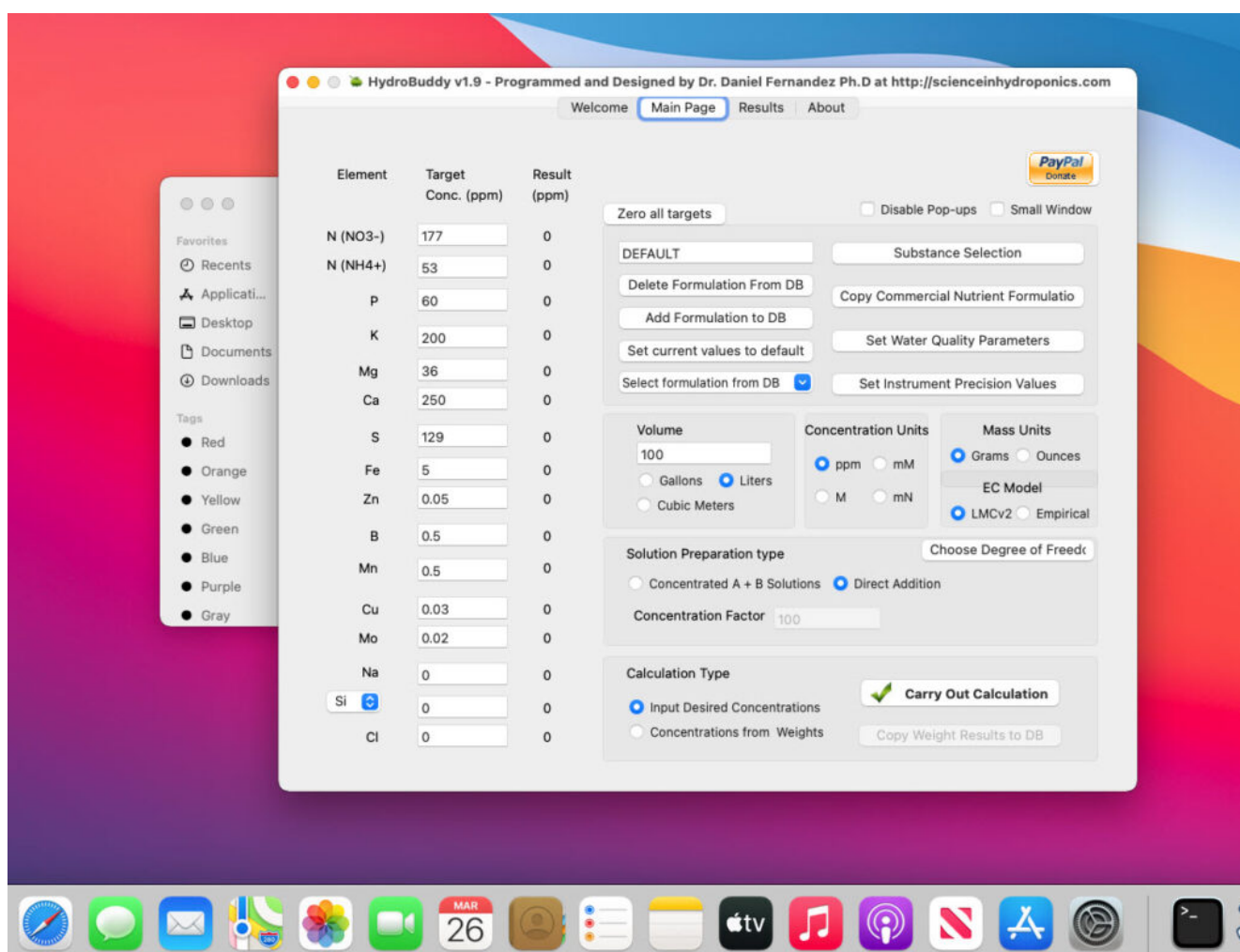


# HydroBuddy v1.9, MacOS binary, new EC model, many bug fixes and more!

Today I am releasing a new version of [HydroBuddy \(v1.9\)](#) which contains many suggested and needed improvements from the previous version of the software. In this post I want to discuss the changes within this release and how they will affect the way things are done in the program. Some big changes have been implemented so make sure you go through the list below if you want to use this new version. **Thanks to all of you who contributed your suggestions about HydroBuddy and/or reported bugs to me.**



One of the biggest changes in this release, the return of precompiled MacOS binaries.

## Here is the list of changes in this version:

- A MacOS binary compiled in Big Sur 11.0.1 has been released.
- Ability to make any formulation the “default” formulation. This selected formulation is loaded when the software is started.
- The LMC conductivity model has now been replaced with LMCv2 which is an important improvement. See [here](#) to learn more. The LMCv2 model now adjusts conductivity based on each specific ion’s charge and the overall ionic strength of the solution. It now includes no arbitrary terms.
- The treatment of liquids/solids in the program has now been changed. Instead of specifying liquid or solid (and the program having to make assumptions) users can now select whether the percentages and substance amounts are going to be either in g and w/w% or in mL and w/v%. This should simplify the interpretation of results and the addition of substances.
- An additional column has now been added in the results page to specify the unit of the amount being calculated. When a user wants a substance’s contribution to be calculated in mL, the appropriate unit will be shown here.
- When adding a new substance, all fields are reset to null values (previously the program kept the values from previously opened/updated substances).
- Density has now been eliminated as a variable used in the program since it is not needed if there is no cross between w/w% and w/v% calculations. It is only kept in the “Copy commercial nutrient formulation” dialogue.
- An error where P and K were mixed up in the product comparison window of the “Copy commercial nutrient formulation” function has now been fixed.
- The wording of options in the “Substance selection” dialogue has been changed so that the buttons better

describe what they do. For example the “Delete” button has now been changed to “Do not use”.

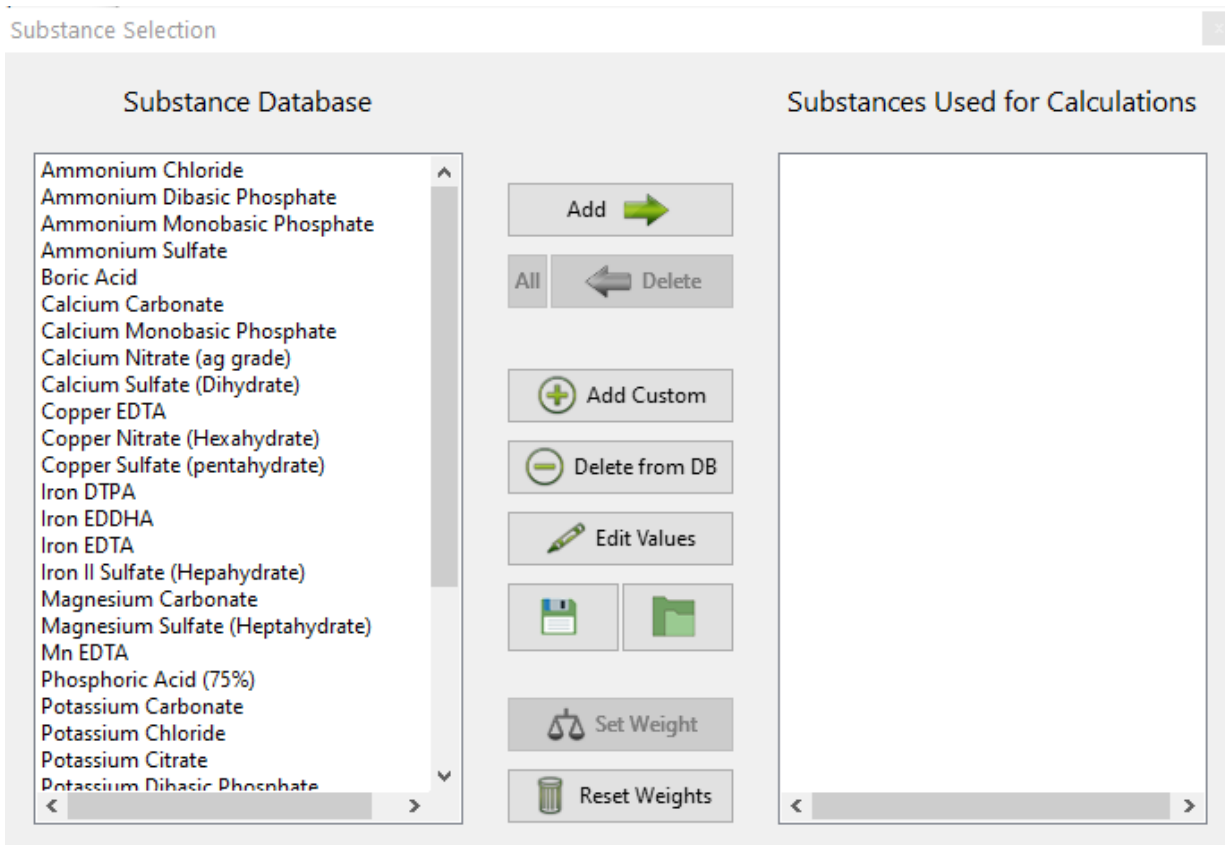
- Two buttons have been added next to the EC model prediction in order to allow users to increase or decrease the EC by adjusting all nutrient concentrations by +5%/-5%. This will allow you to see how nutrient concentration changes affect conductivity in a straightforward manner.

The above modifications are now committed to the [github repository](#) as well. Feel free to take a look if you’re interested in how any of the above variations were coded into the program.

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## About the default fertilizer database in HydroBuddy

Hydrobuddy is an open source calculator that seeks to help growers create their own hydroponic nutrient solutions. In order to do this, the program includes a database with a list of curated fertilizers that should be a good starting point for those interested in making their own nutrients. However, why these salts are included might not be clear to most growers, so I wanted to create a blog post to explain my reasoning behind this particular repository and the purpose each one of these different salts might serve. It is also worth noting that the default list of nutrients is not by any means definitive – for example no silicon containing substances are included – so users are welcome to add their own substances using the “Add Custom” option and entering the composition of the fertilizer they want to add.



The HydroBuddy “Substance Selection” screen (v1.8) showing some of the nutrients in the default database

The idea of the database that comes with HydroBuddy is to allow you to create several types of nutritional tools, using different types of approaches. The table below shows you what each one of the substances contributes in terms of nutrition, as well as its qualitative effect on the pH of the solution and what its most popular use is. While some of these substances – such as Potassium Sulfate – are mainly intended to be used as part of the main nutrient solution, others such as Potassium Carbonate, are not intended to be used in this manner but they are intended to be used as buffering agents when doing pH adjustments or creating concentrated pH up/down buffering solutions. There are also substances like – like Ammonium Chloride – that are not intended to be used for either of these purposes but mainly for supplementing a nutritional component, in this particular case, N as ammonium.

The main nutritional use of substances is also dependent on what the end-user has in mind. For example when a user wants to create a concentrated stock solution, substances such as

Calcium Sulfate or Zinc Sulfate might not be very useful – due to their limited solubility or stability – while for users who want to create final solutions by direct addition of salts, these substances might be the best potential choice. Several different substances are provided for some nutrients to allow for this type of flexibility.

Another important factor can be cost, sometimes this is a more important factor than other considerations, such as which nutrient is the absolute best from a botanical perspective. This is part of the reason why – for example – 4 different forms of iron are present within the default database, this way users can see how much iron they would require from different sources and – depending on their particular application and cost range – make a decision about which iron source might be optimal. This also allows a user to consider using a cheaper source of iron – like Iron II Sulfate Heptahydrate – and then preparing their own chelates using a chelating agent, such as disodium EDTA.

Name	N1	N2	P	K	Mg	Ca	S	Fe	Mn	B	Zn	Cu	Mo	Cl	Na	Use	pH effect
Ammonium Chloride	■													■		S	↓
Ammonium Dibasic Phosphate	■		■													MN	↑
Ammonium Monobasic Phosphate	■		■													MN	↓↓
Ammonium Sulfate	■						■									MN	↓
Boric Acid										■						MN	↓
Calcium Carbonate						■										B	↑↑
Calcium Sulfate (Dihydrate)						■	■									MN	
Calcium Nitrate (ag grade)		■				■										MN	↓
Copper EDTA												■			■	MN	
Copper Nitrate		■										■				MN	
Copper sulfate							■					■				MN	
Iron DTPA								■							■	MN	
Iron EDDHA								■							■	MN	
Iron EDTA								■							■	MN	
Iron II sulfate (heptahydrate)							■	■								MN	
Magnesium Carbonate					■											B	↑↑
Magnesium Sulfate (heptahydrate)					■		■									MN	
Mn EDTA									■						■	MN	
Phosphoric Acid (75%)			■													B	↓↓↓
Potassium Carbonate				■												B	↑↑
Potassium Chloride				■										■		S	
Potassium Citrate				■												B	↑↑
Potassium Dibasic Phosphate			■	■												MN	↑
Potassium Monobasic Phosphate			■	■												MN	↓↓
Potassium Nitrate		■		■												MN	
Potassium Sulfate				■			■									MN	
Sodium Borate										■					■	MN	
Sodium Molybdate													■		■	MN	
Sodium Nitrate		■													■	S	
Zinc Nitrate (Hexahydrate)		■										■				MN	
Zinc Sulfate (Monohydrate)							■					■				MN	
Zn EDTA												■			■	MN	

This table shows all the salts included in the default HydroBuddy database (v1.8). N1 is N as Ammonium, N2 is N as nitrate. MN = Main nutrition, B = Buffering, S = Supplementation

For those with experience in hydroponic nutrient solutions it will be clear that many commonly used substances are missing – such as Magnesium Nitrate, Potassium Silicate, Nitric acid, Sulfuric acid, etc – these were present in previous versions of the software, but the abundance of choices was confusing to newer users, especially when they couldn't easily get their hands on many of these fertilizers from a practical perspective. Some nutrients, like urea, were specifically removed because of the larger potential to cause more harm

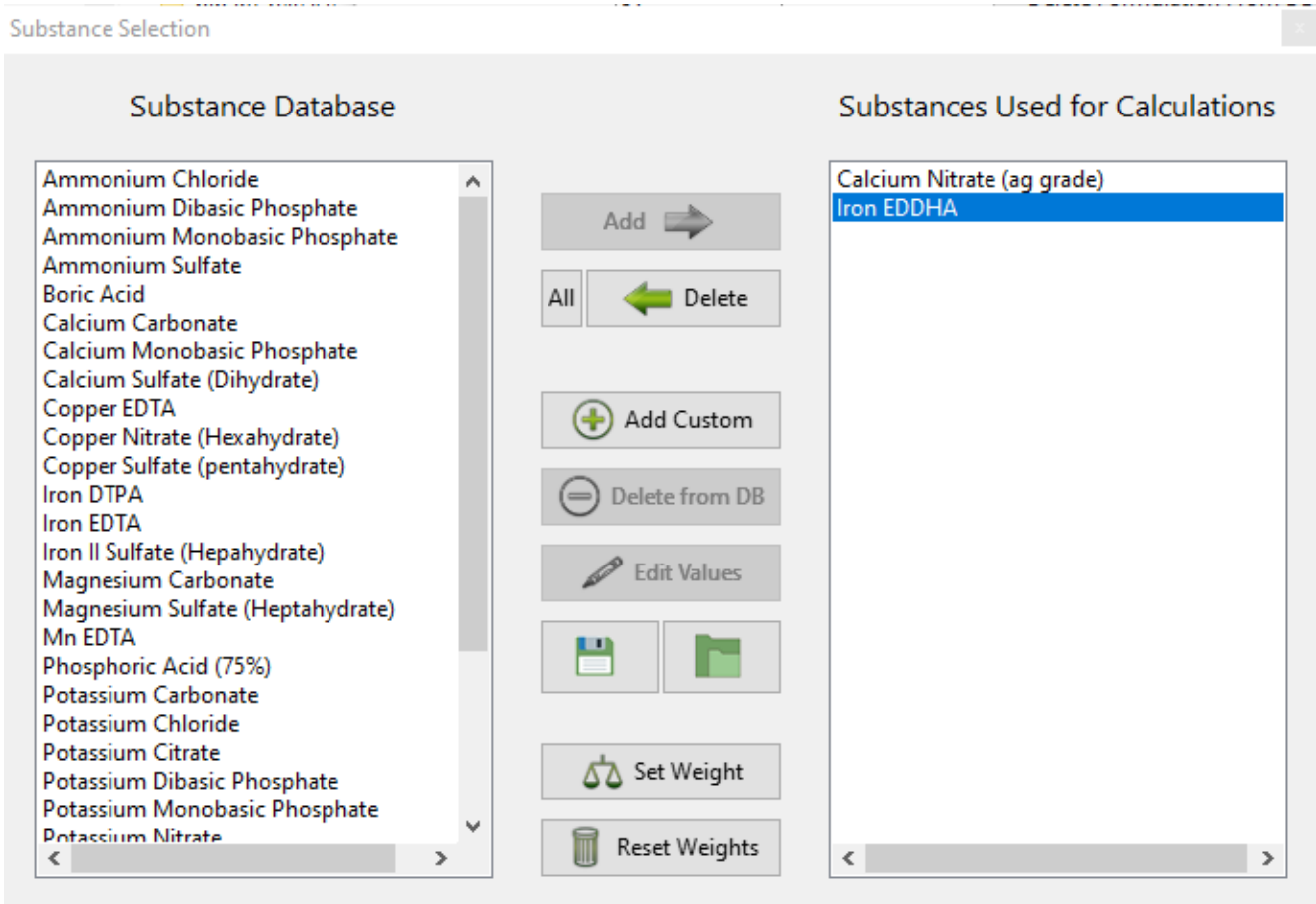
than good when used in hydroponics. The modifications to the database seek to solve these issues by providing a more condensed, yet very flexible list, that users can more effectively leverage to create their own solutions. *However, remember that you can add any substance you want by using the "Add Custom" button in the substance selection screen.*

As you can see many considerations go into creating nutrient solutions and this database is a very generic attempt to provide you with the best tools to get you started in this world. However, if you find this task difficult or you would simply like to have additional help and guidance, feel free to book an hour of consultation time by using the booking function on the website or contacting me directly through the [contact page](#).

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## **HydroBuddy has now been updated to v1.70: New features and modifications**

My free and open source hydroponic nutrient calculator has been available since 2010, going through many iterations and changes through the years. The latest version as of May-24-2020 is now 1.70, which you can download [here](#). This new release implements some important updates and modifications. In this post I will write about these, the reason why they have been made and the features that I am implementing for the next version of the software.



New substance selection screen in HydroBuddy v1.70

Most changes in this version have been done in the “Substance Selection” section of the program, which is accessible through the button of the same name in the “Main Page” tab. This is the “heart” of the program as this is where users decide what raw inputs they want to use and where they can manage the library of inputs that are actually available for calculations. In previous versions a very wide library of inputs was available by default, including many inputs that were rarely of any practical use in hydroponics and were there for illustrative purposes. A good example of this is a salt like “Calcium Nitrate (Tetrahydrate)” which is very rarely used by hydroponic growers as commercial “Calcium Nitrate” is actually a calcium ammonium nitrate salt that is very different in chemistry and composition to pure calcium nitrate tetrahydrate.

To solve the problem mentioned above I have completely rebuilt the substance database to include only commercially available raw fertilizers that make sense and are actually used in



common situations in hydroponics. This included adding a lot of different metal chelates and salts that were previously ignored but are now part of the HydroBuddy default database.

Another issue I wanted to address was the confusion some users have about where to buy these chemicals and potentially get some revenue to support the development of the software at no additional cost to the user. For this reason I have added manually selected links to all the raw fertilizers that are included with the DB so that users who want to buy small quantities of those can also support the software when they do so.

HydroBuddy v1.7 - Programmed and Designed by Dr. Daniel Fernandez Ph.D at <http://scienceinhydroponics.com>

Welcome Main Page Results About

Substance Name [click for url]	Formula	Mass (g) [Edit to fine-tune]	Preparation Cost
Calcium Nitrate (ag grade)	5Ca(NO3)2.NH4NO3.10H2O	141.378	1.1
Ammonium Monobasic Phosphate	(NH4)H2PO4	0	0
Potassium Monobasic Phosphate	KH2PO4	63.758	2.8

Clicking leads to amazon affiliate links that support the software at no additional cost to the user

Element	Result (ppm)	Concentration	Deviation
N (NO3-)	203.584	1.8%	+/- 0.1%
K	183.189	-8.4%	+/- 0.1%
P	145.1	383.7%	+/- 0.6%
Mg	0	0%	+/- 0%
Ca	268.618	0%	+/- 0%
S	0	0%	+/- 0%
Fe	0	0%	+/- 0%
Zn	0	0%	+/- 0%
B	0	0%	+/- 0%
Cu	0	0%	+/- 0%
Mo	0	0%	+/- 0%
Na	0	0%	+/- 0%
Si	0	0%	+/- 0%
Cl	0	0%	+/- 0%
Mn	0	0%	+/- 0%
N (NH4+)	15.552	-22.2%	+/- 0.1%

Values calculated for the preparation of 100 liters

Predicted EC Value: EC=1.6 mS/cm

Stock Solution Analysis

Nutrient Ratio Analysis

Detailed Per Substance Contribution Analysis

Export To Csv

HydroBuddy v1.7 contains clickable substance names in the result tab that take you to amazon affiliate links that sell the products mentioned at no additional cost to the user.

The "Substances Used" tab has also been enhanced with a new

“Save/Load” functionality that enables users to save or load lists of substances used to avoid the hassle of having to go through and select substances whenever they want to prepare a certain solution. This has also been very annoying for me in the past as having to go through different sets of inputs used for different purposes can be a very time consuming exercise. With this new feature all I have to do is save one list for each one of my needs and a single click of the “Load” button can easily change a list of 5+ inputs without the need for any tedious and – mistake prone – manual changing. Another small manual enhancement has been the addition of a small “All” button next to the “Delete” button, which allows you to delete all the substances present in the “Substances Used for Calculations” list.

Another change in this version was a decision to go with a 32 bit compiler in Windows in order to ensure that the variables for this operating system are all 32 bit. This will enable users who are using both 32 and 64 bit operating systems to use the software without problems. This was an issue in the past as many users still use old 32 bit systems and they were having problems having to manually compile HydroBuddy in some of their old machines. Sadly I still do not own a Mac, so HydroBuddy has yet to be available as a download for MacOSX and the software will need to be individually compiled by all of those who wish to use it in their MacOSX setups.

One of the features that is lacking most now is an ability to import databases from previous versions, as each time the software is updated users haven't been able to take advantage from previous custom databases built using the software due to problems with compatibility across releases (new DB fields being added, edited, etc). For the next version of the software I am working on a DB importing feature that should eliminate this issue so that users can benefit from the latest HydroBuddy releases without having to tediously add all their old substances to the new release.

With all the above said, I hope you enjoy this new version of the software. If you have any suggestions or comments about the above please feel free to leave your comments in this post!

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# **Nutrient solution conductivity estimates in Hydrobuddy**

People who use Hydrobuddy can be confused by its conductivity estimates, especially because its values can often mismatch the readings of conductivity meters in real life. This confusion can stem from a lack of understanding of how these values are calculated and the approximations and assumptions that are made in the process. In this post I want to talk about theoretically calculating conductivity, what the meters read and why Hydrobuddy's estimations can deviate from actual measurements.

HydroBuddy v1.62 - Programmed and Designed by Dr. Daniel Fernandez Ph.D at <http://scienceinhydroponics.com>

Welcome Main Page Results About

Substance Name	Formula	Mass (g) [Edit to fine-tune]	Preparation Cost
Yara Calcium Nitrate	Yara_Ca(NO3)2	1028.04	102.8
Potassium Nitrate	KNO3	491.68	49.2
Potassium Monobasic Phosphate	KH2PO4	148.47	14.8
Magnesium Sulfate (Heptahydrate)	MgSO4.7H2O	486.815	48.7
Boric Acid	H3BO3	2.86	0.3
Iron EDTA	Fe(EDTA)	19.231	1.9
Copper Sulfate (pentahydrate)	CuSO4.5H2O	0.079	0
Zinc Sulfate (Dihydrate)	ZnSO4.2H2O	0.151	0
Sodium Molybdate (Dihydrate)	Na2MoO4.2H2O	0.025	0
Manganese Sulfate (Monohydrate)	MnSO4.H2O	1.538	0.2

Element	Result (ppm)	Gross Error	Instrumental Error
N (NO3-)	216.165	2.9%	+/- 0%
K	232.791	-0.9%	+/- 0%
P	33.789	9%	+/- 0%
Mg	48	0%	+/- 0%
Ca	195.328	-2.3%	+/- 0%
S	63.661	-0.5%	+/- 0%
Fe	2.5	0%	+/- 0.1%
Zn	0.05	0%	+/- 6.6%
B	0.5	0%	+/- 0.4%
Cu	0.02	0%	+/- 12.7%
Mo	0.01	0%	+/- 39.7%
Na	0.005	0%	+/- 0%
Si	0	0%	+/- 0%
Cl	0	0%	+/- 0%
Mn	0.5	0%	+/- 0.7%
N (NH4+)	11.308	0%	+/- 0%

**Total Cost is 217.9**

Values calculated for the preparation of 1000 liters

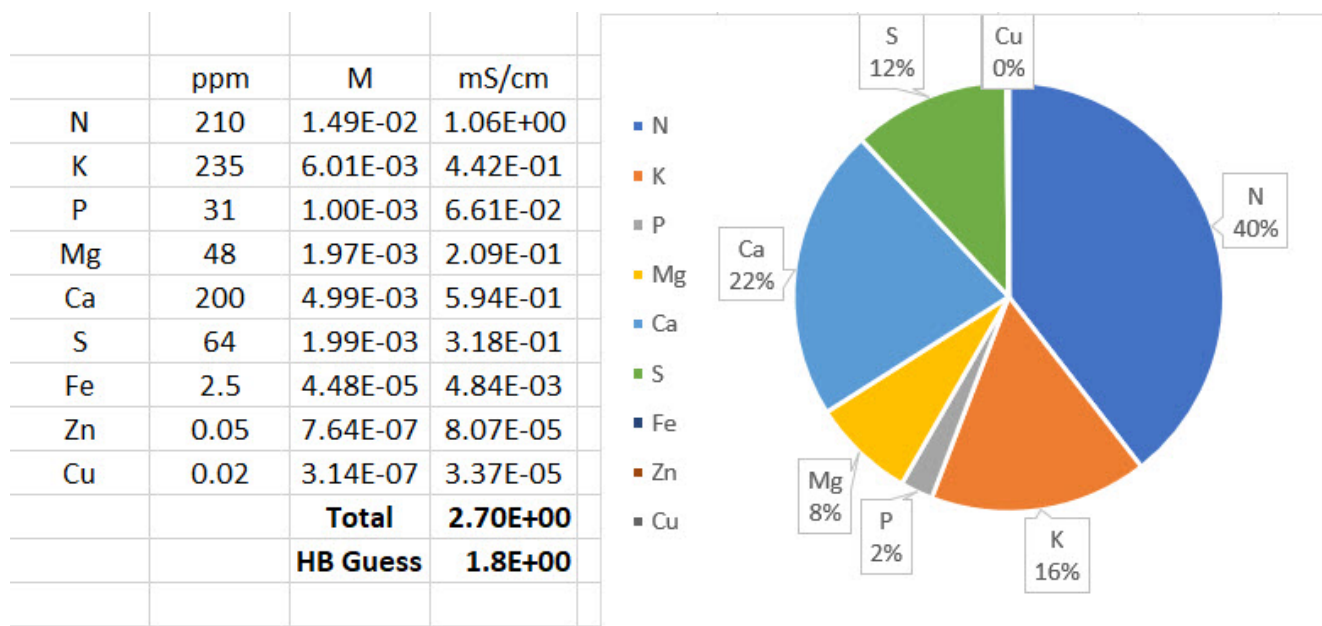
Predicted EC Value

Standard Hoagland solution calculation using HydroBuddy with a set of basic chemicals.

The images above show the use of HydroBuddy for the calculation of a standard Hoagland solution for a 1000L reservoir. The Hoagland solution's recipe is expressed as a series of elemental concentrations, all of them in parts per million (ppm) units. The results show that the final conductivity of this solution should be 1.8 mS/cm but in reality the conductivity of a freshly prepared full strength Hoagland solution will be closed to 2.5mS/cm. You will notice that HydroBuddy failed to properly calculate this value by an important margin, missing the mark by almost 30%. But how does HydroBuddy calculate this value in the first place?

Conductivity cannot be calculated by using the amount of dissolved solids in terms of mass because charges are transported per ion and not per gram of substance. To perform a conductivity calculation we first need to convert our elemental values to molar quantities and then associate these values with the limiting molar conductivity of each ion,

because each ion can transport charge differently (you can find the values HydroBuddy uses in the table available in [this article](#)). This basically means we're finding out how many ions we have of each kind and multiplying that amount by the amount each ion can usually transport if it were by itself in solution. The sum is the first estimate in the calculation of conductivity.



Conductivity calculations carried out by HydroBuddy, also showing conductivity contributions per ion. This is done by converting ppm quantities to moles, then multiplying by limiting molar conductivity values here.

The image above shows the result of these calculations for an example with a perfectly prepared Hoagland solution. You can see that the estimate from limiting molar conductivity is initially 2.7 ms/cm – much closer to the expected 2.5 mS/cm – but then HydroBuddy makes an additional adjustment that lowers this down to 1.8 mS/cm. This is done because limiting molar conductivity values make the assumption of infinite dilution – what the ion conducts if it were all by itself in solution – but in reality the presence of other ions can decrease the actual conductivity things have in solution. HydroBuddy accounts for this very bluntly, by multiplying the result by 0.66, in effect assuming that the measured value of conductivity will be 66% of the value calculated from the

limiting molar conductivity values. This is of course wrong in many cases, because the reduction in activity due to the presence of other ions is not as strong. However it can also be correct in many cases, primarily depending on the substances that are used to prepare the formulations and the ratios between the different nutrients.

In my experience HydroBuddy tends to heavily underestimate the conductivity of solutions that receive most of their conductivity from nitrates, as this example, but it tends to do much better when there are large contributions from sulfate ions. When I first coded HydroBuddy all my experiments were being done with much more sulfate heavy solutions, so the correction parameter value I ended up using for the program ended up being a bad compromise for solutions that deviated significantly from this composition. With enough data it might be possible to come up with a more advanced solution to conductivity estimations in the future that can adjust for non-linear relationships in the conductivity and activity relationships of different ions in solution.

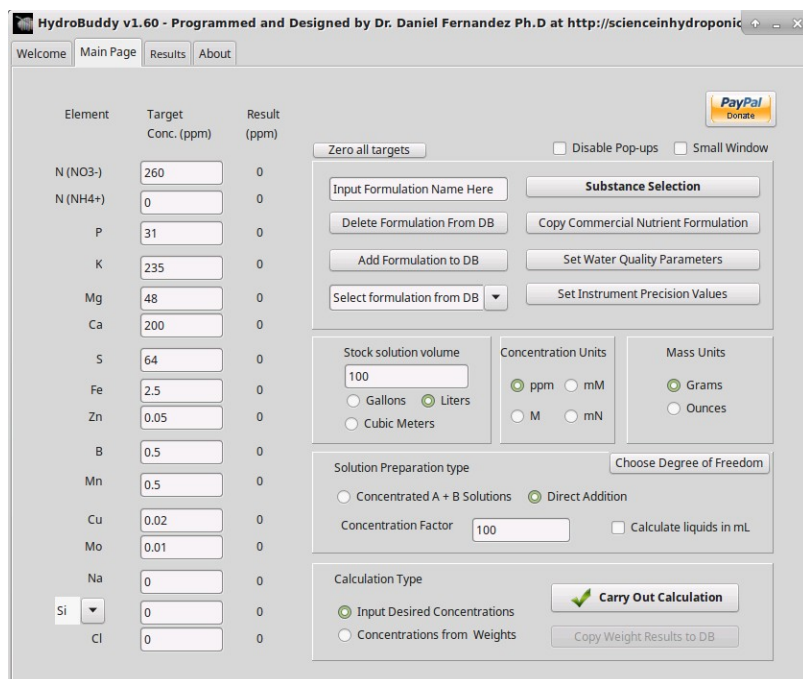
If your measured conductivity deviates from the conductivity calculated in HydroBuddy you should not worry about it, as HydroBuddy's values is meant to be only a rough estimate to give you an idea of what the conductivity might be like but, because of its simplicity, cannot provide a more accurate value at the moment. The most important thing is to ensure that all the salts, weights and volumes were adequately measured in order to arrive at the desired solution.

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# Hydrobuddy v1.60: A new update with important changes

During this past few weeks I have been working on modernizing Hydrobuddy in order to get it to compile with the latest versions of Lazarus and the Free Pascal Compiler (FPC) so that other people can more easily build the software from source. Today I want to talk about the latest release for Hydrobuddy (v1.6) that comes with some important changes that take the software a step forward and seek to make usage and building of the program much easier. If you're interested in downloading the source or binaries for the new version of Hydrobuddy please visit its official page [here](http://scienceinhydroponic.com).

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I have decided to greatly simplify the program in order to remove sections and features that were complicated and really not used very often. This helped eliminate libraries that were previously required, some of which are no longer compatible

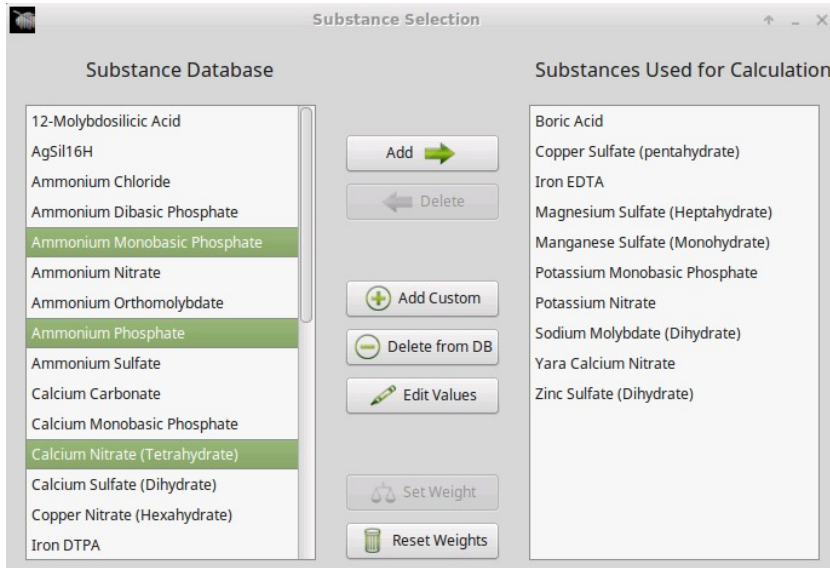
with the latest version of the Lazarus IDE. I have therefore removed the program's ability to automatically update on startup and have also completely eliminated the data log section of the program. The elimination of the automatic updating makes the program much easier to compile as it eliminates some complicated requirements that were significantly difficult to install for those unfamiliar with the Lazarus RAD environment.

In addition to these changes I have also eliminated the Windows and Linux installers since these two made the overall setup and building process more complicated while they provided little additional benefit. The elimination of the installer means that the program can now be installed by simply extracting a zip file – how it was installed in the very beginning – something that makes it suitable for portable applications while before there might have been permission issues when attempting to run the installers on Windows/Linux.

In addition to the above I have also created separate versions of the program databases for Linux and Windows since these files are not compatible between operating systems and trying to build on Linux/MacOS – with the databases present that were Windows files – caused issues when testing the program. There are now suitable conditional headers that use the appropriate table files depending on the operating system being used.

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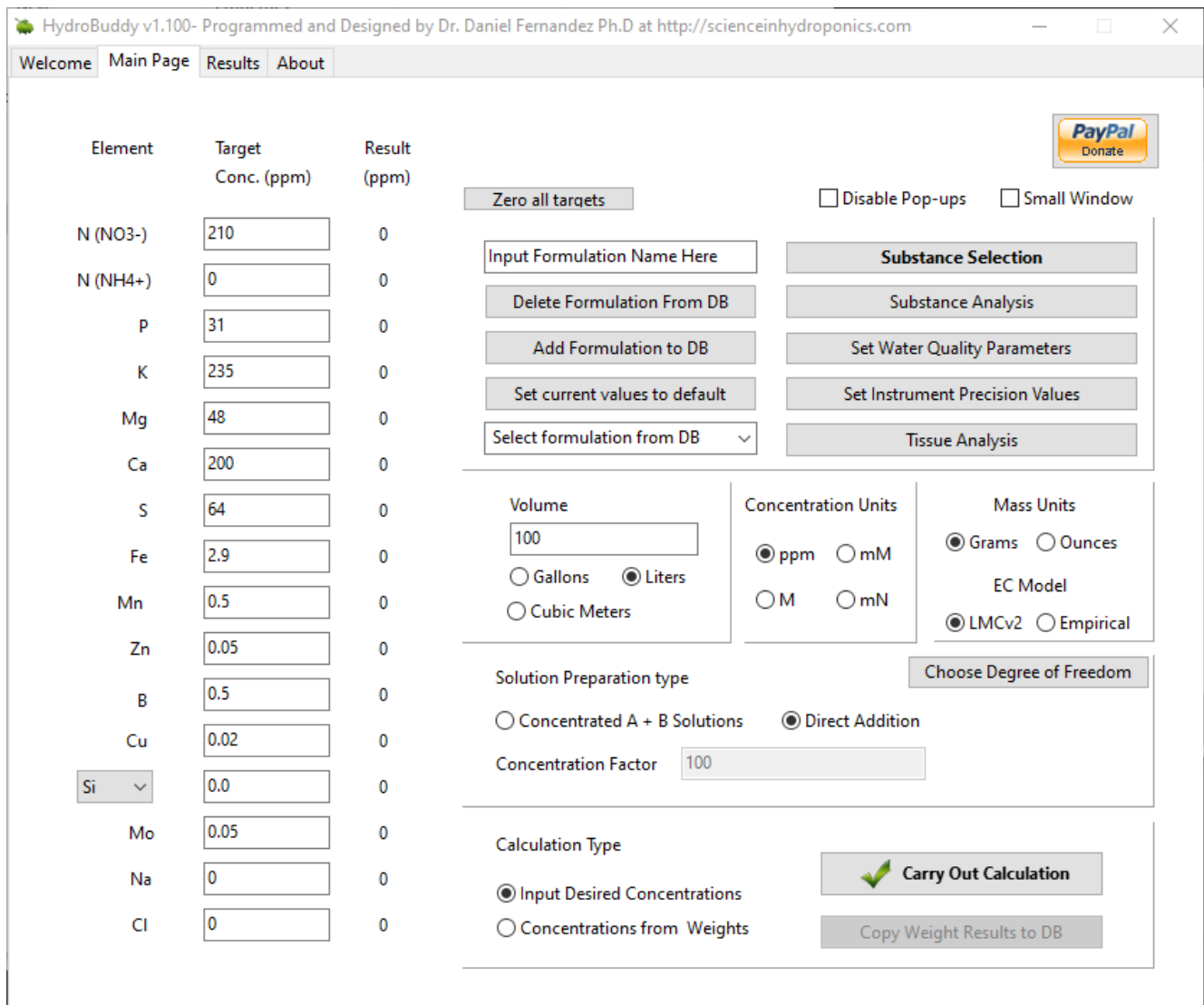
I have also implemented a few additional features that improve some practical aspects when using the program. The substances used form now allows for multiple selects within the two substance columns so that you can perform multiple substance additions and deletions at the same time. This becomes very useful when you're changing your substance selections all the time since it allows you to easily add/delete multiple substances at the same time. In addition to this I have also implemented a "Zero all targets" button in the home page which basically sets all the ppm targets to zero. This can be very useful when you want to target particular single nutrients or you want to write targets from scratch.

Hydrobuddy's source is also now available via a [github repository](#) to enhance the level of contributions from other programmers. This means that others can now checkout the source, modify it and contribute their own code changes to the program so that we can implement additional features or functionality.

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# **HydroBuddy v1.100 : The First Free Open Source Hydroponic Nutrient Calculator Program Available Online**

HydroBuddy is a completely free and open source program for the calculation of nutrient solutions for hydroponics and general agriculture built by me – Daniel Fernandez – based on my experience in hydroponics as a professional chemist. This piece of software was coded from the ground up using the Lazarus open source programming suite and implemented using appropriate database solutions as well as a powerful linear equation solving algorithms from AlgLib. HydroBuddy binaries are available for Linux, MacOS and Windows. HydroBuddy is released under the GPL license.



HydroBuddy v1.99 running on Windows

These are some of HydroBuddy's features :

- Calculates the weights of specific substances needed to arrive at specified concentrations of different elements (formulation to salt weights calculation)
- Easily fine tune your salt weights after calculations.
- Contains library with commonly available fertilizer salts (new in v1.7)
- **Leaf tissue database and conversion to concentrations needed in solution based on water use efficiency equations (v1.99)**
- Raw salts in the included DB have links to help new users know where to buy them (accessible by clicking the salt name in the results tab). Please note these are

amazon affiliate links that support the development of the software at no extra cost to you. (new in v1.7)

- Includes ability to save and load lists of substances used for calculations. (new in v1.7)
- Empirical model for the prediction of EC (new in v1.8)(read more [here](#))
- Figure out the nutrient contribution from different acids to neutralize different levels of total alkalinity (v1.95)
- Calculate the percent composition of the solid mix used to prepare a given solution (v1.95)
- Program state is completely saved when the application is properly closed (v1.95)
- Calculations in ppm, mmol/L, mol/L and meq/L.
- Calculate liquid additions in mL and add any custom substances as liquids
- Edit the percentage elemental composition of each substance or add new ones to fit your needs
- Powerful open source linear equation solver provided by AlgLib
- Always tries to find the best mathematical fit to a formulation by a given group of substances
- Allows to get the concentration values for the addition of a certain specified amount of substances (salt weights to formulation calculation)
- Easy-to-use interface for the addition, edition and assignation of substances to calculations
- EC prediction module based on limiting molar conductivities, ionic strength and ion charge (new in v1.9)(read more [here](#))
- Use the resulting weights of a formulation calculation to perform a calculation of the opposite nature and vice versa (easily allows you to see the effect of manual modifications)
- Calculations for both direct additions and A+B concentrated solutions
- Use any custom substance as a part of an A+B

concentrated solution calculation

- "Substance Analysis" module which allows you to analyze different substance, it can be used to figure out the ppm contributions of commercial fertilizers.
- Water quality module allows you to include water quality analysis within the calculations
- Adequate implementations of instrumental and gross errors with custom instrument precision input
- Proper database implementation allows you to easily save your custom formulations
- Set default water quality and data log data sets that load automatically on program startup
- Save and load formulations using any concentration unit.
- Choose between grams or ounces
- Choose between liters, gallons and cubic meters for volume inputs
- Export calculation results to a CSV file
- Tutorial tabs showing and explaining the main features of the program !

The program allows anyone to easily carry out calculations for the preparation of nutrient solutions, a very cumbersome task that can take a lot of time and effort when done manually. **If you're having trouble with HydroBuddy and you would like to purchase support please email me by using the [contact form](#) with your requirements to receive a quote. If you are using HydroBuddy for academic purposes please cite its use as follows:**

*Daniel Fernandez Pinto, "HydroBuddy: An open source nutrient calculator for hydroponics and general agriculture", v1.100, url: <https://github.com/danielfppps/hydrobuddy>, 2022*

**If updating from an old version by replacing only the executable, make sure you delete all the csv and ini files within the folder to avoid configuration issues.**

***Versions are numbered sequentially (v1.96, v1.97, v1.98,***

**v1.99, v1.100...). Version v1.100 is the last version available.**

You can download the program binaries through the following links:



Get HydroBuddy for Windows

Just unzip the program and run the hydrobuddy.exe file. Binaries provided are 64-bit. For 32-bit binaries please compile from the source on the github page.



Get HydroBuddy for Linux

Unzip, then make sure you execute `“chmod +x hydrobuddy”` within the folder so that you can execute the program.



Get HydroBuddy for MacOS

Unzip all files into a folder, then run the app file. If you get a permissions error message, go into the hydrobuddy.app/Contents/MacOS folder in a terminal and execute the command `“chmod +x hydrobuddy”`. If you get an error about the app author, hold the control key while launching the app. Note that you will need to select the HydroBuddy folder each time you start the program. This binary was compiled in MacOS Monterey.



Get HydroBuddy Source

A simplified version of the program with most of its basic functionality is also available on Android. You can get it through the google play store by using the link below:



Get HydroBuddy for Android

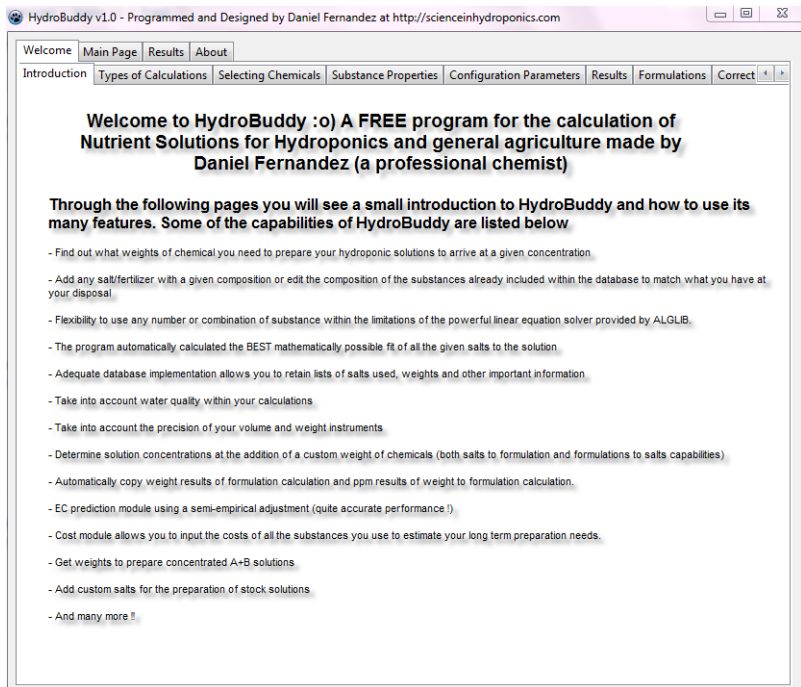
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# **Almost There Guys ! The New HydroBuddy v1.0 is Just Around the Corner :o)**

Through the past few months its been very quiet here at scienceinhydroponics.com mainly because I have been very busy with the development of the latest version of HydroBuddy as I mentioned within my last post. Through the past few weeks I have worked many hours on this new implementation and I am glad to say that the results are almost ready for me to show :o) Within this post I will talk to you about some of the many improvements of this new version of HydroBuddy as well as what I will be removing, some of the changes I have introduced and the many and great advantages of this much more robust program.

The first thing I want to mention – which I am very happy to announce – is that HydroBuddy has now been coded again (from the ground up) so everything is new and done in a much better way :o) Probably many of you will be happy to know that HydroBuddy has been in fact implemented within Lazarus, making it available now natively on Linux and Mac as well as Windows. Although I haven't tested the Mac or Linux binaries I can say that it doesn't use any windows proprietary components so it should work right away on most regular linux and Mac implementations.

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There are certainly a ton of improvements that I have implemented within this new version of HydroBuddy, redesigning the way in which everything was coded to be more transparent and efficient. Perhaps the most important change is the implementation of an adequate database system so now we don't need to handle all those nasty text files and do things in the primitive way in which HydroBuddy was doing them. Although the program did its job – for the most part – the implementation was too inflexible and everything was “hard coded” – so to speak. The new database flexible implementation allows you to add or edit the composition of any of the salts included within the program and even to use custom salts within concentrated solution preparations.

The next improvement – which is the one I like the most – deals with the introduction of a much more powerful linear equation solver which allows us to fully exploit the power of our computers to carry out the simulations. Previously HydroBuddy used a very primitive solver which was “scotch tapped” with many different manual rules to make it yield adequate results. Of course the problem of this – as many of you discovered – was that HydroBuddy was “picky” about its



choices and it wouldn't use two salts with Mg – for example – if it was already using one. Now the new solver is a very powerful AlgLib implementation which allows the program to find the best mathematical solution for a formulation, making sure that you get the absolute best possible case out of all the salts you choose.

HydroBuddy v1.0 - Programmed and Designed by Daniel Fernandez at <http://scienceinhydroponics.com>

Welcome | Main Page | Results | About

Substance Name	Formula	Mass (g)	Costs of preparation
Potassium Nitrate	KNO3	50.65	5.1
Magnesium Sulfate (Heptahydrate)	MgSO4.7H2O	2.318	0.2
Calcium Nitrate (Tetrahydrate)	Ca(NO3)2.4H2O	82.919	8.3
Boric Acid	H3BO3	0.286	0
Zinc Sulfate (Dihydrate)	ZnSO4.2H2O	0.007	0
Copper Sulfate (pentahydrate)	CuSO4.5H2O	0.005	0
Sodium Molybdate (Dihydrate)	Na2MoO4.2H2O	0.002	0
Magnesium Nitrate (Hexahydrate)	Mg(NO3)2.6H2O	26.838	2.7
Potassium Monobasic Phosphate	KH2PO4	13.622	1.4
Manganese Sulfate (Monohydrate)	MnSO4.H2O	0.154	0
Iron EDTA	Fe(EDTA)	1.923	0.2
			Total Cost is 17.9

Element	Result (ppm)	Gross Error	Instrumental Error
N (NO3-)	260	0%	+/- 0.1%
K	235	0%	+/- 0.1%
P	31	0%	+/- 0.2%
Mg	48	0%	+/- 0.2%
Ca	200	0%	+/- 0.1%
Fe	2.5	0%	+/- 0.6%
Zn	0.05	0%	+/- 160.1%
B	0.5	0%	+/- 3.6%
Cu	0.02	0%	+/- 196.7%
Mo	0.01	0%	+/- 461.5%
Mn	0.5	0%	+/- 6.6%
S	6.391	-90%	+/- 0.1%

Any observations about the calculations will be posted here

Predicted EC Value  
EC=1.7 mS/cm

The "salts used" tab has also been eliminated in favor of a much more convenient implementation which allows you to simply select salts from a list and set which ever values you want. Another advantage of the database implementation is that any choices you make will be saved and there for you when you reopen HydroBuddy. The program also implements database components to save formulations, water quality parameters, etc, making it much easier to get into previously saved data without the problem of having to read text files (which was a very bad decision for HydroBuddy in retrospective).

Another things you guys might like a lot is that I have added "hints" to almost all important buttons so hovering your mouse over things will now make them show you what they do. Another improvement is the addition of a tab with descriptions and tutorials, allowing you to get to know the software very well without having to open up a website, "copy and paste URLs" or

any other such stuff.

To sum it up, HydroBuddy v1.0 is coming and it will be a very positive change for this very useful – at least in my opinion ! – piece of software :o). The fact that all software components are much more transparent now will also make it much more eligible for academic use, something which I also want this program to be about :o) So its coming ! And its coming soon !

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## **Walking Towards v.1.0 : Why Development of HydroBuddy is Taking Its Time**

If you had been following my development of the free HydroBuddy nutrient calculator your probably have wondered why development seems to have “stopped” during the past few months. The truth is that beyond the fact that I have been quite busy – with my other occupations – I have actually decided to implement some very large changes to HydroBuddy before version 1.0 comes out. On today’s post I will take some time to discuss the changes I will be implementing and what these changes will bring when v.1.0 finally comes out, probably in January-February 2011. I will talk about the current problems on the calculator and what solutions I am working on.

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HydroBuddy is currently a stand-alone free hydroponic nutrient calculator which anyone can use. It is a simple tool for the calculation of nutrient weights or the reverse-engineering of commercial nutrient solution allowing users to perform a ton of analysis without too many complications. However the software does have a few problems which I believe need to be solved if HydroBuddy is to become the most complete and BEST hydroponic nutrient calculator online (even when compared amongst commercial ones).

The first big problems that come from HydroBuddy lies within its software implementation. The program was built within Delphi 2010, reason why compatibility with other operating systems is minimal (if available at all). For this reason I have decided to port the whole program into Lazarus, allowing me to get full Linux and Mac versions released from v1.0 onwards without any further problems.

The second – and perhaps the biggest problem – in HydroBuddy, is the way in which the calculations and database were implemented. HydroBuddy doesn't use a formal database but a series of arrays which it uses to calculate/store the solutions to the problems its presented with. The new version will include a proper database engine which will allow us to greatly expand the scope of HydroBuddy, this will also allow

me to solve another problem which makes HydroBuddy “miss” some solutions if combinations of certain salts are used. By implementing a proper database and powerful linear equation solvers the new version of HydroBuddy will be much more powerful and good enough to become a standard for not only hobby but many scientific applications.

As you see, the above changes require me to practically reimplement the whole program but certainly they are worth making since they will make HydroBuddy’s core much more robust than with its current implementations. With this HydroBuddy will be able to easily store much more data, solve problems much more accurately and become much more “user friendly”. It will certainly take me some time – as I only do this development when I have free time – but it will definitely pay off in the end as it will be a free solution for anyone looking for a software package to help them calculate their nutrient solutions.

In the meantime feel free to use the v0.98 of HydroBuddy which already solves many of the problems of nutrient solution making and allows anyone to prepare their own hydroponic solutions without having to perform any manual calculations :o) Thank you very much for all your support and interest !

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## **Instrument Precision : Its Importance in the Preparation of Hydroponic Nutrient**

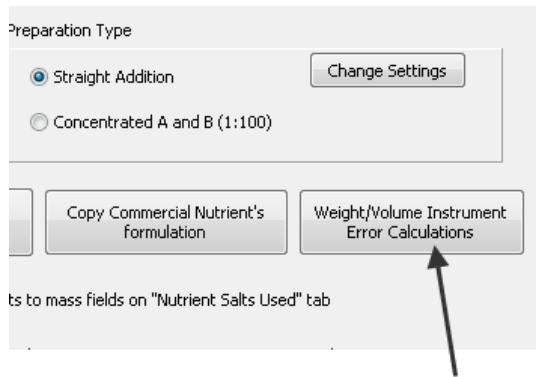
# Solutions

One of the most overlooked aspects when preparing hydroponic nutrient solutions is the actual precision of the instruments used to measure the salt or liquid reagent additions. People who are not familiarized with the preparation of solutions usually underestimate the importance of this aspect of solution making – both concentrated and final – which is absolutely vital for the accurate and reliable preparation of solutions. On today's post I will attempt to explain the concept of instrument precision, the errors caused by this fact and how they are calculated by HydroBuddy to give us an idea of how dependent our calculations are upon our instruments. After reading this article you will be able to know if the instruments you are using for your solution preparation needs are adequate or what you need to do in order to ensure that the preparation of your solutions remains reasonably accurate.

What is instrument precision ? This point is best illustrated by a practical example. Imagine that you are using a ruler to measure the length of a simple pencil. A common ruler (in metric units) generally has large divisions (in centimeters) and smaller divisions (in millimeters), when you measure the pencil you will note that the length of the pencil will be between two of the finest divisions – or very close to one – but you will not be able to determine the measurement beyond this accuracy. For example if the measurement of the pencil is between the 2.3cm and the 2.4 cm line you can say that the pencil measures  $2.35 \pm 0.05\text{cm}$  this means that we can be absolutely sure that the pencil has a measurement between 2.3 and 2.4 cm but our instrument does not allow us to “see” any further. In this example the three digits of the measurement are called “significant figures” while the last one is called the “measure of uncertainty” since it is a value we can only be certain about within a certain threshold.

When you measure your hydroponic solutions you need to use instruments to weight your salts or liquid fertilizers and you also need to measure the volume of your solutions (either concentrated or final). When you weight your salts your scale will have some uncertainty (usually represented as the point value of the last digit) so for example if your scale displays a weight for a salt of 5.50g the actual measurement is  $5.50 \pm 0.01\text{g}$  as – in analogy with the pencil example – the scale cannot determine the latest digit beyond a certain threshold. The problem with this is that if your salt's weight is in the vicinity of the scales last digit your uncertainty will be a big magnitude of what you want to weight. For example, if you want to weight 0.05g of a salt with the above scale the uncertainty of instrument will be  $\pm 0.01\text{g}$  so you will effectively have an instrumental error of  $\pm 20\%$  of the salt's mass, meaning that your final concentration will probably be VERY deviated from what you intend to measure.

Another important factor is the precision of your volume measuring gear since errors add up as you continue the preparation. If you can measure the volume of your reservoir with a precision of  $\pm 1\text{L}$  the you need to prepare at least 100L such that the error you get from the measurement of your nutrient solution's volume is not greater than 1%, however if you are preparing a concentrated nutrient solution (for 10L for example) you will need to use a more precise method of measuring volume, an instrument with a precision of at least  $\pm 0.1\text{L}$ . If you are uncertain of what the precision of your volume instruments are then you need to look at their graduation, the precision of a volume measuring instrument can usually be approximated to half its finest graduation. If you are measuring volume -for a concentrate solution for example – with a cup that has a line every 100mL then your precision is  $\pm 50\text{mL}$  (or  $\pm 0.05\text{L}$ ).



Access this button to input the precision values for your scale and volume measuring instruments

The above picture shows you where you can change the precision of the instruments used within HydroBuddy so that the program can calculate the error caused by your instruments in your preparation. Some people may have noted that when calculating “direct additions” there is no instrumental error while when calculating concentrated solutions there is, this is associated with the precision in volume since when straight additions are made the amount of volume that needs to be measured is MUCH higher while for concentrated solutions a much more precise volume instrument is required (depending on solution volume) since the volume is lower.

Final Expected Nutrient Levels and Errors

N (NO3) 260 ppm	Error is 0%	+/- 0%
P 30.99 ppm	Error is -0.03%	+/- 0%
K 235 ppm	Error is 0%	+/- 0%
Ca 270.9 ppm	Error is 35.45%	+/- 0%
Mg 48 ppm	Error is 0%	+/- 0%
S 64.9798 ppm	Error is 1.53%	+/- 0%
B 0.5 ppm	Error is 0%	+/- 0%
Fe 2.5 ppm	Error is 0%	+/- 0%
Zn 0.05 ppm	Error is 0%	+/- 0%
Mn 0.501 ppm	Error is 0.2%	+/- 0%
Cu 0.0204 ppm	Error is 2%	+/- 1%
Mo 0.0099 ppm	Error is -1%	+/- 4%

Weights of Salts to

MgSO4 mass = 48
Ca(H2PO4)2 mass
KNO3 mass = 60.1
Ca(NO3)2 mass =

Salt Elemental Contributions

MgSO4 - S = 63.22 ppm

Micronutrient Concentrated Solution (1)

ZnSO4 m

Instrument errors are shown here. Note that micro nutrients such as Cu and Mo have the highest errors due to their minimal weight. A value of 0% does not mean that the instrumental error is 0 but that it is below 0.005%.

If you get very large instrumental errors (for the calculations you are doing) then there are several things you can do to correct them. The first is to prepare large amounts

of concentrated solutions since the amount of salts weight will be much larger. Preparing 20L of a concentrated solution with a 1:200 concentration factor will allow most people to weight their salts in a scale with a 0.01g precision while other solutions -such as using the direct addition methodology with concentrated micro and Fe solutions – are also possible. In the end you need to take very good care of instrumental errors and take them into account since they will determine the final accuracy of your nutrient solutions. For macro nutrients the errors shouldn't be above 0.05% while for micro nutrients such as Mo and Cu, errors as high as 20% can be tolerated since higher precision would require the use of much higher purity salts since these elements are also possibly contained as impurities within other salts (meaning that salt purity becomes a higher factor than instrumental error below 20%).

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## **Understanding Reagent Purity and Its Importance in Hydroponics**

When making hydroponic nutrient solutions one of the most important concepts we need to understand is “reagent purity” and how this affects the overall quality and composition of our hydroponic nutrient solutions. People who have not been academically trained in science usually do not have a very good understanding of this concept and its implications and how they need to take it into account when doing their hydroponic formula calculations. HydroBuddy – my free hydroponic nutrient calculator – allows the user to specify the purity of all the reagents used in the preparation of



nutrient solutions so that accurate and adequate calculations are done. What does purity mean ? How do you determine the purity of the reagents you want to use ? What does a 100% purity mean ? Keep reading the following few paragraphs to find out.

What is reagent purity ? Imagine that you have 80g of a pure substance – table salt for example – and you mix it up with 20g of sand. The original salt – which was pure – was 100% table salt while the new resulting mixture is only 80% table salt. This degree of presence of a given “pure substance” with a defined composition within a mixture is what we call the “purity” of a reagent. The objective of purity is to know how much of what you are buying actually fits the chemical composition of what you intend to buy and how much is “other stuff”. The nature of impurities -what is different than what you intend to buy – is different depending on the fabrication process and intent of the reagent you want to use. The nature and amount of these impurities may sometimes be very important while other times it can simply be neglected.



People who are not familiar with this concept generally get confused when people start to talk about the composition ratios of pure substances. For example iron EDDHA is an iron complex which contains about 7% iron. This does not mean that EDDHA is only 7% “pure” but it means that within this pure substance iron accounts for 7% of the weight. The purity of

the reagent does not have ANYTHING to do with the composition of the pure substance you intend to get – the iron EDDHA in the above example – but it refers to other things that might be present with what you intend to buy due to the fabrication process. So for example you can buy Iron EDDHA 7% with a purity of 98% which means that from every 100g, 98g are iron EDDHA with a 7% iron content while 2g are made up of other substances with undetermined composition.

In hydroponics we want to provide our plants with the correct amount of nutrients and for this reason we must make sure that we provide what our formulation demands as a minimum. For this reason when preparing hydroponic nutrient solutions we must always use salts with purity levels above 95% with levels above 98% being better. Salts that are 98% pure aren't very expensive while the purer grades – used for the biochemical and fine chemical industries – are generally several orders of magnitude more expensive. While you can get a calcium nitrate ammonium double salt with a purity of 98% for just a few dollars per kilogram a single kilogram of this chemical at a 99.999% purity (which is often considered analytical grade) would cost around one thousand dollars. This difference in cost arises because as a salt becomes purer, eliminating the small impurities becomes harder and harder. Salts for which extremely high purity levels are achievable (such as NaCl which can be purified to almost 100%) are known in chemistry as “primary standards” because their composition is known to an extremely high degree.

When preparing hydroponic solutions we should not be worried that much about getting very expensive reagents as the impurities we get and the errors we have in our composition are not bound to affect our plants significantly, however we should take them into account so that we know exactly how much of what we know is pure is being added. So even though a reagent may have a purity of 98%, taking into account this will allow us to add enough so that we are certain that at

least certain concentration levels are achieved. Of course, using a 100% purity for the reagents is not bound to increase tremendous error if the actual value of the purity of the salts is unknown but making sure that the purity is above 95 or better 98% is always something that should be done to ensure that high quality preparations are being done. You should also understand that the impurities within your salts might actually be insoluble so some small fractions of the salts may remain undissolved when concentrated nutrient solutions are prepared.