Hydroponics 101

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(Everything that I mention in this guide can be found HERE at my storefront for easy access)

Hydroponics explained

The best way that I can explain Hydroponics in a nutshell would be like this;

Roots, all roots, absorb water, moving the water around the different parts of the plant using osmosis. In traditional soil gardens the water passes through the nutrient rich dirt, collecting tiny soluble bits of nutrients rich debris. Microscopic particles of nutrients are absorbed along with the water through the roots. Let's be clear here though, the plant does not soak up the soil directly. The roots absorb water that is rich in nutrients. When you start to understand things this way, you can begin to understand why hydroponics works so well.
Using this example, imagine if we removed all the dirt, compost, manure, castings, if we take everything out, then extract the nutrients directly from the items. Then we add just the nutrients back into the water so now there is nothing standing between the roots, the water and the nutrients. Suddenly we have a hydroponic garden. With hydroponics you simply remove the middle man, the messy, unnecessary, smelly, pest ridden SOIL!

As it turns out, when you remove the soil and deliver the nutrients directly to the roots with the water, you see some radical benefits. Because the plant has constant, unimpeded access to the water and nutrients, the growth will be more than doubled. With some plants you will see as much as 3 times the growth in the same time period over soil. This direct approach also yields benefits in other areas. Because the gardener (you) has complete control over every variable, hydroponic grown produce has been proven to contain a substantial amount more vitamins and antioxidants.

Plants don't get vitamins and antioxidants from the nutrients, plants synthesize these on their own. This means that if a plant has to focus it's energy elsewhere, for example aphids, nutrient deficiency, too dry or wet… it cannot produce vitamins and antioxidants. For a plant to produce the most vitamins and antioxidants it needs to be "pampered". When a plant feels that it is taken care of and it can focus on photosynthesis, you will see the healthiest growth in every sense of the word. In hydroponic growth environments, plants are quite happy, they can typically reach their maximum potential while sitting cozy in a hydroponic garden. It is safe to say that hydroponic grown fruit and vegetables are better for you than traditional soil grown produce.

When we start getting into the minutia we begin to realize the need for different types of hydroponic gardens. Some plants require very little root space while others grow massive roots. Some plants can thrive with nearly no water while

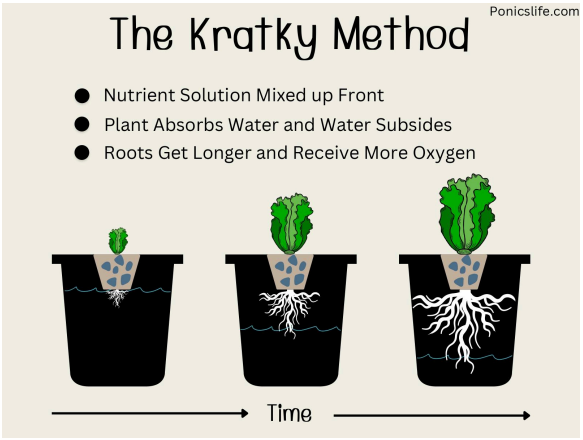
others thrive with their roots completely submerged. Some plants cannot get soaking wet at all (tubbers) so they have to grow in a dense fog or high pressure fine mist. You have to start with WHAT you want to grow then move to the corresponding garden.

Different types of hydroponic gardens.

There are several different categories of hydroponics and then even more subcategories within. So, for the sake of simplicity and readability, I'm not going to touch on every single type. I want to talk more about the brad categories, **Kratky, DWC, Drip, Ebb and Flow, NFT and Aeroponics.**

- ## Kratky

Named after Barnard Kratky, a researcher at the univ of Hawaii. He coined the term "Non-circulating passive hydroponics". This technique is taking the world by storm. Mainly because all you require is a container, water and nutrients. A true set it and forget it passive garden. The roots remain suspended in water for the entirety of the growth. The water level is required to drop in order to give the roots much needed oxygen. So with the Kratky method, you only refill the water when it falls below the bottom 1/3rd.

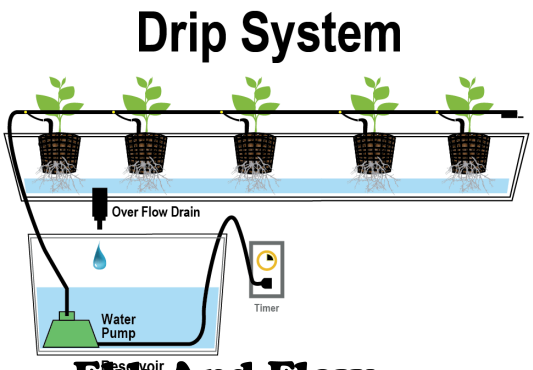


- ## DWC

DWC or deep water culture is a method much like the Kratky method in that you suspend your roots in water. With a DWC however you leave the water topped off. You don't need to deliver oxygen to the roots that way, because with a deep water culture, you have an airstone and air pump delivering oxygen to your roots.

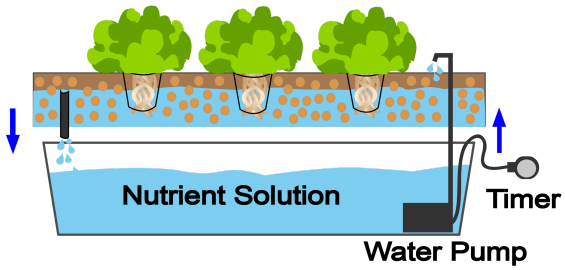
- **Drip**

This type of garden was the first to introduce and see the benifits of aeroponics. With a drip setup you are suspending the roots in air, then delivering the nutrient water through a small drip tube. The idea is to set the drip to just enough to give the plant what it needs to grow while allowing it to absorb as much oxygen and carbon as possible. This is the basic fundamentals behind aeroponics.



- **Ebb and flow**

My first hydroponic garden was ebb and flow style, mainly because it's simple. You have a container holding your substrate, in my case fish tank pebbles. Then circulate water from another container holding nutrient water. The water fills the container with the plants and pebbles, then drains out. It does this for 15 min every hour.

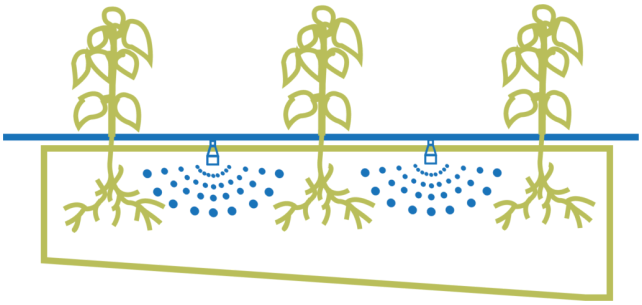


- **NFT**

Nutrient film technique is becoming increasingly popular with large scale greenhouse operations. What we are seeing a lot is a simple system built with pvc gutters laid horizontal. The top of the gutter has several holes drilled into it for the plants to go into, while the nutrient water flows along the bottom of the gutter.

- **Aeroponics**

The epitome of gardening. Aeroponics provides the most optimized growing environment for just about anything. The principles are to suspend the roots in air then deliver the nutrients through water droplets. The fine tuning of this system in setups like High pressure aeroponics has proven to be highly advantageous to growth.



What is pH? And how do I adjust it.

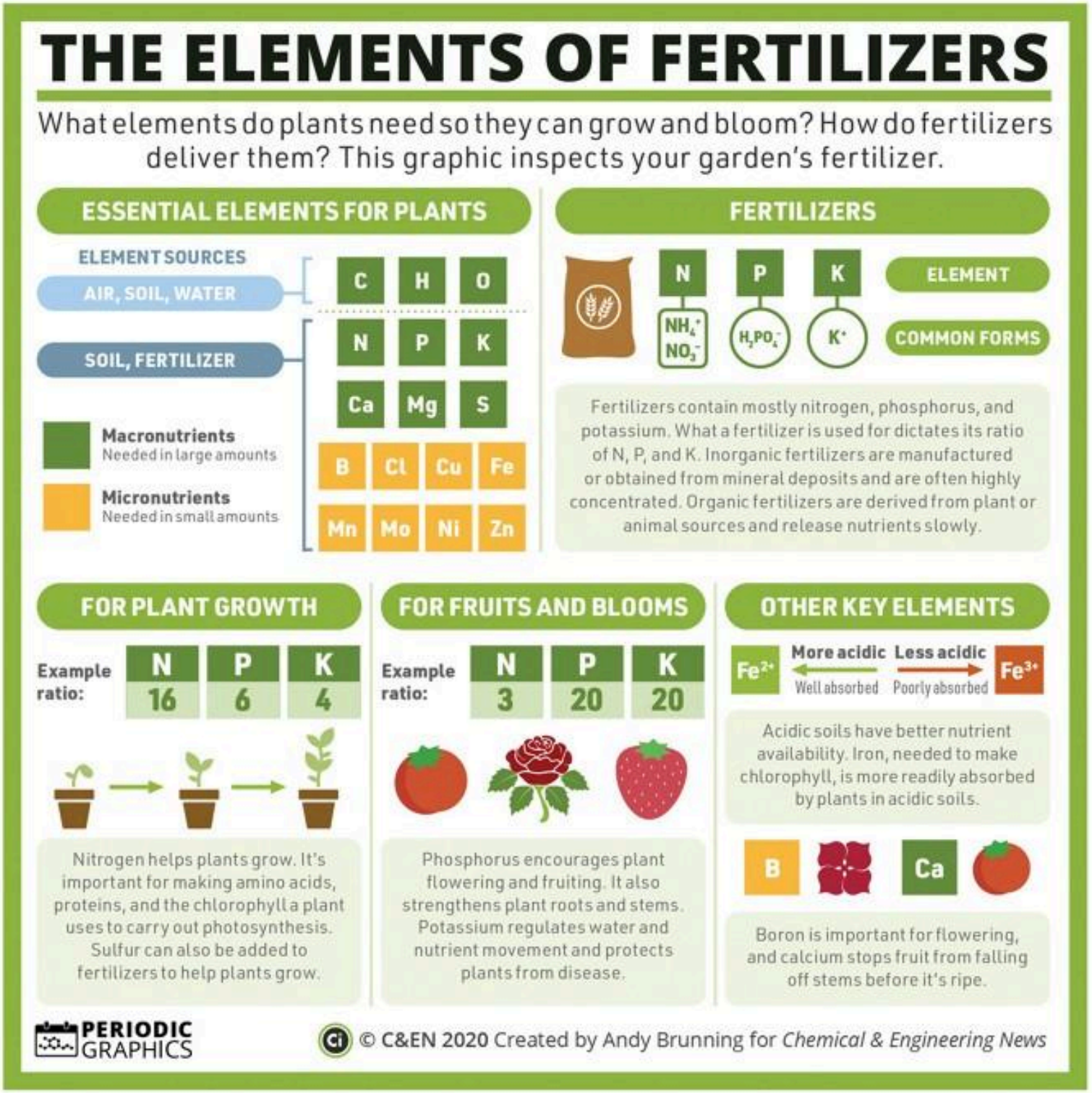
Waters pH is a numerical representation of where if falls between ACIDIC and BASIC. This is measured between 0 (acidic) to 14 (basic). Most plants, around 70%, enjoy a pH right in the middle at 7.0. There are certainly several plants that do not, so be sure to check the list below as a reference. Blueberries for example require a very acidic ph around 4.5-5.

To measure your pH. You can use either a digital ph meter (get one here) or analog strips or iodine (get it here) . I prefer digital. The only disadvantage is the need to calibrate the meter every few uses. This is easy and requires calibration solution (get it here)

To adjust your pH. Use pH up or pH down solutions (get them here)

Hydroponic Nutrients 101

It's now time to pull out our laminated, pocket sized periodic table of elements….just me? Ok, well instead of a full biology class, I found this chart as a bit of a cheat sheet.



Notice how this page is for soil gardening? Well, plants don't know the difference when it comes to what nutrients they need. All of that is exactly the same no matter what you are growing in. With hydroponics we just have more control, and I believe that control is what scares some people away from hydroponics. With a little simple understanding, you can master your hydroponics garden and be in control of the success of your plants in the best way imaginable.

To check out the nutrients that I use click HERE

N.P.K If you look at the front of any nutrient of fertilizer, you will see 3 numbers broken up by dashes. Something like -0-14-6 this is called the N.P.K and it is a numerical representation of the amount of Nitrogen (N) Phosphorus (P) and Potassium (K) that is in the fertilizer. NPK are certainly not the only nutrients needed, Carbon (C), Oxygen (O), Hydrogen (H), Calcium (Ca), Magnesium (Mg), Boron (B), Zinc (Zn), Copper (Cu), Sulphur (S), Iron (Fe), Chlorine (Cl), Nickel (Ni), Manganese (Mn) would complete the set. But when it comes down to the most used Macronutrients, Nitrogen, Phosphorus and potassium are the most needed in the highest quantity. In a lot of plants, they will also want more calcium, magnesium, and sulfur.

Macronutrients

Nitrogen: Responsible for the creation of amino acids (protein). Nitrogen is also vital to the development and success of chlorophyll, which as we know, is the key pigment protein responsible for photosynthesis. Nitrogen makes up approximately 78% of the air we breathe, 21% is oxygen and a small amount of other gasses such as carbon dioxide, neon and hydrogen molecules. Of all the macronutrients, nitrogen is by far the most important to plant growth. Too much of a good thing can cause harm however, so be sure to measure your EC appropriately. Many hydroponic nutrient solutions have already balanced the N.P.K to ensure a proper distribution of all. It is up to us as the gardener to distribute the nutrients appropriately.

Phosphorus: Plays a key role in photosynthesis. Phosphorus helps to metabolize sugars, assists in energy storage and transfer, cellular division, cell enlargement, and is responsible for the transfer of genetic information.
For a plant to grow, it converts energy from the sun, water (hydrogen and oxygen) and nutrients into Glucose sugars to support its growth. All living beings run on glucose sugars. Therefore the production and conversion of these sugars is paramount for a plant to thrive. Phosphorus's primary role is to metabolize these sugars, store and convert them into energy and cells for the plant's growth.

Potassium: Responsible for the transfer of sugars, water, and nutrients. Potassium is the vehicle on the highway of photosynthesis. Carrying along the necessary pieces for the plant to synthesize. Potassium is one of the key nutrients that can either speed up

or completely halt growth. Another key role of potassium is to activate enzymes within the plant. This activation is key in the production of starch (sugars) Protein and adenosine triphosphate (ATP) production. In regards to plant growth, the production of ATP can directly regulate the rate of photosynthesis.

To put the rolls of these 3 Macronutrients in (grossly) simply terms;
Nitrogen is the building block
Phosphorus is the power plant
Potassium is the vehicle

So, what about the other Macronutrients?

Calcium: We can think of calcium in a plant the same way we would relate it to how humans use it. To put it very simply, calcium helps create stronger, more resilient plants. Calcium strengthens cell walls as well as helps to regulate pH. It also activates enzymes within the plant to fight disease and repair cellular tissue.

Sulfur: Sulphur is the ultimate support nutrient. Sulphur aids in the transfer and metabolism of nitrogen. It encourages and regulates enzyme activity and oil and protein synthesis. All of which are crucial components in a healthy, thriving plant. Identifying the difference between a sulfur deficiency and a nitrogen deficiency can be nearly impossible because of this. Understanding how these macronutrients work together is crucial when identifying underlying issues commonly seen with discoloration. A plant that has plenty of nitrogen, can still exhibit signs of deficiencies because of the sulfur, which assists in metabolizing nitrogen, is low. Therefore, your nitrogen is basically going unused.

Magnesium: Is an electrolyte, meaning it is electrically charged. This means that Magnesium is crucial for the communication within the plant, triggering enzymes. More importantly though, Magnesium is the nutrient at the core of chlorophyll, it is the central atom of chlorophyll. Without magnesium, chlorophyll would not be able to do its job, meaning no photosynthesis, meaning no growth. Chlorophyll remember, is what makes a plant green, therefore a deficiency in its central atom, would result in a loss of green coloration.

Micronutrients

Boron (B)

Boron plays a crucial role in regulating your plants hormones. Just like in humans, hormones are necessary for growth. In short, hormones are chemical messengers. Telling the cells to react in a certain way. Some hormones tell the plant when to flower and for how long, some tell the plant to build stronger cellular walls or even to regrow roots in the case of cloning. Boron assists in this communication, subsequently leading to better growth, stronger plants, more flowers and a longer flowering duration. You can find chemical Boron in the form of Borax.

When adding Borax to your garden, you should add it in ¼ tsp increments.

Chlorine (CL)

Chlorine aids in metabolism, photosynthesis, balancing ions within cells and most of all it helps regulate osmosis. Osmosis is the movement and absorption of water in and out of the cells. Chlorine is a great “Nanny” nutrient in that it helps make sure everything else is running smoothly and in perfect balance. Cl can improve the overall yield in many plants. However, too much can cause total leaf yellowing and death.

Copper (Cu)

Cu is one of the micronutrient building blocks required to create amino acids (proteins). Chlorophyll is a pigment protein, and to create a complete chlorophyll protein, Copper is required. Cu is also required for several enzymatic functions as well as seed production. Although copper is used on a chemical level, if you think about it structurally, as something needed for the plant to create anything, You begin to realize that copper is required for all parts of photosynthesis and growth.

Iron (Fe)

Iron plays 2 main roles in photosynthesis;
Assisting in communication between cells and creating chlorophyll. Just like within the human body, plants communicate through tiny electrical signals. Those signals tell the plant to release certain hormones for different tasks. Like Auxin the growth and regrowth hormone or Ethylene the ripening hormone, in essence the control of these hormones are the plants central nervous system. Plants may not have brains and spinal cords like we do, but they are very alive and can communicate with themselves and other plants in amazing ways. Plants use conductive metals like Iron to transmit the signal needed for the release of enzymes and hormones. Iron actually has so many electrons that it assists in the formation of chlorophyll by donating them to the cellular structure.

Manganese (Mn)

Simply put, manganese is the star player of all of the ionic metals (Ie, iron, zinc, copper, nickel) . The exchange of information in the form of electronic signals, then the subsequent release of enzymes, is the key role of manganese. It plays such a vital role in enzymatic production that without manganese, your plants will begin to show signs even in very early stages of growth. Finding the balance with Mn is crucial. Too much manganese can ruin your crop, while too little can stunt the growth and photosynthesis.

Nickel (Ni)
Nickel is a crucial catalyst for converting urease into usable ammonium ions. Which plants can then use as a source of nitrogen. Without nickel, the urease buildup can become toxic for plants and lead to severe leaf growth issues. Typically the first sign of a nickel efficiency can be seen on the tips of the leaf. Nickel also plays a role in enzyme functionality, all ion carrying metals lend their ionic charge to the creation and release of enzymes throughout the plant. Therefore all metals like Cu, Ni, Fe, Mn, Ni play a role in enzymatic function and hormone regulation. Think of these metals as being the communication device in which the plant regulates and adjusts itself accordingly. Different ions in different metals lend a hand to different functions of the plant.

Zinc (Zn)
Zinc is a crucial mineral for your plants metabolism. Plants metabolize sugar and starch to create growth. Without Zinc driving the many enzymatic reactions responsible for proper metabolic synthesization, Your plant will show signs of a nutrient deficiency very quickly. Zinc also assists in the exchange of ions that we know now is how plants communicate internally. Zinc also helps your plant to withstand colder weather for longer seasons. Primarily though, Zinc aids in the synthesis of plant growth materials (cellular construction) and enzyme systems.

Tips tricks and pointers

- Adding Hydrogen Peroxide

Hydrogen peroxide is a fantastic natural oxygenator. By creating and releasing bubbles that attach to “dirty” surfaces, the H2o2 breaks up and removes any micro organisms. Using a gentle blend will also clean your roots while providing additional oxygen.

Add 10 ml of 3% h2o2 for every gallon of water. You can do this a few times a week if you need to or just once a week for general maintenance. Be sure to use food grade H2o2. The brown bottle antiseptic stuff contains additives for extending shelf life.

You can get the exact blend that I use (and have used for years) here (3% food grade H2o2)

H202 will keep your garden and roots clean as well as add vital oxygen to your roots.

- Prevent Algae

Adding H202 will help with this as well, but the best way to prevent algae growth is to prevent light from reaching wet surfaces. Algae thrives in well lit wet places, so try to keep your surfaces as dry as you can by covering your rock wool with pebbles or anything that will block light.

- Prevent root rot and pH spikes

One variable that will throw off your hydroponic garden more than any other is temperature. Water temperature affects pH. Levels drastically. If your water gets too hot, it can also have a significant effect on your water's oxygen level. This happens above 85 degrees fahrenheit and can be easily prevented by managing water temperature. When the oxygen level reaches critically low levels, the plants begin to rot. This is called root rot. Large amounts of H202 can reverse the root rot over time, but it is better to prevent altogether.