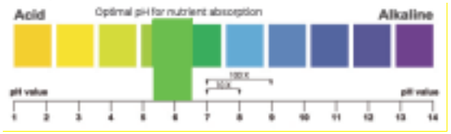
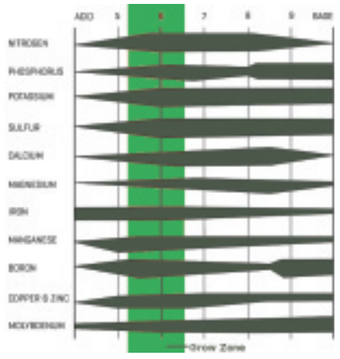
5. Water chemistry

5.1. pH (Potential Hydrogen) - The pH value of water is measured on a scale of 0 to 14 with extreme acidity being 0 and extreme alkaline being 14.



Plants require adequate amount of water adjusted in the correct range of pH 5.2 ~ 6.5 to optimize nutrient availability and maximize nutrient absorption that results in lush growth. Solution pH values within this range ensure that the nutrients are kept in suspension and are able to be delivered to the plant. At pH values above or below this range some nutrients precipitate out of the solution and become unavailable to the plants.

This is called nutrient LOCK OUT.



The pH value of the reservoir water must stay within the required range to maximize nutrient availability and absorption, and maximize lush growth. Water with high alkalinity or salt content can cause nutrient imbalances and poor plant growth.

5.2. TDS (Total Dissolved Solids) is a measure of the combined content of all inorganic and organic substances contained in a liquid. TDS is measured in ppm (parts per million) or in mg/l. The higher the TDS, the more dissolved mineral salts are present in the test solution.

5.3. EC (electrical conductivity) is related to the concentration of dissolved salts in test sample. It estimates the total amount of dissolved solids in water -TDS. Dissolved salts are positively charged ions and negatively charged ions that conduct electricity. EC is used to quickly and inexpensively check TDS changes using portable meters but does not provide any information about the ion composition in the water.

5.4. ORP (Oxidation Reduction Potential) measures the amount of oxidizing or reducing agents in a solution. During chemical reactions, there is a tendency to transfer electrons between the components. The more negative the OPR reading, the greater the substances' tendency to give away electrons and be reduced; the more positive the ORP reading, the greater the substances' tendency to pick up electrons and be oxidized. As

and example, when iron nail is exposed to oxygen and moisture, iron oxide, or rust, is created and the iron nail is considered to be oxidized.

Using ORP in Hydroponics - Solutions with a high ORP with positive mV readings usually create a more sterile environment. Solutions that maintain a low ORP with a negative mV reading may allow more organic matter in the solution. In an organic or aquaponics system, keeping a low water and nutrient solution ORP may help promote balanced micro-organisms. Research suggests water with an ORP of 680 mV or higher can kill pathogens such as pythium, root rot and E. coli bacteria in less than three seconds. Under normal conditions maintaining an ORP reading of approximately 420 mV is considered safe and effective. If you introduce beneficial micro-organisms into your system keeping the ORP value and sterilizing effect low. Conversely, using a safe oxidizer in your inorganic systems will greatly contribute to maintaining a sterile environment, reducing the chance of plants injured by a destructive pathogen.

5.5. Salt levels greater than 0.5 millions or 320 parts per million are likely to cause an imbalance of nutrients. Artificially softened water should not be used. Some water quality problems may be overcome by custom mixing the nutrient solutions to compensate for the salts in the water.

6. Equipment Troubleshooting - *During the hot summer months,* a hydroponic system will lose large quantities of water through plant respiration. If there is an interruption in the water supply, the plants will recover slowly and production will be reduced even after the proper moisture level has been restored.

6.1. Pumps and Power Adapters

The pump is the "heart" of the hydroponics system and the plants depend on the pump to circulate nutrient solution and water. The pump in your hydroponic system should provide years of service. If the system pump does malfunctions, you may have little time to help your plants survive. Proper care and maintenance is key to long pump life.

INSPECT the pump intake regularly for restrictions. If you notice the water flow is reduced, check the pump ASAP. Clean the pump thoroughly using pressured water from the faucet. Never pull or carry the pump by the cord.

It is good practice to keep a spare pump ready in case your system pump fails. If your pump does malfunction, the following information may assist you to troubleshoot the problem and provide a quick fix to start the system functioning properly again. After years of service, a pump may need to be reconditioned or replaced.

If your pump is experiencing problems, the troubleshooting steps below will help you quickly identify and solve the problem with a failed pump.

INSPECT the pump. Is it completely stopped, or is there a hum, or a loud *noise? Follow these steps until the problem is found:*

i. A loud noise from the pump:

Possible vibration against the side of the reservoir. Place a foam mat under the pump stop the vibration.

Possible debris around the pump impeller or the impeller itself may be broken. Inspect the intake area thoroughly.

ii. A hum coming from the pump but no water flow:

Possible clog in the intake or in the discharge pipe.

INSPECT the pump intake to ensure that it is free from debris. If clean and the problem persists, try placing the pump in a tub of water with no pipe attached and see if it works. If so, you will need to clean your plumbing lines.

Possible vapor lock (air in the pump). Vapor locks can be common when reinstalling a pump after cleaning it. Tilt the pump on its side and back and forth while submerged. You may see bubbles rise from the pump. If possible, do this with the pump on.

Possible capacitor failure. The pump will need to be replaced.

A loud grinding sound. Possible bearing failure. The pump will need to be replaced.

iii. The pump does nothing:

The thermal overload protection may have engaged. Most submersible pumps feature a thermal overload protection to minimize damage to the pump should it overheat. When it cools off it can restart. Give the pump time to cool down, this may take up to an hour. Then try again, ensuring that the pump stays submerged. Repeated engagement of the thermal overload protection can damage the pump.

iv. Power and Switch problems:

No electricity to pump. Check the outlet with another electrical device and/or check the pump on another outlet that uses a different circuit.

The pump liquid level switch may fail to turn on because the switch has shifted inside the reservoir and has become lodged against the side of the reservoir;

A piece of debris is interfering with the movement of the level switch.

INSPECT the level switch to CONFIRM the level switch and float arm assembly move freely.

7. GROW MEDIA

THDC Vertical Hydroponic GrowTube™ Systems can accept several different types of fibrous grow media. THDC currently installs a majority systems with coco-coir fiber strips.

7.1. Advantages of Using Coco Coir Grow Fiber

*Coconut coir is a superior hydroponic grow media fiber that is totally environmentally friendly – it is organic, bio-degradable, light weight, never shrinks, cracks or produces crust.

*Coir provides a great hormone rich and fungus free grow medium. It has naturally evolved to nurture coconut germination and nurtures plants in the same way.

*Plants started in coir peat can be directly transplanted into grow tubes without using other media. Coir's soft structure allows plants to develop strong root structures through easy penetration and healthy growth.

*Coir has excellent drainage and provides great aeration even when completely saturated - air circulates through the root zone even when wet so roots remain healthy.

*Coir has a very high water retention capacity and a longer drying time than many synthetic fibers – Coir holds up to eight times its weight in water and loses it very slowly so plants are protected from power outages and water flow can be very regulated to save electricity.

*Coir has a high lignin to cellulose ratio that helps slow its rate of decomposition. It has a life of 3 to 4 years.

Coir has an ideal pH range of 6-6.7 and has a very low EC.

It is largely inert and with time develops a high buffering capacity that helps plants overcome a short term fluctuations in nutrients and water chemistry.

*Coir has a high cation-exchange capacity (CEC) - the grow media has a higher capacity to hold nutrient cations and a larger nutrient reserve. It is able to hold and release nutrient elements according to the plant's needs and the prevailing conditions in the medium itself.

*Contains significant amounts of natural nutrients phosphorous (10-50ppm) and potassium (150-450 ppm), which are essential major plant nutrients.

*Coco coir has natural anti-fungal properties that help protect plants from soil borne diseases. It inhibits pathogens like Pithium.

7.2. Preparation and Nutrient Considerations

New, untreated coir may contain high levels of potassium, chloride and sodium salts that are best flushed and buffered before use.

Coir contains natural levels of potassium and sulfur that need to be compensated for in the nutrient solution used in the system.

Concentrations of nitrate, potassium, magnesium and phosphorus may increased in coir media over the grow cycle and need to be compensated for in the nutrient mix.

Coco coir can be used for more than one crop cycle if properly prepared – sterilize the media with a weak solution of bleach (cellulose) and flush with a buffer before reuse.

7.3. Flushing and Buffering Coir Fiber strips with Water

*Slide the coir grow fiber replacement strips into the GrowTube™;

*Fill a large container like a barrel with water;

*Place the GrowTube™s with new coir grow fiber replacement strips into the barrel;

*Circulate the barrel water through (flush) the GrowTube™s with a pump;

*Continue to circulate for a few hours until the water becomes brown like tea;

*Remove the GrowTube™s and replace the dirty water with fresh water;

*Adjust the barrel water pH with buffer concentrate to pH 6.0 with EC=1.4;

*Circulate the barrel water through (flush) the GrowTubes™ again for a few hours and adjust pH as necessary until pH stablizes in the 5.2 ~6.5 zone;

*After pH stabilizes, remove the GrowTube™s and stand to dry.

7.4. Measuring Coco Coir pH: take fiber samples from around the root zone, mix these with distilled water (1:5), then test with a pH meter.

7.5. Signs of Toxicity

*Slow/stunted growth

*Yellowing

*Burning

*Rusting on edges of leaves

*Rust spots on leaves

New Age Urban Garden

Taiwan Hydroponics Development Co., Ltd. (THDC)
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Congratulations on your purchase of a Vertical Hydroponic GrowTube™ System – Please check our online information at www.taiwanhydroponics.com for additional resources.

TABLE OF CONTENTS

SAFETY PRECAUTIONS

Please read and follow all instructions in this manual. When in doubt, please have a professional inspect your installation. This manual classifies precautions into Warnings and Cautions. Be sure to follow all precautions listed below. They are important to avoid use injury, prevent damage to the system and assure proper system operation.

WARNING – ***Confirm system is properly assembled and level before operating.***
WARNING – ***Confirm system is properly anchored or sheltered from wind and extreme weather.***
WARNING – ***Confirm electrical connections are properly connected, grounded and sheltered from water before starting the system.***
WARNING – ***Properly drain the top feeder tank and unhang the GrowTubes™ before attempting to move the system or mounting rack.***
WARNING – ***Wear Protective Gloves and Eyeware when handling Chemicals.***
CAUTION – ***Check & Confirm Water Levels*** in the system is at proper levels to prevent system from running dry and harming the pump.
CAUTION – ***Periodically Check Hoses, Connections and Filters*** to confirm plumbing is connected and free of obstructions. Especially confirm bottom drain connections and hoses are free of obstructions.
CAUTION – ***Keep Plants Trimmed and Properly Rooted*** to prevent leakage from the system.

1. BASICS

1.1. System Preparation and Maintenance

i. For New Installations: The grow fiber in new GrowTube™ assemblies should be flushed and buffered before nutrients are added to the system to insure that excess salt and phosphorus is removed and that the system pH values stay in an acceptable 5.2 ~6.5 range. If GrowTube™ assemblies are not properly conditioned before using may cause pH to fluctuate. We recommend flushing the system for 1 week after installation with reservoir water changes every two days. The reservoir water will have a brownish peaty color when circulation starts. After a few days, the water will clear. When the reservoir water clears, the system is ready for planting and nutrient adjustment.

ii. Pick The Right Plants for your THDC Vertical Hydroponic GrowTube™ System. Many varieties of herbs, leafy vegetables and flowers will grow in a Vertical Hydroponic GrowTube™ System including basil, mint, sesame leaf, lettuce, water spinach, gyruna, basella and similar plants. Some reliable annual flowers are alyssum, cosmos, marigolds, and zinnias. Perennials include Shasta daisies, columbines, and hollyhocks.

iii. Daily:

INSPECT: solution levels to make sure system has enough water for sable operation;
INSPECT: for solution leakage around front planting face and bottom caps – trim plants as necessary to assure smooth water flow;
OBSERVE: one system cycle to confirm pump shut off is operating correctly, all hoses and connectors are

secure and water is flowing as desired;

iv. Every three days:
INSPECT: plants for signs of insect infestation.
TEST: water properties including pH, EC, etc.
INSPECT: plants for signs of insect infestation;
INSPECT: connections and manifolds to confirm there are no restricted or blocked hoses, connectors;

v. Every week:
INSPECT: tanks for debris.
CONFIRM: plants are properly trimmed and water is not escaping the system.
CONFIRM: spare nutrient amount on hand.

vi. Every two weeks:
CHANGE: reservoir solution –
*disconnect power and allow all solution to drain to bottom reservoir tank;
*remove feeder hook from top feeder tank and position near drain;
*connect power and allow nutrient solution to run to drain;
*when reservoir tank is empty, fill with tap water and add appropriate amount of nutrients;
*insert feeder hook in top feeder tank;
INSPECT: grow tube bottom fiber filters for overgrown roots in return hoses;
*connect power and allow top feeder tank to fill;
OBSERVE: one system cycle to CONFIRM proper operation.
vii. Every crop cycle before replanting:
*Remove all old plants and debris from the system;
*Clean dead plant fiber from the grow tube planting ports;
*Wash tanks and hoses with water. Avoid using a sterilizing agent (bleach) unless the system has bacterial problem;
INSPECT: grow fiber and replace fiber strips in tubes that have lost rigidity.

viii. Water flow control
Water flow can be controlled by turning the red valves on the water distribution manifold a the top of the system.
- Decrease water flow when starting new cuttings to help prevent root rot.
- Decrease water flow during winter or cooler weather to help prevent general root rot.
- Decrease water flow during hot weather to help prevent root rot on certain types of crops such as Basella.

1.2. HydroLush® Hydoponic Nutrients

Hydroponics allows the grower to finely control the amount and timing of the nutrients the plants receive. A balanced hydroponic nutrient concentrate provides the macro and micro nutrients required to maximize lush plant growth. Hydroponic nutrient concentrates contain these minerals in water soluble form specifically designed to work in a soilless hydroponic environment. They are pH balanced and formulated to stay in suspension in water during circulation. Regular garden fertilizer products and organic nutrient products are usually not a good choice in hydroponic systems without special techniques because they require additional microbe actions in the soil to become available to the plant.

When mixed properly, a hydroponic nutrient reservoir solution is a precise blend of different minerals nutrients at various ratios and pH values. If the levels of any given element become too high or the pH range is not suitable, essential elements 'lock-out' meaning that they become unavailable to the plants. It is important to test your source water to get an overview of the total amount of dissolved solids present and other parameters. Mineral ratios of the nutrient mix can then be adjusted to suit the life-cycle of the plants in the system.

Many nutrient mixtures have three numbers printed on the label known as the N-P-K ratio, or Nitrogen/Phosphorus/Potassium ratio that tells how much of each macro nutrient the bottle contains. A bottle showing 9-9-9 means that the solution contains 9% Nitrogen, 9% Phosphorus, and 9% Potassium. Optimal NPK ratios for a certain system differ depending on the growth phase of the crop.

HydroLush® Basic Hydroponic Nutrients are available in a concentrated three part formula for leafy green vegetables and herbs. HydroLush® Nutrients are convenient and easy to use. Just mix thoroughly into full reservoir tank water at the desired ratio. Separating the mineral nutrients into different components allows HydroLush® to offer products in higher concentrations. As plants grow through their life-cycle, they may require different ratios of nutrients. Plants need all three parts – just at different ratios depending on their growth stage. HydroLush®'s multi-part formula gives you the ability to adjust the reservoir mix to better suit the different stages of plant growth.

1.3. Mixing the Nutrient Solution

ALWAYS MIX NUTRIENTS INTO A FULL RESERVOIR TANK OF WATER
NEVER COMBINE CONCENTRATED NUTRIENTS TOGETHER BEFORE MIXING INTO THE RESERVOIR TANK.

HydroLush®	***MicroNutrients***	***1ml per 1L reservoir water***
HydroLush®	***Green***	***4ml per 1L reservoir water***
HydroLush®	***Red***	***3ml per 1L reservoir water***

Steps for Mixing Nutrients:
First: Fill your Reservoir Tank with Water.
Second: Add HydroLush® Micro-Nutrients:
1ml per 1 Liter of reservoir water
This contains Calcium, Boron, Copper, Iron, Manganese and Zinc and some Nitrogen for general purpose vegetative growth. Shake the bottle vigorously, measure into a cup and pour into the reservoir tank water. Stir well. Rinse the measuring cup in the tank water.
Stir the Solution Well
Third: Add HydroLush® Green growth component:
4ml per 1 Liter of reservoir water
This contains nitrogen and potassium. Shake the bottle vigorously, measure into a cup and pour into the reservoir tank water. Stir well. Rinse the measuring cup in the tank water.
Stir the Solution Well
Fourth: Add HydroLush® Red stimulating component:
3ml per 1 Liter of reservoir water
This contains phosphate, potassium, soluble magnesium and sulfur. Shake the bottle vigorously, measure into a cup and and pour into the reservoir tank water. Stir well. Rinse the measuring cup in the tank water.
Stir the Solution & Wait 15 minutes
Finally: Check Solution pH Value and adjust as needed
Reservoir tank water pH should be in the to pH 5.2~ 6.5 range for optimal nutrient availability to the plants. check and adjust if necessary. One of the best pH additives for adjusting ph down is phosphoric acid, H_3PO_4. ***Don't add pH adjusters directly to your nutrient solution.*** The sudden drop or rise in pH can cause elements to precipitate out.
*Best practice is to make a diluted solution of pH adjuster with some water. Making up a dilute solution not only makes this process a lot safer but it's also easier to fine-tune the pH of your nutrient solution.
Keep adding, bit by bit, stirring, and re-testing the pH until it falls within the desired range.
*Always wear gloves as pH adjusters are corrosive and can damage your skin.
*Ensure your nutrient solution is at the right temperature. 17° to 19°C.
Water should be tepid. Plants don't like cold roots. If the nutrient solution is too warm, dissolved oxygen levels will be too low.

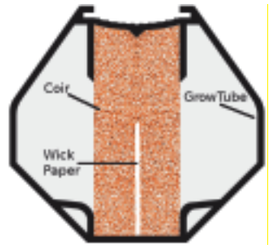
2. Introduction to Vertical Hydroponic Grow Systems
Hydroponic grow systems deliver nourishment to resident plants through a balanced, pH adjusted nutrient solution that is made available to the root mass of the plant. The solution is composed of chemical ingredients that are matched to the plants daily requirements. The resident plants use very little energy to absorb and synthesize nutrients compared to plants in soil based systems that must search out and extract nutrients. This

allows them to focus energy on growth and development. The nutrient mix and other inputs are generally determined by the type of crop grown, the crop's stage of development, the location, and preferences of the grower.

Vertical hydroponic grow systems make it possible to cultivate high density production in a limited space. Major advantages of THDC Vertical Hydroponic GrowTube™ Systems over tradition hydroponic systems include:
*Efficient use of Space: compact towers allow higher production anywhere from 3-8 times more plants per meter with vertical growing.
* Efficient use of inputs: Less energy and less water (up to 85% savings on water)
* Flexible Grow Areas - systems can be installed on balconies, rooftop or and vertical surface.
* Ergonomic Work Positions – vertical position allows you to stand while working with crops and reduces strain and toil of bending;
* Better control of root zone temperature, drainage and oxygen level .- Root zone remains aerated and functioning efficiently even during excessive rainfall.
* Crops: arugula, amaranth, basella, lettuce, spinach, kang kong (water spinach), herbs, flowers, etc.
* GrowTube™s can be easily transported with plants intact.
* GrowTube™ are durable, light and easy to maintain - less expensive than any other hydroponic systems.
* GrowTube™s use Coconut Coir Grow Media - reusable, eco-friendly and creates no waste upon disposal.
*GrowTubes™ perform well outside in natural light as well as indoors with properly installed artificial lighting.
*GrowTubes™ are durable, light and easy to maintain - less expensive than any other hydroponic systems.

3. THDC Vertical Hydroponic GrowTube™ System
3.1. At a Glance
THDC Hydroponic GrowTubes™ are specially designed for use with vertically installed hydroponic systems. Your Vertical Hydroponic GrowTube™ System also includes: nutrient solution reservoir tanks; a pump for circulating the nutrient solution through the system; and various pipes, hoses, and plumbing fittings. THDC GrowTubes™ are compact, light-weight and durable root zone enclosures that can be installed on existing surfaces or installed from dedicated supports.
THDC Vertical Hydroponic GrowTube™ System has several special features not available on competing systems:
** Proprietary Tube Design Creates a Grow Media Pocket* - strips quickly slide into the tube and allow you to conveniently change and maintain the grow chamber duing general cleaning or a change of crop;
** Enclosed Air Columns on Each Side of the Grow Media* - allow roots to breath, provide even nutrient exchange and minimize anaerobic areas in the grow media;
** Concave Planting Face with Splash Guards* - helps direct water flow and minimize nutrient solution leakage;

** Multiple Mounting Faces* - tubes can be suspended vertically from overhead racks, fixed to vertical supports such as walls, or joined in a free-standing array;
** Removable End Caps and Drainage Fittings* - connect the GrowTube™s and ensure proper water flow.
3.2. In Depth
- THDC GrowTubes™ are manufactured from PVC with a profile size of 10cm X 12cm in standard 1.3 meter lengths. Customs lengths are possible depending on quantities, the intended mounting space and the specifics of the nutrient delivery system. In most installations, the tubes are fitted top and bottom with a cap and hose fittings that connect the GrowTube™ to the plumbing network of the system.
- The GrowTube™ profile includes a front planting face, a rear mounting face and angular side faces. The front planting face is designed as a concave surface with a series of round or oblong planting ports cut at intervals along in planting face. These planting ports allow the insertion of plants into the grow media housed in the tube. Required spacing for plants on the planting face is variable dependent on plant type and maintenance requirements. Ridges on either side of the grow face act as splash guards to help prevent errant nutrient solution leaking from the planting ports.



- Narrow slots on either side of the planting face can be used to secure a vapor barrier hood or plant support inserts that can be fitted over the planting face to shield or support new plants during the incubation and rooting period.
- The GrowTube™ is internally partitioned into three cavities – a central cavity that holds the grow media strips which will anchor plant roots, and air column cavities on either side of the grow media that will provide root zone aeration and humidity protection.
- A variety of grow media materials can be fitted into the GrowTube™ including coconut coir, synthetic wool, etc.
- Air columns on either side of the grow media ensure that plant roots receive adequate aeration and humidity. These columns act as aeration zones that allow the plant roots to breathe and aerate as they grow. High humidity and aeration is maintained inside the GrowTube™ due to the constant flow of nutrient solution through the grow media.
- A emitter or dripper is fixed centrally above the grow media column that will emit nutrient solution evenly over the width of the grow media.
The system uses gravity to channel nutrient solution vertically through the grow media to the drainage

plumbing installed at the bottom of the GrowTube™. Plants are inserted into the planting ports and nutrient solution is circulated through the system. Nutrient solution trickles down through the GrowTube™, over the plant roots; providing required nutrients the roots of the resident plants. As the plants mature, roots grow out of the grow media and into the air columns.
- In some installations, spray, dripper or misting nozzles maybe installed into the side faces of the GrowTube™ at various locations along the vertical length. These are used to emit nutrient solution on to the exposed roots. Runoff nutrient solution is channeled through the GrowTube™ and back to the drainage plumbing of the system.
3.3. Advantages
THDC Vertical Hydroponic GrowTube™ Systems help eliminate many of the problems common to horizontal NFT systems.
* A Vertical Flow Path Eliminates the Damming Effects of Root Growth in the GrowTube™ and allows the nutrient solution to flush any old biological material from the media without restricting nutrient solution flow to other parts of the GrowTube™. This prevents anaerobic areas forming in the GrowTube™ around the root zone of the resident plants.
* The GrowTube™ Housing is Designed to Minimize Nutrient Solution Leakage from the system using a Concave Planting Face with Splash Guards. The planting face is formed concave to the interior of the tube to direct nutrient solution to the internal cavity of the tube. The splash guards on the side of the planting face are raised sufficient height to direct any nutrient solution that escapes from the tube along the exterior length of the tube and back to the drainage plumbing installed at the bottom.
* The GrowTube™ Fiber Pocket Design with Enclosed Air Columns on Each Side of the Grow Media Allows Roots to Breath, Provides Even Nutrient Exchange and Minimizes Anaerobic Areas in the grow media. Regardless of weather, the enclosed tube with air columns allows the root zone to breathe, exchange nutrients and dissipate heat. This improves growth in hot weather (35 degree C) and during heavy rains (typhoons).

4. Plant Nutrients
Plants absorb mineral nutrients through their roots and leaves. Nutrients are absorbed by the roots from the grow media and mobilized by the plant as building blocks for growth. Mineral nutrients are essential for normal plant growth and must be present in the nutrient solution in the right percentages and with the correct water chemistry (pH, temperature) to be properly absorbed by the plant.
4.1. Macro Nutrients – Oxygen(O), Carbon(C), Hydrogen(H), Nitrogen (N), Phosphorus(P), Potassium(K), Calcium (Ca), Sulfur (S), and Magnesium (Mg). These are needed in large quantities by the plant for survival and are obtained from both the environment and the nutrient solution.
4.2. Micro Nutrients – Iron (Fe), Manganese (Mn), Boron (B); Chlorine (Cl); Copper (Cu); Zinc (Zn); Molybdenum (Mo). These are required in smaller quantities for a healthy plant and completely obtained from the nutrient solution.
4.3. Additional Nutrients - Silicon (Si); Aluminum (Al); Cobalt (Co); Vanadium (V); Selenium (Se); Platinum (Pt); Nickel (Ni). Certain species accumulate these elements. Not all are essential for growth but may aid in overall health and vigor. Some are also more beneficial for the consumers of the plants than the plants.