My Indoor DWC Hydroponics System

by LancePenney on July 28, 2008

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I am a fourth year university student in the science faculty. My major is Biology with a minor in Biochemistry. I live in St.John's, Newfoundland, Canada. I have a very big personal drive to live with zero impact to the environment and I think everyone else should too. Therefore I want to try to develop many projects relating to green energy and plant growth.

Intro: My Indoor DWC Hydroponics System

Update Jan.22 2009
I just harvested my banana peppers and did away with the plants. I now have all the pictures I need to update every section of this instructable so I'll work on that ASAP. Hopefully I'll get a step done every couple of days. I also have a new crop of tomatoes almost ready to go into my new NFT system. Happy growing!

This instructable will cover the build and operation of a deep water culture hydroponics system. So far, I have sucessfully grown banana peppers in this setup with complete ease since most of the process is automated.
Also, these plants were grown indoors completely under artificial light that outputs about 60 watts. The entire unit requires about 65 watts and runs for about 16 hours every 24 hours. It costs about 9 cents a day to run it.
When I first wrote this instructable it was about a month before I planted anything in it. Since then I have made many modifications to the hydroponics system such as a third light and a more advanced electrical system. I'm soon going to make a fabric cover for it with built in fans for air circulation. As a result you'll see some old and new pictures mixed together. Please bear with me untill I find enough time to re-write the whole thing.
Until then, I'll keep posting up-to-date photos of the developing peppers. Enjoy!

Image Notes
1. I ate one of these guys and it turned out to be sweet. WTF is going on !?!?

Image Notes
1. This is a waste of biomass for such a small yield of food. I think from now on I'm gonna stick to growing vegetables.

Image Notes
1. The roots grow out of the rockwool cube and use the clay pellets in the pot to anchor it down.

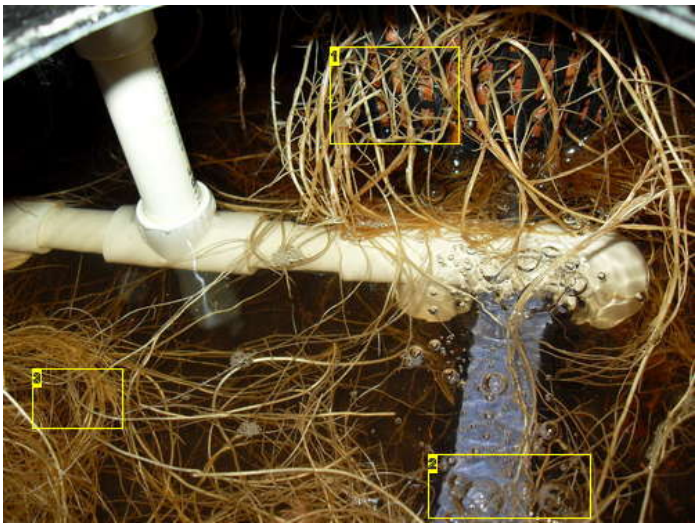


Image Notes
1. The roots grow out of the pot and down into the solution with dissolved nutrients.
2. Airbars and an air pump provide the roots with oxygen.
3. Looks like there's some root rot going on. I think it's because the air pump ran continuously.

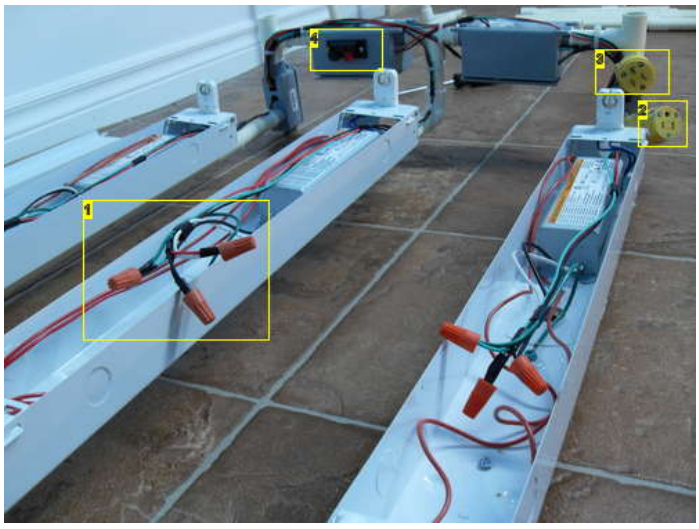


Image Notes
1. All the light fixtures are wired in from the electronic ballast.
2. This outlet is meant to supply electricity to the air pump
3. This plug is the input for all of the system's electricity.
4. These connectors supply 12 volts DC to the fans.

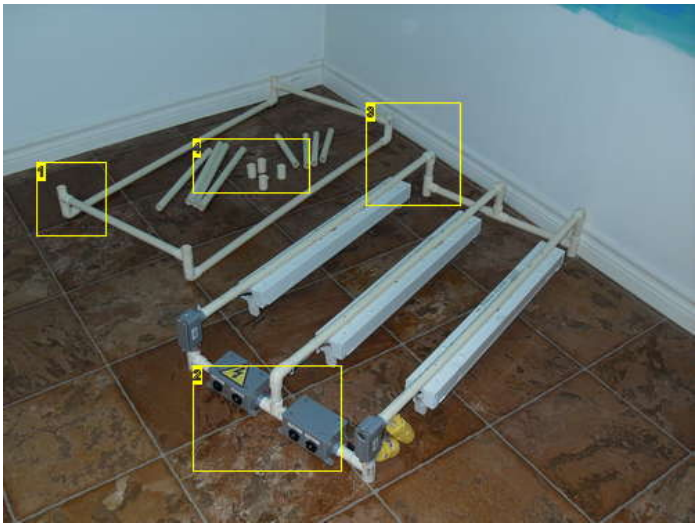


Image Notes
1. The frame is built mainly from 3/4 inch CPVC pipe and fittings.
2. The electrical system is controlled by these switches.
3. The frame can be collapsed for easy transport or storage.
4. The height of the frame can be adjusted by adding different lengths of vertical pipe.

Image Notes
1. This is an old picture showing the emergency blankets being used to keep the light in.

Step 1: Warning Science Content: An Introduction to Plant Physiology

To the naked or untrained eye, plants can appear as very simple and boring forms of life. In reality, plants are very complex creatures. In fact, genetically speaking plants are about twice as complex as humans.

They exist in two very separate yet two very interconnected and equally important worlds. There is the above ground world of the shoot system and the underground world of the root system.

The shoot system of the plant is what we normally see when we look at a plant in the ground. From figure 1B you'll notice that the shoot system is extensively branched to allow a maximum surface area for the absorption of sunlight. This part contains the leaves, which is where the chemical reaction we learned in junior high takes place:
6 CO2 + 6 H20 ==> 6 O2 + C6H12O6

This chemical process is known as photosynthesis in which the radiant energy from the sun is harnessed and converted into chemical energy in the form of sugars. Excess sugars produced by the plant can be stored in bulk, usually in the form of a fruit that is meant to provide a developing seed with energy until it can grow it's own leaves and manufacture it's own glucose.

The process of photosynthesis is actually much more complex than the above chemical reaction. It is really a series of dozens of chemical reactions that are only a small part of a plant's overall metabolism, which requires many other nutrients such as Nitrogen, Potassium, and Phosphorus. But how does the plant collect these nutrients? From it's root system.

The root system is responsible for providing the leaves and the rest of the plant with the required raw materials for metabolism and photosynthesis. From figure 1B you'll notice that the root system is extensively branched to allow a maximum surface area for adequate absorption of water and nutrients from the soil. Anything that is absorbed by the roots are transported up to the leaves through the plant's stem. In return, some of the oxygen and sugars produced by the leaves are transported down to the roots through the stem. The roots are not exposed to sunlight and therefore cannot manufacture it's own sugars.

There are three main problems with soil that limit the growth of a plant:
One is that soil does not contain a whole lot of oxygen that the roots need to survive. Roots need to "breathe" just like we do and this can cause a lot of problems when oxygen is scarce. Hydroponics systems help with this by delivering a highly oxygenated nutrient solution to the roots. This is most commonly achieved through the use of air pumps and bubblers similar to those used in aquariums.

The second problem with soil it that nutrients are often scarce and in a form not usable by the plant. For example, nitrogen in soil is often in the form of ammonia or gas and must be processed by nitrogen fixing bacteria before the plant can use it. Hydroponics systems suspend the roots directly in a nutrient rich solution that can be readily absorbed by the roots and used for growth.

Finally, soil can contain many pathogens that can lead to diseased plants. Hydroponics solutions can be easily sterilized to prevent any nasty creatures from infecting your plants.

By addressing these three problems, hydroponics allows plants to grow and develop at an accelerated rate. With all that being said, I finally give to you my design of an indoor Deep Water Culture (DWC) hydroponics system.

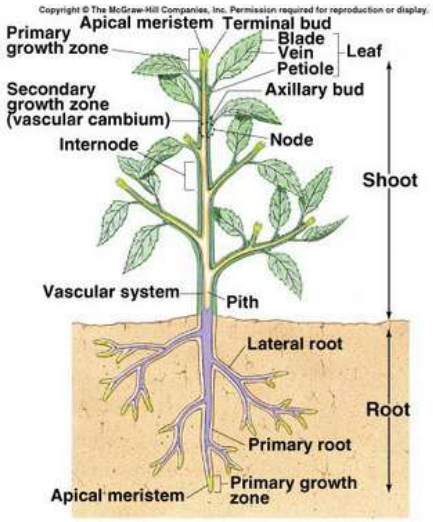


Fig. 1B

Step 2: The Deep Water Culture Design, Materials and Methods

Please refer to figure 2A for an illustration of the DWC system.

In Deep Water Culture (DWC) systems the plant sits in a mesh basket filled with an inert medium such as clay pellets. The inert medium does not provide the plants with nutrients but only acts as a support to anchor the plant down.

The basket is suspended in a reservoir filled with a solution of nutrients. As the plant grows, the roots will protrude through the holes in the basket down into the nutrient solution where they can be readily absorbed. (Figure 2B)

At the bottom of the reservoir sits an airstone hooked up to an aquarium pump. Air is bubbled through the solution and up to the roots to provide them with oxygen.

Although the leaves must be exposed to light, the walls of the reservoir must be opaque to prevent the nutrient solution from being exposed to light. Not only can roots be damaged by light but light in the reservoir will promote the growth of alge which is harmful to the plant.

The nutrient solution must be changed on a regular basis because the nutrients can be used up and "nutrient toxicity" can occur. Also, the pH of the solution tends to go up as the plants use up the nutrients. It can rise to extreme levels and end up killing the plant.

There are many versions of the DWC system available for retail but they are expensive and aren't DIY. I made mine from materials available at any Canadian Tire and Wal-Mart. Please note that I got the idea for the reservoir system from this build by trebuchet03 entitled Hydroponics - at Home and for Beginners .

I encourage you all to design your own DWC system, using this instructable only as a guide to expand and improve on my design. With that being said I will still provide a complete list of the materials I used below.

Lighting Frame and Supporting Structure:
3/4 inch CPVC pipe
3/4 inch CPVC tees
3/4 inch CPVC 90 degree elbows
1/2 inch CPVC pipe
1/2 inch CPVC tees
1/2 inch CPVC 90 degree elbows
1/2 inch PVC Conduit Boxes
PVC primer
PVC solvent cement

Electrical, Wiring and Lighting:
24 inch fluorescent light fixtures
24 inch fluorescent grow lights
18 gauge wire in black, red and green spools
A grounded plug that can be self-wired
Rocker switch rated for at least 125VAC at 1 amp
Programmable timer*****
Wire connectors
Electrical tape
Zip ties
Vinyl shrink tubing
A firm knowledge of Ohm's law, circuit wiring and electrical safety

Aeration:
Aquarium air pump
Aquarium air tubing
Aquarium air bars
Air tubing shut-off valves
Zip Ties

Nutrient Reservoir, Solution and Growth Media:
27 litre storage tote with lid
Can of black spray paint
5 inch mesh baskets*****
Expanded Clay Pellets*****
General Hydroponics FloraGro concentrated nutrients*****
General Hydroponics FloraBloom concentrated nutrients*****
General Hydroponics FloraMicro Concentrated Nutrients*****
Syringe*****

***** For those of you that live in the St.John's, Newfoundland area, I recommend dropping by Grow Crazy . I got a lot of my materials there that I would otherwise have to get shipped in from the USA. The guy there is very helpful and there's a great selection of nutrients and equipment for any setup.

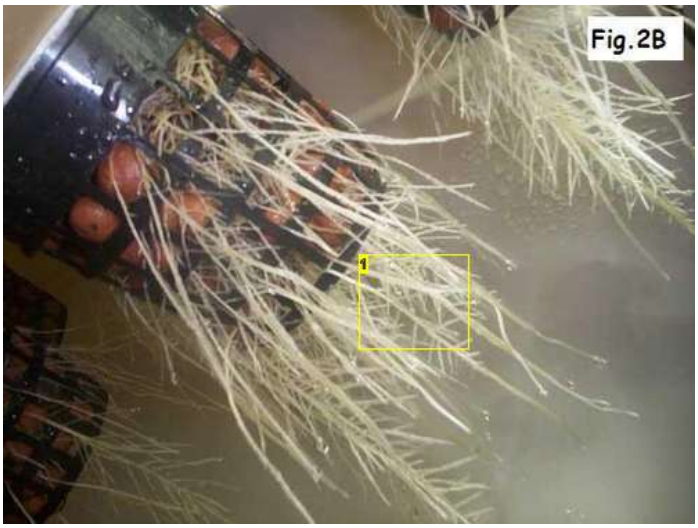


Image Notes
1. Looks kinda like an upside-down bush without the leaves.

Step 3: The Lighting Frame and Support Structure

The main purpose of the lighting frame is to suspend the fluorescent light fixtures over the plants in the nutrient reservoir. I also designed it to be adjustable in hieght so that the lights remain only a few inches above the plants at all times. Also, I can hang some chicken wire or string from the top of the frame to help support the plant if needed.

The frame is constructed completely out of 3/4 inch CPVC pipe and fittings. There is also the 1/2 inch PVC electrical conduit boxes making up two of the top corners. These boxes house the on/off switch for the lights and all the electrical connections.

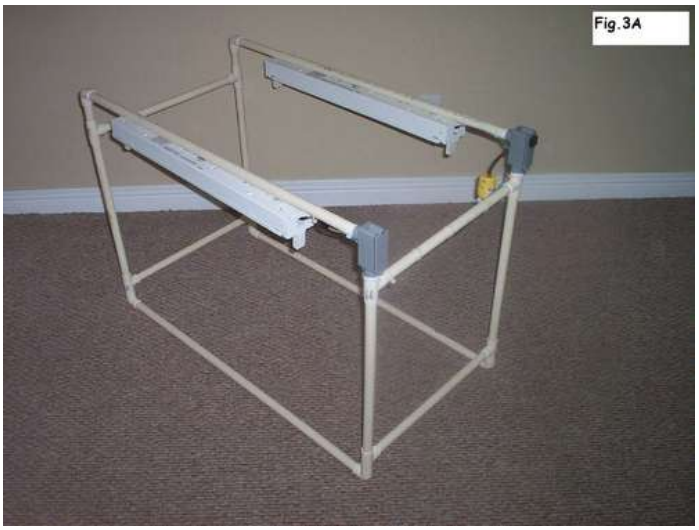
The top and the bottom portions of the frame are permanantly assembled with the CPVC cement. However, the vertical sections of the frame are not glued in. This allows the frame to be easily adjusted in height by adding or subtracting lengths of vertical pipe through the use of 3/4 inch couplings. The frame can also be easliy collapsed for storage or transport. (Figure 3B).

For some weird reason the 3/4 inch pipe fits almost perfectly into the 1/2 inch conduit boxes. However, I did have to sand down the pipe a tiny bit before it fit into the conduit box.

When cutting the pipe make sure you use a mitre block and deburr the pipe with sandpaper prior to glueing. Dry fit the pipes before priming and glueing.

The support structure is ment to hold the airbars in place underneath the mesh pots and to prevent the lid of the reservoir from sagging under the weight of the plants. It straddles both airbars and holds them far enough apart so that they line up underneath both rows of mesh pots. It is just the right hieght so that it holds the reservoir lid level. (Figure 3C).

The support structure is constructed of 1/2 inch CPVC pipe and fittings. You could make it out of leftover 3/4 inch pipe and fittings from the lighting frame but in my case the 1/2 inch fittings fit around the airbar better. I did not glue this one together, it holds together just fine without glue.



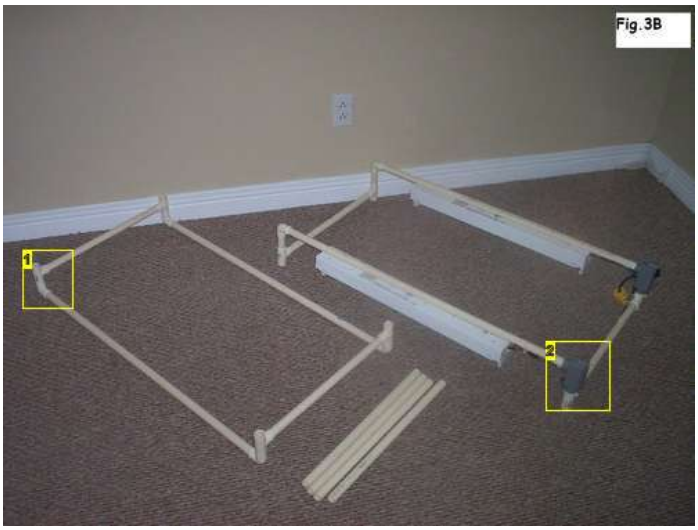


Image Notes
1. 3/4 inch CPVC tee and elbow
2. Conduit boxes make up two corners.

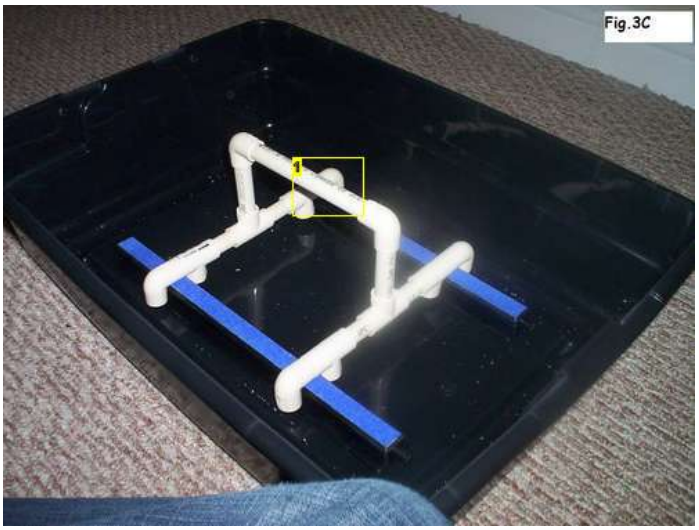


Image Notes
1. Centre of lid held up here

Step 4: The Electrical System

The electrical system consists of the three fluorescent lights, the two on/off switches, the plug, the outlet, the fuse and the wires. It allows the unit to be plugged into any standard wall outlet while the lights and auxillary outlet can be controlled by the toggle switches (Figure 4B).

Even though the light fixtures are ment to be celing mounted and wired directly into the house's electrical grid, I wired them with the plug so that this unit could be easily disconnected and then transported or stored. The use of a wall outlet for power also enables a standard programmable timer to automaticly control all of the electronics (Figure 4C).

This step is critical in terms of safety. If you wire this wrong or allow any exposed terminals to cross, you could start an electrical fire. An electrical fire could also result from using wire that is not rated high enough for the current and voltage loads that these devices require. Obviously, you also run the risk of getting an electric shock. MAKE SURE YOU KNOW WHAT YOU'RE DOING!!

Each of these lights require 120VAC and run at 20 watts. Using Ohm's law (I = P/E = 20W/120V = 0.167A) I know that each light will draw a current of 0.167 amps. The lights are wired in parallel so that the voltage does not divide between them. This means that the main power cord will carry a current of 0.5 amps. The 18 guage hook up wire that I used was rated for a maximum current of 2.32 amps so it should be safe.

The wire came in a package with three colors. I used black for the live wire, red for the neutral wire and green for the ground wire. It is important to stay consistent with this or you could wire it up wrong and end up in big trouble when you plug it in and flip the switch.

When making connections, only splice a small portion at the top of the wire. Hold the two ends together and slip a wire connecter over them. Twist the connecter and youre done. Make sure you cover any exposed parts of the wire with electrical tape.

In the fluorescent light housing you'll find the live and the neutral wires coming out of the electronic ballast box. The ground wire should be connected to a metal part of the housing (Figure 4D) When you're looking at a standard north american wall outlet, the neutral hole is on the left, the live on the right and the ground on the bottom. This should be kept in mind when wiring up the plug and the outlet. Please note that a plug and an outlet face each other so the live and the neutral wires are on opposite sides(Figure 4E).

The main power cord runs from the plug into the main electrical box. This box is the main hub of power distribution for the electrical system. Inside, all like wires from the main power cord, the light power cord and the outlet power cord are connected in parallel. The live wire for the main power cord is interrupted by a 2 amp fuse before being connected to the other power cords. The live wires for the lights and the outlet are interrupted by a toggle switch before contuining to their respective loads (Figure 4F).

Three wires from the light power cord and three wires from each light run into the left conduit box (Figure 4G). From here it's just a matter of using wire connecters to connect all three wires of each color(Fighre 4H). **Please note that Fig 4H only shows the connections for two lights, I'll update soon!**

To make everything nice and neat I used electrical tape to bundle each set of wires from the lights and power cord. I used zip ties to secure the bundles to the frame. I also used a piece of shrink tubing to cover the wires running from the plug to the first conduit box (Figure 4I).

You'll notice that the entire electrical system is contained within the top portion of the frame. This allows the frame to be taken apart without having to disturb any wires.

When I first turned the unit on I monitored it very closely for hours. I inspected it frequently for signs of electric arcing or current overload. I also felt the wires every couple of minutes to ensure they wern't heating up. Fortunately, everything ran smoothly.

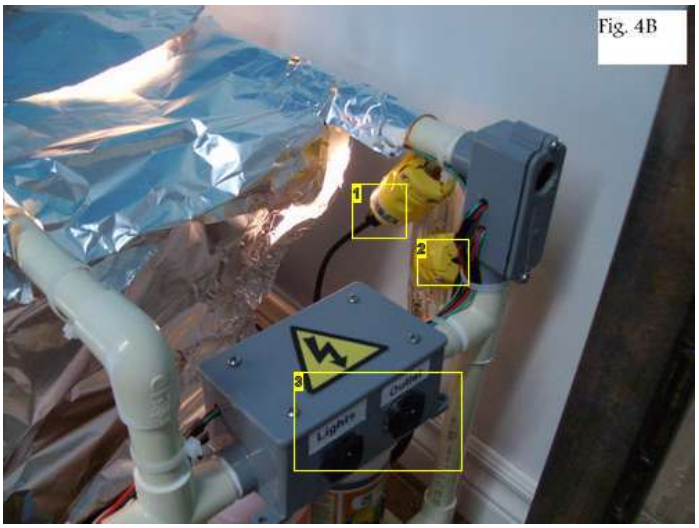


Image Notes
1. The air pump is plugged in here.
2. The power is supplied to the unit from this plug.
3. These switches control the lights and the outlet.

Image Notes
1. This timer can be set to turn the power on or off any time of day
2. Manual on/off switch.
3. Electrical system plugs into here and the timer plugs into the wall outlet.

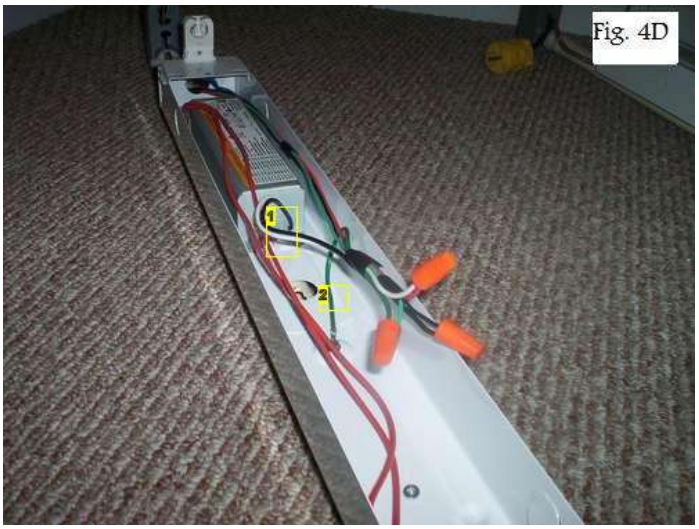


Image Notes
1. Live and neutral wires come from the electronic ballast.
2. Ground wire comes from the metal casing.

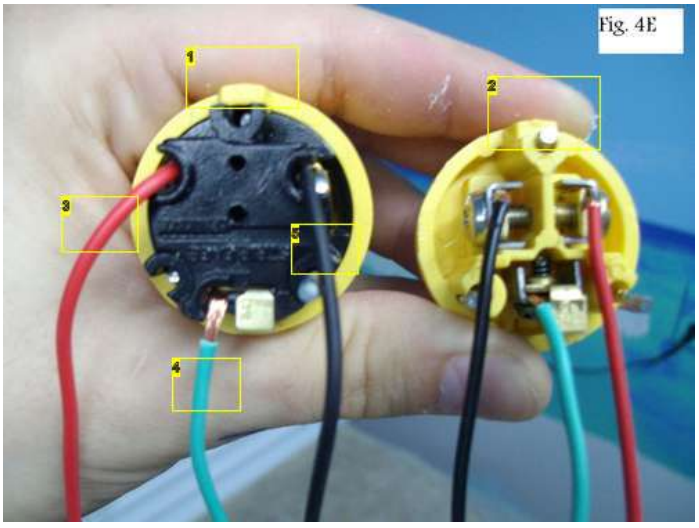


Image Notes

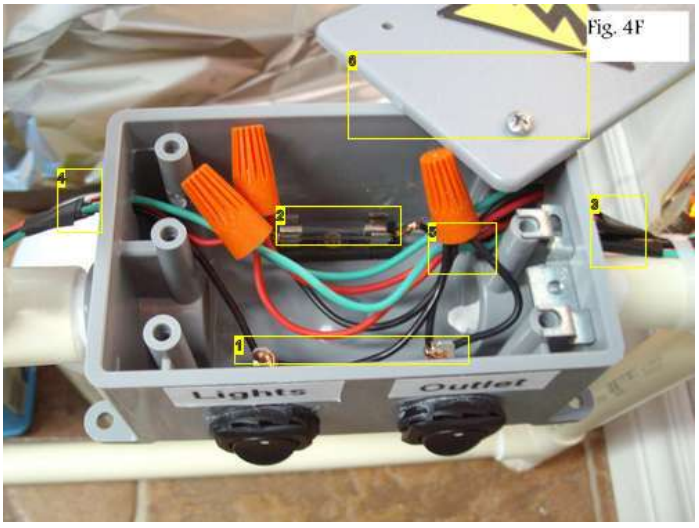
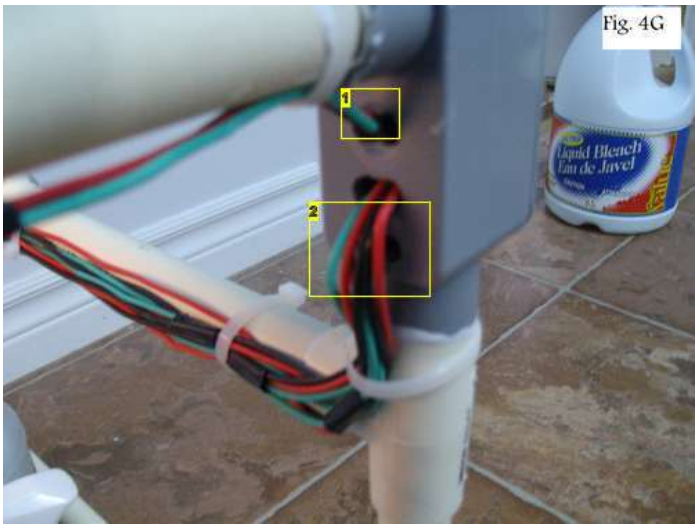


Image Notes

1. This is the outlet.
2. This is the plug.
3. Neutral wire.
4. Ground wire
5. Live wire

1. Live wires for each load is interrupted by the switch
2. Live wire for the main power cord is interrupted by the 2 amp fuse
3. Main power cord on it's way in and the outlet cord is on it's way out.
4. Light power cord is on it's way out
5. All like wires are connected in parallel.
6. With the new setup I can remove the cover and service the inside without disturbing the wires.



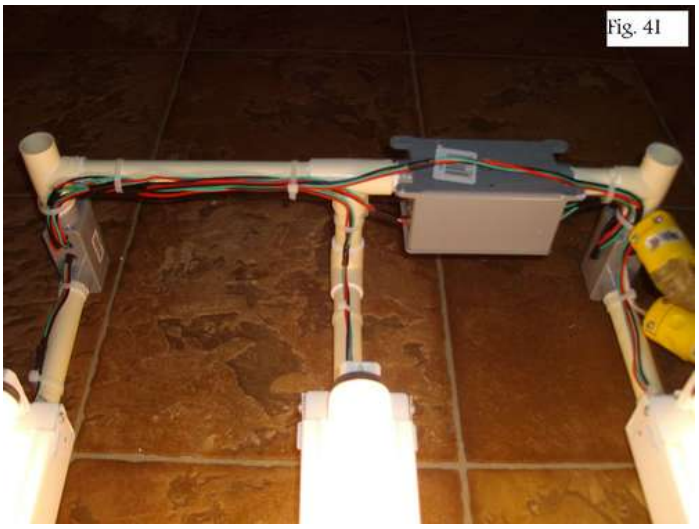


Image Notes
1. Cord from nearest light enters
2. Cord from the other two lights and the main light power cord enters.

Step 5: The Nutrient Reservoir

The nutrient reservoir is built out of a storage tote and 5 inch mesh pots. The pots are nested in holes in the lid of the tote so that they are partially suspended in the nutrient solution in the tote. It allows for the plant's roots to grow down into the solution while the shoot system grows up into the light.

I picked the tote so that the lid would hold six pots in two rows of three. Four of the pots are located in the extreme corners of the lid and the other two spaced evenly between them. This maximizes the space between plants.

The pots are not prefectly cylindrical in shape. The radius of the top is bigger than the radius of the bottom. I traced out the tops of the pots on the lid of the tote and cut out the holes with a utility knife. The holes are sightly smaller than the traces so that the lip of the pot catches on the edge of the hole and does not fall into the reservoir. The reservoir must be deep enough so that there is a gap between the bottom of the pots and the top of the air bars.

When I bought the tote it was transparent. I coated the tote and lid with a can of black spray paint to prevent any light from reaching the inside of the reservoir. However, I think a roll of duct tape would work just as well or better.

Finally, two holes were drilled in the side of the tote as close to the top as possible. The air lines are run through these holes so that taking of the lid of the tote does not disturb the air lines (Figure 5C).

Image Notes
1. Support structure seen through the mesh pot

Image Notes
1. Reminds me of a six pack of beer cans

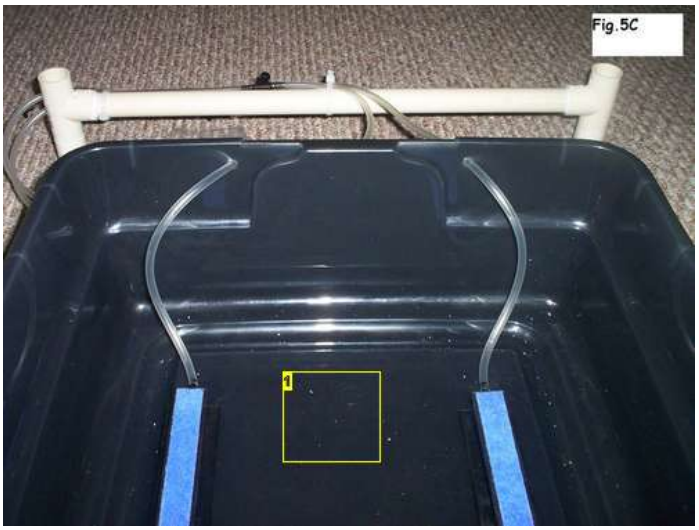


Image Notes
1. Nutrient solution will eventually go here

Step 6: The Aeration System

The Aeration System is set up to deliver a continuous, controlled airflow into the nutrient solution. It is made up of the air pump, air tubing, shut-off valves and airbars (Figure 6B).

The air tubing came packaged in a tightly wound coil. This was very cumbersome to work with because the tubing always tends to spring back into that shape. I let the tubing soak in a bowl of hot water for a few minutes and then stretched it out while it was still hot. When it cooled the tubing remained straight and was much easier to work with.

Between the air pump and the airbars, the tubing is interrupted by the shut-off valves. The rate of airflow into each airbar can be easily adjusted by twisting the knobs on the valves.

From the valves the tubing is fed through the holes in the side of the reservoir and into each airbar. the tubing runs through the side of the reservoir rather than the lid so that the lid can be removed without disturbing the air lines (Figure 6C).

Finally, the airbars are positioned so that they line up underneath all six of the mesh pots. From there they distribute air evenly to each plant (Figure 6D).

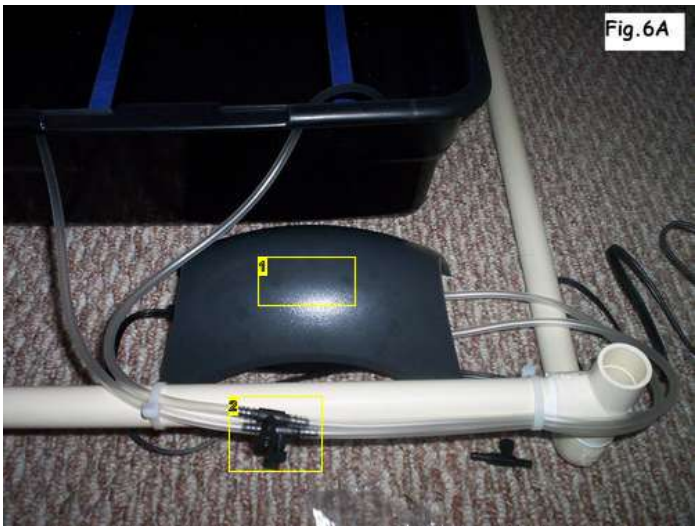


Image Notes
1. Monsterous air pump
2. Airflow for each airbar controlled from here

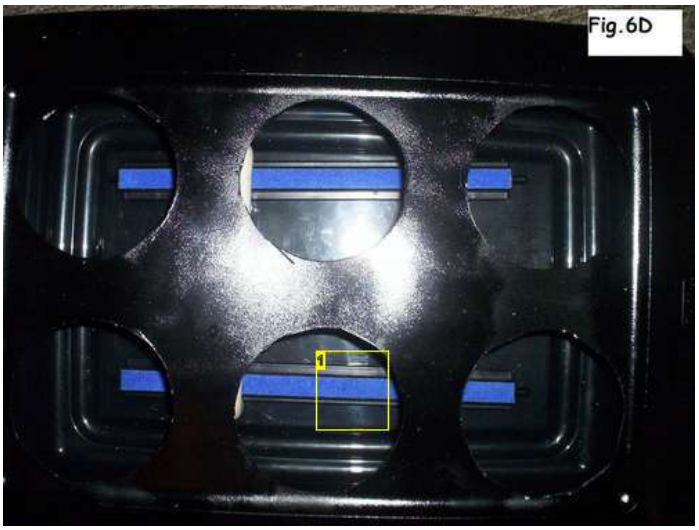


Image Notes
1. Those roots are sure gonna like this!

Step 7: The Integrated System With Room For Many Improvements

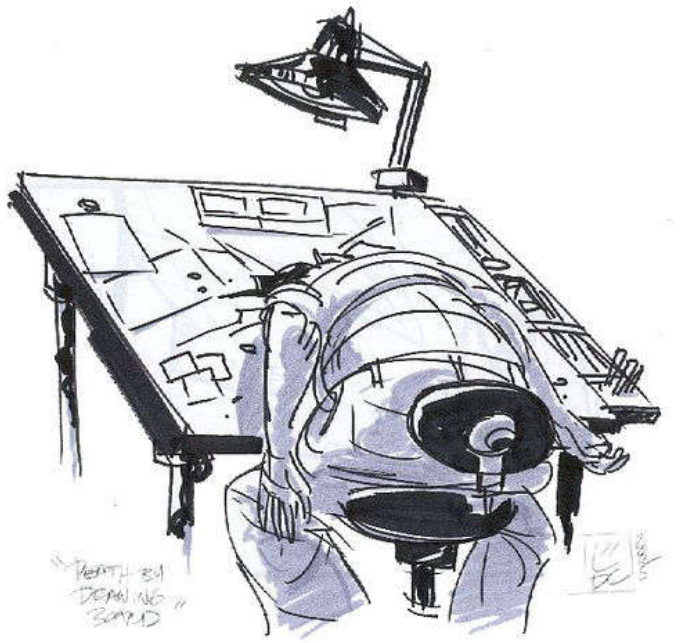
And there you have it, when you put everything together you end up with a freakin' awesome DWC hydroponics system.

However, I barely have it finished and I can already think of a few improvements to be made:

>Integrating the air pump's power cord into the electrical system so that it can be controlled via an on/off switch. (DONE)
>Painting the lid of the reservoir white so that it reflects light back up to the plant rather than absorbing it.
>Running all of the wires through the CPVC pipe for an even neater look.
>Adding a water pump to circulate the nutrient solution through a UV sterilizer to keep out unwanted organisms.
>Sewing together a fabric cover to slip over the frame and help keep out ambient light while trapping in growing light. (In Progress)
> Addition of a third growing light. (DONE)
> Adding solar cells, a battery bank and a power inverter to make it run on free electricity. (In Progress)
> And of course, expansion, expansion, expansion!

I will soon add some more steps on mixing the nutrient solution, testing and adjusting the pH, setting the light timer and eating fresh picked vegetables whilist up to my ears in snow!

Thank you for reading. I hope you enjoyed this instructable and I welcome any constructive feedback. Happy growing!



Step 8: Ok, So I Built the Thing....Now What?

Well now I have to grow something in it or else it would be a terrible waste of time and effort. Even though hydroponics is a relitively easy and sucessful method of growing, it still requires a signifigant effort and regular care and maintenence. The following steps should provide some insight into the things that need to be done to grow a plant hydroponicly.

But I can't do anything untill I have a plant to grow and the selection of that plant is important. Each plant has specific requirements that have to be met such as the pH of the nutrient solution, the size of the setup, the spacing between plants, the amount of light, etc. You should do your own research on any plant you may be thinking about growing hydroponicly. My first selection of plants were banana peppers for three main reasons:

1)I love spicy food and I like hot peppers as a topping on just about anything.

2)This is a fruit producing plant so I can test how adjusting the timing of the lights will affect the onset of the different stages of the plant's growth.

3)This plant produces it's fruit above the ground. I don't think plants that produce sub- teranian food like carrots and potatoes would be suitable for this type of application.

So in order to get the pepper I need to start with the seed. Read on to find out how...

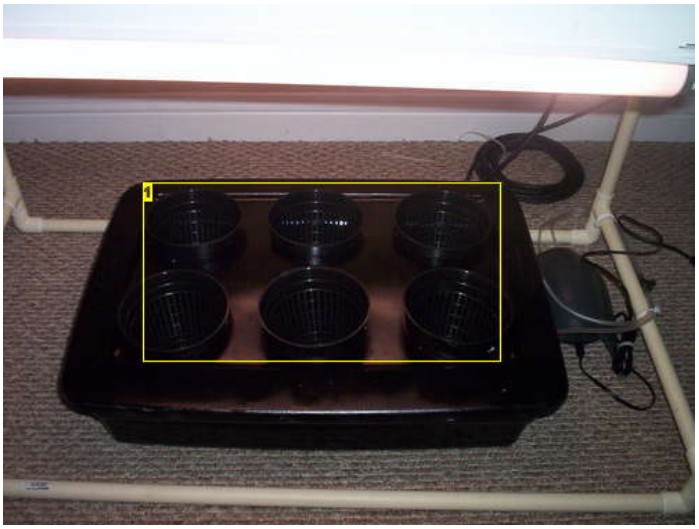


Image Notes
1. Here, in this very spot will soon rest my first crop, banana peppers!

Step 9: Germinating the Seeds

I've read a lot about how seed germiation is a complex and delicate process where only the most talented gardener can hope to have a 50% sucess rate. In my personal experience it was easy and I've almost never had a seed that did not germinate. You just need a few simple materials that are easy to obtain from any department store around spring and summer.

The main requirements are (Figure 9A and 9B):

>A humidity dome. This is basically a mini greenhouse that allows sunlight to enter and keeps moisture in. A developing seed's worst nightmare is drying out. These can be bought for pretty cheap but I've used cake domes and chicken domes before and they worked just fine.
>Rockwool cubes. It's just a piece of fibreglass-like-material with a hole in the middle. They hold in moisture well, are breatheable and allow the rootst easily grow through them. Peat pellets work great too but are not suitable for hydroponics setups.
>Some plant food. There's all sorts of fancy and expensive formulas especially for starting seeds but I just use the good ol' general purpose plant food. Just mix it with water in a spray bottle and use it whenever you water the plants.

Start by soaking the rockwool cubes in the plant food solution for a few minutes. Remove them from the solution and lay them in the bottom of the humidity dome. Drop a seed into the hole in the cube. Place the lid on the humidity dome and leave it in a sunny location indoors.

The seeds will need to be watered daily. A lot of condensation will collect on the lid of the dome. I just shake the condensation into the sink and mist the cubes a couple of times. Repeat this as long as they are inside the dome.

When roots are protruding from the bottom and sides of the cubes and they have developed a pair of secondary leaves, they are probably ready to be transfered to the hydroponics system (Figure 9C). It is now time to disinfect the nutrient reservoir and fill it with nutrient.

Image Notes
1. Clear plastic dome lets light in and traps moisture. The black bottom absorbs light and warms up the seedlings.

Image Notes
1. Plant food
2. Rockwool Cubes
3. My first crop

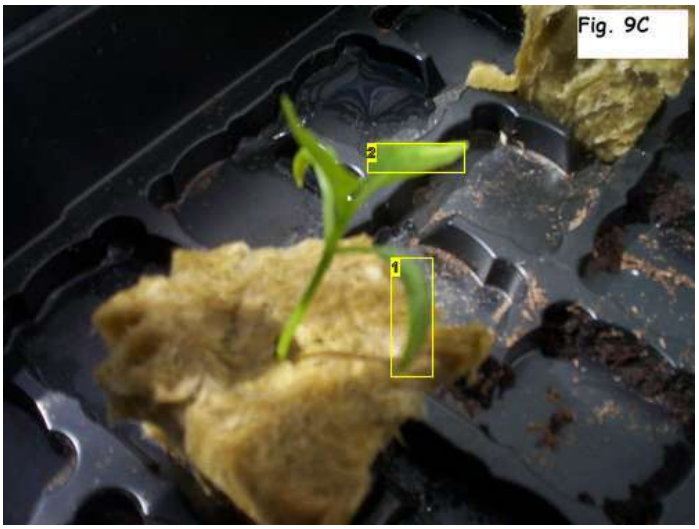


Image Notes
1. One of the primary leaves
2. One of the secondary leaves

Step 10: Disinfecting and Filling the Reservoir

The Nutrient Reservoir can become quite a utopia for all sorts of nasty microorganisms that can wreak havoc on your plants. If I've only learned one thing from my years working in microbiology labs it's that they are persistent little buggers. If you give them half a chance they will take over your entire setup in no time flat. There's no way that you can completely suppress them, but you can prevent them from flourishing with a few simple preventative measures.

First of all, the reservoir and growth medium has to be disinfected prior to use. All you need is a bathtub, some hot water and some chlorine bleach. The clay pellets a covered in dust before their first use so I rinsed them off before filling each mesh basket with them (Figure 10B). I laid all six mesh baskets in the empty reservoir and then added a generous portion of chlorine bleach. I filled the reservoir with hot water and let the whole thing sit for about an hour. Then I gave everything a quick rinse and it was ready to be filled.

The water level here is important. At first the roots probably won't be sticking out of the rockwool cubes so you should fill the reservoir up to soak the cubes directly. As the roots grow down it is necessary to lower the water level until there is a small gap between the surface of the water and the bottom of the mesh pot. The roots should have to pass through a small air space between the pot and the solution.

Now to prepare a good nutrient solution, a few skills in mathematics are required. Most hydroponics nutrients come in a very concentrated form that must be diluted before the plant can use it. The bottle should give you an amount of nutrient to mix with an amount of water (Figure 10C). As you can see the nutrient comes in three parts that must be mixed in different proportions depending on the stage of the plant's growth. The bottle only lists how much of each nutrient to mix with 100 liters of water. Since my reservoir does not hold that much I need to come up with an equation that generalizes how much I need to add to any volume of water.

Vn = (Vr/100L) x Vb
Where:
Vn = Volume of nutrient needed (ml)
Vr = Volume of water in reservoir (L)
Vb = Volume of nutrient per 100L as listed on bottle (ml/100L)

For example, when I first filled my reservoir I used 14 liters of water to accomidate my plants through the vegetative growth stage. The amount of nutrient listed on the

bottles were:
FloraGro: Vb = 396 ml/100L
FloraMicro: Vb = 264 ml/100L
FloraBloom: Vb = 132ml/100L

Therefore the volumes of nutrient I had to add to my reservoir were:
FloraGro = (14L/100L) x 396ml/100L = 55 ml
FloraMicro = (14L/100L) x 264ml/100L = 37 ml
FloraBloom = (14L/100L) x 132ml/100L = 18 ml

Of course, all of these volumes have to be measured accurately. For the water I used a measuring cup and for the nutrient I used a syringe. A pen, some paper and a calculator also comes in very handy when doing this task (Figure 10D).

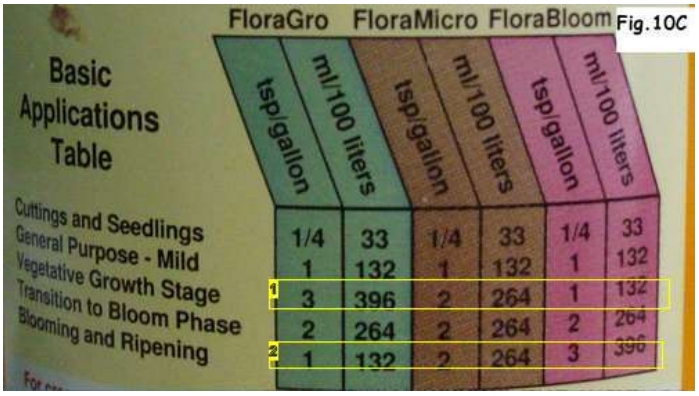


Image Notes
1. These are the volumes I have to use to grow my plants up to the point where they can produce flowers.
2. These volumes are for when the flowers are bloom and the peppers grow and ripen.

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Comments

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steveF5 says: Aug 11, 2010. 2:40 PM **REPLY**
nice instructable!, while plants are still small and their root systems have not extended far enough to reach the water, should you just water them top down from the reservoir below?

russvan says: May 8, 2010. 3:42 PM **REPLY**
ive seen that weird blue snorkel tube coming up from the bottom of the bucket in alot of DWC systems, and I cant figure out what it is!! does anyone know?

PYUS says: May 16, 2010. 10:52 AM **REPLY**
semi-transparent tube allows user to view water level inside the bucket ... which must be opaque to block light, which damages roots and stimulates algae.

russvan says: May 16, 2010. 12:24 PM **REPLY**
makes sense, thanks!

Jamezino26 says: Feb 10, 2010. 7:02 AM **REPLY**
Hey LancePenny,

Awesome instructable, however, I can't seem to download it. Everytime it tries to load it just gets stuck or quits (times out) on me after 10 mins of nothing. Maybe I should take it up with the Instructables crew rather. What say you?

Would love to look at the instructable in full.

Thanks

J

nafango22 says: Aug 11, 2008. 1:33 AM **REPLY**
banana pepper seeds. mmmhmmm, im sure.

LancePenney says: Aug 13, 2008. 7:04 AM **REPLY**
lol when they start growing I'll update with pictures and you can see for yourself!

grampa tom says: Feb 4, 2010. 6:15 PM **REPLY**
Im having trouble getting setup for your PRO membership.. I wounder if you can accept checks on line. would appricate hearing from you.. You have a nice site . keep up the good work. espically like your hydroponic s im trying to learn how to grow indoors. Thank You

Grampa Tom

g.roller says: Feb 4, 2010. 4:21 AM **REPLY**
how much did this cost you to buid?

kNeXFreek says: Jan 30, 2010. 1:52 PM **REPLY**
cool

tj the gnome says: Jan 4, 2010. 6:13 AM **REPLY**
can you include some quantities of each item? i want to get all the parts at once.

apider36439 says: Aug 10, 2008. 7:12 PM **REPLY**
why don't you just run the wires inside the pipes ????

LancePenney says: Aug 11, 2008. 4:58 AM **REPLY**
The wire is pretty stiff and it would have been very hard to feed it through all the 90 degree turns in the pipe. I suppose I could have tied some string to the wires and pulled them through the pipes but then I would have to wire it up before I glued it together. That would make the structure and the wiring ten times harder to complete.

auroraoutdoorlighting says: May 3, 2009. 9:28 AM **REPLY**

If you use stranded wire, it's much easier to feed through the pipes. Plus, you can probably go a gauge smaller since there's more surface area on stranded wire for the electrons to pass through.

bohner says: Jul 2, 2009. 8:06 PM **REPLY**

you are wrong with your calculations but within reason your lights would more likely be pulling .23 amps. The reason for that is there is alot more than one calculation you can use to calculate current draw. Because the ballast of the florescent lights you need to use another calculation but you don't have the proper testing tools to actually find the right variables. Your best way to actually find the current draw is to use an ammeter. And just because you use stranded wire DOES NOT mean it can handle more current.

littleangels says: Nov 10, 2008. 12:52 AM **REPLY**

WOW! I am completely impressed! Just starting to investigate hydroponics, you make it seem so simple! (I am sure that is a "ha-ha"). Where I live, (USA, on west coast, no sun), is in an agriculture belt, but alas, I can't even grow tomatoes...no sun, too many pine trees...So, this seems perfect! If you ever want seeds, I have been collecting organic seeds for many years, have LOTS, and am willing to share. Pumpkins, Italian Butter beans (really good), all the way to pears, apples, persimmons and tangerines. Let me know if you would like any seeds to experiment with. How would fruit trees do in hydroponics?

babybackribs says: Jun 29, 2009. 6:02 PM **REPLY**

um...i'm gonna have to say that fruit trees get way too big for hydroponics even before they are ready to bear fruit. I have just purchased 6 seedlings that are about 6 feet high and in 4 gallon planters that won't produce fruit for at least a few years until they are well established in the soil. I guess it's possible on a huge scale, but not practical.

sonhakkai says: Jun 23, 2009. 7:24 PM **REPLY**

From experience growing peppers, and tomatoes, if you remove the flowers the first time they show up, and let the roots become a bit stronger, generally speaking you get larger yields. I've also heard, but not tried, that if you remove some of the lower leaves you also get more fruit. I'm not sure how well this works, and as this is my first growing season in the area I'm in, I'm not doing much experimenting.

passerby06 says: May 21, 2009. 9:10 AM **REPLY**

Most three strand electrical wiring that I've encountered in the U.S. comes with either black/white/green strands, or black/white/bare. A cute ditty for remembering the assignment of these strands is, "Black is hot, white is not and the ground is always green." Commit that to memory and you shouldn't have any problems with messed up polarities. (You'll probably also be cursing my name for not being able to get it out of your head.) ;-) Also, with modern grounded outlets, the black/power lead attaches to the "short" slot, white/neutral attaches to the "tall" slot.

aandre says: Mar 26, 2009. 9:41 PM **REPLY**

I loved your instructable and am going to do something similar in the future with potted plants and LEDs. I only have one very important recommendation, however. That is, you should go with a lower rated fuse, something much closer to the actual power being used. I would recommend a 1A for your particular application.

LancePenney says: Apr 8, 2009. 8:43 AM **REPLY**

I put a 1A fuse in it just then. I was always particularly worried that some of the nutrient solution may somehow get in contact with the lights or wires and cause a short. Never did happen though. I only have the light frame set up right now. It's growing tomato plants in pots of soil that I'm going to put outside in the garden as soon as its warm enough. Not quite as dangerous. Thanks for the tip!

diamondice00085 says: Apr 7, 2009. 8:15 AM **REPLY**

i had a question about maintaining the solution. Obviously you would want to make sure that the PH and PPM were within specified parameters. However, on this system you would have to lift the lid to check the solution and/or remove the solution. Does lifting the lid and recycling your solution disrupt the plants at all?

LancePenney says: Apr 8, 2009. 7:38 AM **REPLY**

Before the plants were so tall that they needed support, I would remove the entire lid, plants and all, and place it on top of an identical container. Then I could carry the entire reservoir over to the bathtub to dump it out. I would fill the reservoir in the bathtub and carry it back to it's spot under the lights and then replace the plants. This did not seem to harm the plants at all. Once the plants had to be tied up to the top of the frame it became impossible to move the reservoir. After that, I would use a siphon to remove the solution. Since the reservoir was on the floor, I could only empty the solution onto the floor and mop it up as it came out. Then I would mix the solution in the identical container and siphon it into the reservoir. Lifting a corner of the lid a tiny bit to collect a sample for pH and ppm measurement or to insert a siphon did not disrupt the plants but changing the solution was very cumbersome. This is part of the reason I don't recommend building one of these for larger plants like peppers. I would suggest using a setup like this only for things like herbs, lettuce, cabbage, celery, spinach and the like.

orisj says: Apr 8, 2009. 3:05 AM **REPLY**

What a well put together instructable! And very complete. Good job!

2cardGUTZ says: Apr 2, 2009. 1:23 PM **REPLY**

its called mylar, reflects 95% of light, use it. believe it or not aluminum foil @ 50% and yes flat white is a better option better than foil

manofadventure says: Mar 7, 2009. 9:28 PM **REPLY**

Nice! I might build one of these in a different country!:-)

SixTwelve says: Jan 19, 2009. 2:18 AM **REPLY**

I really enjoyed the article. I'd like to share one project suggestion and one article suggestion. Project: Instead of painting the reservoir lid white, you might consider aluminum foil. Spray tack doesn't cost any more than paint, and for that matter flour paste would likely bond foil to the plastic irretrievably, and practically for free. Article: I understand you recommended an understanding of Ohm's law. The thing is, laypersons tend to over-estimate their safety in this area. I only point this out because a 50% safety barrier is generally considered minimum in the industry. You did this and more with your example wiring; I would suggest spelling that out, though. Thanks for an entertaining and informative read!

AsianSpanker says: Feb 28, 2009. 7:32 PM **REPLY**

I read somewhere that flat white reflected back as much light as aluminum foil. Or that the difference was so small that it was not worth doing expensive reflector systems. But that was 10 years ago. We be some more smarter now.

sensoryhouse says: Feb 17, 2009. 12:30 AM **REPLY**

Congrats! Your IP has just been traced by the DEA.....Yay!

AsianSpanker says: Feb 28, 2009. 7:27 PM **REPLY**

Yes, those banana peppers look extremely addictive. Good that you have such a keen eye! LOL

twhaley says: Feb 23, 2009. 12:42 PM **REPLY**

Tune in next week for : "Build your own meth-lab" ;)

LancePenney says: Feb 17, 2009. 5:30 AM **REPLY**

Well I'm in Canada so the DEA can just f**k off! Besides, weed is basicly legalized here anyways.

twhaley says: Feb 19, 2009. 7:08 AM **REPLY**

A long time ago I made something like this with my roomate at college.

obstructio says: Feb 21, 2009. 6:30 PM **REPLY**

Probably weren't growing banana peppers though, were you?

testoffer says: Feb 19, 2009. 2:30 PM **REPLY**

There is a much cheaper solution to the reflective tape to prevent root rot (if indeed that is what's happening). Use a piece of an Emergency Solar Blanket (space blanket, Mylar blanket). You can get one for under two bucks. They are 84" by 52". Cut a strip big enough for the bottom and then cut some slits from the edges so you can get it round the stems/trunks of the plants. Also, you are wasting at least half the light from each of the two outer bulbs. Someone alluded to this earlier. Get a second space blanket and use the rest of the first one to make a curtain that goes around the lighting frame. This curtain along with the piece at the bottom will reflect most of the light output of the bulbs back toward the plants. This will effectively double the efficiency of the bulbs (even better if you use the T8s). Also, for the hand pollinating you can use a small, natural fiber, arts and craft paintbrush (round with a flat bottom). Use a twirling motion from stamen to pistil.

LancePenney says: Feb 19, 2009. 5:31 PM **REPLY**

Hey, The idea for the emergency blankets on the reservoir is a good one but I've been already using them to cover the system most of the time. I just removed it to take the pictures. I'll put a couple pictures of that up on the intro page in just a minute.

kd1s says: Feb 19, 2009. 2:55 PM **REPLY**

I have to build this. The electricity usage is pretty low and having fresh veggies and other items throughout winter would be nice. I understand plant nutrition so there isn't a barrier there.

dalecarlile says: Feb 19, 2009. 11:11 AM **REPLY**

I spent several years as a kid working in commercial greenhouses. Their Hydo system was a system of galvanized metal boxes running along the walls of a greenhouse. These boxes were about one foot wide by one and a half feet deep by eight feet long. They were mounted on a slight slope, about one inch difference between the box ends. The low end had a hole in it about one inch from the top of the end. Each box had one below it that the solution fell into. The two foot drop into the next box was the aeration. They used pea gravel for the rocks. The reservoir was an open metal tank too. It ran about fifty feet along under the growing trays. It was open and had a pump at one end to lift the solution back up to the first box. They used fish base fertilizer and let the algae grow. Monthly the solution was drained out onto the greenhouse soil where they grew flowers for florists. Fish base smells, but worked great. No root rot problems either. They grew most vegetable crops including beets and carrots. Potatoes did not work well though. They had a net that hung beside the boxes to keep the plants upright. Lighting was played with to extend the growning season to year around and they settled on some high pressure bulbs with a yellowish light after a lot of experimenting. I know this is too large for a home, but it might work for those with a small greenhouse.

Veyron says: Feb 18, 2009. 2:54 PM **REPLY**
About how long did it take from germinated seed to fruit bearing plant?

LancePenney says: Feb 19, 2009. 9:05 AM **REPLY**
About four months. I believe it was relatively slow because the T12 fluorescent lights have a pretty low output. If anyone tries to make something like this I recommend using T8 bulbs and fixtures.

Darrone says: Jan 31, 2009. 8:48 AM **REPLY**
One suggestion on your root rot: You have an oxygen rich environment, with nutrients, there is only 1 addition element for bacteria or "root rot" to grow, and that is light. Although you cannot see it, and the black color helps, light is still entering that container you have. You're best bet for blocking out light is to wrap the reservoir with reflective tape, its somewhat expensive at about 7 dollars a roll at most hardware stores, but its worth it. It will completely block any light from passing through, and prevent root rot in the long run.

LancePenney says: Jan 31, 2009. 2:17 PM **REPLY**
Thanks for the tip, I'll probably try it out next time. However, I was also thinking that the roots may not be rotting but are instead being dyed by the nutrient solution itself. The solution is an orange/brown color and since the roots are in constant contact with it and channel it up to the shoot system, it might have just taken on the same color. I forgot to mention that in the instructable. Root rot is commonly associated with weak, slimy roots and unhealthy plants. I found the roots to be very strong and these plants were the healthiest I've ever seen.

Darrone says: Jan 31, 2009. 3:08 PM **REPLY**
I agree that they look like strong healthy roots, and if it is a case of root rot, its minor. However, i use a similar nutrient solution, its creates a redish orange tint in the water, and my roots are still a strong slight yellow/white color, and never deviate. I've found even tiny light leaks will allow bacteria to grow in your reservoir. If you feel there is some root rot going on in there, try adding a few ml of hydrogen peroxide. this will kill almost all bacteria and not hurt your roots.

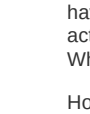
hapyman says: Feb 19, 2009. 8:46 AM **REPLY**
I was thinking Hydrogen Peroxide as well. Trace amounts of it are created in the atmosphere and falls to earth during a nice rain. It should also be good if your pH is getting too high.

Punkindoogurl says: Feb 19, 2009. 6:36 AM **REPLY**
oh, you built a sophisticated hydroponics system to grow banana peppers? mhm yeah sure. pretty cool though

deepcore says: Feb 18, 2009. 2:08 AM **REPLY**
Consumption of nutrients? When to change/add to solution?
I have a similar, but smaller system in my office designed to keep my office plants alive, eliminating the need for watering them.

I do however wonder: How to figure out when to add new nutrients to the solution or change the water. I only have 6 plants, but don't really know when they have used up all their nutrients - and i have not been able to find a way of measuring it? I usually just add some more when "I feel it is time" but I don't actually have any basis for making the assumption.
What do you guys do?

How do you figure out when to add more solution?
Is it better to entirely change the solution? (which i gather would be rather costly if it was a big system)



LancePenney says: Feb 18, 2009. 6:06 AM **REPLY**
The two main things you want to watch for in your nutrient solution is the pH and the ppm. The pH refers to the concentration of H3O+ / OH- ions in your solution on a logarithmic scale. The ppm refers to the concentration of other dissolved ions such as potassium, nitrogen and phosphorous in parts-per-million. You can buy a special electrode that you can dip in the solution and it will give you a readout of these two numbers. It looks a lot like a pen. It can cost up to $200 though. Every different plant has its own range of pH values that they grow best in. You should do your own research to see what your own plants need. Generally, the pH of a hydroponics nutrient solution tends to go down over time (gets more acidic). Periodically, you can adjust the pH by adding some "pH down" (usually dilute hydrochloric acid) or "pH up" (usually dilute potassium hydroxide), both chemicals available at any hydroponics store. The ppm of the solution tends to do down over time as well. you can bring it back up to optimal levels by adding more nutrient to your solution. Keep in mind that while the plants are absorbing the nutrient solution, they are also dumping metabolic waste products into it. If you leave the solution too long the waste can rise to toxic levels and kill the plants. It's time to flush the system and start with fresh solution before that happens. I recommend a change every week but you might even make it up to two weeks. It depends on the size of the reservoir and the size/number of plants. Hope that helps!

conrad2468 says: Feb 16, 2009. 8:21 PM **REPLY**
1. 2. 3. WEED!

SinAmos says: Feb 15, 2009. 2:11 PM **REPLY**
You are on page with me. Thanks for sharing.

Holden_vy_s says:
IMA GO GROW ME SUM WACKY TABACKY Good ible though

Feb 14, 2009. 11:25 PM **REPLY**

view all 77 comments