Hydroponics For Beginners

Leafy Greens & Herbs

What is Hydroponics?

Hydroponics is a method of growing plants in soilless cultivation. The plant nutrients normally derived from the soil are simply dissolved into water and taken up by roots suspended in the soilless medium or net cups.

Benefits of Hydroponics

⇒ You can grow a crop anytime. All year production.

⇒ Rapid plant growth and short crop cycles (faster than in the soil).

⇒ Greater yield.

⇒ Uses less water.

⇒ Greater control over production - nutrients, light, oxygen, temperature.

⇒ A way to avoid soil-borne pathogens or insects.

⇒ Allows crop production where there is poor soil or contaminated soil.

Hydroponics Drawbacks

⇒ High energy use.

⇒ No power = no water. Crops can wilt quickly.

⇒ Higher investment: more cost associated with setup.

⇒ Can require more management.

⇒ Limited crops can be grown in hydroponics.

Considerations for Hydroponics

Water: Quality water is needed for healthy plants. Test the water source. There are laboratories that can help assess the suitability of water for irrigation.

Light: The amount of light required varies. Fruiting crops need more light than leafy greens and herbs. In hydroponics, artificial light is needed: fluorescent or LED. A timer can be used to operate lights 16 to 24 hours a day.

Temperature: Cool-season plants such as lettuce and greens generally require 65 to 70° F. Herbs require 10° F higher.

Air: Roots need oxygen to thrive and it is achieved by aerating the nutrient solution.

Nutrients: Plants grown hydroponically must get all nutrients and minerals from the nutrient solution. Focus on Primary macronutrients: nitrogen (N), phosphorus (P), potassium (K) and secondary macronutrients: calcium (Ca), magnesium (Mg), sulfur (S).

pH and EC: Must be tested and recorded daily.

⇒ pH: How acidic or basic a nutrient solution is or the concentration of H+ ions. Each crop will have a preferred pH range so it is important to have a correct pH. Incorrect pH blocks nutrients from being absorbed by the plants.

⇒ EC (electrical conductivity): Concentration of nutrients in the solution (mS/cm). This can be used as an indirect indicator of nutrients dissolved and can be measured to make sure the fertilizers are mixed accurately.

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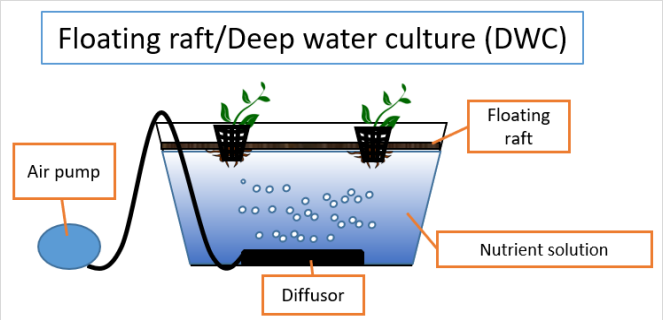
Home Hydroponic Growing Systems

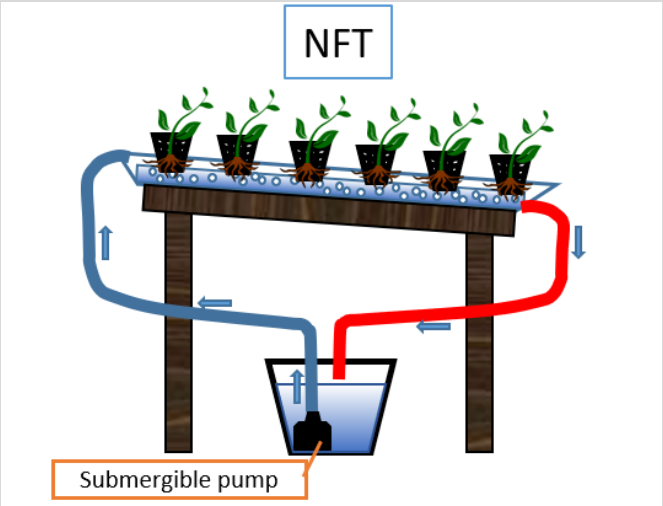
Floating Raft or Deep Water Culture (DWC): A passive system where the roots are saturated in water. Seedlings are started in soil-less media and transplanted into net pots supported by rafts. This is low cost and low maintenance. Great for leafy greens and herbs. Aeration is needed in the water by an air pump.

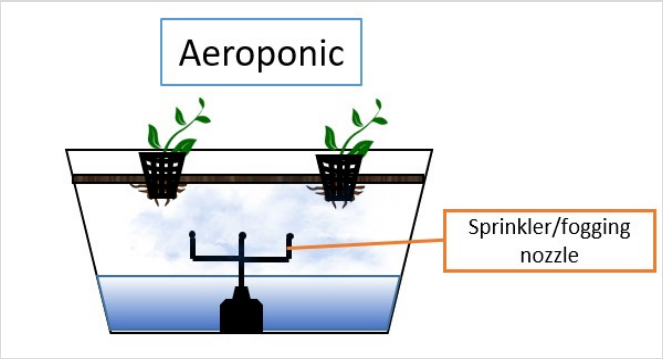
Nutrient Film Technique (NFT): An active hydroponic system with a reservoir and a submersible pump that moves the nutrient solution into a channel, tray or trough where the roots are suspended. Seedlings are started in soil-less media and transplanted into net pots supported in the sloped tray (1 to 2% slope or 1/8th of an inch over one foot) so the nutrient solution runs over the roots and back into the reservoir which oxygenated the water. Nutrients flow over roots up to 24 hours a day. Any long period of interruption in the nutrient flow can cause the roots to dry out and the plants to suffer. Needs a submergible pump.

Aeroponics: An active growing system for leafy greens, herbs and strawberries. No need for aeration. Root of the plants are sprayed with misting water droplets. Requires less water than NFT and DWC. Requires good water quality to prevent clogging misting jets. Plants can wilt immediately if the pump fails or emitters clog. Needs a submergible pump.

Types of Hydroponic Systems







Images created by Juan Cabrera

System Preparation before transplant:

⇒ Clean debris from previous crop (if used)

⇒ Waterproof electrical outlets or power strips

⇒ Quality lights

⇒ Inspect system for leaks and broken parts by doing a test run before planting medium and plants are added to the system (image to the right)

⇒ Make sure all meters and materials are in stock:

- Fertilizers, acid and base for adjusting pH
- Conductivity and pH meters with calibrating solutions
- Air pump with diffusers or submergible pumps

Test run equipment to look for leaks before adding plants.

Growing Medium Options

There are several options for growing mediums in hydroponics. Selection of a growing medium depends on the type of plant, pH of irrigation water, cost and the type of systems being used. The three mediums below are preformed materials for lettuces, greens, and herbs.

Growing Mediums	Cost	Notes	pH	Image
Rockwool: Stone wool from basalt (lava rock), heated to 1,500°C, spun into threads, and cooled. Varying sizes to accommodate plant size/stage.	Medium	Not Reusable Not Compostable	Basic	
Oasis cubes: A synthetic material for starting seeds. Seeds can be planted into a preformed divot.	Medium	Polyurethane Not reusable Not compostable	Neutral	
Peat Pellet: Compressed peat in pellet form that absorbs water and increases in size. Seeds can be planted into a preformed divot.	Low	Not reusable Compostable	Acidic	

How to Use Growing Mediums:

Seeds are directly sown in divots or holes that are preformed in the materials. Seedlings are allowed to germinate in high humidity conditions. Once seedlings have been allowed to grow to true leaf stage (for approximately for 2 weeks), seedling can be transferred to net cups similar to what is show at the right. Net pots are then placed into the hydroponic systems.

Crop Timeline for Lettuce, Various Greens and Herbs

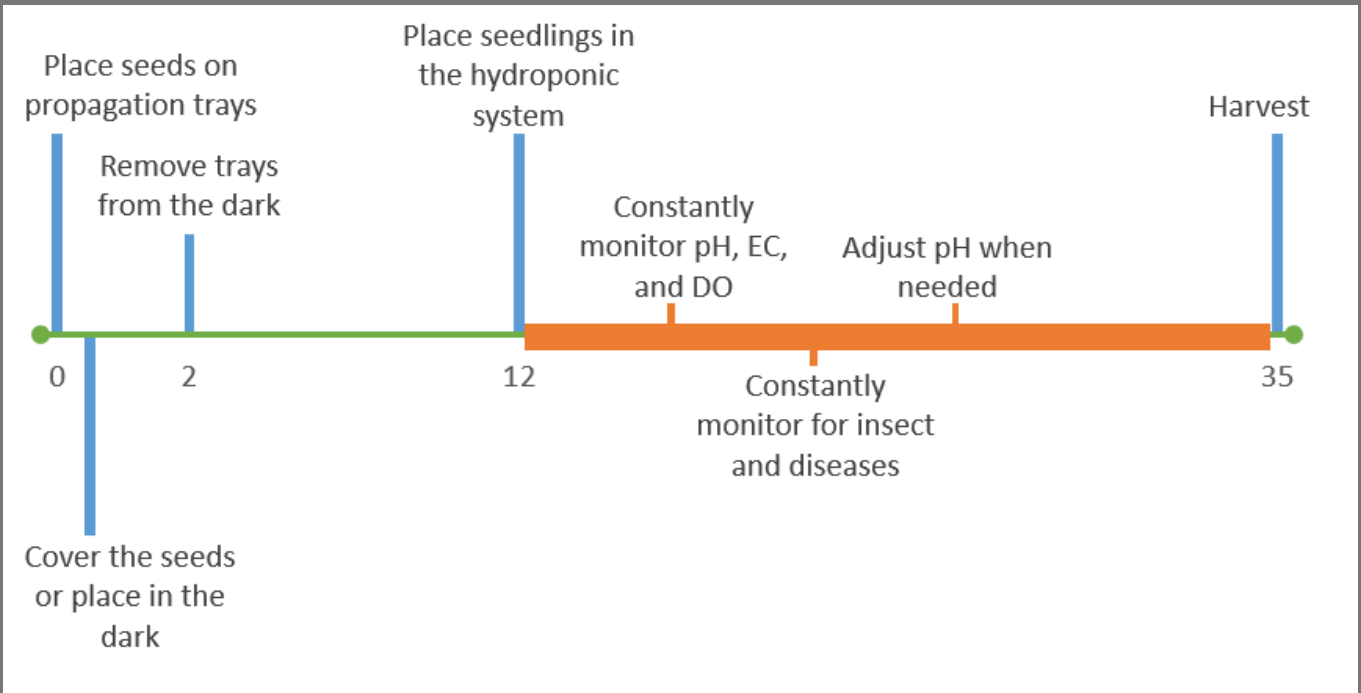
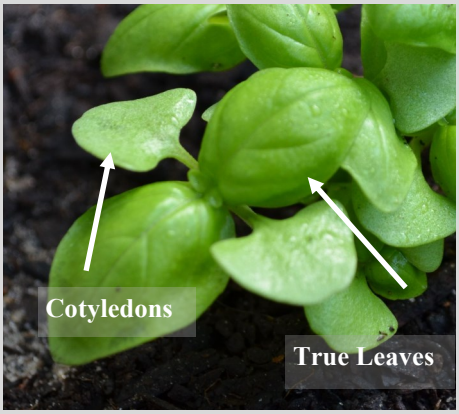


Chart created by Juan Cabrera

Starting Seedlings for Hydroponic Systems

1. Choose desired varieties (preferably bred, selected and trialed in hydroponic systems.
2. Choose your medium. Saturate the media with water without fertilizer.
3. Place the seeds on the media. Close media over seeds if possible. Place in a leakproof tray.
4. Keep seeds moist with plain water.
5. Cover the seeds for 24 to 48 hours with a plastic dome to keep humidity high (or place in a dark room) for germination.
6. Maintain optimal temperature for germination based on crop.
7. Once seedlings start to emerge, remove the cover and place seeds under lights and keep them moist using a 75 ppm N nutrient solution.
8. Seedlings will be ready when the first pair of true leaves. are fully expanded. About 2 weeks after germinating.
9. Place the seedling in the system (in net pots)

Seed placed in divots in rock wool (top) and peat pellets (bottom).



Two smaller leaves are cotyledons and the larger leaves are true leaves.

Nutrient Solution for Lettuce, Various Greens and Herbs

Sample Fertilizer for Lettuce and other Various Greens

⇒ For every 10 gallons add
- 1.34 oz (40 grams) of 5-12-26 fertilizer
- 0.87 oz (25 grams) of 15.5-0-0 fertilizer

⇒ Dilute the fertilizers separately each in 5 gallons then combine the dissolved fertilizers

⇒ Measure pH and EC

⇒ Adjust the pH between 5.5 to 6.0 (depending on the crop)

Element	Required ppm	Provided by fertilizers
Total N	150	150.75
P	31	110
K	210	260
Ca	90	123.5
Mg	24	31
S	0	40
B	0.16	0.5
Cu	0.02	0.15
Fe	1	3
Mn	0.25	0.5
Mo	0.02	0.1
Zn	0.13	0.15

Checking EC (Electrical Conductivity)

1. Fill the nutrient tank with tap water and add fertilizer. Based fertilizer rate on manufacturer recommendation.
2. Calibrate the EC meter probe using the buffer solution.
3. Stir the nutrient solution and allow the reading to stabilize which may take a few minutes.
4. Take the EC reading. If the reading is higher than the optimum level for the crop, dilute the solution by adding more water. Repeat testing in step 3.
5. If the reading is below the optimum level, add fertilizer concentrate until the optimum level is reached by testing on step 3.
6. After optimum reading is reached, rinse the probe in tap water and

Meters from Hannah Instruments test for pH and EC in one unit. No endorsement is implied. Used only for example.

Checking pH

1. Check and adjust the proper EC value for the crop.
2. Calibrate the pH meter probe using the buffer solution.
3. Stir the nutrient solution and allow the reading to stabilize which may take a few minutes.
4. Take the pH reading. If the reading is higher than the optimum level for the crop, add phosphoric acid, citric acid, vinegar or pH down products slowly. Repeat testing.
5. If the reading is below the optimum level, add potassium hydroxide, potassium carbonate or a pH up product slowly. Repeat testing.
6. After optimum reading is reached, rinse the probe in tap water and store in probe-cleaning fluid.

Putting It All Together...

1. Determine the hydroponic system desired.
2. Test water quality.
2. Determine the desired crop(s) for the hydroponic system.
3. Start seeds.
4. Determine Nutrient requirements for desired crop and calculate fertilizer for nutrient solution.
5. Prepare nutrient solution.
6. Do you need aeration of some type? (if a submersible pump will not be used.)
7. Measure and adjust pH of nutrient solution
8. Measure EC.
9. Place seedlings into unit the into nutrient solution.
10. Adjust lighting over plants.
11. Check pH and EC of the nutrient solution regularly (daily).

Homemade NFT system for greens and herbs. Two runs of 4 inch PVC capable of 7 plants each. This system has a 800 GPH submergible pump that recirculated the nutrient solution throughout the system. Nutrient solution is stored in the grey can. Large PVC pipes at 1% slope help the nutrient solution return back to the reservoir.

Resources:

- Water Analysis, University of Missouri Extension https://extension.missouri.edu/programs/soil-and-plant-testing-laboratory/spl-water-analysis
- *Hydroponics*, Oklahoma Cooperative Extension Service https://extension.okstate.edu/fact-sheets/hydroponics.html
- *Electrical Conductivity and pH Guide for Hydroponics*, Oklahoma State University https://extension.okstate.edu/fact-sheets/electrical-conductivity-and-ph-guide-for-hydroponics.html
- *Hydroponics Systems: Nutrient Solution Programs and Recipes*, PennState Extension https://extension.psu.edu/hydroponics-systems-nutrient-solution-programs-and-recipes
- *Home Hydroponics*, Illinois Extension https://extension.illinois.edu/sites/default/files/illinois_extension_hydroponics_handouts.pdf
- *Homegrown: DIY Hydroponics for All Gardeners*, University of Illinois, https://extension.illinois.edu/blogs/know-how-know-more/2020-02-18-homegrown-diy-hydroponics-all-gardeners
- *Set it and Forget it Hydroponics*, University of Florida, https://blogs.ifas.ufl.edu/orangeco/2020/04/09/set-it-and-forget-it-hydroponics/

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