The Wheel Garden

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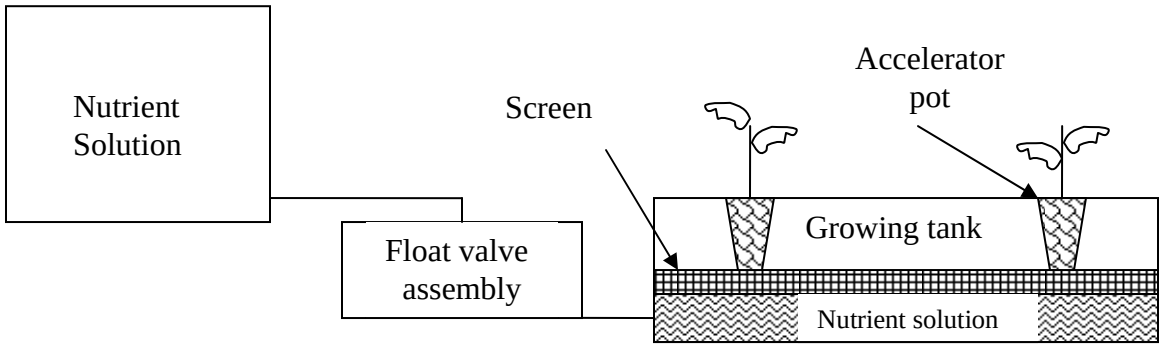
A commercial garment rack has been modified into a 'Wheel Garden' wherein 5 different crops are being grown by 4 different growing methods.

Nutrient stock solutions. Concentrated fertilizer stock solutions were prepared by adding 1 lb Hydro-Gardens Chem-Gro 8-15-36 hydroponic fertilizer plus 0.6 lb of magnesium sulfate to water so the final volume was 1 gallon (**Stock Solution A**) and 1 lb of soluble grade calcium nitrate to water so the final volume was 1 gallon (**Stock Solution B**). The recommended amounts of the stock solutions to be added are discussed for each growing method.

Growing Tomatoes by a Sub-irrigation System

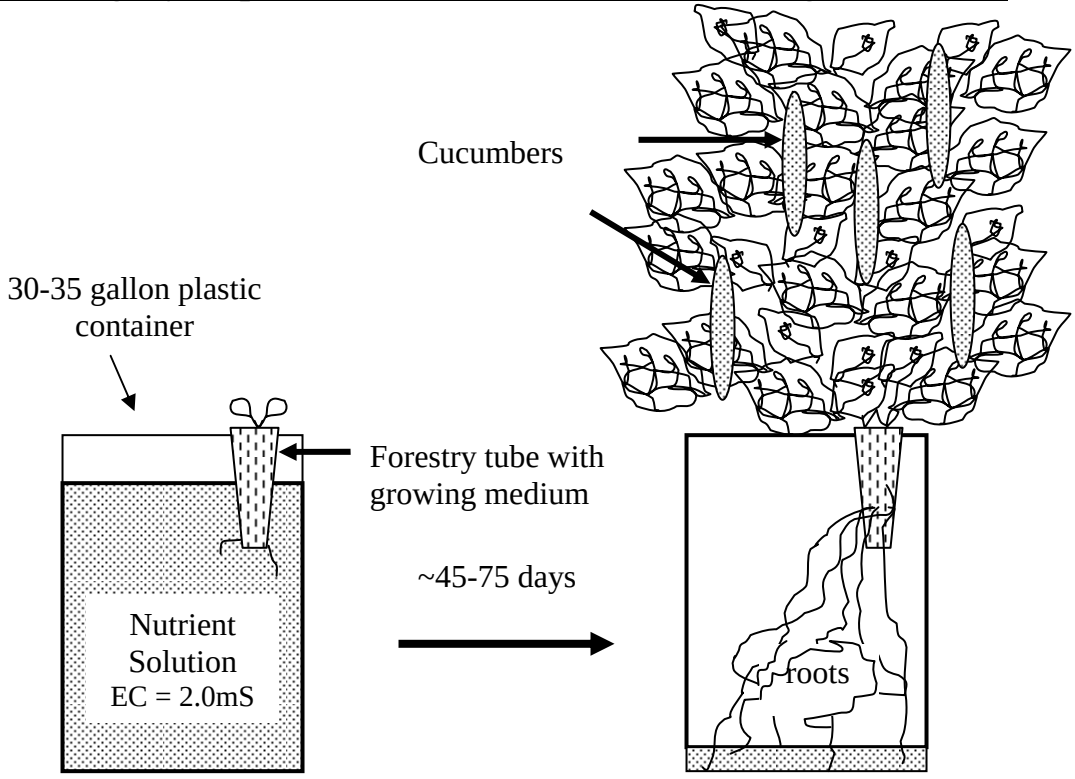


Nutrient solution flows by gravity from a storage tank to a float valve assembly which is set to maintain a 2-inch liquid depth inside of a plastic ice cube tray. A small hole is made near the bottom of the nutrient solution container with a punch and a 3/16-inch polyethylene tube is inserted; no fittings are needed. The tubing is routed to the supply line of the float valve. A hole is punched near the bottom of the ice cube tray and a 3/16-inch polyethylene tubing is inserted; the other end is inserted into the lower portion of the growing container.

A growing container consists of a 23" x 16" x 5" plastic storage container with holes in the lid for 4 accelerator pots (3 ¼ inches diameter x 4 inches deep). The container is covered to exclude light and this will deter algae growth. A screen at the bottom of the accelerator pots provides the roots with an attachment surface and causes more aggressive root growth. The bottom of the growing container should be at the same level as the bottom of the float valve assembly so that 2 inches of nutrient solution will flow into the growing container. A float indicator will display the liquid level. Roots may plug the 3/16 inch polyethylene supply tubing and restrict the supply of nutrient solution. If this happens, the grower needs to manually clean the tube with a tweezers or wire. Good water quality is required for this growing method, because salts may concentrate as the nutrient solution is consumed and this could retard growth. Insect and foliage disease problems will likely be similar to field-grown crops.

Excessive vegetative growth occurs when plants receive too much fertilizer early in their growing period. The following fertilization schedule is recommended:
Transplanting until first fruit set: 10 ml (2 teaspoons or 1/3 oz) of **Stock Solution A** plus 10 ml (2 teaspoons or 1/3 oz) of **Stock Solution B** per gallon of water. The resultant nutrient solution EC (electrical conductivity) should be about 1.0 mS.
After first fruit set: 20 ml (1.33 tablespoons or 2/3 ounce) of **Stock Solution A** plus 20 ml (1.33 tablespoons or 2/3 ounce) of **Stock Solution B** per gallon of water. The resultant nutrient solution EC (electrical conductivity) should be about 2.0 mS.

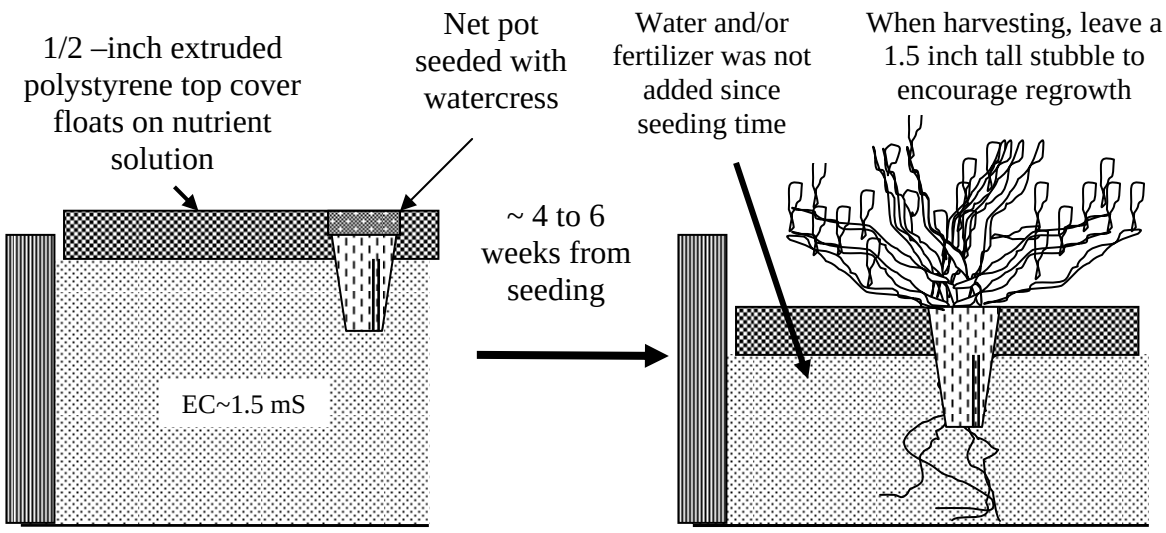
Growing Hydroponic Cucumbers in a Plastic Storage Container



Cucumbers may be grown in a large plastic trash or storage container (30 – 35 gallons) by a simple non-circulating hydroponic method that does not require electricity or a pump. The container is filled with nutrient solution which consists of 20 ml (1.33 tablespoons or 2/3 ounce) of **Stock Solution A** plus 20 ml (1.33 tablespoons or 2/3 ounce) of **Stock Solution B** per gallon of water. The EC of the growing solution should be about 2.0 mS. The lid is placed on the container. Cut a 1.5 inch diameter hole (with a hole saw) in the container lid. Drill 6 or more holes (1/4 inch diameter) in the sides of a forestry tube. This will allow the roots to emerge from both the bottom and the sides of the forestry tube. Fill the forestry tube with growing medium. Tap the tube to help settle the growing medium, but do not pack too tightly. Only one or two forestry tubes are needed for each growing container. Plant 1 cucumber seed in a ½-inch deep hole and cover it lightly with growing medium. If the growing medium is dry, slowly add a teaspoon of water. The seed should germinate in 2-5 days. If the seed does not germinate, you may have poor quality seed. Heat and high humidity destroy seed viability, so keep seed in the refrigerator from the time it is purchased. The forestry tube should fit snugly in the container lid. This will help to prevent mosquitoes from entering the growing container which could then become a breeding ground. The lower 1 to 3 inches of the forestry tube should be immersed in the nutrient solution. A small amount of growing medium may fall into the nutrient solution. That's normal. The nutrient solution level will recede as the plant grows. Plants prefer that the nutrient solution level remains the same or lowers as the plants grow, but cucumbers can tolerate adding 1 inch of nutrient solution when the container is ¾ empty. After the roots have emerged from the forestry tube, do not pull the forestry tube from the lid or else the roots will be damaged.

Harvest the cucumbers when they are ready. First harvest is generally about 45 days from seeding. The crop will be terminated when most of the nutrient solution is consumed or when insect and/or disease pressure becomes excessive (usually after about 1 month of harvesting). Aim for a yield of about 5 lbs per plant. Upon termination of the crop, empty the remaining nutrient solution on some bushes or trees in the yard. Remove the root mass from the trash container and wash the container. Remove the growing medium from the forestry tube and wash the forestry tube. Then start the next crop.

Watercress Growing System



The growing tanks are filled with nutrient solution by adding 15 ml (1 tablespoon or ½ oz) of **Stock Solution A** and 15 ml (1 tablespoon or ½ oz) of **Stock Solution B** to each gallon of water. Holes for 2-inch net pots are cut in a ½ inch-thick Styrofoam extruded polystyrene board which is placed in the tank and floats on the nutrient solution. The net pots were filled with a peat-perlite growing medium such as Sunshine #1 and they are supported by the floating Styrofoam boards. The lower 1.5 inches of the net pots are immersed in the nutrient solution. This moistens the growing medium in the containers by capillary action, thus automatically watering and fertilizing the plants.

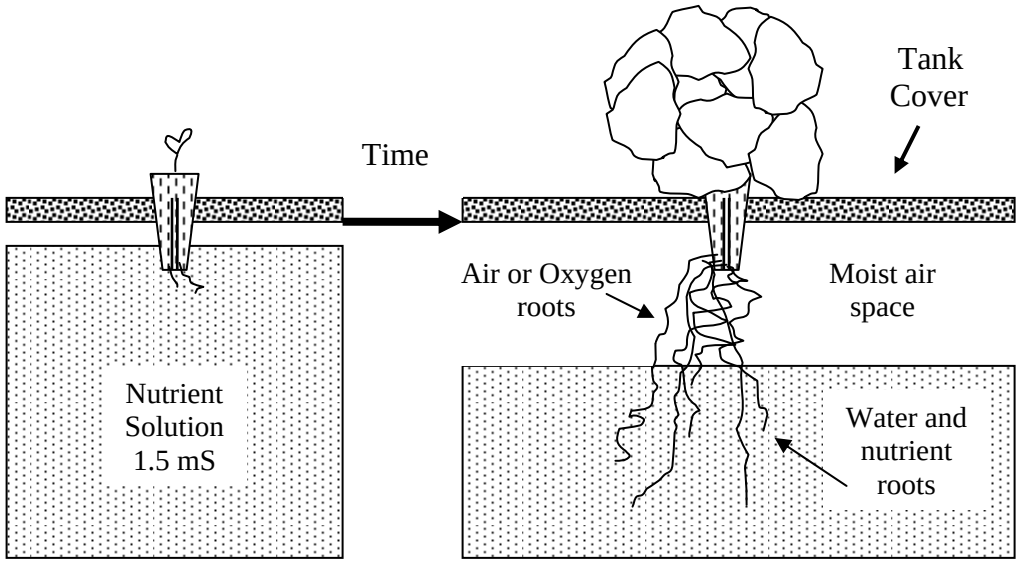
Approximately 10-20 watercress seeds were planted per 2-inch net pot. Seeds may be sown on the surface of the growing medium in the net pot. They are not covered. A shaker-type tube seeder consists of a plastic tube with a 5/64-inch hole drilled in the cap. *There are 4631 watercress seeds/gram = 2,102,247 seeds/lb.* Watercress seed (*Nasturtium officinale*) is available from Johnny's Seed Co. (1-877-564-6697) and Stokes Seed Co. (www. Stokeseeds.com).

Seeds usually germinate within 3 days. Watercress plants continue to grow for 4 to 6 weeks without any attention. The tank should be filled with water prior to harvesting, because the nutrient solution level drops during the growing period. Watercress is harvested by cutting with a scissors or similar tool - preferably in the morning or evening. Leave a 1.5-inch high stubble to encourage ratoon regrowth. After harvesting, fertilizer is added from **Stock Solutions A** and **B** based upon the number of gallons of water added to the tank. After 3 to 4 more weeks, a ratoon crop of watercress may be harvested. Then, the tank is drained, the net pots are emptied and cleaned, and the whole growing process is repeated.

Mosquitoes can breed and multiply in nutrient solution which is not circulated or aerated and become both a health menace as well as a nuisance to workers. Mosquito control methods include salt-tolerant fish in the tanks, specifically approved *Bacillus thuringiensis subspecies israelensis* toxins or by pesticides in the air or nutrient solution which are labeled for watercress. Cool air temperatures or dry, windy conditions discourage mosquito populations.

Insect problems should be similar to field-grown watercress. However, this hydroponic system allows a grower to completely shut down, and this disrupts insect populations.

Suspended Pot Method for Growing Lettuce and Kale



A tank was filled with nutrient solution by adding 15 ml (1 tablespoon or ½ oz) of **Stock Solution A** and 15 ml (1 tablespoon or ½ oz) of **Stock Solution B** to each gallon of water. *The tank should be large enough to hold 1 to 2 gal of nutrient solution per plant so that it will not be necessary to add any more nutrient solution for the duration of the crop.* The tank was covered with 1-inch-thick expanded polystyrene beadboard. Lettuce and kale were seeded in net pots containing growing medium. The net pots are supported by the tank cover such that their lower portions are initially immersed in nutrient solution.

Plants are automatically watered, because the growing medium in the net pot becomes moistened by capillary action. Plant growth causes the nutrient solution level to decrease, and this creates an expanding moist air space between the tank cover and the nutrient solution. At some point, the liquid level drops below the net pots and direct capillary wetting of the growing medium is no longer possible. However, the expanding root system is capable of absorbing nutrient solution from the tank. Roots occupying the moist air space above the solution have been described as *oxygen roots* whose main function is aeration; these roots experience vigorous lateral and branching growth. Roots extending into the nutrient solution are considered to be *water and nutrient roots* that have limited elongation capabilities, because the oxygen content of the nutrient solution becomes progressively lower with depth. The nutrient solution level may remain the same or be lowered, but it should not be raised because submerging the oxygen roots will cause the plant to 'drown'. Therefore, the tanks should be sheltered from rain. Prolonged overcast weather followed by a hot, sunny day causes severe wilting of plants, but they normally recover by late afternoon.

After harvesting, the tank is drained and the growing process is repeated.

Mosquitoes can breed and multiply in the nutrient solution and become both a health menace as well as a nuisance. Mosquito control methods include salt-tolerant fish in the tanks, specifically approved *Bacillus thuringiensis subspecies israelensis* toxins or by pesticides in the air or nutrient solution which are labeled for the crops. Cool air temperatures or dry, windy conditions discourage mosquito populations.