University of Nevada Cooperative Extension

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Hydroponics: A Brief Guide to Growing Food Without Soil

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What is hydroponics?

Hydroponics comes from the Greek word "hydro," meaning water, and "ponos," meaning labor. In other words, hydroponics is gardening without soil. Growing food in a desert can be difficult because of extreme temperatures, low natural precipitation and limited arable soil. Hydroponics can be a viable option to reliably grow fruits, vegetables and herbs, regardless of climate, soil availability or space.

Advantages of hydroponics

- Plants can be grown anywhere year-round.
- Greater control over growing conditions for increased crop yields and faster growing time.
- No weeding required.
- Saves water, up to 90 percent.
- No need for crop rotation.
- Plants can be spaced close together and stacked vertically.
- Materials can be reused.

Limitations of hydroponics

- Higher start-up costs compared to soil growing systems.
- Diseases, when present, can spread easily.
- Requires some basic skills and knowledge to maintain.

Growing crops hydroponically

Hydroponic produce can be grown in a home, apartment, greenhouse or office space. The six things needed are light, air, water, nutrients, heat and space.

Hydroponic growing can be done indoors or outdoors. In either setting, plants will need five to six hours of light per day, access to electricity and an area that is level and without excessive wind. Optimal temperature depends on the plant type and variety.

Hydroponic growing systems

Hydroponic systems can be classified as either water-culture or medium-culture. Water culture systems do not use a medium to support the roots, only the nutrient solution. Medium culture systems use a solid substrate, such as sand, to support the plant root structure. Systems can be either open or closed. In an open system, the nutrient solution flows past the roots, and the solution is not recycled. In a closed system, the surplus nutrient solution is recovered, recharged and recycled through the system.

Water-culture systems use one of the following three methods:

- Nutrient film technique (NFT): Plant roots are placed in a small-diameter PVC tube or trough, and the nutrient solution flows across the roots forming a nutrient-dense film of water around them. NFT systems can be open or closed.
- Raft or floating system: Plants are supported by sheets of Styrofoam floated on aerated nutrient solution. The roots hang through small holes in the Styrofoam and are suspended in the solution. Raft systems are closed, and the nutrient solution must be frequently monitored and adjusted.
- Aeroponics: Plants are placed in a supporting container; the roots are suspended in air. The roots are misted with nutrient solution rather than being immersed in it. Aeroponic systems can be open or closed.

Medium-culture systems use one of the following methods:

- Ebb-and-flow system: Nutrient solution is pumped from a reservoir into the grow bed, flooding the medium. Nutrient solution drains back to the reservoir by gravity. This is an example of a closed system, in which the nutrient solution is recycled.
- Drip system: Nutrient solution is provided to plants, supported in a solid medium, by drip irrigation. Modifications of this system have resulted in various commercial applications, such as the tower garden, in which plants are supported in a vertical PVC pipe by a porous medium. Nutrient solution is applied from the top of the pipe by a drip emitter. Nutrient solution can be either recycled (closed) or discarded (open).
- Subirrigation system: Plants are grown in a porous medium. Nutrient solution is transported to the roots by high capillary action.

Media selection for medium-culture systems

The hydroponic medium must provide oxygen, water, nutrients and support for the plant. Medium moisture retention is determined by its particle size, shape and porosity. Popular choices for media are foam, gravel, perlite, rockwool, sand, Hydroton (Fig. 1), coco coir and pumice. Each medium has advantages and limitations, and the choice will reflect availability, cost, quality and type of hydroponic system used.

Rockwool, a mineral fiber derived from basaltic rock, is the most popular hydroponic medium. It provides rapid crop turnaround and minimal risk of crop failure. The open rockwool system also limits diseases in the system.

Fig. 1. Hydroton is a popular medium for hydroponic growing systems. It is made from expanded clay, has a neutral pH and is reusable.

Nutrient solutions

Nutrients are provided to the plant by dissolving fertilizer salts in water. The two options for obtaining nutrient solutions are purchasing a commercial solution or making your own stock solution. An optimum formulation depends on several variables, such as the plant species, stage of plant growth, part of the plant representing the harvest, season during growing and the weather (if outdoors).

Managing the hydroponic system

Recharging the nutrient solution:

In an open system, the nutrient solution is used only once on crop plants. In a closed system, the nutrient solution is used once, then analyzed for pH and nutrients and adjusted to the proper levels. It must also be sterilized to control the spread of pathogens, and returned to the plants. Common methods for sterilization include heat, ultraviolet radiation and ozone.

Sterilizing hydroponic media:

Medium-culture hydroponic systems are susceptible to pathogenic microorganisms accumulating in the medium with each successive crop. For best results, it is recommended to sterilize the system in between each crop.

Sterilization:

- Steam sterilization is effective at 180 F for at least a half hour, and is effective at cleaning beds up to 8 inches in depth.
- Chemical sterilization is used when steam sterilization is not feasible. Bleach is commonly used and should be applied at a concentration of 10,000 parts per million. The solution should be allowed to sit on the medium for half an hour, and then the medium should be rinsed thoroughly. Other options are formaldehyde (as a fungicide), chloropicrin (as an insecticide), Vapam (water-based fumigant) or basamid (granular soil fumigant). Many of these chemicals are toxic to humans; those applying these chemicals should read the label carefully for use and safety information about the product.

Pest and disease management:

Integrated pest management (IPM) is the most effective and environmentally sensitive approach for both commercial and home hydroponic settings. IPM is not a single pest control method but one that is based on frequent monitoring and use of a variety of management techniques that depend on user tolerance to pests and severity of the outbreak. The grower should set action thresholds based on economic threat, monitor and identify pests, practice prevention and control for both effectiveness and risk. The grower must use the most appropriate IPM technique for the situation at hand.

Nutritional quality of hydroponically grown produce

No conclusive evidence is available regarding the nutritional quality of hydroponically grown produce as compared to soil-grown produce. Since hydroponics allows for control over all aspects of growing conditions, it is thought that hydroponically grown crops may eventually be superior to soil-grown crops in nutritional quality.

At University of Nevada, Reno, hydroponically grown strawberries and raspberries were compared to their soil-grown counterparts. Results indicated significantly higher levels of vitamin C, vitamin E and total polyphenolic compounds, but significantly less fructose and glucose, in hydroponically grown strawberries as compared to soil-grown strawberries. Hydroponic raspberries showed significantly lower levels of fructose and sucrose as compared to soil-grown raspberries. These findings may contribute to providing an environmentally sustainable food source in arid or urban growing conditions. More research is needed to determine best methods for hydroponic strawberry and raspberry crop production.

Hydroponics in the future

Hydroponics has been adapted to many situations over a relatively short time period. In the future, areas suffering from drought may use desalinated seawater in hydroponic systems and could, therefore, provide food in areas along coasts, in deserts and in developing countries. Astronauts are already enjoying lettuce grown hydroponically on the International Space Station. Research is currently being conducted to investigate other varieties of vegetables for growing hydroponically during space travel that have the potential to feed astronauts on longer missions.

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