Understanding Hydroponics

DID YOU KNOW that the National Aeronautics and Space Administration (NASA) is looking at hydroponics as a means of providing food during space exploration? We tend to think of hydroponics as a new, high-tech form of producing plants. Yet, evidence exists that the ancient Egyptians applied the principles of hydroponics thousands of years ago.

Objective:

Describe hydroponics and types of hydroponic systems.

Key Terms:

aeroponics
aggregate culture
circulating system
hydroponics
nutriculture
nutrient film technique
parts per million
respiration
rock wool
soilless culture

Hydroponics

The term *hydroponics* was first used in the 1930s by California researcher W. F. Gerike. It is a combination of two Greek words—*hydro* meaning "water" and *ponics* meaning "labor." Together they mean "water labor." **Hydroponics** is the growing of plants with their roots in a medium other than soil. Sometimes hydroponics is referred to as **soilless culture** because soil is not used. Recent years have seen widespread expansion in hydroponic systems due to a better understanding of plant growth, nutrient needs, and technological requirements.

Hydroponic production has a number of advantages over field production.

- Because hydroponics does not use soil, harmful insects that live in soil cannot damage hydroponic crops.

- Hydroponic systems do not have weed seeds that might germinate and compete with crops for water, nutrients, and light. Soil contains dormant weed seeds that germinate when given the right conditions.
- Hydroponic systems allow for every plant's optimal nutrient needs to be addressed. The plants do not have to compete for available nutrients and can therefore be placed closer together. The amount of nutrients needed by plants can be adjusted as they grow. As plants mature, the type and amount of nutrients can be easily adjusted in a hydroponic system.
- Hydroponic systems allow the pH levels available to plants to be adjusted quickly. Adjusting the pH of the nutrient solution helps in nutrient uptake.
- Hydroponics allows for high-quality yields in parts of the world that have nonproductive land or poor growing conditions.

FIGURE 1. Plants being grown in a hydroponic greenhouse.

Some disadvantages, however, are associated with hydroponic systems.

- The initial investment in a commercial hydroponic system is high.
- Some diseases can spread rapidly throughout a hydroponic system.
- Many hydroponic systems are set up in greenhouses. Flower pollination can be difficult in greenhouses.

FIGURE 2. Flower pollination can be difficult in greenhouses.

BASIC REQUIREMENTS FOR PLANT GROWTH

Plants grown hydroponically have the same basic requirements as plants grown in soil. All hydroponic systems must supply support, water, nutrients, and air. The major differences between hydroponic systems are the way in which plants receive support and the method in which nutrients are made available.

Temperature

Most hydroponic systems are in greenhouses or confined areas. In these spaces the grower can set specific temperatures. Each type of plant has an optimal temperature range for maximum growth.

FIGURE 3. Roses need a hothouse to be productive.

Light

All vegetables and most flowering plants need large amounts of light. Hydroponically grown vegetables require 8 to 10 hours of direct sunlight daily for healthy growth. Commercial operations sometimes use high-powered lamps to increase light intensity and duration.

Water

Providing plants with enough water is not a problem with water culture systems. However, water quality can be an issue. The pH of water should be tested and, if necessary, adjusted for the particular crop being grown. Softened water may contain harmful amounts of sodium and should be avoided.

FIGURE 4. Water quality must be monitored.

Oxygen

Perhaps the most critical factor is supplying the root system with enough oxygen for healthy root growth. Plants and plant root systems require oxygen for respiration. **Respiration** is the chemical process in which a plant converts stored energy to carry out plant functions.

Nutrients

Plants grown hydroponically have the same nutrient requirements as those grown in soil. The difference is essential nutrients must be provided to plants with the water solution within a hydroponic system. The solution requires careful calculations to ensure that the optimal amounts of macronutrients and micronutrients are provided. Nutrients in a solution are measured in parts per million (ppm). **Parts per million** means that out of a million molecules, a given number are of a specific type. For example, a solution of 200 ppm nitrogen means that 200 out of 1 million molecules are nitrogen.

Support

Soil provides a firm anchor for plants to grow upright. In hydroponic systems, artificial support can be provided. This can be accomplished through string stakes, trellises, and mesh materials.

FIGURE 5. Control system for mixing and supplying nutrients in a hydroponic greenhouse.

TYPES OF HYDROPONIC SYSTEMS

The term *hydroponics* is used to describe many different types of systems. Since most are unique designs, they can vary in size, appearance, and method of operation. Generally, all systems can be classified as either aggregate culture or water culture.

Aggregate Culture

Aggregate culture involves the use of aggregate or substrate materials that help support plants. Such materials allow the plants to take root. Common substrates include sand, perlite, vermiculite, gravel, peat moss, and rock wool. **Rock wool** is a spongy, fibrous material spun from molten volcanic rock. All these materials are considered inert. They do not provide nutrients to the plants.

Solutions provide the plants with essential nutrients. Common methods of supplying a solution are through drip, trickle, and subirrigation. One method involves flooding the aggregate for 10 minutes. The aggregate is allowed to drain for 30 minutes and then flooded again.

Water Culture

Water culture is also called **nutriculture**. In this type of system, no substrate is used. Although plants may be started in rock wool, most of the roots are growing in a nutrient solution. Usually, a system of this type has a continuous flow or mist of nutrient solution that is recycled. Such a system is referred to as a **circulating system**.

The water culture system most commonly used in commercial operations is **nutrient film technique** (NFT). In an NFT system, a continuous flow of nutrient solution runs through a series of tubes or troughs. A pump raises the nutrient solution to desired levels, and gravity allows it to drain. The system is constantly recycling the nutrient solution.

FIGURE 6. Correct water circulation is as important as water quality.

Aeroponics is another type of water culture system. In such a system, plant roots are suspended in the air within a closed container. Inside the container, spray nozzles mist the roots.

Summary:

Hydroponics is the growing of plants with their roots in a medium other than soil. All hydroponic systems must supply support, water, nutrients, and air. The major differences between hydroponic systems are the way in which plants receive support and the method in which nutrients are made available.

Aggregate culture involves the use of aggregate or substrate materials that help support plants. Common substrates include sand, perlite, vermiculite, gravel, peat moss, and rock wool. Rock wool is a spongy, fibrous material spun from molten volcanic rock.

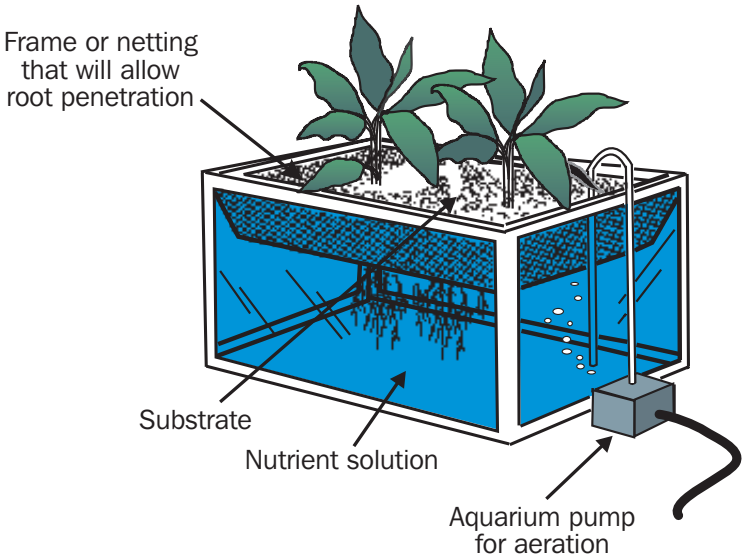
Water culture is a system in which no substrate is used. A continuous flow or mist of nutrient solution is recycled or circulated within the system. A nutrient film technique system involves a flow of nutrient solution through a series of tubes or troughs. Aeroponics involves the use of a system designed to have plant roots suspended in the air within a closed container. Inside the container, spray nozzles mist the roots.

Checking Your Knowledge:

1. What is hydroponics?
2. What basic requirements for plant growth must be provided?
3. What is aggregate culture?
4. What is water culture?
5. How do nutrient film technique and aeroponics differ?

Expanding Your Knowledge:

Construct a desktop hydroponic unit. Obtain plans for the project from references found in your library or on the Internet. Be sure to consider the basic requirements for plant growth and carefully select the plants to be grown based on the growing conditions you can provide.



Web Links:

Basic Hydroponic Systems and How They Work
http://www.simplyhydro.com/system.htm

Hydroponics
http://ag.arizona.edu/PLS/faculty/MERLE.html

Hydroponic Systems
http://quest.nasa.gov/smore/teachers/act3.html
http://www.aces.uiuc.edu/vista/html_pubs/hydro/hydroponic.html

History of Hydroponics
http://archimedes.galilei.com/raiar/histhydr.html

Agricultural Career Profiles
http://www.mycaert.com/career-profiles