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Research Question/ Title: *Can plants still grow without soil?*

September 19, 2013

Background Research

Hydroponics is a technique for "growing plants without soil. Instead of nutrients in the soil, plants thrive on nutritious chemicals, which contain the recourses that the plant needs. The plants rely on getting energy directly from the nutrient solution, rather than scavenging soil. The material, where the roots of a plant are growing in, is called a growing medium. Grow media, such as gravel and mulch, is often used to clutch moisture around the roots of the hydraulically grown plants. Although it helps to contain humidity, the growing medium is not a source of nutrients (www.gchydro.com).

Vegetation that is grown in hydroponic systems always sustains the finest nutrient and moisture levels, so they develop faster and healthier. Without soil there are no weeds, few pests and no viruses from diseased ground. Root systems for hydroponically grown plants stay smaller, allowing the plant to focus most of its growth energy on generating plant shape. More plants per square foot of growing area can be produced due to this. While hydroponic plants never are connected to the ground, they do not need to be transplanted. Hydroponic crops can last longer than produce grown in the ground (www.gchydro.com).

All organisms that are in the Plantae kingdom use photosynthesis. Photosynthesis is the biological procedure by which the energy of the sun is absorbed and used to power the development of organic compounds from carbon dioxide and water. Although primarily associated with green plants, photosynthesis also occurs in algae and a limited number of bacteria. This process ultimately supplies the energy required by all living organisms for their continued survival. Aristotle, who was Greek philosopher, may have been the first to attempt to

explain the process of photosynthesis. He believed that plants could obtain all the components required for growth from the soil. (Clayton, R.K. et al 277)

Although hydroponics is the agricultural method of the future, it has been used for numerous years by several different kinds of people. Examples of 'Hydroponic' culture are the floating gardens of the Aztecs of Mexico, the hanging gardens of Babylon, and various other civilizations. Ancient Egyptian hieroglyphic records, from long ago, describe the growing of plants in water. In 1699 Woodward, who was an Englishman, proved that plants could be grown in water by liquefying soil in it. Certain elements, which were needed by the plants, were released when the dirt dissolved (www.gchydro.com).

For over a century, scientist and gardeners have experimented with hydroponics. In 1804 De Saussre hypothesized that plants were made of components obtained from water, soil, and air. Boussingault, who was another Frenchman, proved this theory to be correct by growing plants in sand and nourishing them with assorted substance combinations. Salem-Horsmar constructed techniques using sand and other motionless media in 1856. In between 1860 and 1865, Sachs and knop developed methods that enabled them to grow plants in a nutrient chemical. All of these methods are still used today. (Jones et al 4)

In the 1920's and 1930's the basis for almost all of the forms for hydroponics, generally, came from the work of Dr. Gericke. Dr. Gericke is famous for his way of growing vegetables. Dr. Gericke's methods were still in use, but many hydroponic gardeners encountered problems it. The Gericke system required plenty of technical knowledge and it took skill to build. Gericke's system was made of channels over which he stretched a fine wire net. The vegetation was positioned on the mesh, with the roots extending downward into a nutrient liquid in the basin. (Jones et al 4)

Keeping a sufficient supply of oxygen in the nutrient chemical was one of the main problems of this method. The plants would quickly exhaust the oxygen. Then it would ascend through the roots. It was important that, through a method of ventilation, a constant source of fresh oxygen was introduced into the chemical. Another difficulty was maintaining the plants so that the tips of the roots were properly held in the solution. It was challenging to keep all of these components controlled. (Jones et al 4-5)

When hydroponically gardening it is important that certain measures are followed. If the plant specimen lacks its needs for life it will be hard to receive accurate results. Plants grown in hydroponic systems must have stable levels of light, nutrients, and humidity. They also must constantly be checked for pest such as aphids. Before rushing to conclusions it is important to first, identify the problem. If problems do occur, it is necessary to correct them. (Nicholls 92-93)

There are six major methods of hydroponics. The Aeroponic System is one of the hydroponic systems with high technology. The Drip System is the most widely used hydroponic system. The Ebb and Flow System can be modified in multiple ways. The hydroponic system that is most normally thought of is the Nutrient Film Technique System. The Water Culture System is very simple to use, but the Wick system is the simplest of them all. (http://www.hannainst.com)

In an Aeroponic System the growing medium is mostly air. Every few minutes vapor is sprayed to provide nutrients to the roots. The roots, which will have no reason to look for nutrients, will be short due to lack of soil. To ensure the plants are properly humidified, a timer must be used to control the pump. A Reservoir, Grow Media, Pump and Spray Nozzles and Nutrient Solutions are needed for this form of hydroponics. It is also necessary to have a pH and EC/TDS controller, such as the Hanna HI 2500. (http://www.hannainst.com)

There are two types of Drip systems. Each Hydroponic Drip Growing System includes a timer, which operates an immersed pump that discharges the chemical onto the foundation of each plant. In a Recovery Drip system, the excess nutrient solution is collected and reused. Although it is more sustainable, the pH and nutrient strength levels may decrease because the nutrient formula is reused. In a Non-Recovery Drip system excess solution is not recycled. In these hydroponic systems the timer must be accurate to avoid wasted chemicals. (http://www.hannainst.com)

In an Ebb and Flow System the grow tray is temporarily, flooded with nutrition chemicals. Then the nutrient liquid drains back into the reservoir, which is utilized by an immersed pump on a timer. The timer comes on, several times a day, to release the chemical into the grow tray. The nutrient solution is collected back into the tank, when the clock stops. This system can be improved in various ways such as filling the grow dish with chippings or grow rocks. One key disadvantage of this system is the possibility of a power outage and/or pump timer failures, due to the growing medium that is used. (http://www.hannainst.com)

The Nutrient Film Technique (N.F.T.) is the most commonly thought of hydroponic system. It has a continuous flow of nutrients and there is no need for a timer for the submersed pump. The nutrient chemical is driven into the grow dish over the plant roots. Then it is drained into the container. Air is the only grow medium for this hydroponic system. Usually, the roots dangle into the nutrient solution, while the plants are reinforced in little plastic baskets. (http://www.hannainst.com)

A Water Culture System is simple to use. A Styrofoam stage normally holds the vegetation and floats on the nutrient chemical. An oxygen pump is used to supply air to a fizzy stone. This

discharges the nutrient liquid and provides air to the plant's roots. Lettuce is the major plant that is grown in this system. There is a limited amount of other plants that grow well in the Water Culture System. (http://www.hannainst.com)

The wick system is the simplest hydroponic system of all. It is a passing system. This means it does not have any moving parts. The chemical, which is nutritious, is released into the grow tray through a wick. This hydroponic growing system can have several different growing mediums. Some of these mediums are Coconut Coir, Perlite, gravel, rock wool and much more. (http://www.hannainst.com)

The word hydroponics is resulting from the Greek words, "hydro" denoting water and "ponos" meaning labor. Hydroponics is the skill of soil-less gardening. Gardening hydroponically is highly efficient and environmentally sustainable. Rather than dirt, plants grow in receptacles using replacement mediums such as clay, gravel, sand, vermiculite, and coconut fiber. There is a continuous flow of water, which is mixed with a nutrient liquid, to keep plants healthy. There are many different types of hydroponic systems such as the drip systems, and water culture systems. Hydroponic systems come in all forms and magnitudes. They can be vertical or horizontal, used inside or in conservatories. They can also be used outdoors somewhat successfully. All of the systems have one similar feature: they are fully used without soil. Because of this, problems of overflows and earth erosion are non-existent. (www.boswyckfarms.org)

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