HYDROPONIC AGRICULTURE

IN

KOSCIUSKO COUNTY.

CULLISON

HYDROPONIC

ETNA GREEN

No
Records
1986

Kosciusko Leadership Academy

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Barry Cullison

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FOREWARD

I would like to thank the Triton School Corporation and Dr. Bates for allowing me the opportunity to participate in Kosciusko Leader Association (K.L.A.) this past year. It was a very beneficial and meaningful experience.

INTRODUCTION

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INTRODUCTION

For seven years I have been raising hydroponic tomatoes commercially in Etna Green, Indiana. During this time I have met hundreds of people who have been amazed by the methods used to achieve the end result; a vine ripened delicious product. As a result of people coming to the greenhouse and taking a tour, I have been able to dispel misconceptions they had about the product.

Even today many people don't understand the concept of a plant being water-fed. When the word hydroponic is mentioned, some individuals immediately begin thinking of something that is unnatural and uncommon to that which is grown in the garden.

Through this publication, I hope to enlighten everyone about what hydroponic agriculture actually is and where the idea comes from.

People need to understand that this idea is not new, and that the very plants used are the same as those used in the garden.

The idea of soilless culture takes on many different forms and the process which I use will later be described as the true form of the hydroponic practice of raising vegetables, which is a plant totally water-fed without the use of any other medium.

We will look first at the history of hydroponics and at the advantages of growing crops using this scientific method. I am sure that once you understand this scientific method, you will more fully appreciate the product when you have an opportunity to try it.

HISTORY OF HYDROPONICS

THE PAST

Hydroponics, the growing of plants without soil, has developed from the findings of experiments carried out to determine what substances make plants grow and the composition of plants. Such work on plant constituents dates back as early as the 1600's. However, plants were being grown in a soilless culture far earlier than this. The Hanging Gardens of Babylon, the floating gardens of the Aztecs, and those of the Chinese are examples of "hydroponic culture." Egyptian hieroglyphic records dating back to several hundred years B.C. describe the growing of plants in water.

Before the time of Aristotle, Theophrastus (372-287 B.C.) undertook various experiments in crop nutrition. Botonical studies by Dioscorides date back to the first century A.D.

The earliest recorded scientific approach to discover plant constituents was in 1600 when a Belgian, Jan van Helmont, showed his classical experiment that plants obtain substances from water. He planted a five pound willow shoot in a tube containing 200 pounds of dried soil that was covered to keep out dust. After five years of regular watering with rain water he found the willow shoot increased in weight by 160 pounds, while the soil lost less than two ounces. His conclusion that plants obtain substances for growth from water was correct. However, he failed to realize that they also require carbon dioxide and oxygen from the air. In 1699 an Englishman, John Woodward, grew plants in water containing various types of soil, and found the greatest growth occurred in water which contained the most soil.

He thereby concluded that plant growth was a result of certain substances in the water, derived from soil, rather than simply from water itself.

Further progress in identifying these substances was slow until more sophisticated research techniques were developed and advances were made in the field of chemistry. In 1804, DeSaussure proposed that plants are composed of chemical elements obtained from water, soil, and air. This proposition was verified later by Boussingault (1851), a French chemist, in his experiments with plants grown in sand, quartz and charcoal which he added solutions of known chemical composition. He concluded that water was essential for plant growth in providing hydrogen and that plant dry matter consisted of hydrogen plus carbon and oxygen which came from the air. He also stated that plants contain nitrogen and other mineral elements.

Various research workers had demonstrated by that time that plants could be grown in an inert medium moistened with a water solution containing minerals required by the plants. The next step was to eliminate the medium entirely and grow the plants in a water solution containing these minerals. This was accomplished by two German scientists, Sachs (1860) and Knop (1861). This was the origin of "nutriculture." Similar techniques are still used today in laboratory studies of plant physiology and plant nutrition. These early investigations in plant nutrition demonstrated that normal plant growth can be achieved by immersing the roots of a plant in a water solution containing salts of nitrogen (N), phosphorous (P), sulfur (S), potassium (K), calcium (Ca) and magnesium (Mg), which are now defined as the macroelements or macronutrients (elements required in relatively large amounts).

With further refinements in laboratory techniques and chemistry, scientists discovered seven elements required by plants in relatively small quantities--the microelements or trace elements. These include iron (Fe), chlorine (Cl), manganese (Mn), boron (B), zinc (Zn), copper (Cu) and molybdenum (Mo).

In following years, researchers developed many diverse basic formulas for the study of plant nutrition. Some of these workers were Tollens (1882), Tottingham (1914), Shive (1915), Hoagland (1919), Trelease (1933), Arnon (1938), and Robbins (1946). Many of their formulas are still used in laboratory research on plant nutrition and physiology.

Interest in practical application of this nutriculture did not develop until about 1925 when the greenhouse industry expressed interest in its use. Green house soils had to be replaced frequently to overcome problems of soil structure, fertility and pests. As a result, research workers became aware of the potential use of nutriculture to replace conventional soil cultural methods. Between 1925 and 1935, development took place in modifying the laboratory techniques of nutriculture to large-scale crop production.

In the early 1930's, W.F. Gericke of the University of California put laboratory experiments in plant nutrition on a commercial scale. In doing so he termed these nutriculture systems hydroponics. The word was derived from two Greek words hydro (water) and ponos (labor) -- literally "water working."

Hydroponics can be defined as the science of growing plants without the use of soil, but by use of an inert medium, such as gravel, sand, peat, vermiculite, pumice or sawdust, to which is added a nutrient solution containing all the essential elements needed by the plant for its normal growth and development. Since many hydroponic methods employ some type of medium it is often termed "soilless culture," while water culture alone would be true hydroponics.

Gericke grew vegetables hydroponically such as beets, radishes, carrots and potatoes; and cereal crops, including root crops, fruits, ornamentals and flowers. Using water culture in large tanks, he grew tomatoes to such heights that he had to harvest them with a ladder. The American press made many irrational claims, calling it the discovery of the century. After an unsettled period in which unscrupulous people tried to cash in on the idea by selling useless equipment, more practical research was done and hydroponics became established on a sound scientific basis in horticulture, with recognition of its two principal advantages, high crop yields and its special utility in nonarable regions of the world.

Gericke's application of hydroponics soon proved itself by providing food for troops stationed on nonarable islands in the Pacific in the early 1940's. In 1945 the U.S. Air Force solved its problems of providing its personnel with fresh vegetables by practicing hydroponics on rocky islands normally incapable of producing such crops.

After World War II the military continued to use hydroponics. For example, the U.S. Army extablished a 22-hectare project on Chofu Island, Japan. Commercial hydroponics expanded throughout the world in the 1950's to such countries as Italy, Spain, France, England, Germany, Sweden, the U.S.S.R. and Israel.

THE PRESENT

With the development of plastics, hydroponics took another large step forward. Plastics freed growers from costly construction associated with the concrete beds and tanks previously used. Beds are scraped out of the underlying medium and simply lined with a heavy vinyl (20 mil.), then filled with the growing medium. With the development of suitable pumps, time clocks, plastic plumbing, solenoid valves and other equipment, the entire hydroponic system can now be automated, reducing both capital and operational costs.

Hydroponics has become a reality for greenhouse growers in virtually all climate areas. Large hydroponic installations exist throughout the world for the growing of both flowers and vegetables. For example, large hydroponic greenhouse complexes are now in operation in Tucson, Arizona (11 acres), Phoenix, Arizona (about 15 acres), and Aba Dhabi (20 acres).

In the Canary Islands, hundreds of acres of land are covered with polyethylene supported by posts to form a single continuous structure housing tomatoes grown hydroponically. The structure has open walls so that prevailing winds blow through to cool the plants. The structure helps to reduce transpirational loss of water from the plants and to protect them from sudden rain storms. Such structures can also be used in such areas as the Caribbean and Hawaii. Almost every state in the United States has a substantial hydroponic greenhouse industry. Canada also uses hydroponics extensively for growing greenhouse vegetable crops.

In arid regions of the world, such as Mexico and the Middle East, where the supply of fresh water is limited, hydroponic complexes combined with desalination units are being developed to use sea water as a source of fresh water. The complexes are located near the ocean and the plants are grown in the existing beach sand.

In the U.S.S.R. large greenhouse soilless farms exist at Moscow and Kiev, while in Armenia an Institute of Hydroponics has been extablished at Erevon in the Caucasus region. Other countries where hydroponics is used include Australia, New Zealand, South Africa, the Bahama Islands, Central and East Africa, Kuwait, Brazil, Poland, the Seychelles, Singapore, Malaysia and Iran.

THE FUTURE

Hydroponics is a very young science. It has been used on a commercial basis for only 40 years. However, even in this relatively short period of time it has been adapted to many situations, from outdoor field culture and indoor greenhouse culture to highly specialized culture in atomic submarines growing fresh vegetables for crews. It is a space age science, but at the same time can be used in developing countries of the Third World to provide intensive food production in a limited area. Its only restraints are souces of fresh water and nutrients. In areas where fresh water is not available, hydroponics can use seawater through desalination. Therefore, it has potential application in providing food in areas having vast regions of nonarable land, such as deserts. Hydroponic complexes can be located along regions in combination with petroleum--fueled on atomic desalination units, using the beach as a medium for growing the plants.

Hydroponics is a valuable means of growing fresh vegetables not only in countries having little arable land but also those which are very small in area and have a large population. It could be particularly useful in smaller countries whose chief industry is tourism. In such countries tourist facilities, such as hotels, have often taken over most arable areas of the country, forcing local agriculture out of existence.

Hydroponics could be used on the remaining nonarable land to provide sufficient fresh vegetables for the indigenous population as well as the tourists. Typical examples of such regions are the West Indies and Hawaii, which have a large tourist industry and very little farm land in vegetable production. To illustrate the potential use of hydroponic tomatoes grown in this way could yield 150 tons per acre annually. A 10-acre site could produce three million pounds annually.

In Canada the average per capita consumption of tomatoes is 20 pounds. Thus, with a population in excess of 20 million, the total consumption of tomatoes is over 400 million pounds (200,000 tons). These tomatoes could be produced hydroponically on 1,300 acres of land!

ADVANTAGES OF HYDROPONICS

The large increase in yields under hydroponic culture, over that of soil, may be due to several factors. The soil may be poor, or the presence of pest or disease could greatly reduce overall production. Under greenhouse conditions the environment is the same as those of soil grown plants except for the medium used. The practice of sterilization and the use of heavy applications of fertilizer eliminate many problems found in the gardens.

The main disadvantages of hydroponics are the high initial capital cost, and diseases such as Fusarium and Verticillium which can spread rapidly through the water. Complex nutritional problems may be encountered if proper procedures are not practiced. As the science is further studied new techniques will help to reduce cost to the producer. Many plants have been developed to resist disease in the greenhouse environment.

Overall, the main differences of the two methods of growing vegetables are the increased production, being able to control the environment easier, and gaining a headstart on the normal growing season. We are able to do many things easier and provide almost everything a plant needs to complete a productive life cycle.

Plant nutrition is controlled, thus providing a relatively stable homogeneous quantity of nutrients to all plants, in sufficient quantities. This also allows the solution to be tested for available nutrients while at the same time controlling the PH of the solution.

Limited only by available light; closer spacing of plants is possible per unit area. This allows for more efficient use of space resulting in higher yields per unit area.

Since the plants are grown in an enclosed environment, there are no weeds competing for the all important nutrients and water. There are no diseases or insects from the soil that create problems. Those which create problems at times are those organisms which are air borne and are treated accordingly.

With any crop, available water is always a problem. Within this type of environment we have no water stress on the plants. It is possible to use a relatively high saline water, which is impossible in soil. With efficient water use, we are not dealing with losses due to percolation beyond the root zone or by surface evaporation. If managed properly, water loss should equal transperational loss.

When you compare fruit quality at your supermarket, you very often are dismayed with some vegetables. Often the fruit is soft or puffy due to pottassium and calcium deficiencies. This results in poor shelf-life for soil grown vegetables. When compared with hydroponic fruit, we find firm fruit with a long shelflife. This enables growers to pick vine ripened fruit and still be able to ship it relatively long distances. Little, if any, spoilage occurs at the supermarket. Tests have shown higher vitamin A content in hydroponically grown tomatoes, as well as other nutrients, than those grown in soil.

CLOSING THOUGHTS

When one understands the concept of hydroponics, we are able to more fully enjoy knowing that the product tastes as good or better than those grown in soil and also has a higher nutrient content. The product may cost more, but remember cheaper is not always better.

As an added thought, recently a local radio station told its listeners of a study done by the University of Georgia. They stated that in their study, 90 percent of the people could not tell the difference between a gassed tomato, (one picked green and sprayed with ethylene gas to turn them red), and one grown in the soil. The announcer commented, "Why do they taste like cardboard"? No such comments can be made about a hydroponic tomato!