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Hydroponic Culture of Plants

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For normal growth, plants require a root environment that contains moisture, nutrients, a proper pH and oxygen. This environment is normally found in a good soil. These conditions can, however, be supplied in a variety of artificial ways. In hydroponics or water culture, plants are grown with their roots suspended in a liquid nutrient solution. This can be modified by growing the plants in an inert medium such as washed gravel or perlite, in which case the plants are irrigated frequently with the nutrient solution.

Although this may seem like a lot of bother just to grow plants, this technique is most useful for studying nutrient requirements of plants. Also, where good soil does not exist nutrient cultures can be used to grow food. During World War II hydroponics was used to produce fresh vegetables on islands where good soil was not available.

A coleus plant thrives in liquid nutrient. The aquarium pump provides the necessary air supply.

Today hundreds of acres of greenhouse vegetables and floral crops are grown hydroponically. Hydroponics offers the advantage of exact control of the nutrients in the root environment and, therefore, makes possible an approach to maximum yield under greenhouse conditions.

Many chemical elements are required for proper growth of plants. These are called essential elements. Nitrogen, potassium, phosphorus, calcium, sulfur and magnesium are used in relatively large quantities and are called macronutrients. Others—chlorine, iron, manganese, boron, copper, zinc and molybdenum—are used only in very small quantities and are called micronutrients. Although these are used in very small amounts they are essential and necessary for plant growth.

Macronutrients

For hydroponics the essential nutrients are supplied to the plant from chemical salts. For an exact mixture a good balance is necessary for weighing the salts. The macronutrient table (over) gives the amounts of each salt in tablespoons as well as grams.

Micronutrients

The micronutrients are used in very small quantities and must be mixed carefully to avoid toxicity to the plants. It is necessary to make solutions of the micronutrients and to use measured amounts of these in the nutrient solution.

To make the micronutrient solution, add 2 level teaspoons (10 grams) boric acid and two-thirds teaspoon (4 grams) manganese chloride to 1 gallon of water. Add 1 cup of this solution to 25 gallons of nutrient solution. Iron can be added to the nutrient solution by dissolving 1 level teaspoon of iron sulfate or iron tartarate to 1 quart of water and adding 1 cup to the nutrient solution just before use. Copper and zinc will generally be present if tap water is

		Amount for 25 Gallons of Solution	
Macronutrients			
Salt	Nutrient	Grams	Tablespoons
Potassium Phosphate (Monobasic)	Potassium, Phosphorus	14	1
Calcium Nitrate	Calcium, Nitrogen	85	6
Potassium Nitrate	Potassium, Nitrogen	56	4
Magnesium Sulfate	Magnesium, Sulfur	42	3

* One ounce equals approximately 28 grams

used and the water is not alkaline. Do not use softened water since it will contain harmful quantities of sodium. The solutions should be stored in the dark to prevent algae growth.

Most plants grow best at a pH between 5.5 and 6.5. The pH of the nutrient solution should be measured and if below 5.5 sodium hydroxide should be added until the pH reaches the proper range. If the solution is above 6.5 dilute hydrochloric acid should be added. The pH can be conveniently measured with paper strips which change color when exposed to a specific pH range.

Water Culture

The container for water culture may be any watertight jar or crock. Metal containers are not recommended since they may add toxic elements to the solution. If a glass jar is used it should be painted with black paint to prevent algae growth.

The top of the jar should be fitted with a cork with a hole in it large enough to accommodate the plant as it grows. The plant may be held in place with cotton or sponge rubber.

Provision must be made for aeration of the solution. This can be done with an aquarium pump fitted with plastic tubing and an airstone. The container should be filled to about one inch from the bottom of the cork with nutrient solution. As the solution is used more should be added. Every 7 to 10 days the solution should be changed completely to prevent buildup of salt.

If water culture is to be carried out on a large scale a trough-like structure is needed. This could be made of wood, metal or cement and lined with a sheet of plastic film. The plants can be held in place by wire mesh.

Sand or Gravel Culture

Commercial growers use sand or gravel for the plants to grow in. This eliminates the problem of supporting the plant. The nutrient solution is pumped into the gravel either from above or below and then allowed to drain off into a tank. The solution may be pumped into the gravel several times a day, depending on how much water the plants are using and how much solution is held by the gravel. If sand is used it should only need irrigation once a

Vegetables growing in sand culture. Note in the photo above the small tomato plants between rows of the larger vegetables. Intercropping such as this maintains productivity of a small greenhouse area.

day whereas pea rock or coarse gravel may need irrigation several times. A time clock can be used to turn the pump on at specific intervals.

A modification of this technique is to have a reservoir of nutrient solution raised above the plants and let the solution drip into pots at a rate that keeps the gravel moist. A provision should be made to allow some of the solution to drain through the pots to prevent salt buildup on the gravel. In any event, the pots should be flushed weekly with water.

For the beginner who might not want to bother with preparation of all the solutions, relatively good results can be accomplished using a very dilute solution of a soluble fertilizer available at most garden stores. The fertilizer should contain micronutrients and should be diluted to one-third the normal concentration used to fertilize plants growing in soil. If the plants do not grow well at this dilution the amount of fertilizer can be changed.

Vegetables grown under hydroponics are equally as good as those grown in soil. Yields can often be more than from similar plants growing in soil since nutrient level and aeration can be controlled more closely.

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