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Hydroponics—growing plants without soil

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Quick Facts

Hydroponics is a term used to describe the growing of plants without soil.

In this process the plant roots can either be suspended in the nutrient solution (water culture) or be allowed to root in in an inert aggregate material (aggregate culture).

For proper growth, 13 elements must be supplied in the nutrient solution in variable quantities.

Nutrient mixtures containing these elements can be purchased ready to use, or salts containing the various elements may be purchased and mixed.

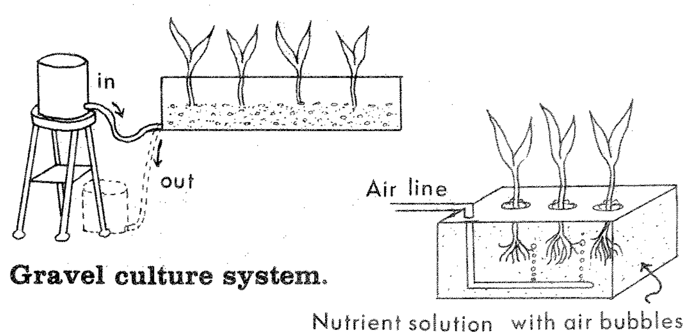
Hydroponics remains an interesting hobby and a useful research tool but a debatable method for commercial production.

Many amateurs and commercial gardeners have become interested in growing plants with the roots in an inert medium instead of soil. This method of growing plants is commonly known as "hydroponics." The term "hydroponics" was first used by Dr. W. F. Gericke in the early 1930s. This method of culture also is referred to as nutrient-solution culture, soil-free culture, water culture, gravel culture and nutriculture. Soil-free culture, however, has been known since 1699 when Woodward in England conducted an experiment in which he tried to determine whether water or the solid portion of soil was responsible for plant growth.

Systems of Soil-Culture

Water culture: This method involved supporting the plant while its roots are submerged in the nutrient solution. This may be done by slipping the roots through a hole in a thin, flat piece of material and holding it in place by stuffing cotton around the stem. It also can be done by sowing the seed in a thin layer of inert material and floating or suspending it just above the nutrient solution. The chief advantage to this method over aggregate culture is that a large volume of solution is always in contact with the root system, providing an adequate water and nutrient supply. The major disadvantages are the difficultues of providing an air supply (oxygen) in the solution for the roots and proper support and root anchorage for the plant.

Aggregate culture: This method is often referred to as "sand culture" or "gravel culture." Aggregates are used much as soil is used in conventional plantings, that is, to provide anchorage and support for the plants. The aggregates in the container are flooded with a nutrient solution as often as necessary to keep the roots moist and keep the plants from wilting. The advantages of this system of hydroponics over the water-culture method are the ease of aerating roots and transplanting seedlings.



Gravel culture system.

Water culture system.

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Nutrient Solutions

For proper growth, plants must be supplied with nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, boron, zinc, copper, molybdenum and chlorine. When these nutrients are deficient or present in excess in the solution, the plants will suffer.

Chemicals for hydroponic growth are available in a premixed state, ready-to-use, and may by obtained through garden catalogs or garden supply stores. For the hobbyist, this is by far the best way to purchase chemicals for hydroponic growth in view of the number of different compounds that must be located, purchased, measured and mixed if a premixed formula is not used. Whether the premixed formula or individual chemicals are used, once the chemicals are put into solution they should be stored in opaque, closed containers, to reduce algae growth and evaporation.

The nutrient solution worked out by Dr. D. R. Hoagland is a good standard for soilless culture. It is made up as follows:

Salt	Grade	Amount for 25 gallons (95 liters) of solution
Potassium monophosphate	Technical	1 tsp (5 ml)
Potassium nitrate	Fertilizer	4 tsp (20 ml)
Calcium nitrate	Fertilizer	7 tsp (35 ml)
Magnesium sulfate	Technical	4 tsp (20 ml)

This 25-gallon (95 l) mixture of nutrients is not complete since it does not contain the minor elements. To complete this solution, five more solutions are required as follows:

Salt	Amount water to add to 1 tsp (5 milliliters) of salt	Amount to use for 25 gallons (95 l) of solution
Boric acid (powdered)	½ gal (1.9 l)	1 cup (240 ml)
Manganese chloride ($MnCl_2.4H_20$)	1½ gal (5.7 l)	1 cup (240 ml)
Zinc sulfate ($ZnS0_4.7H_20$)	2½ qts (2.4 l)	½ tsp (2.5 ml)
Copper sulfate ($CuS0_4.5H_20$)	1 gal (3.8 l)	1/5 tsp (1 ml)
Iron tartrate	1 qt (.95 l)	½ cup (120 ml)

To each 25 gallons (95 l) made in the first table, add the indicated amount of the five solutions in the second table and use this final mixture for watering the plants. If less than 25 gallons (95 l) is desired, appropriate reductions in the amount of material will need to be made.

One has the choice of using a fresh solution at each watering, or recycling the same solution. The advantages of using a fresh solution is that it is more likely to be free of disease and have the elements in proper balance. The disadvantages are cost and a possible disposal problem. When a solution is recycled, there is a danger of spreading disease throughout the whole system; and the nutrients can become out of balance if used too long. Any attempt to "doctor up" a solution that has been in service by adding more salts is not recommended. Rather than run the risk of injury to the plants, the solution should be discarded after a week's service and a new solution put into use.

While Hoagland's solution may be used successfully by the hobbyist, a commercial grower will want to tailor the solution for the particular crop being produced. The grower will want to know the analysis of the water being used and will want to monitor the pH and salt levels of the solution. After the solution has been in service for a week or so, it will be discarded and a new solution put in service.

It should be apparent from the preceeding that the imposition of a hydroponic system on a greenhouse operation is a costly undertaking in terms of equipment, materials and labor, and these must be weighed carefully against the anticipated returns of the marketed produce. Unless a premium price can be realized for hydroponically grown produce, the economics do not favor this system. However, for the home gardener it can be a very rewarding hobby and the basis of some very interesting experiments in plant nutrition.

References

Butler, J. D. and N. F. Oebker, 1974, *Hydroponics as a Hobby*, University of Illinois, Circ. 844.

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