9-22-61, Reprint 10,000

Mrs Holland

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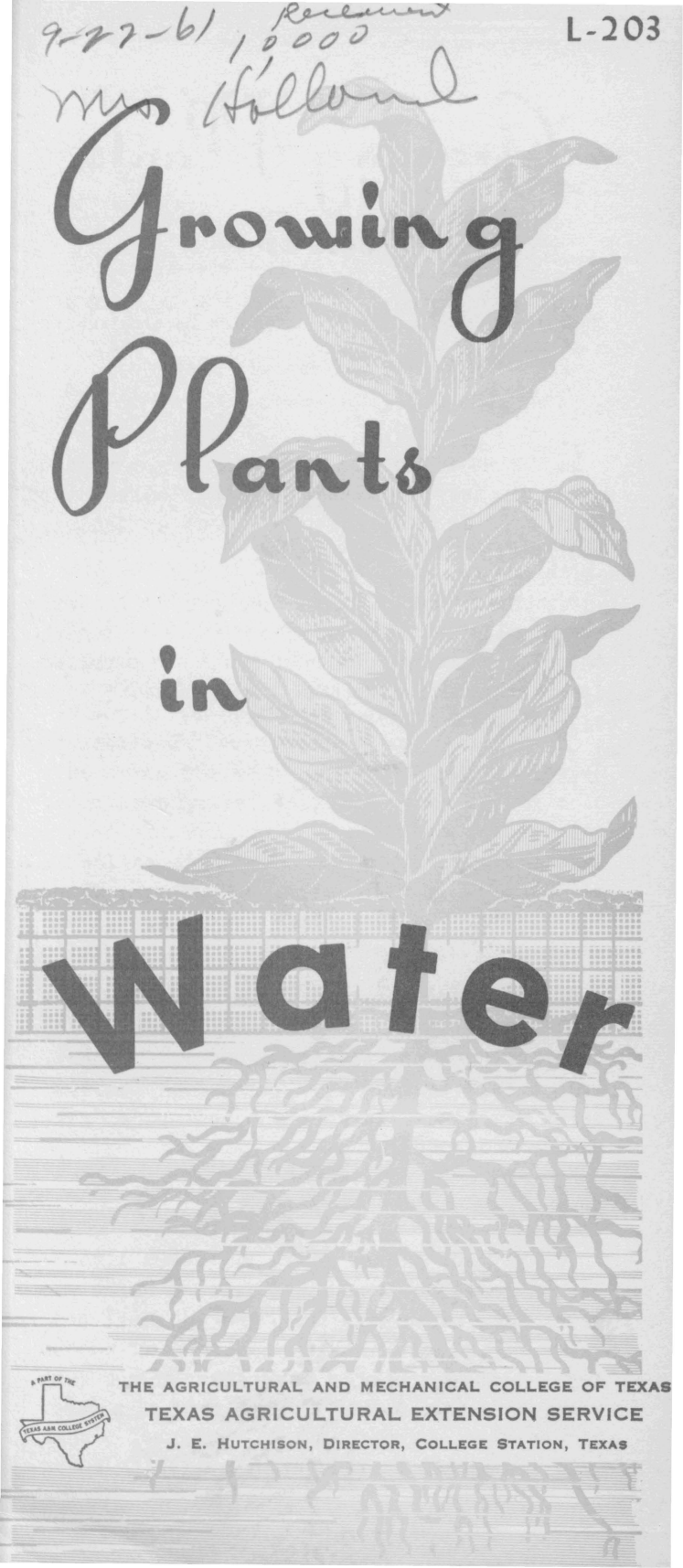

THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
TEXAS AGRICULTURAL EXTENSION SERVICE
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Growing Plants in Water—

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GROWING PLANTS without soil is a method known by several names, such as "soil-less" culture, water culture, chemical gardening, hydroponics and tank farming.

These methods of plant production are essentially the same as when using soil except that the necessary plant nutrients are supplied in water solution rather than in soil.

Growing plants in chemical solution, or hydroponics, usually should be attempted only as a hobby. Under existing Texas conditions, this method of plant growing has not proved practical or economical. For information on the use of nutrient solution cultures for growing plants on a commercial basis, obtain the references listed at the end of this leaflet.

Vegetables that have been grown in nutrient solution include tomatoes, green beans, eggplant, pepper, lettuce and turnip greens. Ornamentals include ivy, carnations, tulips, iris, narcissus, larkspur, snapdragons, gardenias and roses.

USING WATER

To grow plants in water, use a 1 to 3-gallon container, such as a glazed porcelain crock. Start the plants in sand or plant bed. The young plants should be placed on wooden trays with the bottom covered with 1/4-inch mesh screening. On top of this, arrange a layer of excelsior, shavings or moss. Set young plants into holes made in these trays with the roots

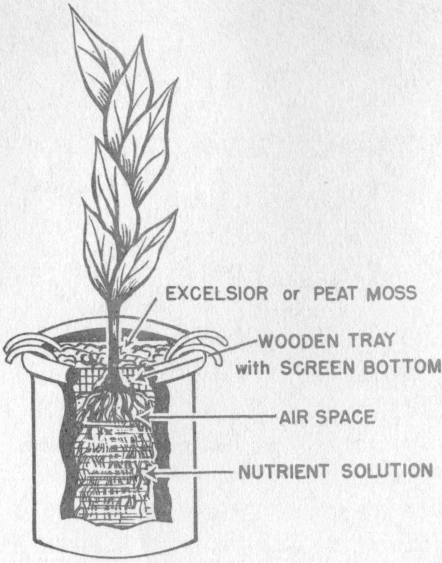

Figure 1. Diagram for growing plants in water.

suspended below in the solution, which, at the beginning, remains level with the screen. As roots develop, the level of the water should drop so that approximately 2 inches of air space is maintained between the solution and the screen. As the plants grow, they may have to be supported by stakes or strings attached to overhead wires.

Since water does not retain sufficient oxygen necessary to sustain most plants, usually the solution needs to be changed every day with fresh solution, or a means of aeration must be provided. An inexpensive method of providing adequate aeration would be to use a small pump similar to the ones used in fish aquariums. Small containers could be aerated best by using a "porous air stone." A small continuous stream of air bubbles should be adequate. Avoid vigorous agitation of the solution.

USING SAND

Another method of growing plants in nutrient solution, which may be more convenient, is to use coarse sand or small gravel as the

rooting medium. For coarse sand, use a 1 to 3-gallon crock with a small outlet at the bottom (see Figure 2). Obtain a one-hole rubber stopper to fit the outlet. Place a 2-inch piece of glass tubing in the rubber stopper and attach a 2 to 4-foot length of rubber tubing. Place the stopper in the outlet and cover the inside opening with glass wool or absorbent cotton. Then fill with coarse sand to within approximately 3 inches from the top of the container. Place about 6 to 8 seeds on top of the sand and cover with 1/4 to 1 inch of sand (depending on the size of seed). Add sufficient water to cover the sand and then allow excess to drain out. Water each day with tap or distilled water until the plants emerge and then switch to the nutrient solution for watering.

After the plants have been growing for several days, thin to one or two healthy plants, depending on the size the plant will be when it is grown.

For the technique of adding the nutrient solution, pinch off the rubber tubing on the outlet. Add the nutrient solution slowly (to keep from disturbing sand) until the solution is standing on the surface. Allow this to stand for about 5 minutes; unclamp the hose on outlet, and allow the excess to drain out. Frequency of adding the solution depends on the age of the plant. When the plant is young, once a day is sufficient. As the plant gets older (about 2 weeks), add solution twice daily. If sand dries out between additions of the solution, add the solution more often. The excess solution which is drained off can be saved and reused. However, it should be kept in a sealed dark container so that no light will enter and cause algae growth. Discard the excess about once each week (or more often as plants get older).

For use of fine gravel, the same general pattern as listed for coarse sand can be followed. If gravel is used, leave the nutrient solution in the container for 20 to 30 minutes before draining off the excess.

NUTRIENT SOLUTIONS

To prepare the nutrient solution, weigh out the following materials and mix in 1 gallon of tap water:

Chemical*	Weight (oz.)	Amount in level tbsp.
Potassium phosphate (monobasic)	0.5	1
Potassium nitrate	2.0	4
Calcium nitrate	3.0	7
Magnesium sulfate (Epsom salt)	1.5	4

*Technical grade chemicals may be used.

This is the *stock* nutrient solution which provides the primary and secondary elements. Take 1/2 cup of the stock solution and dilute to 1 gallon for plants growing in late spring, summer and early fall. For early spring and late fall use 3/4 cup of the stock solution. For winter months, use 1 cup. This diluted solution is the nutrient solution to be applied to the plant. Keep it in a closed container in the dark. The stock solution also should be kept in a dark place.

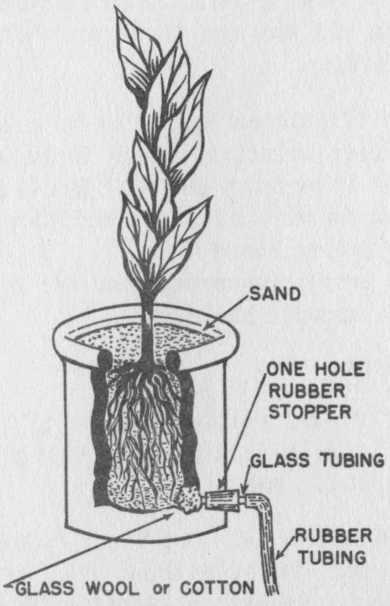

Figure 2. Diagram for growing plants in water, using a sand culture.

MINOR ELEMENTS

Minor elements may need to be added. Minor elements necessary for plant growth are boron, manganese, iron, zinc, copper, nickel and molybdenum. The first three listed are usually the ones that need to be added since the last three usually are supplied as impurities in the chemicals, water or from the containers. If technical grade chemicals are used to supply the primary and secondary plant nutrients, minor elements, with the exception of iron, should be adequate.

For boron and manganese, dissolve 1 1/2 teaspoons of powdered boric acid and 1/2 teaspoon of chemically pure manganese chloride ($MnCl_2.4H_20$) or manganese sulfate in 1 gallon of water. From this stock solution, add 1 ounce (or 2 tablespoons) to every gallon of the growing solution. To supply iron, dissolve 1 teaspoon of iron sulfate, iron tartrate or iron citrate in 1 gallon of water, or use 2 teaspoons water-soluble iron chelate per gallon of water. Add 1 ounce of this stock solution to each gallon of growing solution.

For best growth, the plants should be in full sun all day and in an area of high relative humidity.

Difficulties may arise in growing plants in nutrient solution. These include: (1) maintenance of proper pH, (2) providing proper aeration in pure nutrient solution, (3) maintaining proper conse
taining proper concentration, (4) poor sunlight and (5) improper humidity.

REFERENCES

Ellis & Swaney, Soilless Growth of Plants, Second Edition, Reinhold Publishing Corp., New York 22, N.Y., 1953.

Hoagland and Arnon, The Water Culture Method for Growing Plants Without Soil, California Agricultural Experiment Station Circular 347, Berkeley, California, 1950.

Shive and Robbins, Methods of Growing Plants in Solution and Sand Culture, New Jersey Agricultural Experiment Station Bulletin 636, New Brunswick, N.J., 1956.

Alexander, Morris and Young, Growing Plants in Nutrient Solution, Ohio Agricultural Experiment Station, Special Circular 56, Wooster, Ohio, 1939.

Cooperative Extension Work in Agriculture and Home Economics, The Texas A. & M. College System and the United States Department of Agriculture cooperating. Distributed in furtherance of the Acts of Congress of May 8, 1914, as amended, and June 30, 1914.