Method for Growing Plants Aeroponically

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Method for Growing Plants Aeroponically[1]

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ABSTRACT

A simple, inexpensive system for growing plants with their roots bathed in nutrient mist is described. The aeroponics system uses a spinner from a home humidifier to propel nutrient solution into a polyethylene-lined plywood box atop which plants are supported on plastic light-fixture "egg crating." Success in growing a number of herbaceous and woody species, including nodulated legumes and nonlegumes, is reported.

An aeroponics system was developed at the Cabot Foundation Laboratories during 1973–1974 as a method for studying root nodules on peas. The present system is the result of a long series of empirical changes and improvements. The principle is to grow plants with their root systems exposed constantly to a nutrient mist. The technique used by Went (5) at the Earhart Laboratories in Pasadena, California in the 1950s involved a black, watertight box into which a nutrient spray propelled by an atomizer was injected under pressure. The root system developed into the dark nutrient mist, absorbing necessary inorganic ions from the dilute nutrient medium provided. A highly aerobic environment with a constantly replenished nutrient supply was provided for the root system.

Earlier reference was made by Went to a method devised by Vyvyan and Travell (4). Still earlier accounts of methods to achieve root growth in water vapor have been published (1, 3). In the present system, the atomization of the nutrient solution is achieved by a rotating impellor which draws upon a standing pool of nutrient solution which is replenished at regular intervals.

MATERIALS AND METHODS

An excellent feature of this system for growing plants in the greenhouse is that it is simple to operate and involves no complex machinery. The impellor system is composed of three parts: the motor, the shaft, and the spinner (Fig. 1).

1. The motor turns the spinner. In the early model, we used a small fan motor rated at 1/50 hp, 115 v running at 3000 rpm with a 0.635 cm shaft. These motors are light (0.91 kg), inexpensive, and readily available. Unfortunately, such small motors are built with porous bearings which tend to burn out rather quickly (4–6 months) when used in a vertical position (they are designed to run horizontally). For the past year, we have been testing a small (1.4 kg) ball-bearing type motor, which promises to run longer and more uniformly than the porous bearing type. It was obtained from the Bodine Electric Co., Chicago, Ill. and is listed as follows: fractional horsepower motor, type NS1-13, with 1.4 hp, 3450 rpm, 0.6 amp and 115 v.

2. The shaft is solid stainless steel, 1.27 cm in diameter and 33 cm long, attached to the motor shaft at one end by two 0.32 cm set screws and to the plastic spinner at the other. Stainless steel is heavy, putting a load on the motor, but it is important that the shaft be made of a noncorrosible, nontoxic material. Shafts made of hollow stainless steel have also been used successfully.

3. The spinner, made of light durable plastic, creates the mist in which the plant roots grow. The tip of the spinner dips into the nutrient solution sucking it up by centrifugal force. At the top of the spinner, fluid is forced out through small openings becoming vaporized. Such spinners are available from manufacturers of home humidifiers. Spinners used in our system were obtained from Northern Electric Co., P.O. Box 469, Waynesboro, Miss. 39367.

The box in which the plants are grown (Fig. 2) is made of 0.96 cm plywood with the following inside dimensions: 61 cm wide, 122 cm long, and 45.7 cm high. The box is lined with two layers of 4 mil polyethylene sheeting (either clear or black available at hardward stores). The top of the box consists of one piece of the molded plastic fluorescent light screening known as "egg crating" which is strong and rigid with 1.27 cm^2 compartments. Such screening is available at any large builder's supply outlet and comes in sheets 61 cm × 122 cm × 1.27 cm. The plastic screen is first covered with a sheet of 4 mil black polyethylene and then a layer of heavy duty aluminum foil (to reflect light and keep heat from building up inside the box). With a razor blade, holes are cut in the plastic foil covering at the intervals at which plants are to be spaced. For pea plants, the optimal spacing is 5.08 cm. For other plants, a different spacing may be needed. Plants should not be placed closer than 25.4 cm from the motor on any side. Plants placed closer than this will not receive enough mist to sustain growth in the early seedling stage.

The motor with its attached spinner is supported on the top center about 0.32 cm above the box on a frame made of a horizontal board supported at either end by two vertical boards (47 cm high). In this way the vibration of the motor is not transferred to the plants.

When fully assembled and supplied with nutrient solution, the tip of the spinner should just dip (1.27–1.9 cm) into the medium. Care must be taken to make sure that the spinner is always at least 1.27 cm into the solution and that no obstruction of the orifice at the bottom occurs. Regular cleaning of the spinner after each period of use is necessary.

Plants grow well in aeroponics, primarily because of the highly aerobic environment it creates for plants (Fig. 3). Unlike water culture, plants grown aeroponically always show good root hair development, which is an extremely important consideration in nodulation studies. In this regard, it also provides for uniform

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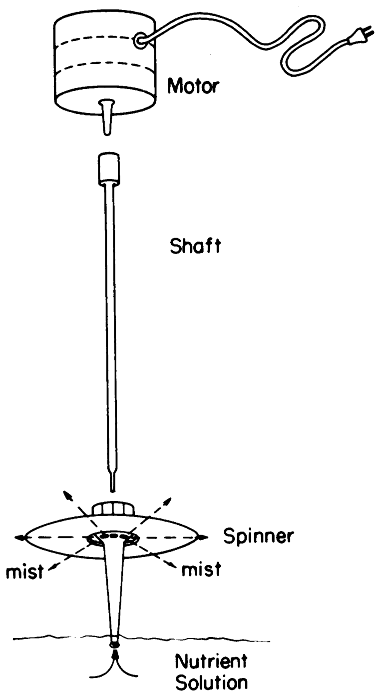

FIG. 1. Mechanical components of the aeroponics system. See text for details.

inoculation of the system with *Rhizobium*. Infection is achieved simply by introducing a suspension culture of the bacterium into the nutrient pool. Most important, the aeroponics system makes it possible to examine completely intact root systems without disturbing or damaging them, and to obtain clean samples for chemical or histological work without interference from mechanical substrates.

Successful cultivation of the following plant species has been achieved: *Pisum sativum* L., *Vicia faba* L., *Arachis hypogaea* L., *Glycine max* (L.) Merrill, all with effective rhizobial nodulation; *Casuarina cunninghamiana* Miq., a tree species and *Comptonia peregrina* Coulter, a brush species, with effective nodulation; and *Helianthus annuus*. One-eighth strength Hoagland's solution (2)

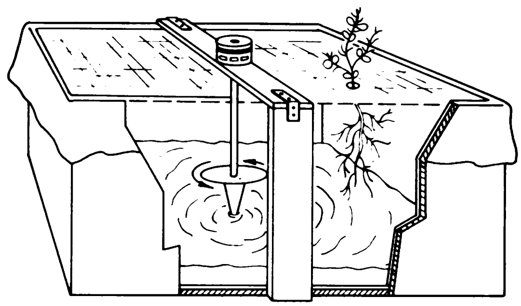

FIG. 2. Diagrammatic cut-away view of the aeroponics box for growing plants. The diagram is not drawn to scale but shows the relationships of the parts.

FIG. 3. View looking into the aeroponics box, showing the root systems of pea plants at about 3 weeks from planting. This lot of plants was not inoculated with *Rhizobium*.

lacking nitrogen was used in the nodulation studies and the complete mixture (one-eighth strength) of inorganic elements for other plants without nodulation.

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