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Observations on a Noncirculating Hydroponic System for Tomato Production

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Abstract. **Tomatoes (*Lycopersicon esculentum* Mill.) were grown in a noncirculating hydroponic system and also in conventional soil beds. Yields from the two cultural systems were statistically similar, i.e., 3.5 kg/plant in the hydroponic system and 3.1 kg/plant in the soils beds.**

Hydroponic culture provides an alternative to growers in the tropics who are plagued with soil-related problems such as nematodes, diseases, and nutrient imbalances. Most hydroponic methods currently used require aeration or circulation of the nutrient solution to provide optimal conditions for aerobic respiration by roots (3). Equipment costs and external power requirements for these systems are high. Further, plant survival often depends on the continued proper operation of mechanical equipment and on an uninterrupted electrical supply. The latter is a luxury unknown in many tropical agricultural areas.

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Arnon and Hoagland (1) grew tomatoes successfully with a passive hydroponic technique whereby aeration was achieved by positioning the tank cover 50 mm above the nutrient solution level. However, yields were about 25% lower than when the solution was mechanically aerated. Imai (2) increased the spacing between the tank cover and the nutrient solution to 0.12 to 0.17 m and placed a net 10 to 20 mm above the nutrient solution. We endeavored to adapt Imai's method to greenhouse tomato production and to obtain yields comparable to those in conventional soil culture.

A polyethylene-lined earthen trough, 0.4 m deep × 0.4 m wide was filled to within 30 mm of the top with nutrient solution containing the following (mg·liter^{-1}): N (as NO_3), 173; P, 63; K, 213; Ca, 210; Mg, 47; Fe, 3; Mn, 1.1; Cu, 0.2; Zn, 0.4; B, 0.5; and Mo, 0.1. The solution-filled trough was covered with 6-mm-thick plywood painted with white latex paint (Fig. 1). Fiberglass window screen was clamped onto a rectangular 25-mm-diameter PVC pipe frame 0.35 m wide × 2.35 m long. This assembly was attached to the plywood cover with pipes so that it rested 0.10 m below the cover. The screen encouraged development of fine roots and also served as an anchor point to enable the roots to support better the plant.

'Vendor' tomato seedlings were grown in tapered rockwool cubes (625 mm^2 top × 225 mm^2 bottom × 40 mm deep). When the seedlings were 0.1 m tall (29 Sept. 1986), they were inserted into holes (23 mm diameter) drilled 0.3 m apart in the plywood cover so that the top 10 mm of the cube extended above the cover. Care was taken to ensure that the roots extended into the nutrient solution, which was allowed to recede through evaporation, absorption, and transpiration until its level was at or slightly below the level of the screen (0.1 m below the cover). In our tropical climate, several weeks usually are required for this change. Thereafter, addition of either water or nutrient solution may be needed once or twice a week to maintain the nutrient solution within 20 mm of the desired depth of 0.30 m. In another trial, plants continued to grow well even when the solution level gradually dropped an additional 80 mm, i.e., to a solution depth of 0.22 m. However, the sudden addition of 80 mm of water to restore the solution depth to 0.30 m caused the plants to wilt.

Roots were partitioned into oxygen and nutrient/water gathering components by exposing the upper portion of the root system to the humid air and by immersing the lower portion in the nutrient solution. Roots that were exposed to air became short and stubby whereas those immersed in nutrient solution became long and thin.

The technique for adding water or nutrient solution is especially important since there is no circulation in this system. Roots between the screen and the cover can be inadvertantly exposed to concentrated nutrient solution. This causes the plants to manifest symptoms of severe salinity damage. A nutrient-layering effect occurred when water alone was added from a single point above the screen. K levels at 30, 100, and 170 mm below the nutrient solution surface reached 104, 248, and 376 mg·liter^{-1}, respectively.

Yields of tomatoes growing in the noncirculating hydroponic system were compared with those of tomatoes growing in a soil bed (Manu silt loam) in a thrice-repli-

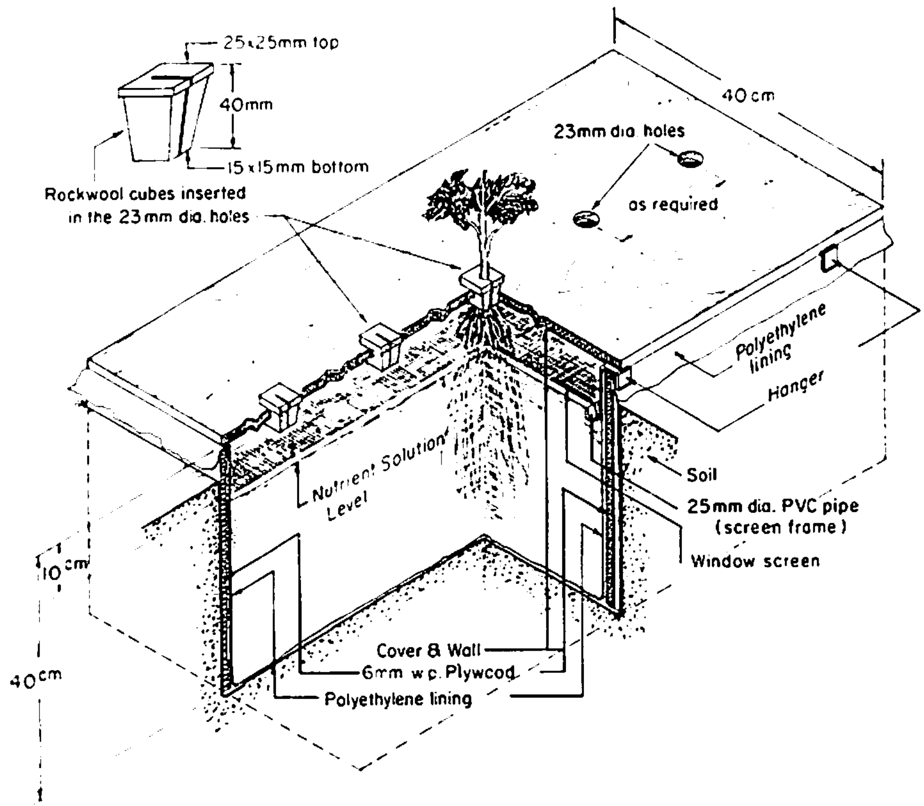

Fig. 1. A noncirculating hydroponic system.

cated greenhouse trial. The original concentrations of nutrients were maintained in the hydroponic trial by making five applications of a 10N–24P–8K fertilizer plus micronutrients, potassium sulfate, potassium nitrate, and calcium nitrate. Plants growing in the soil were given a preplant application of 75 g 7N–18P–5K and 15 subsequent applications of 5 g 12N–11P–21K plus micronutrients per plant. Yields of salable tomatoes from the hydroponic treatment (3.5 kg/plant ± 0.38 SE) and the soil bed treatment (3.1 kg/plant ± 0.23 SE) were similar during the harvest period (11 Dec. 1986 to 11 Feb. 1987).

More information is needed on the effects of air and nutrient solution temperature; the amount, level, and content of the nutrient solution; the physical design and optimal size for the tanks, and the physiological effects of nonaerated hydroponic culture on the plants. Although this noncirculating hydroponic system requires neither mechanical aeration nor circulation of nutrient solution, it permits tomato yields similar to those from soil-bed trials. It thus offers a simple and inexpensive system that should find widespread application and acceptance in intensive agricultural systems.

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