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Outdoor Sand–Nutrient Culture System

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Many different hydroponic systems and methods have been used for growing plants. This report describes an outdoor sand-nutrient culture system that has been used for more than 10 years to study the response of vegetables to inorganic nutrition under natural outdoor conditions and with controlled rooting conditions. The system is simple, dependable, and provides abundant aeration for plant roots.

Four independent plant-growing beds are located near the center of a 1-ha grass-sod area. A pumping or nutrient recirculating housing unit is located ≈50 m northeast of the planting growing beds.

Each system consists of a plant growing bed (or box) that supports the plants in sand-filled, bottom-perforated pots near the top of the box and that holds the nutrient solution in a reservoir in the bottom of the box (Fig. 1). A timer-controlled pump recirculates the nutrition solution from an outlet in the bottom of the box and returns the solution tubes to the plants in the pots. Each plant growing bed is 2.44 m (8 ft) square, and the sides are 61 cm (2 ft) high. Two sheets [1.22 x 2.44 m each (4 x 8 ft)] of exterior grade plywood 1.9-cm- (3/4-in) thick are used for the bottom. The center seam between the two sheets of plywood is held smooth by under-support of wood. The sides are also exterior-grade plywood. The bed is lined with a double-layer of 0.15 mm (6 mil) black polyethylene plastic. The bed is placed 51 cm deep into the soil with 10 cm remaining above the surrounding surface. Pots are held by plywood fitted inside the box and are supported 10 cm below the top of the sides by wood studs 5 x 10 cm (2 x 4 in) bolted through the sides of the box and by 11 equally spaced 5 x 10 cm cross supports between the rows of pots.

One hundred equally spaced (10 x 10 rows) circular holes 11.4 cm in diameter (with 10.8 cm between holes) were drilled in the plywood to hold the pots. The pots are lined with plastic window screen on the inside bottom half and filled with inert white silica sand to within 1 cm of the top. A coarse sand (4 Q-ROK) is used for rapid drainage.

An outlet line is connected through the plywood and plastic liner in the bottom of the bed and leads downward underground to the inlet side of a centrifugal electric pump. The pump is controlled by an electric timer so that the solution may be circulated at any desired interval of time. Generally, the solution is recirculated for 30 sec every 30 min during the daytime and for 30 sec every 2 hr during the night. The solution goes from the outlet side of the pump underground to the plastic distribution network on top of the bed to each of the 100 pots per bed. The distribution system is made of three rows of 1.91-cm black plastic pipe installed and secured across the bed between the pots with tubes 1.4 mm (i.d.) placed in each pot at a depth of 3 cm.

Seeds are pregerminated and planted into the sand. The tops of the pots are misted with water periodically to prevent the sand surface from drying until root growth and seedling emergence. Early in the growing season, the temperature of the solution in the beds may be below the minimum temperature for good germination of the seeds and growth of the seedlings. In order to raise the temperature of the solution, the solution is cycled continually through a water heater using a by-pass line direct into the bed without going to the plants, until the temperature of the solution in the beds reaches ≈17°C.

Four of these systems have been used to study the N (especially nitrate), P, and K nutrition of snapbean (*Phaseolus vulgaris* l. var *humulis*, spinach (*Spinacia oleracea* L.), and table beet (*Beta vulgaris* L.). These systems provide uniform and controlled rooting conditions to determine plant responses to weather, such as rate of growth and uptake and assimilation of nitrate N within plants as affected by solar radiation and air temperature. Also, the maximum rooting conditions are used in determining the genetic production potential of varieties and genotypes of vegetables.

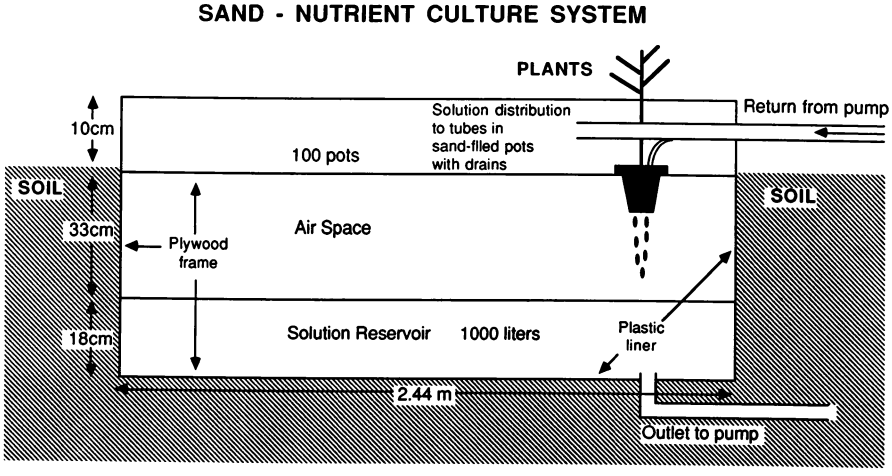

Fig. 1. Diagram of side view of system.

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