PROC. NAT. AGR. PLASTICS CONG 29: 210-215.

NON-CIRCULATING HYDROPONIC CUCUMBER PRODUCTION IN PLASTIC TRASH CONTAINERS AND POLYETHYLENE-LINED BARRELS

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Abstract: Plastic trash containers (120 liters) and metal barrels (208 liters) with polyethylene liners were filled with a complete nutrient solution at an electrical conductivity of 2.0 mS. Forestry tubes and plastic net pots containing 'Sweet Slice' cucumbers were transplanted in the containers which were supported by the top covers of the containers. No additional watering, fertilization or monitoring for pH or electrical conductivity was performed throughout the crop. The highest salable yields of cucumber fruit recorded in 5 trials were 7.25 kg for the 120 liter container and 10.63 kg for the 208 liter container. Cucumbers grew very well with this growing method even after the nutrient solution level fell below the bottom of the forestry tubes. Active growth continued until the nutrient solution was nearly depleted which means that the distance between the nutrient solution level and the bottom of the forestry tubes or net pots exceeded 70 cm.

Keywords: cucumbers, non-circulating hydroponics, nutrient solution, rainshelter

CULTURE HYDROPONIQUE DE CONCOMBRES SANS CIRCULATION DANS DES RECIPIENTS DE PLASTIQUE POUR ORDURES ET DANS DES SACS DE POLYETHYLENE EN BARIL

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Résumé : Des sacs plastiques à ordures (de 120 litres) et des barils en métal (de 208 litres) munis de sacs de poubelle en polyéthylène ont été remplis d'une solution nutritive complète d'une conductivité électrique de 2,0 mS. Des tuyaux de sylviculture et des pots à maillage plastique contenant des concombres de la variété « Sweet Slice » ont été repiqués dans ces récipients et soutenus par les couvercles de ces derniers. Ni irrigation supplémentaire, ni fertilisation, ni vérification du pH ou de la conductivité électrique n'ont été effectuées pendant la culture. Le plus grand rendement de concombres commercialisables obtenu au cours de 5 essais a été de 7,25 kg pour le récipient de 120 litres et de 10,63 kg pour le récipient de 208 litres. Cette méthode de culture des concombres s'est montrée très efficace, même une fois le niveau de solution nutritive descendu en dessous du bas du tuyau de

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Introduction

There are numerous methods of growing greenhouse cucumbers in soil and hydroponic systems (1). Cucumbers were successfully grown in non-circulating hydroponic systems wherein 0.35 liter aluminum beverage cans, 3.8 liter plastic pots and rockwool blocks rested in a tank containing 5 cm of nutrient solution which was replaced as needed by the crop (2). Non-circulating hydroponic methods expose the upper root system to air with high humidity and yet allow the lower roots to gather water and plant nutrients (3). Lettuce was grown in forestry tubes supported by the top cover of a tank containing 75 mm of nutrient solution whereby no additional fertilization, watering or monitoring was required from transplanting through harvesting (3, 4, 5, 6). Similarly, a hydroponic kit consisted of 3 lettuce plants growing in forestry tubes supported by the lid of a 19 liter bucket and no attention was needed after transplanting until harvest time (5, 6).

Nutrient solution consumption for cucumbers growing by non-circulating hydroponic methods typically ranges from 18 to 40 liters/kg of fruit (2). Thus, plants spaced 60 cm apart in 30 cm wide tanks would require a nutrient solution depth of 50 to 110 cm for the whole crop to produce 5 kg of cucumbers per plant. It could be considered more prudent to apply this much nutrient solution incrementally in shallow, inexpensive tanks rather than bear the burden of building deep tanks with a substantial structure. However, there is a certain allure to the concept of making only one application of nutrient solution for the whole crop. This study will evaluate cucumber growth when all of the required nutrient solution for the entire crop was applied in 120 liter plastic trash cans or polyethylene-lined 208 liter metal drums prior to planting.

Materials and Methods

Trials were conducted in rainshelters at 1300 m elevation on the Island of Hawaii. Nutrient solution consisted of a ratio of 1:1:0.6 Hydro-Gardens Chem-Gro Cucumber Formula (8-7-30-0.05-0.05-0.20-0.10-0.01-0.05% N-P-K-B-Cu-Fe-Mn-Mo-Zn, respectively):calcium nitrate:magnesium sulfate added to rainwater such that the final concentration was equal to an electrical conductivity of 2.0mS. Plastic trash cans (120 liter) and metal barrels (208 liter) lined with polyethylene bags were filled to 3 cm from the top of the container and were covered with the stock plastic covers or 13 mm thick plywood painted white, respectively (Figure 1). 'Sweet Slice' cucumbers were seeded in a peat-perlite growing medium in 160 ml tapered forestry tubes (40 mm diameter and 218 mm deep) . Ten additional holes (6 mm) were added to the existing 4 oval holes (4 x 12 mm) on the lower part of the tubes and the 7 mm hole on the bottom of the tubes. After 3 to 4 weeks, the seedlings in the forestry tubes were transplanted into the top covers of the trash cans or plastic-lined metal barrels such that at least the bottom 25 mm of the forestry tubes were immersed in nutrient solution. No additional water or fertilizer was added.

Trials were terminated when the plants were excessively infected with disease or when the nutrient solution was nearly consumed. All trials had 1 plant per tube and 1 tube per container for the first 4 trials. In the fifth trial, 2 tapered net pots (40 mm diameter x 80 mm deep) were transplanted in each barrel.

Results and Discussion

Cucumbers proceeded to grow very well with this growing method even after the nutrient solution level fell below the bottom of the forestry tubes. Initially, plants were watered by capillary action, because the lower portion of the growing medium in the forestry tubes or net pots was submerged in nutrient solution. As the crop grew, the nutrient solution level dropped below the bottoms of the forestry tubes or net pots. However, roots extended downward into the nutrient solution and continued to absorb nutrient solution until it was nearly depleted. This means that in the case of a 208 liter barrel, the nutrient solution level at the end of the cropping period was more than 70 cm below the bottom of the forestry tubes or net pots and no mechanical assistance was required to nourish the plants.

Total salable yields of 9.56 kg/plant to 10.63 kg/plant were obtained from plants growing in 208 liter barrels in trials 1, 3 and 5 which were conducted during warm and favorable weather conditions (Table 1). Salable yields from plants growing in the 120 liter plastic trash cans were significantly lower in trial 1 (6.48 kg/plant), but not in trial 3 (7.25 kg/plant). The lower yields obtained in trials 2 and 4 were due to cooler temperatures.

The nutrient solution efficiency ratio for cucumbers growing in the 120 liter plastic trash cans was 16 liters/kg of salable fruit in trial 3 and this exceeded a ratio of 18 achieved in a previous experiment (2). Certainly, the maximum achievable yield with this growing system is limited by the amount of nutrient solution. We do not recommend adding more nutrient solution to the containers as the plants grow, because submerging that portion of the root system which has been acclimated to air may cause it to drown and the plant will wilt (3). Tomatoes are more sensitive to drowning than are cucumbers.

The coefficients of variability for cucumber yields ranged from 22.5 to 25.2 for the larger containers in trial 1, 3 and 5. This appears to be an excessively high variation, but data were based on only 6 to 8 plants in each trial and typically plant weight data from vegetables such as non-heading Chinese cabbage, Chinese kale and choy sum have been shown to require 16 to 20 samples to achieve a coefficient of variability of 10% or less (7).

This growing method has a number of advantages. Firstly, plastic trash cans, barrels and polyethylene liners are readily available. Only one application of water and fertilizer is needed. No monitoring or adjustments were made in pH and electrical conductivity in these trials and yet, high yields were obtained. A permanent trellis system could be established since there is no need to dismantle the trellis system to till soil beds. Weed control could be accomplished by a plastic weed mat or by applying a nonselective herbicide to the soil. In an open-field situation, placing a sheet of old roofing at an angle in the barrel would greatly increase the amount of rainwater collected. As soon as the barrels filled with water, fertilizer could be added and the crop cycle could begin. This hydroponic technique is ideal for elementary and high school projects, because the necessary materials are inexpensive and readily available and weekend watering is not needed.

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Table 1. Yield data from 5 trials wherein cucumbers were grown by a non-circulating hydroponic method in 120 liter plastic trash cans and 208 liter metal barrels with polyethylene trash liners.

Container	No. of Plants	Grade 1 kg/plant	Total Salable kg/plant	% CV[z]	Cull kg/plant
Trial 1 (Seed 8/25/97, Harvest 10/15 to 12/2/97)					
208 liter barrel	8	8.99 a[x]	9.56 a	22.5	0.62 ns
120 liter plastic can	5	6.12 b	6.48 b	28.2	0.83 ns
Trial 2 (Seed 1/6/98; Harvest 3/16 to 5/8/98)					
208 liter barrel	8	4.73 ns	5.41 ns	35.9	0.31 ns
120 liter plastic can	4	4.83 ns	5.00 ns	14.9	0.16 ns
Trial 3 (Seed 7/1/98; Harvest 8/19 to 9/30/98)					
208 liter barrel	8	8.82 ns	9.57 ns	23.5	0.87 ns
120 liter plastic can	4	6.64 ns	7.25 ns	11.8	0.51 ns
Trial 4 (Seed 11/13/98; Harvest 2/4 to 3/19/99)					
208 liter barrel	8	3.05 a	3.52 ns	37.2	0.63 a
120 liter plastic can	4	0.77 b	1.35 ns	3.1	0.32 b
Trial 5 (Seed 5/18/99; Harvest 7/8 to 8/13/99)					
208 liter barrel	6	7.20	10.63	25.2	0.81

[z] Coefficient of variability (8).

[x] Mean separation within columns by Duncan's multiple range test, $P \leq 0.05$.

Figure 1. A non-circulating hydroponic system for cucumbers.