

## Experimental Non-Circulating Hydroponic Methods for Growing Edible Ginger

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**Abstract:** Non-circulating hydroponic methods were tested as possible alternatives to growing edible ginger (*Zingiber officinale* Roscoe) without the use of methyl bromide. The highest ginger rhizome yields were obtained from upright 43 x 43 x 5 cm plastic nursery seed flats filled with growing medium and supported by upside down flats in tanks filled with 5 cm of non-circulating nutrient solution which was lowered to 4 cm after root formation. Slightly lower yields were obtained from 3.8 to 15 liter pots immersed in 5 cm of nutrient solution. Yields were increased when non-circulating hydroponic tanks were protected by plastic rain shelters and a shelter covered with spunbonded polypropylene (Typar).

**Keywords:** ginger, hydroponics, methyl bromide, nursery flats, pots, spunbonded polypropylene, rainshelters

### Introduction

Edible ginger (*Zingiber officinale* Roscoe) rhizomes are used as flavorings in Oriental recipes and as herbal medicines. The optimal growing season for ginger is 10 months (4). In Hawaii, ginger is typically planted from March to May and harvested from December to February.

Ginger fields are fumigated with methyl bromide prior to planting in an attempt to control root-knot nematodes (*Meloidogyne incognita*), *Fusarium* yellows and weeds (5). Rhizome development is enhanced by several hillings of soil during the growing season. This ensures a vertical growth habit by the rhizomes.

A non-circulating hydroponic growing method has potential to eliminate the need for methyl bromide in ginger culture. Previous work with non-circulating hydroponic systems has been reported on lettuce (1), tomatoes (2) and cucumbers (3) in each of which the harvested portion of the plant is above-ground. Hydroponic production of ginger rhizomes is challenging because the rhizomes grow below-ground.

The purpose of this study is to develop a non-circulating hydroponic method for growing ginger rhizomes without the use of methyl bromide which would present an alternative to the current method.

## Methods and Materials

Experiments were conducted on the Island of Hawaii at experiment stations at Kona (500 m elevation), Mealani (800 m elevation), Volcano (1300 m elevation) and Waiakea (150 m elevation). Treatments consisted of planting disease-free ginger rhizomes by the sub-irrigation pot method in pots perforated with 1 cm apertures (2), in upside-down plastic 43 x 43 x 5 cm plastic nursery seed flats without growing medium, and in plastic nursery seed flats filled with growing medium and placed upon upside-down nursery flats (Fig. 1). These containers were placed in polyethylene-lined tanks (60 cm wide and 10 to 15 cm high) and filled with a 5 cm depth of nutrient solution consisting of water plus Chem-Gro 4-18-38 (plus calcium nitrate and magnesium sulfate) or Steiner 8-5-16 hydroponic fertilizer at an electrical conductivity of approximately 1.5mS. After roots had formed, the nutrient solution level was decreased to 4 cm. Polyethylene topcovers, placed over the tanks, were either slitted for shoots to emerge (nursery flat treatments) or an opening was made for pot treatments. Growing medium consisted of peat, vermiculite and perlite.

**Kona trial.** Polyethylene pot capacity was 15 liters. In an attempt to simulate hilling, growing medium was heaped on the elevated plastic nursery flats during the cropping period. Tanks were placed outside, in a fiberglass-covered rainshelter and in a shelter covered with spunbonded polypropylene (Tyvar). There were 2 tanks containing 3 replicates of each treatment at each of these sites and these were arranged in a randomized complete block design.

**Malani and Volcano trials.** Polyethylene pot capacity was 3.8 liters. Tanks were placed in a polyethylene-covered (Malani) or fiberglass-covered (Volcano) rainshelter. Tanks (3.9 m long) were arranged as randomized complete blocks with 3 replicates (Malani) or 4 replicates (Volcano).

**Waiakea trial.** Polyethylene pot capacities were 0.8, 3.8 and 7.5 liters. Tanks were placed outside except for one treatment which was covered with a 1.7 m high polyethylene-covered rainshelter. Three treatments were placed in a tank with 15 and 20 cm high sides and a sloped roof so that rain would run off; there was a 5 cm opening at the top of the roof for shoot emergence. The other treatments were placed in tanks with 10 cm sides as described above. Tanks were 2.6 m long and there were 4 replicates of each tank arranged in a randomized complete block design.

## Results and Discussion

The highest yielding plots were located at the Kona site (Table 1), and these were planted the earliest. The lowest yields were obtained from the Waiakea site (Table 3) which were planted the latest in the season.

An upside-down plastic nursery seed flat provides an inexpensive support for a nursery flat filled with growing medium (Fig. 1). This method decreases the amount of growing medium which is needed, and thus decreases the labor to handle the material. Surprisingly, the cost of commercial growing medium required to fill a nursery flat costs twice as much as the nursery flat. Plastic nursery flats are not corroded by nutrient solution and can be reused.

The nursery flats with growing medium outperformed flats without medium in all experiments (Tables 1, 2, and 3). Ginger seed pieces in trays without medium were slow

to sprout and the resulting rhizomes were small and knobby as compared to plump rhizomes from nursery flats with growing medium.

Ginger yields were significantly higher from nursery flats with growing medium than from pots in the Mealani trial (Table 2). In all the other trials, ginger yields from nursery flats with medium were higher, but statistically similar to pots.

Since ginger is normally grown outdoors in Hawaii at high rainfall locations, non-circulating systems were placed under both outdoor and rainshelter-protected conditions. Ginger growing outside at the Waiakea site (Table 3) was exposed to an average of 31 cm of rainfall per month (208 cm during the growing season). Yields from ginger growing in pots nearly tripled when the tanks were protected by a polyethylene rainshelter. Ginger growing outside in the Kona trial (Table 1) was exposed to an average of 18 cm of rainfall per month (151 cm during the growing season). Yields were lower, but not significantly, than ginger growing in a fiberglass-covered rainshelter. However, the light levels in this rainshelter were reduced by over 60 per cent due to the age of the fiberglass and this probably decreased the yields in the rainshelter. Rainshelters prevented rain from diluting the nutrient solution and this was particularly evident at the high rainfall Waiakea location. Temperatures are usually higher in rainshelters and this is beneficial for ginger growth. Thus, rainshelters are beneficial for ginger production with the presently tested non-circulating hydroponic methods.

"Tank A" (Table 3) was designed with a sloped top cover which would repel 90 percent of the rainfall and a 5 cm wide slit for ginger emergence. Since this tank design resulted in exposure of termicide treated lumber to rainfall, herbicidal chemicals leached from the lumber into the nutrient solution and caused lower ginger yields from the trays and pots. Although this tank design was unsuccessful, future research should attempt to develop non-circulating hydroponic methodology which would improve outdoor production of ginger.

Ginger yields from a spunbonded polypropylene (Tyvar) covered structure were significantly higher than outside-grown ginger, but these yields were not significantly higher than from a fiberglass-covered rainshelter with less than 40 percent light transmission (Table 1). Although the Tyvar allowed rainfall to dilute the nutrient solutions and reduced light transmission by 25 percent, ginger yields were higher than outdoor culture and some of this may have been associated with air temperatures which were up to 9C higher in the Tyvar structure than outside.

Field-grown ginger is hilled to encourage a vertical growth habit of the rhizomes. Hilling was not practiced in these trials except for the Kona plastic nursery tray treatments which were slightly hilled. A horizontal growth habit resulted and this is acceptable for seed production. However, a vertical growth habit is preferable for the marketplace. Future experiments will be conducted whereby growing medium will be added to pots and nursery flats during the growing season to simulate hilling of ginger.

### Conclusions

The highest ginger rhizome yields were obtained from upright plastic nursery seed flats supported by upside-down nursery flats in tanks filled with 5 cm of non-circulating nutrient solution which was lowered to 4 cm after root formation. Yields were increased when non-circulating hydroponic tanks were protected by shelters covered with polyethylene or spunbonded polypropylene (Tyvar).

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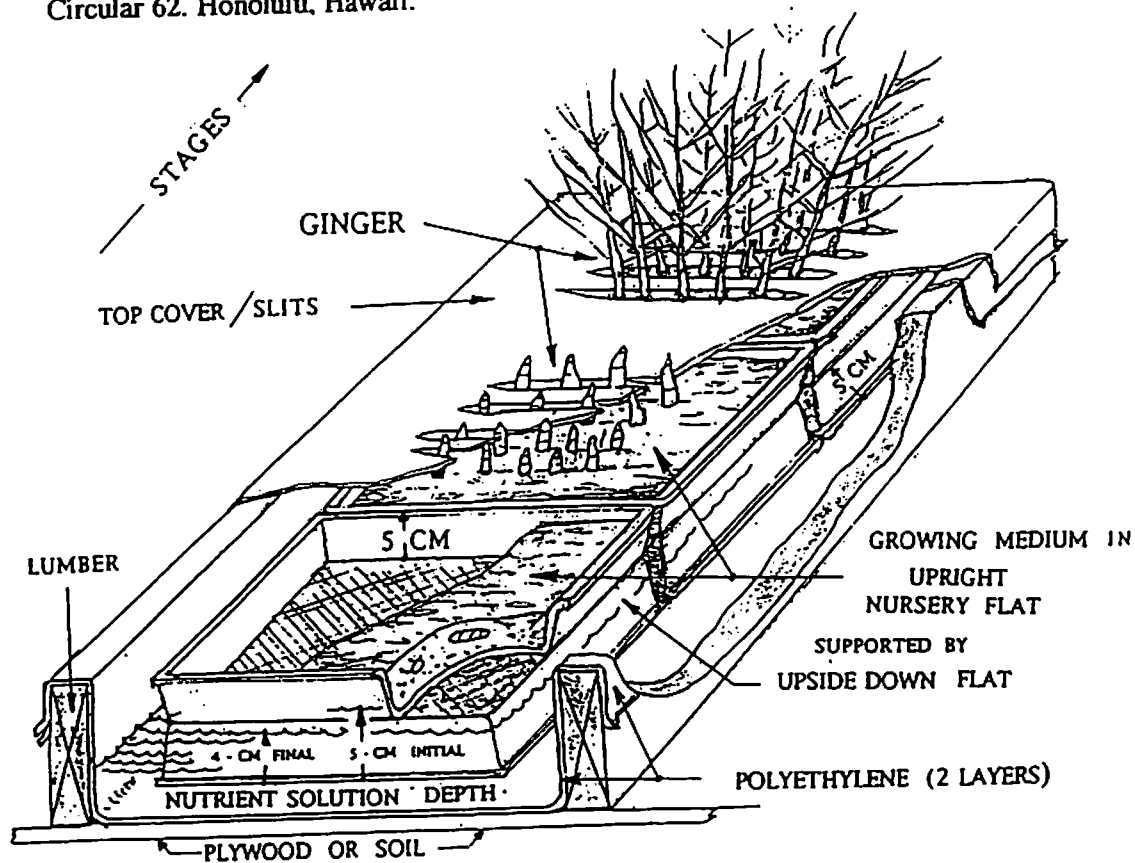


Figure 1. Growing edible ginger in a plastic nursery seed flat filled with growing medium and placed upon an upside-down plastic nursery flat in a tank with 5 cm (at planting) or 4 cm (after root formation) of non-circulating nutrient solution.

Table 1. Yields of ginger rhizomes grown in 15 liter pots and nursery flats with and without growing medium in a non-circulating hydroponic system located outside, in a fiberglass-covered rainshelter and in a structure covered with Typar at the Kona Experiment Station.<sup>1</sup>

<u>Container</u>	<u>Rainshelter</u>	<u>Outside</u>	<u>Typar cover</u>	<u>Average</u>
		kg rhizomes/m of row		
Nursery flat with medium	10.08	7.13	8.92	8.70 A <sup>2</sup>
Nursery flat without medium	2.21	3.83	5.14	3.72 B
15 liter pot	8.35	7.11	8.27	7.90 A
Average	6.89 ab <sup>2</sup>	6.01 a	7.44 b	

<sup>1</sup>Planted - May 13, 1996, Harvested - Jan. 27, 1997.

<sup>2</sup>Mean separation of averages by Duncan's New Multiple Range Test p.05

Table 2. Yield of ginger rhizomes grown in 3.8 liter pots and nursery flats with and without growing medium in greenhouses located at the Mealani and Volcano Experiment Stations.

<u>Container</u>	<u>Mealani Exp. Station<sup>1</sup></u>	<u>Volcano Exp. Station<sup>2</sup></u>
	kg rhizomes/m of row	
Nursery flat with medium	3.76 c <sup>3</sup>	1.82 b
Nursery flat without medium	0.74 a	0.20 a
3.8 liter pots	2.41 b	1.47 b

<sup>1</sup>Planted - May 30, 1996, Harvested - Feb. 26, 1997.

<sup>2</sup>Planted - June 13, 1996, Harvested Feb. 28, 1997.

<sup>3</sup>Mean separation within columns by Duncan's New Multiple Range Test p.05.

Table 3. Yield of ginger rhizomes grown in pots and plastic nursery flats by non-circulating hydroponic methods in an outside location at the Waiakea Experiment Station.<sup>1</sup>

<u>Container</u>	<u>Condition</u>	<u>Tank</u>	<u>kg/m of row</u>
3.8 liter pot		A <sup>2</sup>	0.36 ab
3.8 liter pot	-	B <sup>3</sup>	0.61 bc <sup>4</sup>
3.8 liter pot	rainshelter	B	1.71 d
7.5 liter pot	-	B	0.62 bc
0.8 liter pot	-	B	0.33 ab
Nursery flat	+ medium	A	0.16 a
Nursery flat	+ medium	B	0.77 c
Nursery flat	no medium	A	0.08 a
Nursery flat	no medium	B	0.33 ab

<sup>1</sup>Planted - Sept. 9, 1996; Harvested - April 1, 1997.

<sup>2</sup>Tank A - sides are 15 and 20 cm high, respectively, and there is a 5 cm slit in topcover.

<sup>3</sup>Tank B - Standard tank design with 10 cm high sides.

<sup>4</sup>Mean separation by Duncan's New Multiple Range Test p.05.