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GREENHOUSE TOMATOES IN LOW-TECH NON-CIRCULATING WATER CULTURE

R. V. TYSON
University of Florida, IFAS
Seminole County Cooperative Extension Service
250 W. County Home Road
Sanford, FL 32773-6197

K. W. KING
Seminole Community College, Biological Sciences
100 Weldon Boulevard
Sanford, FL 32773-6199

J. M. WHITE
Central Florida Research and Education Center-Sanford
University of Florida, IFAS
Sanford, FL 32771-96087

J. A. GARGIULO
Seminole County Department of Corrections, Horticulturist
211 Bush Boulevard
Sanford, FL 32773

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Abstract. **Greenhouse tomatoes (*Lycopersicon esculentum* Mill.) were grown in a glass greenhouse at the Seminole Community College Horticultural Unit in Sanford, FL for two growing seasons (1996-97, 1997-98) to determine the feasibility of a passive non-circulating, low-tech water culture system. Water and nutrients were added to troughs lined with 6-mil poly and covered by 4' × 8' insulation panels. Tomatoes in 4" azalea pots were placed in holes on the panels so that the bottom of the pots barely touched the water. An air space was maintained below the panel. Marketable yields during 13 weeks of harvest averaged 13.6 lbs. per plant the 1st season and 9.4 lbs. per plant the 2nd season. Marketable yields and plant vigor declined when daytime greenhouse temperatures were consistently over 90°F in June of 1997 and May of 1998. No significant yield differences were found between tomato cvs. Trust and Match. Suspending a screen in the water for root attachment did not significantly affect yields. The simple system design and maintenance makes it suitable for homeowner, hobbyist, or school demonstration applications provided that ideal temperatures for greenhouse tomatoes can be maintained.**

Introduction

New passive hydroponic systems were developed at the Asian Vegetable Research Center in Taiwan (Anon., xxxx) and studied further by B.A. Kratky and colleagues at the University of Hawaii (Kratky et al., 1988; Kratky, 1993; Kratky, 1996). These systems are low tech and relatively inexpensive compared to traditional hydroponics. Preliminary work in Florida (Fedunak and Tyson, 1997) found that short season lettuce crops performed well in a passive hydroponic system.

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The working principles of the passive hydroponic systems are that a portion of the plants roots must be suspended in air with high humidity or in aggregate containing air (air roots) allowing the absorption of oxygen by the plant. The rest of the roots are in water, absorbing nutrients and water (water roots).

Arnon and Hoagland (1940) grew tomatoes in a passive hydroponic system where the aeration was achieved by maintaining a 50mm air space above the nutrient solution. However, yields were about 25% less than those obtained when the solution was mechanically aerated. Tomato yields from a non-circulating hydroponic system were similar to yields obtained from conventional soil beds in another trial (Kratky et al., 1988). However, these yields were only half of those obtained in hydroponic greenhouse trials in Florida (Hochmuth et al., 1993).

The purpose of this study was to determine the feasability of producing a long-term crop like greenhouse tomatoes in a passive hydroponic system using several leading Florida varieties and grown under local conditions.

Materials and Methods

Two hydroponic growth frames were constructed from 2' × 6' pressure treated wood. Each frame was 18 feet long and 3½ feet wide. Six mil polyethylene plastic sheets were laid in the troughs and water was added to a depth of 4 inches. The plastic was then stapled to the 2 × 6 frame. For the screen treatments, a nylon window screen was stretched across a rectangular frame made with 2-inch PVC pipe and submerged in the troughs.

Nutrients derived from Masterblend hydroponic mix, calcium nitrate, and magnesium sulfate were added to the troughs in a ratio of 2-1-1 respectively until the soluble salts measured 2,000 μS/cm. Phosphoric acid was then added until the pH was 5.5. Thereafter, nutrients and pH adjustment were made in a separate 110 gallon mini bulk tank and added to the troughs as needed by hand with a watering can or with a Little Giant submersible pump. Soluble salts were allowed to fluctuate between 1,500 and 3,000 μS/cm and pH between 5.0 and 6.5.

Each frame was covered by a 4' × 8' × ½ inch silver reflective insulation panel. Four-inch diameter holes were drilled into the panels. Tomato seeds were planted into 4-inch azalea pots filled with perlite, thinned to one plant per pot, and subirrigated for six weeks in a separate growing area before being set in the troughs. Four slits were made down the sides of the pots with a razor knife to accommodate root growth outside the pots, and the pots were placed in the insulation panel holes. Water levels were regulated so that ½ inch of the pots were in the water until noticeable root development, then water levels were gradually lowered to a 2-3 inch depth and maintained there for the rest of the season.

In experiment 1, 'Trust' and 'Match' tomato seeds were planted on November 1, 1996. Harvest began on March 17 and ended June 13, 1997. For the variety treatments 4 plants were arranged in a completely randomized design while for the screen treatments a split block design with two replications

Table 1. Total marketable tomato yields, fruit number and size, and final plant height.

Treatment	Tot. Mkt. Yield Per Plant (lbs.)	Tot. Fruit No. Per Plant	Avg. Fruit Size Per Plant (oz.)	Final Plant Height (inches)
		Experiment 1		
Trust	13.3	38.1	5.6	168
Match	13.0	36.8	5.7	172
Significance[Z]	NS	NS	NS	NS
Screen	13.6	38.9	5.6	170
No Screen	12.6	36.1	5.6	171
		Experiment 2		
Screen	9.4	22.5	6.7	149
No Screen	9.2	22.6	6.5	142
Significance[Z]	NS	NS	NS	NS

[Z]NS indicates a nonsignificant response.

and 5 tomato plants in each plot was used. In experiment 2, 'Trust' tomato seeds were planted on September 17, 1997. Harvest began on February 2 and ended on May 1, 1998. Experiment 2 was a completely randomized block design for the screen treatments with 3 replications and 4 plants per plot. For both experiments, all plants were grown in a 1,600 sq. ft. Holland style glass greenhouse with a pad and fan cooling system and white glazing on the glass to reduce light by about 25%.

Results and Discussion

There was no significant difference between 'Trust' and 'Match' with regards to total marketable tomato yield, fruit number and size, and final plant height in experiment 1 (Table 1). During the thirteen weeks of harvest, the largest yield was obtained by 'Trust' in week 4 (Fig. 1). Average yields for both varieties were (one pound per plant per week. Because there were just 2 replications on the screen treatments, statistics were not run on this data. However, yield trends were similar to those for the variety treatments (Fig. 2). It appeared that providing a screen for root attachment may increase total marketable tomato yields (Table 1).

Experiment 2 was conducted to determine if providing a screen in the trough for root attachment increased tomato yields compared to no screen. However, there was a significant difference between screen and no screen treatments for tomato yield (Fig. 3) or for overall performance (Table 1).

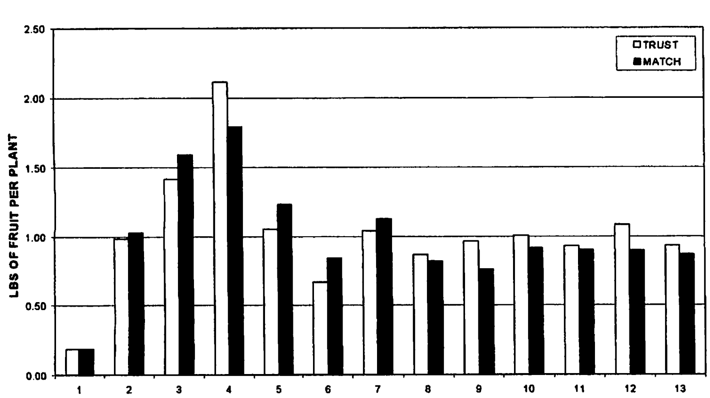

Figure 1. Tomato yield by week for varieties Trust and Match, Exp. 1.

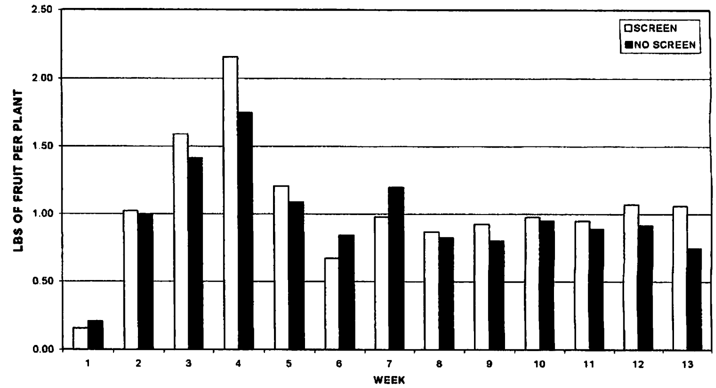

Figure 2. Tomato yield by week for treatments "Screen" and "No screen." Exp. 1.

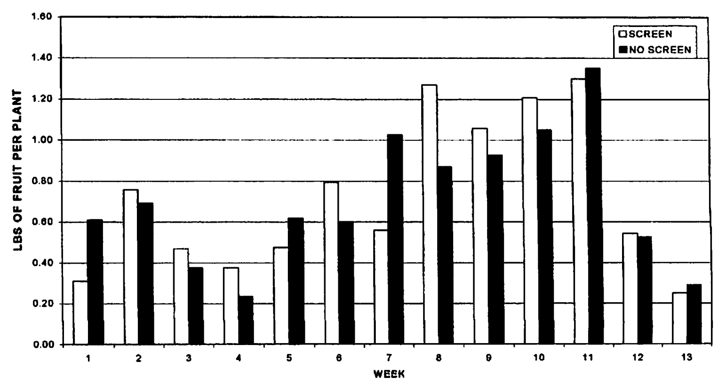

Figure 3. Tomato yield by week for treatments "Screen" and "No screen." Exp. 2.

The results of this study indicate that greenhouse tomatoes can be grown successfully in a passive low-tech hydroponic system. Marketable tomato yields averaging from ¾ to 1 pound per plant per week can be obtained for a period of 13 weeks. Marketable yields and plant vigor declined when daytime greenhouse temperatures consistently exceeded 90°F in June of 1997 and May of 1998. Greenhouse temperatures ranging between 60°F and 85°F are ideal for tomatoes. Short duration temperature fluctuations outside this range are acceptable but consistently high or low temperatures significantly affect plant vigor and yield.

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