Evaluation of Soilless Media for Strawberry Production in Vertical and Horizontal Systems under a Nethouse

Teresa P. Salame and Bielinski M. Santos*
University of Florida, IFAS, Gulf Coast Research and Education Center, 14625 CR 672, Wimauma, FL 33598

Additional index words. Fragaria xanana, coconut coir, pine bark, perlite, peat moss, net house

Florida strawberries (Fragaria xanana) are commonly grown in sandy soils in open field conditions. Protective structures are used to improve strawberry yield and quality, which has led to a significant increase in this practice in Florida. Prices of structures are high and there is a need to find the appropriate combination of production systems to increase the space use efficiency, which maximizes strawberry yields. Soil fumigants and land preparation are costs that also could be reduced by using soilless strawberry culture. Two preliminary studies were conducted to determine the performance of four different soilless media under two production systems. In one study, a soilless horizontal system (wooden boxes) was set up with different media (pine bark, coconut coir, potting mix, and perlite). In the other study, a vertical (Vertigro®) soilless system was used with the same four media. The results indicated that for the horizontal system, there were no significant differences among treatments for early and total fruit number and weight. In the vertical production system study, there were no significant differences among soilless media for early fruit number and weight, and for total fruit weight. However, the total fruit numbers were the highest in pots filled with either coconut coir, potting mix or perlite.

Strawberry is one of the most important small fruit crops throughout the world. Florida has the second largest production value in the U.S., generating more than $350 million from 9,900 acres (U.S. Department of Agriculture, 2011). Most Florida acreage is established in Hillsborough County using the annual hill system, in which raised planting beds are fumigated for soilborne pest control, irrigated with drip lines, and covered with polyethylene mulch. In this part of the state, strawberries are produced in deep sandy soils with rapid infiltration, very low organic matter, and high water table. The nutrient leaching potential of these soils is relatively high, which has important environmental and crop production implications. Open-field production of strawberry uses large water volumes for plant establishment, crop maintenance, and freeze protection. For plant establishment, bare-root transplants are set into mulched beds and sprinkler-irrigated for at least 8 d with an estimated water volume of 60,000 gal/acre for 8 h of irrigation (2.2 acre-inches/acre for 8 h or 17.6 acre-inches/acre for 8 d). This water volume is almost equivalent to the amount needed to maintain the crop during the whole planting season (about 14 acre-inches/acre). For freeze protection, the same sprinkler irrigation system (4 to 5 gal/min per sprinkler) is used between 12 to 14 h for each freezing event.

Currently, alternative production systems are being tested and implemented by growers and rural home owners to produce strawberry and vegetable crops. These consist of soilless (hydroponic) systems, which could be either vertical or horizontal. These systems may provide several advantages from the environmental and economic standpoint in comparison with the open-field production system: a) reduced irrigation volumes and nutrient leaching because watering is more focused with smaller groundwater volumes, while leaching is controlled more effectively by recirculating nutrient solutions and/or planting a second crop at the bottom of each vertical unit; b) the use of strawberry plug transplants considerably reduces establishment water volumes (estimated as more than 80% reduction) compared with bare-root plants; c) reusable growing media (i.e., pine bark and coconut coir) that reduces the cost for future seasons; d) higher yield per plant as has been widely demonstrated throughout the world with strawberry and other crops; e) elimination of soil fumigation because most growing media do not accumulate soilborne disease inocula, thus eliminating high associated labor and equipment costs (i.e., tractors, bedders, fumigation rig, and knives); and f) efficient use of limited space/land because more than 46,400 plants/acre could be established in 1 acre of vertical soilless culture, whereas it would take almost 3 acres for the same number of plants in the traditional open-field system. Some of the possible drawbacks of these systems are high initial set-up costs, which might be offset by higher yield per plant and/or reduced unit costs prorated over time, and the need for retraining and educating growers and field personnel on the differences between the systems, namely changing from “extensive” to “intensive” agriculture.

Among the several growing media available for use on soilless systems; there are the traditional materials such as sand, gravel, and volcanic rock; manufactured materials, including rockwool and perlite; and others of organic origin, such as pine bark, coconut coir, and rice hulls (Hochmuth and Hochmuth, 2012). The chemical and physical properties of the soilless media will vary depending on the origin of the materials, their structure, water and nutrient retention, and microbial activity. Two preliminary studies were conducted to determine the performance of strawberry grown in soilless media in the horizontal and vertical production systems.

Materials and Methods

Two preliminary studies were conducted from Oct. 2011 to Feb. 2012 at the Gulf Coast Research and Education Center in Balm, FL, to determine the performance of four soilless media...
under two production systems. The trials were conducted under a closed 1200-ft² nethouse structure with white, antivirus, 50-
mesh insect net (American Farm Systems, Jemison, AL). The
structure was built using wooden poles for support, 12 ft tall in
the center and 8 ft at the sides. Two soilless systems were used:
a) a horizontal system, which consisted of wooden boxes with a
volume of 42 gal per box, and b) a vertical system with three
levels of 1-gal containers per plot (Verti-Gro® Hydroponic Grow-
ning Systems, Summerfield, FL). The media used were fine-grade
cocnut coir (Botanicoir, London, UK), 1-inch-diameter pine
bark (Elixon Wood Products, Starke, FL), perlite, and potting
mix (65% sphagnum peat moss + 35% perlite, vermiculite, and
dolomitic limestone; Fafard 2, Fafard, Agawam, MA).

Bare-root ‘Strawberry Festival’ strawberry transplants from a
Canadian nursery were planted in Oct. 2011. No preplant fertilizer
was used. After transplanting, overhead irrigation was used for 8
h/d for the first 10 d to ensure plant establishment. Fertilization
and pest control were done according to the requirements of the
crop (Santos et al., 2011). For the vertical system, fertigation
was applied through a single emitter per tower (250 mL/min),
while two drip tape lines were used for the horizontal system
(0.23 gal/100 ft per min). The nethouse area was equipped with
4 gal/min sprinklers for frost protection and crop establishment.

Treatments consisted of the four soilless media for each separate
experiment (vertical and horizontal systems). The experimental
design for each experiment was a randomized complete block
containing four replications and 12 plants per plot. Leaf greenness
was measured with a SPAD-502 (Minolta, Ramsey, NJ). Numerical
SPAD (Soil Plant Analysis Development) values range between
0 and 80, with 80 = dark green. These values are used to estimate
chlorophyll content in leaves. Leaf greenness was taken from
five mature leaves per treatment at 6, 12, and 18 weeks after
transplanting (WAT). A mature, marketable strawberry was a fruit
averaged 7.2 fruit per plant and 121.4 g/plant for fruit number and
weight, respectively, whereas each plant produced approximately
46 fruit and 784 g during the season. These results indicate that

Marketable fruit weight and number were collected two times
per week for a total of 25 harvests during the season. Early yield
was considered to be the fruit weight and number for the first six
harvests, and the total yield included all the harvests. Harvesting
data were analyzed using the general linear model procedure.
Treatment means were separated using Fisher’s-protected least
significant difference test at the 5% level.

### Results and Discussion

For the vertical growing system, there were no significant
differences for leaf greenness at 6, 12, and 16 WAT among all
treatments, with SPAD values ranging from 37.4 to 48.4 (Table
1). For early yield, there were no significant differences among
treatments for fruit number per plant, with an average of 9.6 fruit
per plant, but there were significant differences among treatments
for early fruit weight. There were no early fruit weight differences
among containers filled with coconut coir, potting mix or perlite,
ranging from 126.1 to 172.9 g/plant. Plants growing in pine bark
produced less early fruit weight than those growing in coconut
coir and potting mix. The potting media affected the total fruit
number and weight in the vertical system (Table 1). Containers
filled with coconut coir or potting mix had higher total fruit
number and weight than those filled with pine bark, averaging
34.2 fruit per plant and 548 g/plant, respectively.

In the horizontal system, there were marginal differences in
leaf greenness during the season with a media effect only at 12
WAT, when plants growing in perlite had the greenest leaves
in comparison with the other media (Table 2). There were no
significant differences among treatments for early and total fruit
numbers and weight per plant. For early fruit yield, treatments
averaged 7.2 fruit per plant and 121.4 g/plant for fruit number and
weight, respectively, whereas each plant produced approximately
46 fruit and 784 g during the season. These results indicate that

### Table 1. Effects of soilless media in a vertical production system on leaf greenness at 6, 12, and 16 weeks after transplanting (WAT), and early (6 harvests) and total yield (25 harvests) for strawberries in Balm, FL, 2011–12 season.

<table>
<thead>
<tr>
<th>Media</th>
<th>Leaf greenness (SPAD value)</th>
<th>Early yield</th>
<th>Total yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 WAT</td>
<td>12 WAT</td>
<td>16 WAT</td>
</tr>
<tr>
<td>Pine bark</td>
<td>43.3</td>
<td>44.5</td>
<td>45.2</td>
</tr>
<tr>
<td>Coconut coir</td>
<td>37.4</td>
<td>46.3</td>
<td>45.5</td>
</tr>
<tr>
<td>Potting mix</td>
<td>37.4</td>
<td>41.7</td>
<td>43.8</td>
</tr>
<tr>
<td>Perlite</td>
<td>45.3</td>
<td>48.4</td>
<td>46.6</td>
</tr>
</tbody>
</table>

P < 0.05

*S* Values followed by the same letters do not significantly differ at the 5% level, according to the Fisher’s-protected least significant difference test.

**ns** Nonsignificant and significant, respectively.

### Table 2. Effects of soilless media in a horizontal production system on leaf greenness at 6, 12, and 16 weeks after transplanting (WAT), and early (6 harvests) and total yield (25 harvests) for strawberries in Balm, FL, 2011–12 season.

<table>
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<tbody>
<tr>
<td></td>
<td>6 WAT</td>
<td>12 WAT</td>
<td>16 WAT</td>
</tr>
<tr>
<td>Pine bark</td>
<td>36.0</td>
<td>41.0 b</td>
<td>37.7</td>
</tr>
<tr>
<td>Coconut coir</td>
<td>34.2</td>
<td>40.2 b</td>
<td>39.5</td>
</tr>
<tr>
<td>Potting mix</td>
<td>34.7</td>
<td>41.6 b</td>
<td>39.4</td>
</tr>
<tr>
<td>Perlite</td>
<td>37.9</td>
<td>47.7 a</td>
<td>43.0</td>
</tr>
</tbody>
</table>

P < 0.05

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for vertical systems, coconut coir, perlite, and potting mix are reliable growing media for strawberry production in a nethouse. In contrast, these preliminary results suggest that for horizontal systems, all four growing media were appropriate to produce the crop at a commercial level. Although the two studies were conducted separately, the media, source of plants, timing, and cultural management were similar. In this case, the fruit yields in the vertical system were lower than those obtained in the horizontal system, which hinted at the need for modified fertilization, irrigation, and management practices for production in the vertical setting. Therefore, more research is needed to address the relatively low yields in the vertical system compared with the horizontal setting.

**Literature Cited**

