Greenhouse Strawberry Production In Tennessee?

Dennis Deyton*, Carl Sams, Dean Kopsell, John Cummins, Tina Hayden
Dept. of Plant Sciences, Univ. of Tennessee

Fumiomi Takeda
USDA-ARS, Kearneysville, WV

Presentation at Tenn. Fruit & Vegetable Growers Meeting
Jan. 2009
Presentation Outline

- Europe production
- Production systems
- UT research
  - Problems
  - Results
## Strawberry Production in Central and Southern Europe, 1999

<table>
<thead>
<tr>
<th>Country</th>
<th>Total surface (acres)</th>
<th>Protected cropping (acres)</th>
<th>Protected (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>6900</td>
<td>1280</td>
<td>18</td>
</tr>
<tr>
<td>Holland</td>
<td>5400</td>
<td>400</td>
<td>7</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>7900</td>
<td>1480</td>
<td>19</td>
</tr>
<tr>
<td>Germany</td>
<td>22900</td>
<td>50</td>
<td>&gt;1</td>
</tr>
<tr>
<td>France</td>
<td>12600</td>
<td>1030</td>
<td>8</td>
</tr>
<tr>
<td>Italy</td>
<td>17500</td>
<td>7470</td>
<td>42</td>
</tr>
<tr>
<td>Spain</td>
<td>24000</td>
<td>4900</td>
<td>20</td>
</tr>
</tbody>
</table>

Why Protected Cultivation of Strawberry in Europe?

Advantages

• Higher price
• Continuous supply to market
• Protection from rain, wind, hail
• Minimized herbicides, fungicides.
• Potential for IPM, organic

Disadvantages

• Higher cost of investment
• More intensive management

# Strawberries (2007 AgMRC report)

<table>
<thead>
<tr>
<th>Health:</th>
<th>High in antioxidants, vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumption</strong>:</td>
<td>5th in U.S. (after bananas, apples, oranges, grapes)</td>
</tr>
<tr>
<td>Fresh:</td>
<td>5.8 lbs/person, frozen: 1.8 lbs/person</td>
</tr>
<tr>
<td>Among highest increase rate of fruits and vegetables</td>
<td></td>
</tr>
<tr>
<td><strong>Production</strong>:</td>
<td>4th ($) U.S. fruit, after grapes, oranges, apples.</td>
</tr>
</tbody>
</table>

- **U.S.**: $1.7 billion ($1.6 billion fresh, 919,918 MT)
- **Calif.**: 1st, $1.3 billion, Peak shipping April-May
- **Florida**: $329 Million, winter
- **Mexico**: 71,517 MT @ $132 million

*http://www.agmrc.org/commodities__products/fruits/strawberries/commodity_strawberry_profile.cfm, Retrieved 1/14/09*
High Tunnel Production for Spring Crop

Advance harvest by 3 weeks


http://mtngrv.missouristate.edu/assets/commercial/high_tunnel_straw_web.jpg
High Tunnel Production for Fall Crop

Grower interest is high:
Up to $4.00/lb. in fall

Some Concerns:
• Availability of runner tips for summer transplant
• Winter survival in tunnels

Fumiomi Takeda, USDA/ARS
Greenhouse Strawberry Production - Holland
Greenhouse Strawberry Production - Holland
Container Types/Media Trials

Containers
• Pots
• Lay flat bags

Growing Media
• Perlite
• Pine bark
NFT, Pots in Pipe/Gutter

- Media: Perlite
- Pots: 3"

- Media: Perlite
- Pots: 5"
- Plants: 6” apart
- Gutter: 2 levels
## Carpenter Pots

<table>
<thead>
<tr>
<th></th>
<th>Lb/pot</th>
<th>g/berry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>2.3</td>
<td>10.6</td>
</tr>
<tr>
<td>Middle</td>
<td>0.6</td>
<td>8.3</td>
</tr>
<tr>
<td>Bottom</td>
<td>0.4</td>
<td>8.0</td>
</tr>
</tbody>
</table>
Research Objectives:

To evaluate:

1) Timing of plug plant establishment.
   • July - August

2) Cultivars for fall and winter production.
   • California, Florida, eastern cultivars
   • Spring flowering vs Day Neutrals

3) Pot size
   • 4” to 8” diameter

4) Bumblebee pollination

5) Biorational pest control

Funded by Southern Region Small Fruit Consortium
Tip Cutting Propagation
Production Pictures

‘Camarosa’ plants one week after transplanting into 6” pots (1.4 L)

Strawberry trial on 13 Nov.

’Chandler’ fruit on 28 Nov. 2006.
Irrigation

Amt needed for 10% running-out bottom
Growing Media

50% Perlite (Carolina Perlite Coarse # 20 )

+ 

50% Potting mix (FAFARD #1PV)
Fertility

Nutrient Solutions:
- Hydro-Gardens strawberry formula 8-12-32
- Calcium nitrate
- Magnesium sulfate
De-runner weekly
(1st 4 weeks)
Bumblebee Pollination
Pollen Food
Powdery mildew

Symptoms

• Gray powdery mycelium

Control

Sulfur:
• Spray vs dust
• 1.5 day residual effect on bees
Insect Monitoring
Aphid

**Symptoms**
- Curled leaves
- Reduced growth

**Biological Control**

*Predator*: Lady beetles
Symptoms

Predator: Midge, *Aphidoletes*

Biological Control

*Predator: Midge, Aphidoletes*

*Aphidend (Koppert), contains:*
black pupae mixed with vermiculite, 1,000 midges in hatch.

http://edis.ifas.ufl.edu/HS253
**Spider mites**

**Symptoms**
- Stippling of leaves, webbing
- Reduced growth

Two-spotted mite

[Link to Symptoms Image]

**Biological Control**

Predatory mite: *Phytoseiulus persimilis*

[Link to Biological Control Image]

Spidex (Koppert)
- 35 ml bottle contains 2,000 adults mixed with wood-chips

[Link to Biological Control Information]
White Fly

Symptoms
- Remove sap from leaves,
- Stunts plant growth
- Honeydew

Biological Control
Parasitic wasps
- *Encarsia formosa*
- *Eretmocerus eremicus*

Symptoms
- Remove sap from leaves,
- Stunts plant growth
- Honeydew

http://www.virtual.unal.edu.co/cursos/agronomia/2006631/lecciones/cap04/encarsia%20formosa.gif

http://www.nysaes.cornell.edu/ent/biocontrol/parasitoids/eretmomale.GIF
Enermix: *Encarsia formosa* + *Eretmocerus eremicus*

- 10 cardboard strips each with 5 cards wrapped in a box
- **Contains:** parasitized whitefly pupae, from which hatch 3,000 parasitic wasps
**Thrips**

**Symptoms**
- Damaged stamens, pollen
- Small, leathery berries

[Image of thrips damage and berries]

**Biological Control**

**Predatory mite:**
*Amblyseius cucumeris*,
Feeds on Immature thrips

[Image of Amblyseius cucumeris]

**Predatory bug:**
*Orius insidiosus*,
Feeds on thrips, aphids, spider mite

[Image of Orius insidiosus]

http://www.thebugfactory.ca/shop/images/Amblyseius%20cucumeris.jpg

http://insects.tamu.edu/images/insects/color/mpirate1.jpg

[Link to more information: http://ohioline.osu.edu/b861/pdf/ch02_37-41.pdf]
<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Flowering</th>
<th>Bred</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Evie-2’</td>
<td>Day-neu.</td>
<td>England</td>
</tr>
<tr>
<td>‘Carmine’</td>
<td>Short-day</td>
<td>Florida</td>
</tr>
<tr>
<td>‘Camarosa’</td>
<td>Short-day</td>
<td>Calif.</td>
</tr>
<tr>
<td>‘Ventana’</td>
<td>Short-day</td>
<td>Calif.</td>
</tr>
<tr>
<td>‘Chandler’</td>
<td>Short-day</td>
<td>Calif.</td>
</tr>
<tr>
<td>‘Darselect’</td>
<td>Short-day</td>
<td>France</td>
</tr>
<tr>
<td>‘Raritan’</td>
<td>Short-day</td>
<td>NY?</td>
</tr>
<tr>
<td>‘Northeaster’</td>
<td>Short-day</td>
<td>USDA</td>
</tr>
</tbody>
</table>
2006-2007 Results

**Pollination:** Bumblebees pollinated the flowers.

**Pest Control:** Aphids, spider mites and white flies controlled with predators

13 November- 31 December Harvest Period:
- The five cultivars propagated in July yielded approximately 35% more fruit than those propagated in August.
- ‘Carmine’ (July tip-cutting) had the highest yield (approximately 0.5 lb/plant).
- Plants from July tip cuttings of ‘Camarosa’, ‘Evie-2’, and ‘Ventana’ had approximately 0.4 lb/plant.

13 November - 13 April Harvest Period:
- ‘Evie-2’, ‘Carmine’, and ‘Camarosa’ yielded approximately 2 lb/plant
- ‘Venrana’ and ‘Chandler’ yielded slightly than above cultivars.
- ‘Raritan’, ‘Noreaster’, & ‘Darselect’ yielded less than 1.0 lb/plant – **unacceptable**

**Quality:**
- ‘Evie-2’ were relatively large but poor flavor, and ripened unevenly—**unacceptable**.
- ‘Carmine’ and ‘Camarosa’ had acceptable flavor and fruit size—**acceptable.**
- ‘Ventana’ had the best fruit quality.
2007-2008 Results

**Cultivars Tested:** ‘Camarosa’, ‘Carmine’, ‘Ventana’, ‘Albion’ and ‘Strawberry Festival’

**Pest Control:** Spider mites controlled with *Phytoseiulus persimilis*

White flies controlled with *Encarsia formosa*

Thrips not controlled adequately with *Encarsia formosa*

**Fall Yields:**
- Yields were relatively low for the fall (before 1 January) because of cultural factors.
- Cultivars propagated 1 July yielded about 75% more than those propagated 31 July.
- ‘Carmine’ yielded the most fruit during the fall.

**November through mid-April Yields:**
- ‘Ventana’ yielded the most fruit for the entire harvest period (about 1.3 lb/plant)
- ‘Carmine’ tended to have a higher percentage of its yield in the fall.
- ‘Carmine’ and ‘Camarosa’ yielded just over 1 lb/plant

**Quality:** All cultivars had acceptable quality, ‘Ventana’ the best.
<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Day Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>’Albion’</td>
<td>Day neutral</td>
<td>Calif.</td>
</tr>
<tr>
<td>’Nyoho’</td>
<td>Short day</td>
<td>Japan</td>
</tr>
<tr>
<td>’Palomar’</td>
<td>Short day</td>
<td>Calif.</td>
</tr>
<tr>
<td>’St. Festival’</td>
<td>Short day</td>
<td>Fla.</td>
</tr>
<tr>
<td>’Sw. Charlie’</td>
<td>Short day</td>
<td>Fla.</td>
</tr>
<tr>
<td>’Seascape’</td>
<td>Day neutral</td>
<td>Calif.</td>
</tr>
</tbody>
</table>
Findings

- Tip propagation: < mid-July
- Cultivars: Ventana, Carmine, Camarosa
- Pollination: Bumblebees
- Temperatures: < 90 °F
  - Goal of 70 °F day/60 °F night
- Disease problem: Powdery mildew
- Pest problem:
  - Mites most common
  - Thrips most difficult to control