30 Years of Strawberries

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Time Line

• Beginning
• Middle
• A New Beginning
Challenges

- Impure Benlate
- Anthracnose down South
- Grower Issues
- Plant Source Issues
- The Virus Problem
Sweet Charlie plants at full harvest with a positive diagnosis of Strawberry Mild Yellow Edge virus in a commercial field. Affected plants are stunted. All photos and diagnosis by Frank Louws North Carolina State University in 2004.
Opportunities

- Teaching thermodynamics
  - Heat of fusion of water
  - Heat of evaporation of water
- Teaching Meterology
  - Dew Point
  - Effect of Evaporative Cooling
The Crazy County Agent

- You only have to wash the frost off early in the morning.
- You just need to cover them up good with an ice blanket and then turn it off.
- Right!!
  - 1/10 inch of water per acre per hour with proper spacing and sizing of nozzles.
  - Dew point is critical to calculate when to turn on to avoid evaporative cooling.
Iced up Plant
Properly frost protected

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Frost Protection

- AHC strawberry plants bloom early in the year; recommendations are to begin saving bloom about 35 days ahead of anticipated opening of strawberry sales period (10 Feb – 15 Mar).

- Water continuously freezing on plants will protect open blooms into the teens (heat of fusion of water at 32° F going to ice at 32° F gives up a remarkable amount of heat energy to the surface on which the ice forms).

- Water volume needed will depend on the severity of the freeze (wind & temperature combination) and can be as great as 0.25 in/acre/hr.

- Water application can begin as early as 5 – 6:00 PM and continue until 9 – 10:00 AM for several days.

- Some years have multiple frost protection events.

- Potential water use can be very great – up 2.5 inches per acre per day.

Clemson Extension Service
Latent Heat of Water Shown for 1 Kg of Water (about 2.2 lbs or 1 qt)

The graph at the right shows the heat flow as water is heated from -58° F (-50°C) to above 212° F (100° C).

Notice the horizontal part of the graph at the freezing and boiling points. This indicates the amount of heat that is given up or taken in to make the water change state. It remains at the same temperature after the state change.

2260 Kj = ~540,000 calories

334 Kj = ~80,000 calories

1 Kj = 240 cal
New Frost Protection Technique

- Spun-bond polyester material is used to cover plants.
- Initially used as a season extender in vegetable production.
- Stated to give 5 – 6° F protection.
- Actually, experience has shown a greater degree of protection.

Clemson Extension Service
Tribulations

- Industry Maturation
- Fertility Management Tools
- Row Covers
- SRSFC
- Clemson Team
  - Dr. Schnabel’s resistance work
  - Dr. Schmitt-Jeffris’ arrival
  - Agent team
Tissue Testing

- The very early leaf analysis is important for the B. It has to be injected (if needed) very early to aid in fruit formation (around the end of January).
- After spring growth begins, take samples every two weeks.
- Collect 20 - 25 recently matured trifoliate and petioles, separate into leaves and petioles; submit a leaf sample (only once) and petiole samples.
- Get P, K, Ca, Mg, S & minors from leaves
- Get NO3-N from petioles (PPM)

Clemson Extension Service
Guidelines for Tissue Testing

- Take samples same time each time (AM).
- Petiole NO3-N should decline gradually, no huge drop between samples.
- Boron is very important for berry quality - it should be above 30 PPM in early season.
  - If it is below this on 1st sample in January/February, inject 1/8 lb. of actual B (10 oz of Solubor) per acre, check again (BE CAREFUL).
Petiole NO3-N Curve

N-Rate and Petiole Nitrate
Zone of Sufficiency

Nitrate Nitrogen (ppm)

Sampling Date

03-Mar 17-Mar 30-Mar 13-Apr 26-Apr 11-May 25-May

High
Sufficient
Low

0.0 lb N/ac/da  0.5 lb N/ac/da  1.0 lb N/ac/da  1.5 lb N/ac/da  2.0 lb N/ac/da

Clemson Extension Service
Nitrogen Fertigation Recommendations for Plasticulture Strawberries
Brenda Cleveland, Agronomic Division, NCDA

The following is the sufficiency range for strawberry petiole NO\textsubscript{3} concentration when the grower uses the bloom and/or fruit code on the North Carolina tissue analysis request form. If the analysis report level of petiole NO\textsubscript{3} is below the listed range increase the nitrogen application rate to 1 lb N/acre/day, if it is in the range continue to inject 0.75 lb N/acre/day*, and if it is above the range stop injecting N.

<table>
<thead>
<tr>
<th>Week</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>600</td>
<td>1500</td>
</tr>
<tr>
<td>2 – 3</td>
<td>4000</td>
<td>6000</td>
</tr>
<tr>
<td>4</td>
<td>3500</td>
<td>6000</td>
</tr>
<tr>
<td>5 – 8</td>
<td>3000</td>
<td>5000</td>
</tr>
<tr>
<td>9 – 10</td>
<td>2000</td>
<td>4500</td>
</tr>
<tr>
<td>11</td>
<td>1500</td>
<td>3000</td>
</tr>
<tr>
<td>12</td>
<td>1000</td>
<td>2000</td>
</tr>
</tbody>
</table>

* (by Powell Smith), the general recommendation from NCSU for fertigation is to begin injecting 0.75 lbs N/A/day shortly before bloom begins (anywhere from mid-February to mid-March depending on in what part of the state you farm.)
Table 1. Extrapolated Yield, Percentage of *Botrytis* Decay at Harvest, and Post 5-Day Percentages of Total and of *Botrytis* Decay in SC Field-grown Strawberry¹.

<table>
<thead>
<tr>
<th>Year/Plot</th>
<th>Yield</th>
<th>In Field</th>
<th>Post 5-Day² % Decay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb/A ±</td>
<td>%Decay*</td>
<td>Total ± SE</td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td><em>Botrytis</em> ± SE</td>
<td>Botrytis ± SE</td>
</tr>
<tr>
<td>2011³/Model</td>
<td>18,874 ± 90.5</td>
<td>0.11 ± 0.02</td>
<td>49.5 ± 5.5</td>
</tr>
<tr>
<td>2011/Grwr Standard</td>
<td>18,785 ± 92.1</td>
<td>0.15 ± 0.01</td>
<td>36.2 ± 5.9</td>
</tr>
<tr>
<td>2012⁴/Model</td>
<td>20,810 ± 2,158</td>
<td>0.79 ± 0.30</td>
<td>42.5 ± 8.9</td>
</tr>
<tr>
<td>2012/Grwr Standard</td>
<td>18.603 ± 1,681</td>
<td>0.20 ± 0.07</td>
<td>23.4 ± 2.7</td>
</tr>
<tr>
<td>2013⁵/Model</td>
<td>25,074 ± 861</td>
<td>2.08 ± 0.34</td>
<td>37.8 ± 3.6</td>
</tr>
<tr>
<td>2013 Grwr Standard</td>
<td>24,766 ± 781</td>
<td>0.49 ± 0.04</td>
<td>36.7 ± 2.3</td>
</tr>
</tbody>
</table>

*Percentages were not transformed*

1 All data from six subplots consisting of 25-bed ft of 36”-plastic mulched strawberry bed; corrected for stand loss if needed.
2 5 randomly selected strawberries surface sterilized with NaOCL (1.3%) & rinsed in SDW incubated in a clean egg carton for 5 days.
3 20 harvests over an 11-week period; post 5-day from 13 harvests over a 7-week period.
4 17 harvests over a 9-week period; post 5-day from 15 harvests over a 6 week period.
5 18 harvests over a 9-week period; post 5-day from 17 harvests over a 9-week period.
The SC Strawberry Industry

- In 1988, SC had less than 20 acres of plasticulture strawberry production – a more modern, high-yielding system.
  - Most (around 50 A) at this time were matted-row with a yield of less than 10,000 lb/A. (<$415,000)
- CUCES initiated a program to promote this system to growers around the state.
- In 1988, our average yield was ~15,000 lbs/acre with an average price of $0.83/lb making a farm gate value of $249,000 for the plasticulture crop.
- In 2017, our acreage has risen to ~450 acres with an average yield of 20,000 lbs/acre selling for an average of $1.83/lb giving a farm gate value of ~$16,500,000.
- Strawberries are now our second most important fruit crop.