Strawberry Fertility
Soil, Tissue, and Nematode Sampling

2019 Strawberry Preplant
August 22 2019
Smithfield, NC

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Ag. Agent Johnston County NCCES
Preparation

- “A man has got to know his limitations”
  Dirty Harry Callahan

- How do we do that? What is your limitation?
Preparation is Key
Pre-Plant Fertility
Soil Sampling

- Low soil pH is the most significant problem identified on soil samples submitted from strawberry fields in NC.
- This problem cannot be corrected in a timely manner if the crop has already been planted.
- Low Ca and Mg also usually come with low pH.
- Correct with dolomitic lime
Soil pH should be adjusted 3 to 4 months before bed forming and fumigation.

Optimum pH is 6.0 - 6.2 for mineral soil.

Guessing leads to pH issues.
Collecting Soil Samples

- Collect a separate sample for each soil type.
Sampling Depth

Pasture, Turf, & Conservation Tillage
- 4 inches

Cultivated Crops
- 8 inches
Planting and Establishment

- Importance of Planting well
- Watering plants at establishment
- Neglecting these can make everything else you do be in vain.
Pre-Plant Nitrogen

- 60 lbs N in the Fall
- Too much N will likely produce excess vegetative growth and set fewer fruit.
- Consider applying sulfur if sulfur index is below 30 on sandy soils.
- 20 to 30 lbs/A sulfur
Pre-Plant P and K

- Pre-plant phosphorus, potassium, magnesium and micronutrients should be applied based on soil test results.
- Fall fertilization should meet the nutritional needs of the crop until growth begins in the spring.
- As a general rule a tobacco blend of fertilizer ex. 6-3-18, 10-5-23 etc. work well for our soil needs and have low levels of Cl.
Post-plant Fertility
Spring
Spring Nitrogen

- General N recommendation is 5.25 lb/acre/week
- Fine tune N management by tissue sampling
- Specific N rate recommendations provided on plant analysis report
  - 5.25 lb N/acre/week or
  - 7 lb N/acre/week
- Can help identify hidden hunger
- Crop needs increase rapidly as spring growth increases – weekly tissue sampling is recommended
Spring K (potassium)

- Very important for taste and quality
- Double N rate for K rate
- Through drip
- Monitor with tissue sampling
Boron

- Deficiency resembles pollination problem
- Upper end of sufficiency scale
- Be careful with decimal points
Boron Continued...

- 1/4 lb of actual Boron/acre during 2\textsuperscript{nd} full week of fertilization, repeat every 2 to 3 weeks.
- 20 Mule team Borax - 18 to 19 oz/acre
- Solubor - 12 to 14 oz/acre
- 10% liquid boron - 1 qt/acre
Strawberry Tissue Sampling
What is tissue analysis?

- Measure of essential plant nutrient concentrations
  - Leaf blade analysis:
    - N, P, K, Ca, Mg, S, Na (%)
    - Fe, Mn, Zn, Cu, B (ppm)
  - Petiole analysis:
    - NO$_3$-N (nitrate nitrogen)
- Also includes
  - Interpretation indexes
  - Nutrient ratios (ie. N:S)
  - Nutrient rate recommendations (N, K, Mg, S, Mn, Fe)
  - Agronomist comments
Routine tissue sampling

- Is very important in high-value crops like strawberries
  - Evaluate the fertility program and nutritional status to *prevent* problems

Once a nutrient deficiency has occurred, yield is already lost.

A nutrient deficiency is easier to correct and results in less yield loss the sooner it is detected and corrected.
How to tissue sample

- For monitoring (predictive)
  - Collect biweekly samples from early bloom through harvest (start about March 1st)
  - This is the bloom (B) and fruit (F) growth stages

- For diagnosing
  - Collect samples as soon as abnormal plant growth or color is noted
How to tissue sample

- Collect the most recently mature trifoliate leaves (MRML)
  - Has three leaflets and a petiole
  - Is full-sized and dark green
  - Is healthy--no diseases, insects or harsh environmental conditions (predictive)
How to tissue sample

- Detach the petioles
  - Snap leaves off at the stem then separate the blades from the petioles

Measure NO3-N on petioles

A great predictor of soil N availability
Properly identify the **growth stage and week**

- Bloom/fruit (B/F) has 12 consecutive weeks

- Week 1 of B/F is characterized by the presence of 5–10 open blossoms on at least 50% of the plants

  - Or to state it another way – it means strawberries will be ready to pick in 4½ to 5 weeks

- Week 5 of B/F growth stage coincides with first harvest
## Growth Stage and Week

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>Week</th>
<th>NO$_3$-N Sufficient Range (ppm)*</th>
<th>Nitrogen recommendation when petiole NO$_3$-N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Below-</td>
</tr>
<tr>
<td>B/F</td>
<td>1</td>
<td>600-1500</td>
<td>7 lb N/a/wk</td>
</tr>
<tr>
<td></td>
<td>2-3</td>
<td>4000-6000</td>
<td>5.25 lb N/a/wk</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3500-6000</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>5-8</td>
<td>3000-5000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>2000-4500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>2000-4000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>1500-3000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1000-2000</td>
<td></td>
</tr>
</tbody>
</table>

Understanding the Plant Report

- Interpretation Indexes
  - Scale: 0 to 124
  - Ranges: deficient, low, sufficient, high, excessive

- Nutrient Ratios
  - N:S, N:K, Fe:Mn

- Nutrient recommendations
  - N, K, Mg, S, Mn, Fe

- Agronomist Comments
Understanding the Plant Report

Interpretation Index

[Graph showing the relationship between Growth or Yield (%) and Interpretation Index, with categories including Deficient, Sufficient, Low, High, and Excess]
Concluding remarks

- Plant tissue analysis is a tool – use it properly
  - Consider everything else you know about the field
    - Environment
      - Temperature and rain
      - Soil pH and fertility
      - Disease/insect pressure
    - Production practices
      - Fertilization
      - Irrigation
Lessons learned from 2019

Weather is UNPREDICTABLE!

Instead of a rough spring, we had a rough fall with hurricane and wet conditions.

Rushed fumigation and late planting were many growers concerns.
Root Rot and Crown Rot
Frost Protection

- **Row covers**
  - Limitations: wind, labor, temperature etc.
  - Weight: 1.25 oz good, 1.5 oz better
  - Timing

- **Irrigation**
  - Limitations: wind, water source/volume
  - Timing
Damaged bloom
Bloom and fruit Damage
Control what you can

- pH and fertility
- *Laying the plastic (good beds/tight plastic)*
- *Planting (on time and correct depth)*
- Protection (row covers/frost protection)
- Irrigation/fertigation
- Picking
- Weeds, disease and insects
Irrigation (managing)

- You can not be over observant of soil moisture under plastic- Do Not Get Behind!
- Hot Weather (May 2019) is rough on plants, especially fruiting plants.
- When increasing water, increase number of times during day not duration. Soil can only hold so much water, roughly 2 hrs is long enough. Once soil capacity is surpassed, fertilizer is leached.
Questions?

- **Contact:**
  - E-mail: [don.nicholson@ncagr.gov](mailto:don.nicholson@ncagr.gov)
  - Phone: 919-499-8708
  - Website: [www.ncagr.gov/agronomi/](http://www.ncagr.gov/agronomi/)
  - Address: NCDA&CS Agronomic Division
    1040 Mail Service Center
    Raleigh, NC 27699-1040
Questions?

- Contact info
- Email: bkparker@ncsu.edu
- Phone: office-919-989-5380/cell-919-464-6054
Respirator

- Fit Test!
- Medical Exam
- Make sure it forms a seal

- Store at dry and cool place (not in garage/shop)
- Clean regularly
- Change cartridge regularly

- Never use a cartridge AFTER expiration date
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Face Respirator</td>
<td>$150 – 200</td>
</tr>
<tr>
<td>Cartridge</td>
<td>$30 – 50 (frequent costs)</td>
</tr>
<tr>
<td>Chemical resistant gloves</td>
<td>$20 – 40 / pair (frequent costs)</td>
</tr>
<tr>
<td>Rubber Boots</td>
<td>$20 – 60 / pair</td>
</tr>
<tr>
<td>TiVac</td>
<td>$20 – 30 / piece (frequent costs)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$170 – 230 one time</strong></td>
</tr>
<tr>
<td></td>
<td><strong>$70 – 120 frequent</strong></td>
</tr>
<tr>
<td>Fumigant</td>
<td>Short-Term Exposure</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Chloropicrin</td>
<td>Sever irritation of skin, eyes, respiratory tract</td>
</tr>
<tr>
<td></td>
<td>Difficulty breathing, Headache, Nausea</td>
</tr>
<tr>
<td>1,3 Dichloropropene</td>
<td>Chest Pain, breathing difficulties</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Step 1: Calculate the rate of fumigant per ‘row acre’

‘row acre’ =

43,560 sqft / row spacing
Step 1: Calculate the rate of fumigant per ‘row acre’

Example: Row-Spacing is 5 feet

\[
43,560 \text{ sqft} \div 5 = 8,712 \text{ linear ft of rows} \\
= 1 \text{ acre}!!!
\]

\[
100 \text{ rows} \times 200\text{ft} = 20,000 \text{ linear ft}
\]

\[
\text{Row acres} = \frac{20,000}{8,712} = 2.29 \text{ acres}
\]

**Row acres = 100 rows are equivalent to 2.29 acres**
Step 2: Calculate Broadcast equivalent rate

Total amount of fumigant applied to the treated area (ROWS) divided by the TOTAL LAND

- Total area within the perimeter of the fumigated part of the field
- Pounds/gallons of product per treated acre (rate of product applied in the bed)
- Total treated area: Bed with (bottom), row spacing
Step 2: Calculate Broadcast equivalent rate

Example:
Size of beds and furrows (without ditches)
= 5 acres − 0.25 acres = 4.75 acre

Divide the bed width at the bottom by the row spacing
= 32 Inches / 60 Inches = 0.53

Determine the proportion of the application block to be treated
= 4.75 acres / 5 acres = 0.95

0.53 * 0.95 * 350 lbs/A = 176.22 lbs (Broadcast equivalent rate)
Step 2: Calculate Broadcast equivalent rate

Example:
- Bed with at bottom: 32 inches
- Row spacing: 60 Inches
- Product applied per treated area: 350 lbs
- Application block size: 5 acres
- Ditch size 0.25 acres

Size of beds and furrows (without ditches)
= 5 acres – 0.25 acres = 4.75 acre
Calibration

- Usually calibrated for water!
- Higher density = slower movement!!!

<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Boiling point (°F)</th>
<th>Specific gravity*</th>
<th>Vapor pressure (mm Hg at 20°C)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,3-Dichloropropene</td>
<td>219</td>
<td>1.21</td>
<td>34</td>
</tr>
<tr>
<td>Chloropirin</td>
<td>234</td>
<td>1.65</td>
<td>18</td>
</tr>
<tr>
<td>MITC (dazomet, metam potassium, metam sodium)</td>
<td>246</td>
<td>1.06</td>
<td>13</td>
</tr>
<tr>
<td>Methyl bromide</td>
<td>38</td>
<td>1.73</td>
<td>1420</td>
</tr>
<tr>
<td>Dimethyl disulfide</td>
<td>229</td>
<td>1.05</td>
<td>17</td>
</tr>
</tbody>
</table>

*Specific gravity = the molecular weight of a fumigant divided by the molecular weight of water.
**mm Hg = millimeters of mercury.
Calibration

Must be corrected!

Example:
- Swath width of the rig is 6 feet

Determine the time to treat an acre:
- 100 foot rig test: 22 sec. for 600 sqft (6 * 100)
- 22 sec. / 600 sqft = 0.036 sec./sqft
- 0.036 sec./sqft x 43,560 sqft/acre = 1568 sec./acre = 26.1 min/acre
Calibration

Must be corrected!

Example:
- Time to treat an acre = 26.1 min
- 100 % flow rate (Water) = 2gpa
- Telone EC (93.6 % 1,3D) = 2 x 0.913 = 1.83 gal/min
- 20 gal/a

Determine the flow meter setting
- Total gal/acre = 26.1 min * 1.83 gal/a = 47.7 gal (100%)
- FlowMeter (water): (20/47.7) * 100 = 41.9%
Plastic

Polyethylene Films (PE):
- AEP Sun Film High Barrier 1.0 mil, clear polyethylene AEP Inc.
- Cadillac HDPE 1.25 mil, clear Cadillac Products Packaging Co.
- Canslit Embossed HDPE 0.6 mil, black Canslit Inc./Imaflex Inc.
- Canslit Embossed LDPE 1.25 mil, black Canslit Inc./Imaflex Inc.
- Pliant Embossed LDPE 1.25 mil, embossed LDPE Pliant Corp.

Metalized Films:
- Canslit Metalized 1.25 mil, black/silver Canslit Inc./Imaflex Inc.
- Canslit Metalized 1.25 mil, white/silver Canslit Inc./Imaflex Inc.
- Pliant Metalized 1.25 mil, black/silver Pliant Corp.
Table 1. Effect of plastic mulch color on soil temperature, as compared to unmulched soil.

<table>
<thead>
<tr>
<th>Mulch color</th>
<th>Nighttime</th>
<th>Daytime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>warmer</td>
<td>warmer</td>
</tr>
<tr>
<td>Black</td>
<td>warmer</td>
<td>warmer</td>
</tr>
<tr>
<td>White</td>
<td>warmer</td>
<td>cooler</td>
</tr>
<tr>
<td>Reflective</td>
<td>warmer</td>
<td>cooler</td>
</tr>
<tr>
<td>Film Type</td>
<td>Brand</td>
<td>Thickness</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Virtually Impermeable Films (VIF):</td>
<td>Cadillac VIF</td>
<td>1.25 mil, black</td>
</tr>
<tr>
<td></td>
<td>Can-Block VIF</td>
<td>0.8 mil, black</td>
</tr>
<tr>
<td></td>
<td>FilmTech VIF</td>
<td>1.25 mil, black</td>
</tr>
<tr>
<td></td>
<td>Ginegar VIF</td>
<td>1.25 mil, embossed black</td>
</tr>
<tr>
<td></td>
<td>Guardian Olefinas VIF</td>
<td>1.2 mil, embossed black</td>
</tr>
<tr>
<td></td>
<td>MidSouth VIF</td>
<td>1.25 mil, embossed black</td>
</tr>
<tr>
<td></td>
<td>Pliant Blockade Black</td>
<td>1.25 mil, black</td>
</tr>
<tr>
<td></td>
<td>Pliant Blockade White</td>
<td>1.25 mil, white/black</td>
</tr>
<tr>
<td>Totally Impermeable Films (TIF):</td>
<td>AEP-One EVOH barrier</td>
<td>1.0 mil, clear</td>
</tr>
<tr>
<td></td>
<td>Berry EVOH High Barrier</td>
<td>black</td>
</tr>
<tr>
<td></td>
<td>Berry EVOH Supreme Barrier</td>
<td>black</td>
</tr>
<tr>
<td></td>
<td>Dow SARANEX A</td>
<td>black</td>
</tr>
<tr>
<td></td>
<td>Dow SARANEX B</td>
<td>black</td>
</tr>
<tr>
<td></td>
<td>Klerks/HyPlast TIF</td>
<td>clear</td>
</tr>
<tr>
<td></td>
<td>Raven TIF VaporSafe 1.0 mil, EVOH barrier, clear</td>
<td>Raven Industries Inc.</td>
</tr>
<tr>
<td></td>
<td>Raven TIF VaporSafe 1.4 mil, EVOH barrier, black</td>
<td>Raven Industries Inc.</td>
</tr>
</tbody>
</table>

Joe Noling, UF, 2013
http://edis.ifas.ufl.edu/in403
<table>
<thead>
<tr>
<th>Plastic</th>
<th>Costs</th>
<th>Fumigant efficacy</th>
<th>Control efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE Films</td>
<td>Cheap</td>
<td>Not good</td>
<td></td>
</tr>
<tr>
<td>Metalized Films</td>
<td>More costly</td>
<td>better</td>
<td>Controls Thrips</td>
</tr>
<tr>
<td>VIF</td>
<td>Costly</td>
<td>better</td>
<td></td>
</tr>
<tr>
<td>TIF</td>
<td>Costly</td>
<td>good</td>
<td></td>
</tr>
</tbody>
</table>
TIF Pro

- Increase fumigant efficacy
- Leads to less problems later on
- Increased yields due to more efficient fumigation

TIF Con:

- May increase plant back date
- Higher $$$
Fumigants

- **Dominus**
  Allyl Isothiocyanate (AITC, synthetic; 200-350 lbs/a)

- **Mustard**
  Allyl Isothiocyanate (AITC, natural)

- **Mustard Seed Meal and Pelleted Mustard**
  Allyl Isothiocyanate (AITC, natural)
<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Nematode</th>
<th>Disease</th>
<th>Nutsedge</th>
<th>Other weeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telone C 35 + VIF/TIF</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Telone C 35</td>
<td>++++</td>
<td>++++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>In-Line</td>
<td>++++</td>
<td>++++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Metam Sodium</td>
<td>++</td>
<td>+++</td>
<td>++</td>
<td>++++</td>
</tr>
<tr>
<td>Dominus</td>
<td>++</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Pic-Clor 60</td>
<td>++++</td>
<td>++++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Chloropicrin</td>
<td>+</td>
<td>++++</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
**Fumigants**

- **Pic-Clor 60/80 (300-350 lbs/a, 14-21 days)**
  Chloropicrin (60/80%) + 1,3D (40/20%)

- **Telone C-35 (30-40 gal/a, 21 days)**
  Chloropicrin (35%) + 1,3-D (65%)

- **Paladin (14 days)**
  Chloropicrin (21%) + Di-Methyl Disulfide (79%)

- **Vapam/Kpam/Sectagon and others**
  Metam Sodium/Potassium
Fertility:
Google: ‘Strawberry Fertility Management NCDA’

IPM: www.smallfruits.org

Strawberry: https://strawberries.ces.ncsu.edu/

Homepage: https://smallfruits.cals.ncsu.edu/