Nutrient Management for Perennial Fruit Crops

Webinar

January 13, 2012

Department of Environmental Science and Technology
Perennial Fruit Crops vs. Annual Crops: What’s the difference?

- root morphology
  - deep roots, often with mychorrhizal colonization
- storage of nutrients within plant from year to year
- longer life cycle
- soil testing 0-8” will not tell the true availability story at all stages of the life cycle
  - plant tissue analysis is more informative for mature trees and small fruit
Mycorrhizae or “fungus-root”

Mycorrhizae are specialized, root-like organs formed as a result of the symbiotic association of certain fungi with the roots of higher plants.
Perennial Fruit Crops Follow a Different Paradigm

Nutrient recommendations for perennial fruit crops depend upon the production stage or age category:

- biorenovation
- pre-plant
- non-bearing
- bearing
Sources of Information

• general information
  – PF-1, *Nutrient Management Planning for Perennial Fruit Crops: An Overview*
  – PF-2, *Tissue and Soil Sampling for Perennial Fruit Crops*

• tree fruit, brambles and blueberries
Sources of Information

• grapes
  – Tissue Sampling for Vineyards, UME Information Sheet
  – Pre-plant Renovation and Soil Conditioning for New Vineyard and Small Fruit Plantings, UME Information Sheet
  – Nutrient Management for Grapes, UME (for establishment and non-bearing years) **
Peach Rotation

Biorenovation (1 – 2 years) | 1st leaf | 2nd leaf | Bearing
Non-bearing

1 year 2 years 12 years

Planting

Apple Rotation

Biorenovation (1 – 2 years) | 1st leaf | 2nd leaf | 3rd leaf | Bearing
Non-bearing

1 year 2 years 3 years 20 years

Planting

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# Field Information Sheet for Perennial Fruit Crops

**Farm:**

**Plan Year:**

<table>
<thead>
<tr>
<th>TRACT NO. OR FARM NAME</th>
<th>FIELD NO.</th>
<th>ACRES</th>
<th>CROP(S)</th>
<th>TYPICAL YIELD</th>
<th>TILLAGE METHOD</th>
<th>PRODUCTION STAGE</th>
</tr>
</thead>
</table>

- **Enter FSA tract number or farm name.**
- **Enter field number or unique identifier (this number must be the same field number as on the farm map).**
- **Enter total number of acres in field.**
- **Enter crops grown during year being planned.**
- **Enter typical yield based on your records or other reliable sources.**
- **Enter tillage method used. (Ex: sod/herbicide strip)**
- **Enter production stage. (biorenovation, pre-plant, non-bearing, or bearing)**
Biorenovation

• assessment tool: soil test
• goal: get soil in good physical condition, optimize soil fertility and reduce nematode population
• crop choice?
  – Brassicas – nematode reduction
  – sorghum x sudan grass to reduce soil compaction and supply organic matter
  – corn (grain or sweet) to generate income
  – recs in NuManPro
Pre-plant Stage

- assessment tool: soil test
- goal: adjust pH & enrich the soil with P and K for most or all of the bearing years
  - no pre-plant N
  - N added after planting
- recommendations are in *NuMan Pro*
Non-bearing Stage

- assessment tool: none
- see recommendation publications
- goal: encourage strong growth of young tree or bush
  - precision placement of N fertilizers
Bearing Stage

• assessment tool: tissue analysis and soil tests

• goal: maintain a good balance between vegetative and reproductive growth
  – low fertility reduces yields
  – adequate fertility maintains crop quality and minimizes pruning required
    • “Fruit, not lumber!”
  – excessive fertility leads to excessive growth but no increase in yields
‘Redskin’ Peach  
Fertilized Annually with Urea

<table>
<thead>
<tr>
<th>Leaf Nutrient Analysis (%)</th>
<th>N</th>
<th>P</th>
<th>Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>low N</td>
<td>2.75</td>
<td>0.17</td>
<td>2.45</td>
</tr>
<tr>
<td>(40 lb/A)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>normal N</td>
<td>3.15</td>
<td>0.21</td>
<td>2.26</td>
</tr>
<tr>
<td>(80 lb/A)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high N</td>
<td>3.30</td>
<td>0.19</td>
<td>2.20</td>
</tr>
<tr>
<td>(135 lb/A)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Fertilization, Yield and Fruit Size  
(Walsh, UMCP, Plant Sciences)  

<table>
<thead>
<tr>
<th>Fruit Weight (grams/fruit)</th>
<th>4-Year Yield (kg/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- low N</td>
<td></td>
</tr>
<tr>
<td>(40 lb/A)</td>
<td>157</td>
</tr>
<tr>
<td>- normal N</td>
<td></td>
</tr>
<tr>
<td>(80 lb/A)</td>
<td>172</td>
</tr>
<tr>
<td>- high N</td>
<td></td>
</tr>
<tr>
<td>(135 lb/A)</td>
<td>170</td>
</tr>
</tbody>
</table>

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Tasks for Bearing Stage

- define “blocks”
- select a specie and variety for sampling
- sample plant tissue
- sample soil
What is a block?

- an area within an orchard that:
  - consists of plantings of the same age, species and variety
  - has the same or similar soil types
  - can be managed as one unit

- a block is best determined by the orchard manager
An area in a hypothetical orchard...

Gala Apples
Golden Delicious Apples
Golden Delicious Apples
Fuji Apples

Road

Creek

Cherries

Fuji Apples

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Differences in species, varieties, and soils
So, how many blocks are represented here?
General guidelines for tissue sample collection

- sample at least one variety from each bearing block

- collect tissue samples:
  - within the recommended time frame
  - the recommended plant part (leaf, petiole)
  - the recommended number of samples
  - from a wide selection of plants throughout the block
  - Randomly

- avoid diseased leaves

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## Sample Collection Summary

<table>
<thead>
<tr>
<th>Crop</th>
<th>Time to Sample</th>
<th>Number of Samples/Plant Part</th>
<th>Location on Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blueberries</td>
<td>1st week of harvest</td>
<td>40 leaves (detach petioles)</td>
<td>Current season’s growth</td>
</tr>
<tr>
<td>Brambles</td>
<td>Aug 1st - Aug 20th</td>
<td>60 leaves (detach petioles)</td>
<td>Select the most recent fully expanded leaf blade of each primocane.</td>
</tr>
<tr>
<td>Fruit Trees</td>
<td>July 15th - Sept 1st</td>
<td>50 leaves and petioles</td>
<td>Select shoots at eye level from around outside of the tree. Select shoots that make a vertical angle of 45-60 degrees to the ground. Remove 1 or 2 leaves from the mid-portion of the current season's growth.</td>
</tr>
</tbody>
</table>
What is the appropriate plant part to sample for a fruit tree?

Collect 1 or 2 leaves per tree from mid portion of new shoot growth. (See Sample Collection & Preparation for Perennial Fruit Crops instruction card.)
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Photo Courtesy of Heather Hutchinson
Bud Scale Scar picture

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Photo Courtesy of Heather Hutchinson
Tissue Sampling Guidance

- **Instruction Card** - *Sample Collection and Preparation for Perennial Fruit Crops*
  - tree fruit, brambles and blueberries

- **Tissue Sampling for Vineyards, UME Information Sheet**

- [www.anmp.umd.edu](http://www.anmp.umd.edu)
  - Plan Writing Tools
    - Tissue Sampling and Testing

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Preparing Samples for Shipment

- most labs recommend placing the sample in a paper bag
- label the bag with the block and variety name
  - make sure the label is consistent with the sample submission form and orchard map!
- allow the sample to dry for several days in the open bag
- tape/staple the bag closed and ship to the lab
An exception to the rule...

- Agri Analysis prefers to receive fresh tissue samples.

- If you are sending your samples to Agri Analysis, ship them as soon as possible after sampling. Do not allow the sample to dry.
Many Agricultural Testing Labs Offer Tissue Testing

- laboratory techniques for tissue analysis are standardized
- nutrient analyses from different labs are similar
- total elemental content is measured
- results are typically expressed as a percentage (or parts per million, ppm) of tissue dry weight
## Comparison of Some Labs Testing Plant Tissue
(8/8/11 update)

<table>
<thead>
<tr>
<th>Lab</th>
<th>Cost</th>
<th>Analyses</th>
<th>Comments</th>
<th>Sample Preparation</th>
<th>Tissue Submission Form on Website?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; L Eastern Agricultural Lab</td>
<td>$24.00  w/o recommendations</td>
<td>PT2: N, P, K, Mg, Ca, Na, Fe, Al, Mg, B, Cu, Zn</td>
<td>Air dry if very wet and place in paper bag — no plastic.</td>
<td>Yes. Go to <a href="http://al-labs-eastern.com/forms/Plant.pdf">http://al-labs-eastern.com/forms/Plant.pdf</a></td>
<td>Choose “Submit Form” next to Plant Analysis.</td>
</tr>
<tr>
<td>Agri Analysis, Inc. a division of Pioneer Water Testing Laboratory, Inc.</td>
<td>$24.00</td>
<td>PLT: N, P, K, Ca, Mg, Cu, Fe, Mn, Zn, B, Al, Na, S</td>
<td>Do not dry samples. Place in paper bag.</td>
<td>Yes. Go to <a href="http://www.agrianalysis.com">www.agrianalysis.com</a></td>
<td>Click on “Resources.” Scroll down to the Plant Tissue heading and click on “Plant Tissue Request Form 1.”</td>
</tr>
<tr>
<td>Brookside Laboratories, Inc.</td>
<td>N/A</td>
<td>N/A</td>
<td>Brookside prefers to receive samples from their consultants only.</td>
<td>Samples should be taken by a Brookside consultant.</td>
<td>N/A</td>
</tr>
<tr>
<td>Pennsylvania Agricultural Analytical Services Penn State University, University Park, PA 16802 Ph: 814-863-0841 <a href="http://www.ascc.psu.edu">www.ascc.psu.edu</a></td>
<td>$24.00</td>
<td>Standard: N, P, K, Ca, Mg, Mn, Fe, Cu, B, Zn</td>
<td>Sulfur is not included as part of the standard analysis. $18.00 — sulfur testing</td>
<td>Air dry samples and place in paper bag — no plastic.</td>
<td>Yes. Go to <a href="http://www.ascc.psu.edu/Plant%20Sub%20form%20page.html">www.ascc.psu.edu/Plant%20Sub%20form%20page.html</a> Click on the desired form.</td>
</tr>
</tbody>
</table>

**NOTES:**
- Assume payment must be included with samples.
- Web pages are updated frequently and addresses for the plant tissue information sheets may change. If this occurs, go to the lab’s home page and follow the links to the plant tissue information sheet.

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**Agricultural Nutrient Management Program**
0116 Symons Hall, Environmental Science and Technology, College Park, Maryland 20742
Local Governments U.S. Department of Agriculture Cooperative Extension Programs
www.ascc.psu.edu

University of Maryland Extension programs are open to all citizens without regard to race, color, gender, disability, religion, age, sexual orientation, marital or parental status, or national origin.
Does the Choice of a Lab Make a Difference?

- Penn State gives UME recs for tissue reports that have a Maryland address (except for grapes)

- for other labs, use NM-5 to determine the rec for each nutrient
  - enter nutrient analyses, interpretations and recommendations on summary sheet “Nutrient Management for Perennial Fruit Crops”

- Unless it is a Penn State analysis, do not assume interpretations and recommendations are consistent with NM-5!
# Nutrient Recommendations for Perennial Fruit Crops

**Block:**

**Crop:**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Concentration in Plant Tissue</th>
<th>Relative Level in Plant Tissue</th>
<th>Relative Level in Soil</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen (N) %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus (P) %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium (K) %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium (Ca) %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium (Mg) %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boron (B) ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc (Zn) ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese (Mn) ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (Fe) ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper (Cu) ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Developing Recommendations for Perennial Fruit Crops

- based primarily on tissue analysis
- soil tests provide clarification or confirmation
Let’s consider phosphorus (P) and apples

<table>
<thead>
<tr>
<th>Level</th>
<th>Concentration</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>deficient</td>
<td>&lt;0.11</td>
<td>150 lbs $\text{P}_2\text{O}_5$ *</td>
</tr>
<tr>
<td>low</td>
<td>0.11 - 0.15</td>
<td>125 lbs. $\text{P}_2\text{O}_5$ *</td>
</tr>
<tr>
<td>normal</td>
<td>0.15 - 0.31</td>
<td>No further application</td>
</tr>
<tr>
<td>high</td>
<td>&gt;0.31</td>
<td>No further application</td>
</tr>
</tbody>
</table>

*Assuming this is consistent with the Phosphorus Site Index
See NM-5, page 19 for complete information.
Let’s consider the P in apples in the orchard field...

- FIV-P? ______ 95
- P concentration? ______ 0.23%
- P level? ______ normal
- P recommendation? ______ none

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## Nutrient Recommendations for Bearing Perennial Fruit Crops

### Block: 3
### Crop: Apple

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Concentration in Plant Tissue</th>
<th>Relative Level in Plant Tissue</th>
<th>Relative Level in Soil</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>soil pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nitrogen (N) %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>phosphorus (P) %</td>
<td>0.23</td>
<td>normal</td>
<td>opt</td>
<td>No further application at this time.</td>
</tr>
<tr>
<td>calcium (Ca) %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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What is Different about Soil Sampling in Bearing Perennial Fruit Crops?

- A soil sample should be collected from each bearing block.
- Soil samples should be taken from the same general areas where tissue samples were taken.
  - In a mixed block, take soil samples around the variety from which tissue samples were collected.
- Soil samples can be taken in the fall following tissue sampling when soil sampling may be easier.
How Soil and Tissue Analyses Are Used Together

• Let’s say:
  – tissue analysis indicates that P was deficient
  – soil analysis indicates that plant-available P is in the excessive range
  – suggests a nutrient uptake issue like nematodes or a disease
  – adding additional P is not advisable
How Often Must Soil Samples Be Collected?

• At least every 3 years in:
  – bearing blocks of perennial fruit crops
    • more often if nutritional problems are suspected
  – pre-plant areas of orchards
  – biorenovation fields

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Let’s summarize what we know about the requirements for soil and tissue testing:

<table>
<thead>
<tr>
<th>Age of Planting</th>
<th>Soil Test</th>
<th>Tissue Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biorenovation</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pre-plant</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Non-bearing</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Bearing</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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Let’s summarize...

<table>
<thead>
<tr>
<th>management unit</th>
<th>block</th>
</tr>
</thead>
<tbody>
<tr>
<td>• an area which has been and will be managed similarly (i.e. same crops, same fertility regime)</td>
<td>• composed of plantings of the same age, species, and variety</td>
</tr>
<tr>
<td>• similar mosaic of soil types</td>
<td>• similar mosaic of soil types</td>
</tr>
<tr>
<td>• can be managed as one unit</td>
<td>• can be managed as one unit</td>
</tr>
<tr>
<td>• soil samples are collected up to several months before planting</td>
<td>• soil samples can be collected in the fall in same areas where tissue samples were collected the previous summer</td>
</tr>
</tbody>
</table>
A Few Words about Food Safety

• spread the word about GAPs!
  – *Food Safety Begins on the Farm*
  – leaflet and booklet

• proper precautions must be taken pre-plant, during production, harvest and post-harvest

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Any questions or issues?