Nutrient Management for Perennial Fruit Crops

Practical Experiences in Nutrient Management
9-12-13
UM/Western Maryland Research and Education Center
Reference Publications

• PI-1  *Plant Tissue Analysis*
• PF-1  *Nutrient Management Planning for Perennial Fruit Crops: An Overview*
• PF-2  *Tissue and Soil Sampling for Perennial Fruit Crops*
• NM-5  *Nutrient Management for Tree Fruits and Small Fruits*
Perennial woody crops vs annual crops…What’s the difference?

• root morphology
• storage of nutrients within plant from year to year
• longer life cycle
• soil testing 0-8” may not tell the true availability story at all stages of the life cycle; plant tissue analysis is more informative
Another difference - Mycorhizae

- a symbiotic relationship between roots and certain fungi
Perennial fruit crops are a different matter...

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

- biorenovation
- pre-plant
- non-bearing
- bearing
Peach Rotation

Non-bearing

Biorenovation (1 – 2 years) 1st leaf 2nd leaf Bearing

1 year 2 years 12 years

Planting

Apple Rotation

Non-bearing

Biorenovation (1 – 2 years) 1st leaf 2nd leaf 3rd leaf Bearing

1 year 2 years 3 years 20 years

Planting
Biorenovation

• assessment tool: soil test
• goal: get soil in good physical condition, optimize soil fertility and reduce nematode population
• crop choice?
  – rape – nematode reduction
  – sorghum x sudan grass – organic matter
  – complete recs in NuManPro
# Field Information Sheet for Perennial Fruit Crops

<table>
<thead>
<tr>
<th>TRACT # OR FARM NAME</th>
<th>FIELD or BLOCK NO.</th>
<th>ACRES</th>
<th>CROP(S)</th>
<th>TYPICAL YIELD</th>
<th>TILLAGE METHOD</th>
<th>PRODUCTION STAGE</th>
<th>SHOOT GROWTH OR VIGOR INDICATOR</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

**Farm:** 
**Plan Year:** 

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University of Maryland

DC-5
UMCP-ANMP
09/13
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 N
• complete recommendations are in *NuMan Pro*
Non-bearing stage

• assessment tool: none
• see Table 2 on page 4 of NM-5, “Nutrient Management for Tree Fruits and Small Fruits”
• goal: encourage strong growth of young tree or bush
  – precision placement of nitrogen fertilizers
Bearing stage
(Now the fun begins!)

• define “blocks”
• select a species 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
- Cherries
- Creek
- Fuji Apples
Differences in species, varieties, and soils

- Gala Apples (4 yrs)
- Golden Delicious Apples (4 yrs)
- Golden Delicious Apples (7 yrs)
- Fuji Apples (7 yrs)
- Murrill gravelly loam
- Thurmont gravelly loam
- Road
- Creek
- Cherries (7 yrs)
- Fuji Apples (7 yrs)
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 period
  – the recommended plant part (leaf, petiole)
  – the recommended number of samples
  – from a wide selection of plants throughout the block
  – randomly

• avoid diseased leaves
### 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>Jul 15th – Sept 1st</td>
<td>50 leaves and petioles</td>
<td>Select shoots at eye level from around outside of the tree. Remove 1 or 2 leaves from the mid-portion of the current season's growth.</td>
</tr>
<tr>
<td>Grapes</td>
<td>At full bloom</td>
<td>75 petioles</td>
<td>Remove the petiole across from the first blossom cluster, closest to the cordon or permanent cane.</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.)
SAMPLE COLLECTION & PREPARATION FOR PERENNIAL FRUIT CROPS

Tissue samples for perennial fruit crops are typically taken when nutrient levels in leaves are relatively stable. All leaves for a sample should be collected from the same cultivar. The sampling procedure should be as random as possible. It is best NOT to take multiple leaves from the same bush or tree but rather collect from a wide selection of plants throughout the block you are sampling. Refer to NM-5 “Nutrient Management for Tree Fruits and Small Fruits” for more information on tissue sampling.

Consult Table 1 to determine the appropriate time to sample, number of samples/plant part, and the location on the plant for each fruit crop. Figure 1 has additional information on the proper sampling location.
Why Time of Sampling is Critical

![Graph showing the percent of dry weight over days after bloom. The graph compares different elements such as N and Ca. The critical period is highlighted between July 15 and Sept. 1.](image)
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 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
- results 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
*(4/13/12 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>PI2, 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://www.al-labs-eastern.com/agricultural.html">www.al-labs-eastern.com/agricultural.html</a></td>
<td>Choose the appropriate form.</td>
</tr>
<tr>
<td>Agri Analysis, Inc. 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>In the “Customer Tools” box on the right side of the screen choose “Sample Submittal Forms.” You will need both “Plant Tissue Submittal Form 1” and “Plant Tissue Submittal Form 2” for tree and bush fruit.</td>
</tr>
<tr>
<td>AgroLab, Inc.</td>
<td>$30.00 (10% discount for soil customers)</td>
<td>Standard, N, P, K, Ca, Mg, S, Zn, Fe, Mn, Cu, B, Na, Mo</td>
<td>Air dry and place in a paper bag.</td>
<td>Yes. Go to <a href="http://www.agrolab.us/pdfs/MiscSampleInformationForm.pdf">http://www.agrolab.us/pdfs/MiscSampleInformationForm.pdf</a></td>
<td>Choose “Misc Sample Information Form” on the Home page.</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>
</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.
**Example Tissue Sample Submittal Form**

<table>
<thead>
<tr>
<th>County</th>
<th>Field No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>Variety</td>
</tr>
</tbody>
</table>

Was a leaf sample submitted from this block last year? Yes [ ] No [ ]

Was a soil sample submitted with this block last year? Yes [ ] No [ ]

Sampling time for grapes: bloom sample [ ] veraison sample [ ]
Will the fruit be used for fresh market [ ] or processed [ ]?

Spacing __________ ft x __________ ft (For multiple spacing, enter total area in square feet)

Rootstock (If applicable)
Age of plants sampled:

Lime: __________ applied on __________ (date)

Fertilizer: __________ applied on __________ (date)

Were foliar nutrients applied this year? Yes [ ] No [ ]

Weed control:
Chemical used __________
Amount of active ingredient/acre __________
Date applied __________

The soil is: Gravelly [ ] Loamy [ ] Silt loam [ ] Clay [ ]
quickly [ ]

Very canes are: Poor [ ] Vigorous [ ] Excessive [ ]
Very beds are: Sparse [ ] Medium [ ] Very dense [ ]
Fruit color is: About right [ ] Light Green [ ] Yellow [ ] Brown [ ]

COMPLETE THIS SECTION FOR SPECIAL PROBLEMS ONLY:

If the leaf is discolored, does the color variation occur:
Along leaf margin [ ] Between main veins [ ] Between small veins [ ]
Along veins [ ] Over the entire leaf [ ] In spots [ ]

Leaves were first affected at shoot: Tip [ ] Middle [ ] Base [ ]

Symptoms were first seen: June [ ] July [ ] August [ ] September [ ]

Leaf drop was: Early [ ] Late [ ] Normal [ ]

Leaves dropped first on: New woof [ ] Spurs [ ] Shoot tip [ ] Shoot base [ ]

Fruit color is: Poor [ ] All right [ ] Unusually well colored [ ]

Fruit quality is: Poor [ ] Acceptable [ ] Excellent [ ]

Crop size is: Poor [ ] Average [ ] Heavy [ ]
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 sampling is easier
Developing recommendations for perennial fruit crops

• based primarily on tissue analysis

• soil tests provide clarification or confirmation
# 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>
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<tr>
<td>Nitrogen (N) %</td>
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<tr>
<td>Phosphorus (P) %</td>
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<tr>
<td>Potassium (K) %</td>
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<tr>
<td>Calcium (Ca) %</td>
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<tr>
<td>Magnesium (Mg) %</td>
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<tr>
<td>Boron (B) ppm</td>
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<td>Zinc (Zn) ppm</td>
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<td>Manganese (Mn) ppm</td>
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<tr>
<td>Iron (Fe) ppm</td>
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<tr>
<td>Copper (Cu) ppm</td>
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</tbody>
</table>
Let’s consider phosphorus (P) and apples

<table>
<thead>
<tr>
<th>Level</th>
<th>Plant Tissue 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...

- P concentration? **0.23%**
- P level? **normal**
- P recommendation? **none**
Does the choice of a lab make a difference?

- Penn State gives UME recs for tissue reports that have a Maryland address
- for other labs, use NM-5 and determine the rec for each nutrient
Let’s look at a Penn State tissue analysis.
Do other lab’s recs differ from UME?
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 root uptake issue like nematodes or a disease
  – adding additional P is not advisable
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>
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>• same or similar soil types</td>
<td>• same or similar soil types</td>
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<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>
How often must soil samples be collected?

• In biorenovation areas
• In pre-plant year
• Every 3 years in bearing blocks
  – more often if nutritional problems are observed
5. Tissue Sampling and Testing

Step 5. Tissue Sampling and Testing (if applicable)

Tissue analyses are the bases for nutrient recommendations for fruit nutrient management plans.

The following worksheets and information sheets will assist you with the tissue sampling and testing step of nutrient management plan development.

- Sample Collection and Preparation for Perennial Fruit Crops Instruction Card
- Comparison of Some Labs Testing Plant Tissue (Updated 4-13-12)
- Field Information Sheet for Perennial Fruit Crops
- Fertilizer Recommendations for Bearing Perennial Fruit Crops

Nutrient Management Planning Tools Handbook

- 1. Data Collection
- 2. Soil Sampling and Testing
- 3. Manure Sampling and Testing
- 4. Compost Testing
- 5. Tissue Sampling and Testing
- 6. Calculating the Phosphorus Site Index
- 7. Generating
Resources on Web

Orchards

- NM-5 "Nutrient Management for Tree Fruits and Small Fruits"
- SFG PF-1 "Nutrient Management Planning for Perennial Fruit Crop: An Overview"
- SFG PF-2 "Tissue and Soil Sampling for Perennial Fruit Crops"
- SFG PL-1 "Plant Tissue Analysis" (revised April 2010)
- The Mid-Atlantic Winegrape Grower’s Guide (scroll down to find guide)
Any questions or issues?