Pecan Fertilization

Lenny Wells
UGA Horticulture
Pecans are a Perennial Crop
Not an Annual Crop

• Respond differently to inputs
• Orchard soils are not tilled
• Row Crops grow from seed or young plants
  – Birth, Growth, Death in 6-8 months
  – Everything you do to annual crops affects it that year
  – Effects on perennial crops are often delayed and long term
Leaf Sampling

- Sample trees between July 7th and August 7th.
- Use terminal shoots exposed to the sun.
- Collect leaflets from all sides of the tree.
- Avoid leaflets damaged by insects and diseases.
Soil Sampling

• Useful for pH and toxicities
• Late Fall/Winter
• Sample uniform area
• 1 pint/sample (15-20 cores) over large area
• Sample to 8” depth
• Maintaining a balance among nutrients is essential.
• Excessive application of a nutrient will not increase growth or production and may cause other problems.
• Typically, the only nutrients needed annually are N and Zn.
## Leaf Tissue Results

<table>
<thead>
<tr>
<th></th>
<th>Desired Range</th>
<th>Mean</th>
<th>% Low</th>
<th>% High</th>
<th>Sample Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf N</td>
<td>2.5-3.3%</td>
<td>2.77%</td>
<td>3</td>
<td>0</td>
<td>2.58-3.09</td>
</tr>
<tr>
<td>Leaf P</td>
<td>0.12-0.3%</td>
<td>0.14%</td>
<td>0</td>
<td>0</td>
<td>0.13-0.18</td>
</tr>
<tr>
<td>Leaf K&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.25-2.5%</td>
<td>1.26%</td>
<td>45</td>
<td>0</td>
<td>1.04-1.50</td>
</tr>
<tr>
<td>Leaf Ca</td>
<td>1.0-1.5%</td>
<td>1.84%</td>
<td>0</td>
<td>48</td>
<td>1.37-2.36</td>
</tr>
<tr>
<td>Leaf Mg&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.35-0.6%</td>
<td>0.53%</td>
<td>7</td>
<td>0</td>
<td>0.32-0.66</td>
</tr>
<tr>
<td>Leaf S</td>
<td>0.25-0.5%</td>
<td>0.24%</td>
<td>3</td>
<td>0</td>
<td>0.22-0.28</td>
</tr>
<tr>
<td>Leaf Fe</td>
<td>50-300ppm</td>
<td>71.7ppm</td>
<td>0</td>
<td>0</td>
<td>50-142</td>
</tr>
<tr>
<td>Leaf Zn</td>
<td>50-100ppm</td>
<td>125ppm</td>
<td>7</td>
<td>34</td>
<td>41-292</td>
</tr>
<tr>
<td>Leaf B</td>
<td>50-100ppm</td>
<td>84ppm</td>
<td>0</td>
<td>20</td>
<td>50-146</td>
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<tr>
<td>Leaf Cu</td>
<td>6-30ppm</td>
<td>9.8ppm</td>
<td>0</td>
<td>0</td>
<td>6-14</td>
</tr>
<tr>
<td>Leaf Mn</td>
<td>100-800ppm</td>
<td>562ppm</td>
<td>0</td>
<td>21</td>
<td>190-1251</td>
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<tr>
<td>Leaf Ni</td>
<td>?</td>
<td>2.5ppm</td>
<td>?</td>
<td>?</td>
<td>1-11</td>
</tr>
</tbody>
</table>
# Soil Sample Results

<table>
<thead>
<tr>
<th></th>
<th>Desired Range (lbs/A)</th>
<th>Mean (lbs/A)</th>
<th>% Low</th>
<th>% High</th>
<th>Sample Range (lbs/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil P</td>
<td>30-60</td>
<td>98.3</td>
<td>0</td>
<td>90</td>
<td>48-183</td>
</tr>
<tr>
<td>Soil K</td>
<td>100-150</td>
<td>153</td>
<td>0</td>
<td>34</td>
<td>94-361</td>
</tr>
<tr>
<td>Soil Ca</td>
<td>400-900</td>
<td>988</td>
<td>3</td>
<td>48</td>
<td>192-2241</td>
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<tr>
<td>Soil Mg</td>
<td>90-100</td>
<td>184</td>
<td>7</td>
<td>90</td>
<td>35-436</td>
</tr>
<tr>
<td>Soil S</td>
<td>10-50</td>
<td>26.6</td>
<td>3</td>
<td>0</td>
<td>4-41</td>
</tr>
<tr>
<td>Soil Fe</td>
<td>12-25</td>
<td>22.6</td>
<td>3</td>
<td>24</td>
<td>8-76</td>
</tr>
<tr>
<td>Soil Zn</td>
<td>15-20</td>
<td>25</td>
<td>28</td>
<td>55</td>
<td>3.9-55.3</td>
</tr>
<tr>
<td>Soil B</td>
<td>0.5-1.0</td>
<td>0.99</td>
<td>41</td>
<td>14</td>
<td>0.22-6.0</td>
</tr>
<tr>
<td>Soil Cu</td>
<td>0.5-1.5</td>
<td>1.1</td>
<td>14</td>
<td>10</td>
<td>0.2-7.2</td>
</tr>
<tr>
<td>Soil Mn</td>
<td>15-40</td>
<td>31.9</td>
<td>28</td>
<td>7</td>
<td>13-45</td>
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<tr>
<td>Soil Ni¹</td>
<td>1</td>
<td>1.26</td>
<td>N/A</td>
<td>N/A</td>
<td>1-7</td>
</tr>
<tr>
<td>pH</td>
<td>6.0-6.5</td>
<td>5.96</td>
<td>41</td>
<td>12</td>
<td>5.3-7.0</td>
</tr>
</tbody>
</table>
How Often Should You Lime the Orchard?

- High N rates can lower pH in upper soil layers (2-3”) in the short term
- Lime applied to surface raises soil pH in upper 2-3” only
- Once soil pH reaches 6-6.5 below surface layer, it tends to remain there for a long time
- There is NO research-based evidence for increased yield and growth of mature pecan trees with lime application (Hunter and Hammar, 1947; Johnson and Hagler, 1955; Hagler et al. 1957; Brooks, 1964; Hunter, 1965; Worley et al. 1972)
- Excessive liming can lead to Zn deficiency, mouse ear, and problems with K uptake
- Lime when pH is <6.0 or every 3rd year at most on SE Coastal Plain soils (6.0-6.5); Keep N rates between 75-125 lbs/acre
- Savings: $20/acre
Fertilization Recommendations for Young Trees

• **Focus on P,K, Zn---not N!**

Rate of 10-10-10/per tree

<table>
<thead>
<tr>
<th>Year</th>
<th>April</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.5-1</td>
</tr>
<tr>
<td>2</td>
<td>1-2 lbs</td>
<td>1-2 lbs</td>
</tr>
<tr>
<td>3</td>
<td>2-3 lbs</td>
<td>2-3 lbs</td>
</tr>
<tr>
<td>4</td>
<td>3-4 lbs</td>
<td>3-4 lbs</td>
</tr>
</tbody>
</table>

- Apply Zinc Sulfate at 1-3lb per tree for the 1<sup>st</sup> 3-4 yrs
- 2-3 sprays foliar Zn if deficiency symptoms show
- Mouse Ear Trees:
  - Apply Ni at rate of 1.5 qts/100 gallons
If You Fertigate

*Amount of N/acre*

<table>
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<tr>
<th>Year</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5 lbs N</td>
</tr>
<tr>
<td>2-4</td>
<td>5 lbs</td>
<td>5 lbs</td>
<td>5 lbs</td>
</tr>
</tbody>
</table>

- Apply granular P, K, Zn over the tree row in March or April of years 1 and 2
  - 40 lbs P
  - 40 lbs K
  - 25 lbs Zn Sulfate
Nitrogen

• Initial spring N used by developing foliage comes from storage pools within the tree.
• N demand will be greatest for “on” trees bearing a heavy crop load, since expanding leaves, shoots, and fruit create the greatest demand.
What’s the Best Way to Fertilize Mature Pecans with Nitrogen?

• Apply 75-125 lbs N
• Inject liquid N
  – 3 applications beginning in April (10 day intervals)
  – 1 application in June
    • 1 application in late August/early September if heavy crop
  – No more than 25 lbs N/acre/injection

• Direct broadcast applications toward herbicide strip
  – Base total acreage applied on width of spread, not on total size of orchard
  – Use rate of 75-125 lbs/acre on treated area only

• Eliminate late season applications of N with:
  – Poultry Litter Application in Feb/March or
  – Establishment of good clover stand for 3 yrs

Sandy Soils: Increase rates by 25% and use multiple applications

Dry-Land /Neglected Orchards: Split March/June
Phosphorus (P)

• Phosphorus is rarely deficient
  – P movement in the soil is extremely slow
  – Young trees with small root system frequently respond to P
  – Drought stress can induce P deficiency on mature trees
  – Excess P can reduce Zn availability and some other minor elements.
# Leaf symptoms

<table>
<thead>
<tr>
<th>Element applied</th>
<th>Trees with any necrotic leaf symptoms 29 Aug. 2009 (%)</th>
<th>Tree necrosis rating 4 Oct. 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>66</td>
<td>3.7a</td>
</tr>
<tr>
<td>P</td>
<td>33</td>
<td>1.5b</td>
</tr>
<tr>
<td>K</td>
<td>100</td>
<td>3.3a</td>
</tr>
<tr>
<td>P + K</td>
<td>17</td>
<td>1.3b</td>
</tr>
</tbody>
</table>

Symptoms appear closely linked to P shortage, even in July.

Mike Smith, Oklahoma State University
Phosphorus removal during harvest

• 1000 LBS/ACRE YIELD
  – 540 lb kernels – 1.5 lb P
  – 460 lb shell – 0.1 lb P

• Total P removed = 1.6 lb/acre
How Often Should You Soil Apply Phosphorous

- P relatively immobile and accumulates on soil surface in non-tilled soils
- 1000 lb/acre pecan crop removes 1.6 lbs P per acre
- Annual turnover
- **Yield response to broadcast application of P on mature pecan is extremely rare** (Alben and Hammar, 1939; Worley and Harmon, 1964; Sullivan, 1974; Worley, 1974; Sparks 1988; Smith 1991;)
- Rates of >13,000 lbs P/acre only slightly increased nut size
- No benefit to annual maintenance broadcast application of P to pecans in most managed orchards
- Savings: $20.40/acre
- If soil P<30 lbs per acre, broadcast P
- If soil P>30 lbs/acre and leaf P<0.12, band P

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Potassium (K)

- Potassium is a common deficiency
  - Pecans inefficiently absorb K

- Deficiencies
  - More common in sandy soils
  - Faster correction in sandy soils
  - Clays bind K so that K is very slowly available

- Low potassium causes
  - Symptoms more pronounced with large crops
  - Poor shoot growth
  - Irregular shuck opening
  - Poor nut quality with a low kernel oil content.

- K, Mg, Ca are competitively absorbed — an excess of one can induce a deficiency of another
Potassium (K)

• K is transported to nuts at leaf’s expense
• 50-100 lbs K applied in February/March
• 1.25-2.5 ppm in leaf analysis
• Manage N/K ratio to 2:1
• Manage Mg---(No Dolomitic lime above .45% Mg)
• Deficiency most common on Desirable and Schley
Potassium removal during harvest

• 1000 LBS/ACRE YIELD
  – 540 lb kernels - 2 lb K
  – 460 lb shell – 0.3 lb K

• Total K removed = 2.3 lb/acre
How Often Should You Soil Apply Potassium?

- 1000 lb/acre pecan crop removes 2.3 lbs K per acre
- Annual turnover
  - 70% of total nutrient content of fruit returned to soil in shucks (Sparks, 1975)
- **Yield response to broadcast application of K on mature orchards is extremely rare** (Hunter and Hammar, 1947; Hunter and Hammar, 1948; Sharpe et al. 1950; Sharpe et al., 1952; Hunter, 1956; Gammon and Sharpe, 1959; Hunter and Hammar, 1961; Worley, 1974; Worley, 1994)
- No real benefit to maintenance broadcast application of K in most mature managed orchards
- Savings: $23.40/acre
- If soil K drops below 100 lbs/acre: **broadcast K**
- If soil K is >100 lbs/acre and leaf K is less than 1.1: **band K**
  - Need to keep leaf K at 2:1-2.5 ratio with leaf N, but broadcast application will not increase leaf K to 1.25
Zinc

• Necessary for shoot elongation, leaf expansion, and yield

• Formulated Zinc Sprays or 2 lbs Zinc sulfate + 4 lbs Urea

• Begin 2 wks after budbreak until shoot elongation complete
How Often Should You **SOIL**-apply Zinc?

<table>
<thead>
<tr>
<th>Soil Zn</th>
<th>15-20</th>
<th>25</th>
<th>28</th>
<th>55</th>
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- Most Coastal Plain soils not planted to pecan are very low in Zn
- Most mature orchards have high soil Zn levels
- Zn is immobile in soil
- Broadcast Zinc Sulfate when soil Zn is <15 lbs/acre
- If soil Zn >15 lbs/acre and leaf Zn<50 ppm or visible rosette: band Zn
- Savings: $25/acre
- Make annual foliar Zn applications
Mouse Ear

- Nickel Deficiency
- Zinc Management

- Apply 1 pt/A in spring (April) while canopy is developing (parachute stage);
- 2nd application: 1 pt/A 30-60 days after 1st appl.
- Third application of 1.5-2 pts/A in late Sept.-early October before leaf fall to prevent mouse ear in the spring flush.
Boron

- Foliar B application improves fruit retention and percent kernel in the absence of noticeable B deficiency
- Poor mobility of B to flowers
- 3 sprays beginning with 2\textsuperscript{nd} spray
- Timing of applications should be during the pre-pollination stage
Iron (Fe)

• Fe deficiencies are common in spring
• Cool, wet conditions increase Fe shortages – interferes with transport in the plant

• High concentrations of P, Mn, Cu, Ni or Zn can induce an Fe shortage.
• Can be corrected with foliar applications of FeSO$_4$ or Fe chelates.
Crimson Clover:
70-130 lbs N
3500-5500 lbs dry matter/A

White Clover:
80-200 lbs N
2,000-6,000 lbs dry matter
2010 Nitrogen Availability
Year 3 of Treatment Establishment

Soil NO₃+Soil NH₄ (lbs/A)

- Clover
- Amm Nitrate
- UT

Graph showing nitrogen availability over time (0 days to 240 days) for Clover, Amm Nitrate, and UT treatments.
If you maintain clover in row middles, apply N to herbicide strips
Summary

- Crimson clover contributes about 30 lbs additional N per acre early in the establishment phase; this number increases with time
- Clover also enhances organic matter and biological activity of soil
- Clover competes for water during dormant season and at budbreak but helps maintain soil moisture in summer
- Clover can provide adequate late season N, but fertilizer application is necessary in spring where clover is used
Chicken Litter

- Have sample analyzed
- Typically:
  - N 60 lbs/A
  - P 60 lbs/A
  - K 40 lbs/A
  - Ca 30 lbs/A
  - Zn 0.6 lbs/A
  - Cu 0.6 lbs/A

Nutrients are organically bound

- 60% (36 lbs N/ton) is available for crop uptake during the season.
- Excellent for building up weak land
Chicken Litter

- 1 ton/A of poultry litter -- February

DO NOT APPLY AFTER MAY!!

Within the first 3 years of using poultry litter, apply additional N in spring (50-75 lbs/acre)
Questions?