Using Plant Sap Analysis to Optimize Nutrient Use Efficiency

October 7, 2015

Lorne King
Agenda

• How we got started
• Available tools
• Nutrient uptake
• Nutrient movement in plant
• Conversion of N to Protein
• Sugars/pH/EC
• Lots of study to do
History

• November 2013 – 2 day seminar.
• Limited number of participants.
• February 2015 – 2 day seminar.
• Both new and experienced participants.

• Nova Crop Control
• HortiNova Consulting
Available Tools

• Soil/Substrate Testing
• Tissue (Dry Matter) Testing
• Nutrient Water Testing (Feed, Slab, Drain)

• Plant Sap Testing
• Better your understanding of what is actually occurring.
• Use the information to better target and apply the correct amount of fertilizer
Available Tools

Factors affecting mineral update include:

• Substrate
• Balance of minerals
• pH of the substrate, irrigation water
• Root quality/health
• Climate
• And so on.............
• The final result of these factors can be seen in the plant (sap)
Sampling

- Test from same variety, range, zone, time of day, etc.
- Samples of old and new leaves
- Remove the petioles
- Remove any leaf wetness
- Package samples to avoid evaporation
- Sample from good (representative) plants
- Consistency is key to getting useable results
- 21 parameters reported
# Sample Report – Nova Crop Control

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Current level</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total Sugars</td>
<td>%</td>
<td>0,8</td>
<td>1,2</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td></td>
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</tr>
<tr>
<td>pH</td>
<td>mS/cm</td>
<td>5,8</td>
<td>5,9</td>
</tr>
<tr>
<td></td>
<td>mS/cm</td>
<td>13,7</td>
<td>12,0</td>
</tr>
<tr>
<td>K - Potassium</td>
<td>ppm</td>
<td>4660</td>
<td>4170</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca - Calcium</td>
<td>ppm</td>
<td>4150</td>
<td>2040</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K / Ca</td>
<td></td>
<td>1,12</td>
<td>2,04</td>
</tr>
<tr>
<td>Mg - Magnesium</td>
<td>ppm</td>
<td>838</td>
<td>761</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na - Sodium</td>
<td>ppm</td>
<td>44</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH4 - Ammonium</td>
<td>ppm</td>
<td>110</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO3 - Nitrate</td>
<td>ppm</td>
<td>1759</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
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<tr>
<td>N in Nitrate</td>
<td>ppm</td>
<td>397</td>
<td>156</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N - Total Nitrogen</td>
<td>ppm</td>
<td>1640</td>
<td>1419</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cl - Chloride</td>
<td>ppm</td>
<td>275</td>
<td>464</td>
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<tr>
<td></td>
<td>ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S - Sulfur</td>
<td>ppm</td>
<td>2490</td>
<td>1470</td>
</tr>
<tr>
<td></td>
<td>ppm</td>
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</tbody>
</table>
Nutrient Uptake

Nutrient water testing is not always enough

• A real life example…..Manganese
  • Feed tests report adequate amount
  • Drain tests report close to zero
  • Intuitive response is to add more to feed

But…..

• Plant has sufficient quantity.
• Plant continues to build Mn levels to toxic levels
• Water tests alone were insufficient
Nutrient Uptake

• Antagonistic effects need to be considered
• One of the first things to check is if the element in excess can be blocking the uptake of a deficient element.
• High K = decreased uptake of Ca, Mg
• Applying more Ca may not correct a deficiency if K is too high
• Eg. Balance of the two important for fruit quality
  • Ca for cell wall strength
  • K for fruit quality - size, taste
Nutrient Uptake

Manual for plant fertilization, Rela den Haan, 2007
Nutrient Uptake

- How do you know if you have enough Ca?
- Current water tests may show sufficient concentrations
- Tissue analysis (dry matter) measures total Ca
- Results are picture of several weeks prior
- Sap analysis measures the available Ca at that moment

<table>
<thead>
<tr>
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</tbody>
</table>
### Sample Report – Nova Crop Control

<table>
<thead>
<tr>
<th>Element</th>
<th>ppm 1</th>
<th>ppm 2</th>
<th>ppm 3</th>
<th>ppm 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>P - Phosphorus</td>
<td>784</td>
<td>485</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si - Silica</td>
<td>19,0</td>
<td>26,0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe - Iron</td>
<td>1,49</td>
<td>1,85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mn - Manganese</td>
<td>10,80</td>
<td>6,85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zn - Zinc</td>
<td>1,00</td>
<td>0,74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B - Boron</td>
<td>11,40</td>
<td>9,65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu - Copper</td>
<td>0,42</td>
<td>0,36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mo - Molybdenum</td>
<td>0,25</td>
<td>0,16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al - Aluminium</td>
<td>&lt;0,50</td>
<td>&lt;0,50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- High P = decreased NO3, Fe, Zn, Cu
Nutrient Movement in Plant

• Mobility of Nutrients must be considered
• N, P, K, Mg are mobile nutrients
• Reserves of mobile elements in old leaves are available for young developing parts.
• Excess amounts of P and K in particular are not taken into account
• No one ever lowers concentrations of P or K to zero in the drain
• Why?
Nutrient Movement in Plant

- Theoretically, it is possible.
- Analogy 1. When you finish dinner, and your plate is empty, are you still hungry?
- Analogy 2. Do you want an athlete or an obese patient?
- Why over feed our plants and make them unhealthy?
- Restricting the update of needed nutrients unnecessarily
- Healthy plants have the right balance
- Plants with the right balance have less disease and insect pressure
Nitrogen Conversion to Protein

• Plant has a limited ability to pull things in or keep things out.
• Excess N makes a weak plant.
• Excess water which dilutes concentrates of other nutrients needed for metabolic process, protein synthesis
• Cells cant get enough Ca....weak cells.
Nitrogen Conversion to Protein

- Balance of nutrients drives the rate of conversion
- Mg, S, Mo
- Calculate converted N (1640 - 397 = 1243 ppm)
- NO3-N% (397/1640 = 24%)
Sugars/pH/EC

• Parameters not found on dry matter test
• Total sugars – low sugars = energy poor plant
• pH/EC – All metabolic functions depend on these
  • Photosynthesis
  • Protein synthesis
Summary of what we can see

• Current status of nutrient uptake
• Reserves in the plant
• Total available nutrients that the plant can use for growth
• Identify possible deficiencies or toxicities before we see symptoms
• Reflects the status (health) of the plant
  • Blood test for the plant.
Further Study Needed

- Grower experience
- Follow the research
- pH
- Organic production
- Webinars
Thanks for your attention.

Lorne King