The Nutrition Triangle

- Fertilizer
- Substrate
- Irrigation
Substrate pH

- Douglas fir bark has an abundance of available nutrients.
- Nutrient availability in the bark is dependent largely on substrate pH.
- Nutrient availability changes widely over the range of pH values.
Effect of pH on nutrient availability
Lime affects pH of bark

- **Calcitic lime**
  - CCE = 97

- **Dolomitic lime**
  - CCE = 106

- **Quick lime**
  - CCE = 126
Substrate pH affects P availability
P availability with lime rate

Available P (ppm)

---Calcium carbonate (lb/yd³)---
---Calcium hydroxide (lb/yd³)---
Lime affects on available P

- As pH increases, P availability decreases
  - True for soils and bark

- Ca ions bond with phosphates
  - Calcium phosphate is largely insoluble
  - Calcium phosphate is either unavailable, or leaches in mass flow of water
Phosphorus

- We know high levels are available initially.
- This should make you reconsider your pre-mix fertilizer amendments.
- Wait until we know more before you change your CRF or liquid feed program.
Phosphorus

- OR nurseries contain their runoff water during the growing season.

- What about P leaching during the winter months?
Substrate pH affects Fe availability

$R^2 = 0.88$
Substrate pH affects Mn availability

$R^2 = 0.5345$
Substrate pH affects B availability

Levels 0.7 to 2.5 are recommended.

$R^2 = 0.8119$
Results first trial (6 WAP)

No differences in growth or color

Despite deficient substrate B, plants had sufficient foliar B.
Summary of bark

- Nutrient availability very pH dependent
- pH is very easy to change with lime products
- At typical pH (>6), P and some micronutrients are not sufficiently high in bark
  - Maintain lower pH, reduce applied fertilizers?
Nitrogen

• Virtually no N in irrigation water.
  – Even from recycle ponds, anticipate very low levels.

• Very low N levels in bark
  – N immobilization.
Geranium growth

![Bar chart showing geranium growth with fertilizer N rate (ppm) on the x-axis and shoot dry weight (g) on the y-axis. The chart compares aged and fresh fertilizer at three different N rates: 200, 300, and 400 ppm.]
Nitrate availability in substrate

Nitrate availability in substrate

- Foliar N (%)
- Fertilizer N rate (ppm)

![Bar chart showing nitrate availability in substrate with different fertilization rates and foliar N percentages for aged and fresh fertilizer.](chart.png)
Nitrate availability in substrate

Nitrate availability (ppm)

Fertilizer N rate (ppm)

Aged
Fresh
NDI for fresh and aged bark
Summary of Nitrogen

• Nitrogen is not available from bark

• Nitrogen will be immobilized by bark
  – Immobilization is not biological

• Fresh bark will immobilize more N than aged bark
  – Nursery fertilizer rates offer excessive N
  – Compensates for differences in immobilization
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Water quality over time in OR

Irrigation pH over time

Alkalinity over time

Sodium levels over time

Bicarbonates over time
Hardness

- Hardness refers to the concentration of Ca and Mg in water.

- This term is closely related to alkalinity, but they refer to two different chemical properties.
Water quality in Oregon

R² = 0.9347
Alkalinity

• The measure of a water’s ability to neutralize acids.

• Alkalinity is the concentration of
  – Carbonates and bicarbonates
  – $\text{CO}_3^{2-} + \text{HCO}_3^-$

• Depending on lab, the sum of carbonates, bicarbonates, and/or hydroxides.
Water quality in Oregon

R² = 0.2616

Alkalinity (ppm)

Calcium (ppm)
Alkalinity affects P availability

- Carbonates raise substrate pH
  - P becomes less available

- Ca reacts with phosphates to form:
  - Calcium phosphate
  - Precipitates from solution, not readily available for plant uptake.
Water quality in Oregon

\[ R^2 = 0.249 \]
Summary

• Alkalinity affects substrate pH

• Irrigation water pH has little/no affect on container pH

• Alkalinity and hardness (Ca levels) affect P availability.

• Low irrigation alkalinity is ideal, irrigation pH is irrelevant.
The pour-through method

• Consistency is problematic
  – Use the same person
  – Use the same equipment
  – Use the same protocol
Water placement affects results

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Extract pH

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Fine bark

- Center: b
- Middle: b
- Edge: b

Medium bark

- Center: a
- Middle: b
- Edge: a

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Substrate type, water volume and water application method

Extract pH

<table>
<thead>
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<th></th>
<th>Drip</th>
<th>Pour</th>
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<td>bc</td>
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<tr>
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<tr>
<td>Medium - 100</td>
<td>c</td>
<td>a</td>
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<tr>
<td>Medium - 200</td>
<td>bc</td>
<td>a</td>
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</tbody>
</table>

Legend:
- Drip
- Pour
Pour-through procedure

• Slow application of water produces more consistent results.

• Apply the water along the entire substrate surface.

• Time consuming
BAMB Model 2010

- Automated, multi-container pour-through system
- Pressure compensating
- Uniform placement of water, slow application
- Consistent results!
Summary

• OSU is beginning to document nutrient availability in bark.
  – Also documenting factors that affect nutrient availability.

• This will allow nursery growers to make better fertility decisions.
Website

- http://oregonstate.edu/dept/nursery-weeds/