Visual diagnosis of nutrient deficiencies in plants
Botany 453/553: Summer 2016

Nutrient deficiencies are not easy to diagnose
Various deficiencies can mimic one another
Symptom location and pattern assists diagnosis

Web-based resources
Plant nutrition diagnosis:
http://pnwhandbooks.org/planttissues/pathogen-articles/nonpathogenic-phenomena/plant-nutrition-diagnosis

Essential elements for plant growth:
(University of Wisconsin)
http://www.soils.wisc.edu/~barak/soilsscience326/listofel.htm

Book resources
Mineral nutrition of higher plants
Dicentra spectabilis 'Gold Heart'

Rhododendron: Sunburn
Mineral nutrients required by plants

C, H, O constitute ~ 89% of plant dry matter

**Major nutrients:**
- Nitrogen (N): 4%
- Phosphorus (P): 0.5%
- Potassium (K): 1.5%
- Calcium (Ca): 1.5%
- Magnesium (Mg): 0.5%
- Sulfur (S): 0.25%

**Minor nutrients:**
- Iron (Fe): 0.01%
- Zinc (Zn): 0.003%
- Manganese (Mn): 0.03%
- Copper (Cu): 0.015%
- Molybdenum (Mo): 0.0003%
- Boron (B): 0.005%
- Chlorine (Cl): 0.1%

Also: salt toxicity....

**Location of symptoms:**
- Base of plant – mobile (N, P, K, Mg)
- Whole (mid) plant – partially mobile (S, Mo)
- Top of plant – immobile (Ca, Fe, Mn, Zn, Cu, B)
Flowering plum (Prunus x blireana)

Mobile nutrient: symptoms at plant base

N Deficiency Symptoms

- Uniform chlorosis of older leaves.
- Necrosis of older leaves.
- Abscission of older leaves if possible.
- Red pigment - old leaves - some species
- Earlier flowering with marginal N deficiency (later flowering if severe).

Rhododendron (Rhododendron sp.)

Mobile nutrient: Nitrogen deficiency
N deficiency

Highbush blueberry (Vaccinium corymbosum)

N deficiency

Highbush blueberry (Vaccinium corymbosum)

N deficiency
P Deficiency symptoms

- Deeper green foliage.
- Heavy stunting (compact form).
- Purple (or red) pigmentation in several species.
- Fewer & longer roots, more root mass at first, less when deficiency intense.
- Lower leaf chlorosis → necrosis
Growth of *Thuja plicata* with and without P

Chrysanthemum

Raspberry (*Rubus idaeus*): early P-deficiency

Photo: B. Strik
K deficiency symptoms

- Chlorosis might occur briefly at tip and margin of old leaves.
- Rapid necrosis of margins or spotting across old leaf blades.
- Seedlings are often compact and deeper green prior to above symptoms.
Mobile nutrient: Potassium deficiency

Grape (Vitis vinifera): potassium deficiency

Snap beans (Phaseolus vulgaris): potassium deficiency

Necrotic Spotting

• Corn
• Cucumber

Mg deficiency symptoms

• Older leaves develop yellow spots on edges of leaves
Mobile nutrient: Magnesium deficiency

Raspberry (Rubus idaeus): Mg deficiency

Photo: B. Strik

Grape (Vitis vinifera): Mg deficiency

Photo: S. Renquist

Mg deficiency symptoms

(Chamacyparis) (Cotoneaster)

Sugar beet - Magnesium deficiency
Immobile nutrient-Calcium

Spinach

Tomato (Lycopersicon esculentum): blossom end rot

Apple (Malus domestica): bitter pit
Pear (Pyrus communis): cork spot

Immobile Nutrient – Boron

B-induced crinkling of young leaves due to patches of cells not developing in the leaf blade.

Immobile Nutrient – Ca vs B

Necrosis and Distortion

<table>
<thead>
<tr>
<th>Ca</th>
<th>B</th>
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</thead>
<tbody>
<tr>
<td>Distortion, necrosis, chlorosis</td>
<td>Distortion, necrosis,(chlorosis)</td>
</tr>
<tr>
<td>Incomplete flower formation</td>
<td>Incomplete flower formation</td>
</tr>
<tr>
<td>Roots short, densely branched, &amp; thick</td>
<td>Roots short, densely branched, &amp; thick</td>
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<tr>
<td>Short internodes – rosetting</td>
<td>Thick leaves, corking</td>
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<tr>
<td>Thick leaves, corking</td>
<td>Abortion, branching</td>
</tr>
</tbody>
</table>
Partly mobile nutrient: Sulfur


Soil pH and nutrient availability
Wheat (*Triticum aestivum*): low soil pH

**Soil pH**

Wheat (*Triticum aestivum*): low soil pH

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**Immobile Nutrient: Iron**

Rhododendron (*Rhododendron* sp.): pH-induced Fe deficiency

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Blueberry (*Vaccinium corymbosum*): pH-induced Fe deficiency

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Salt toxicity effects on plants

Bracken Fern (Pteridium aquilinum)
Nursery stock, salt damage

Photo by J. Alland

Winged Euonymus (*Euonymus alatus*)

Soil quality effects on plant performance
The perception is that these soils have:

- low organic matter
- ↓ nutrients
- altered pH
- poor structure
- ↓ biological activity
Sampling done:
- May
- Oct-December

Analyses:
- P
- K
- Ca
- Mg
- Na
- NO$_3$
- OM
- pH
- %sand
- %silt
- %clay

- P declines by half
- Organic matter declines 25%
- Nitrate decreases by half
- pH increases
Soil compaction

"Platy" structure

Granular structure
Compaction causes decreased:
- $H_2O$ infiltration
- $CO_2/O_2$ movement
- biological activity
- root growth
- nutrient uptake

Signs of compaction:
- chlorosis
- other nutrient deficiencies
- drought stress
- poor growth
- root disease problems