

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/plantdisease/pathogen-articles/nonpathogenic-phenomena/plant-nutrition-diagnosis>

Essential elements for plant growth:
(University of Wisconsin)
<http://www.soils.wisc.edu/~barak/soilscience326/listofel.htm>

Book resources

Mineral nutrition of higher plants
3rd edition, 2011. Academic Press

Handbook of plant nutrition
2nd edition, CRC Press, 2015

Plant Analysis Handbook
3rd edition, 2014, MicroMacro Publishing

Nutrient deficiencies and toxicities in crop plants
APS Press, 1996

Western Fertilizer Handbook
Waveland Press, 2002

Soil Fertility and fertilizers
8th edition, Pearson, 2014





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)



Mobile nutrient: symptoms at plant base



Flowering plum (*Prunus x blireana*)

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).

Mobile nutrient: Nitrogen deficiency



Rhododendron (*Rhododendron* sp.)

N deficiency





Highbush blueberry (*Vaccinium corymbosum*)





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

P Deficiency: deep green



Chamaecyparis





Growth of *Thuja plicata* with and without P



Chrysanthemum



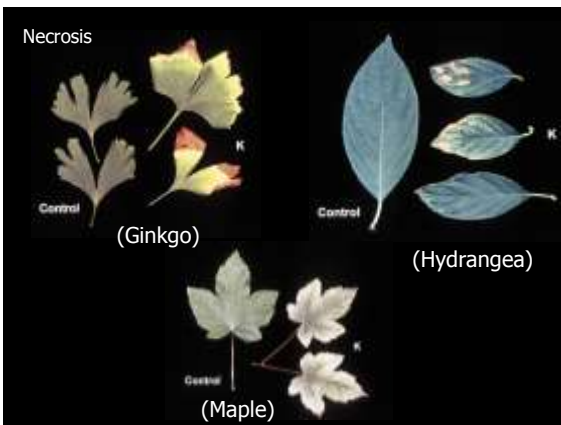
Raspberry (*Rubus idaeus*): early P-deficiency

Photo: B. Strik



K deficiency symptoms

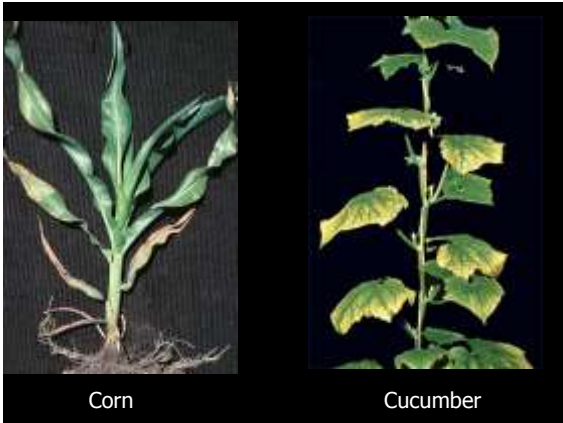
- Chlorosis might occur briefly at tip and margin of old leaves.
- Rapid necrosis of margins or spotting across old leaf blades.
- Seedlings are often compact and deeper green prior to above symptoms.



Mobile nutrient: Potassium deficiency



Snapet (*Atriplex hortensis*) potassium deficiency Photo: Phil & Ben Myers



Corn

Cucumber

Mg deficiency symptoms

- Older leaves develop yellow spots on edges of leaves



Mobile nutrient: Magnesium deficiency



Raspberries (*Rubus idaeus*) - Mg deficiency

Photo: G. R. S. Sisk

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

Ca

- Distortion, necrosis, chlorosis
- Incomplete flower formation
- Roots short, densely branched, & thick

B

- Distortion, necrosis, (chlorosis)
- Incomplete flower formation
- Roots short, densely branched, & thick
- Short internodes – rosetting
- Thick leaves, corking
- Abortion, branching

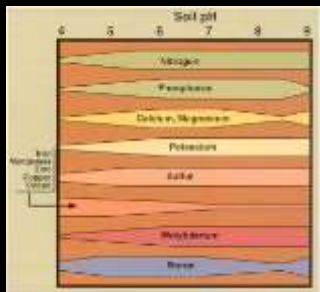
Partly mobile nutrient: Sulfur





Noble Fir (*Abies nobilis*): N, P, K, B nutrient deficiency Photos: S. Castagnoli

Soil pH and nutrient availability



Soil pH



Wheat (*Triticum aestivum*): low soil pH

Immobile Nutrient: Iron



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



Blueberry (*Vaccinium corymbosum*): pH-induced Fe deficiency Photo: B. Strik

Salt toxicity effects on plants



Bracken Fern (*Pteridium aquilinum*)







Nursery stock, salt damage

Photo by J. Altland



Winged Euonymus (*Euonymus alatus*)

Soil quality effects on plant performance












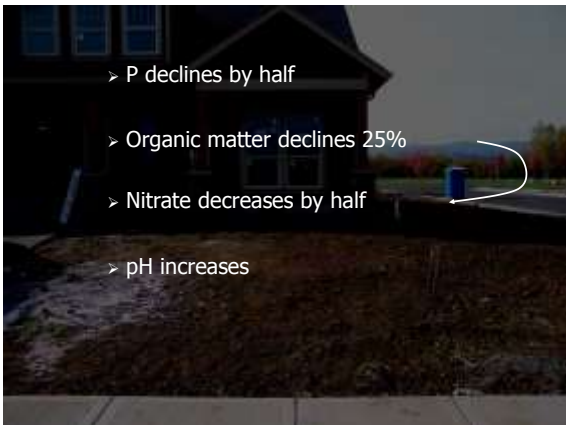


Sampling done:

- > May
- > Oct-December

Analyses:

| | |
|-----------------|-------|
| P | OM |
| K | pH |
| Ca | |
| Mg | %sand |
| Na | %silt |
| NO ₃ | %clay |



> P declines by half

> Organic matter declines 25%

> Nitrate decreases by half

> pH increases

February 2007



July 2007



February 2009



Soil compaction





"Platy" structure



Granular structure



Compaction causes decreased:



- > H₂O infiltration
- > CO₂/O₂ movement
- > biological activity
- > root growth
- > nutrient uptake

Signs of compaction:



- > chlorosis
- > other nutrient deficiencies
- > drought stress
- > poor growth
- > root disease problems

