

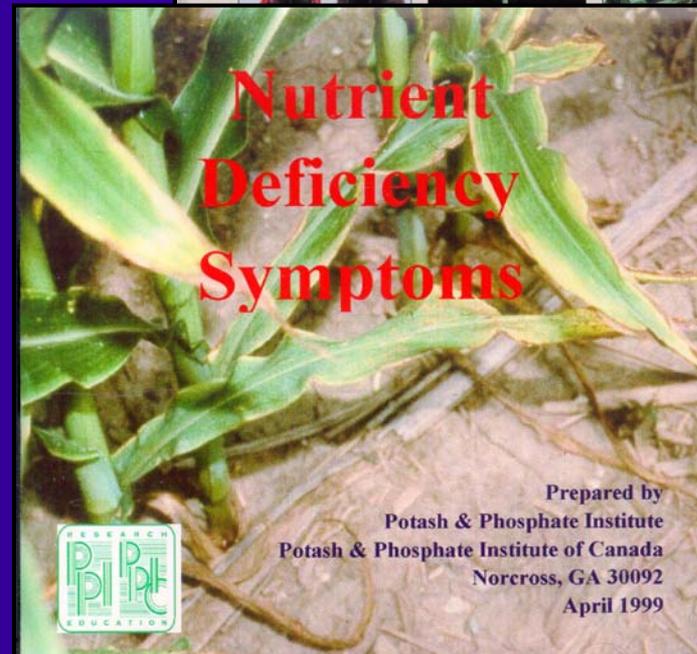
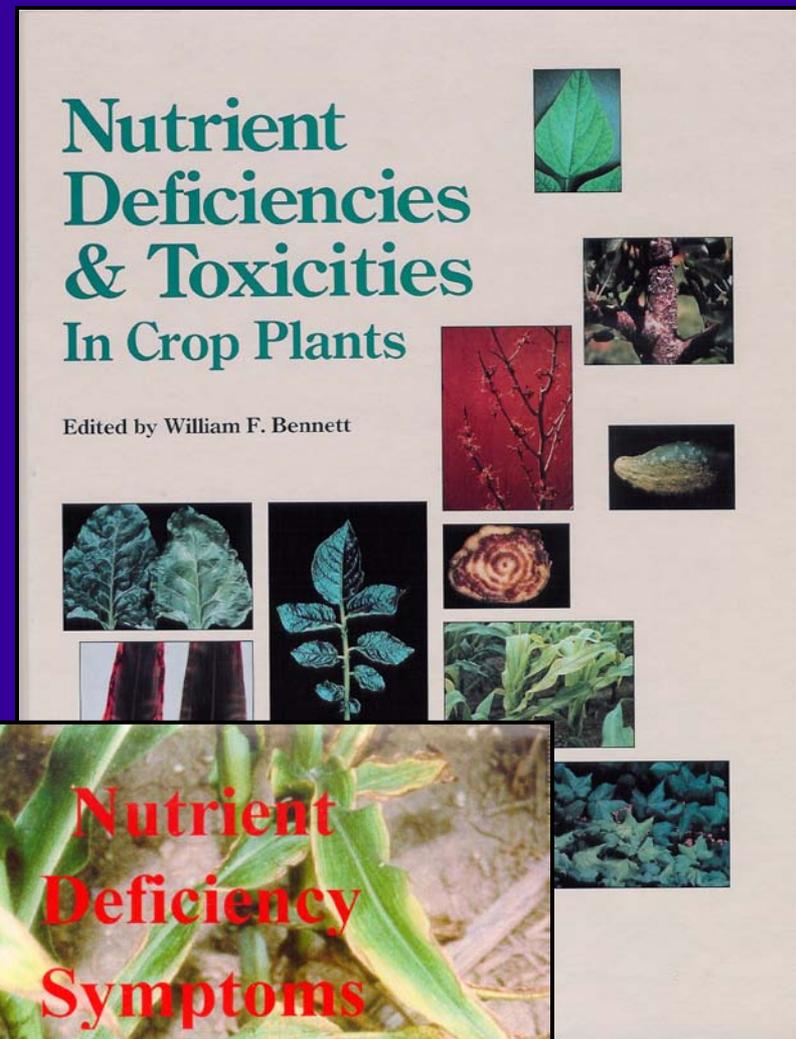
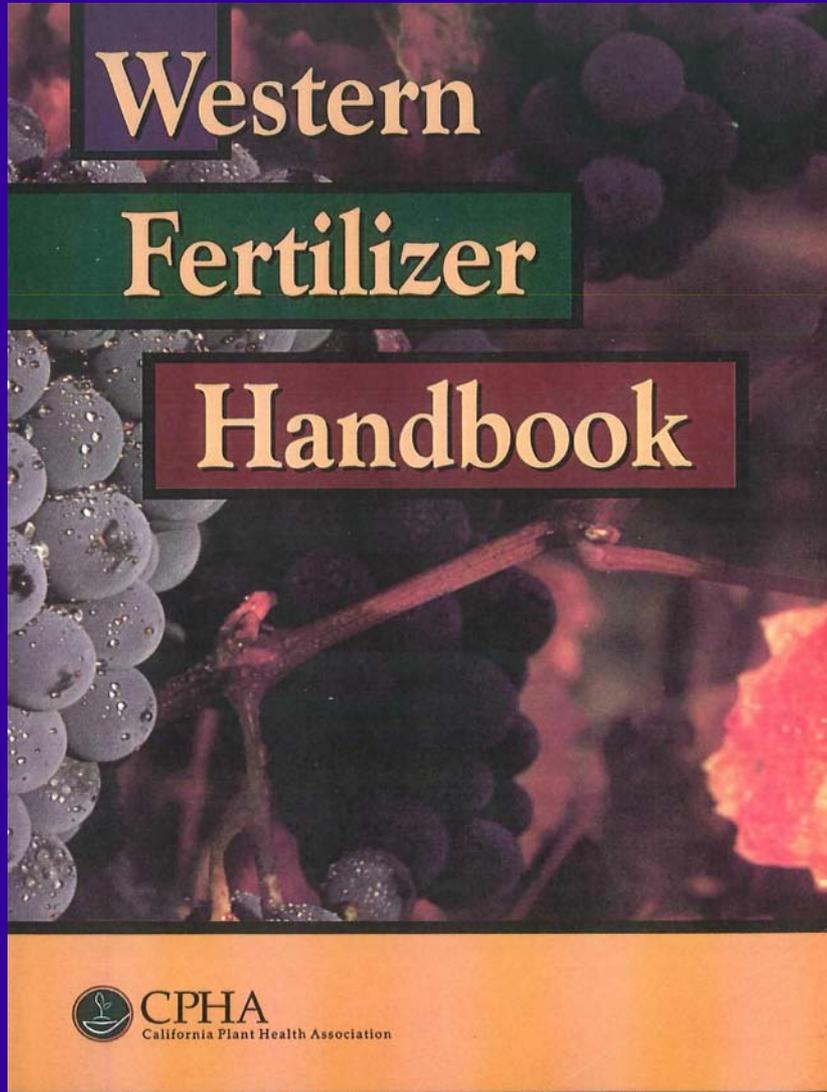
Nutrient deficiencies and their symptoms in selected crops

Modified from Mike Stewart
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Potash & Phosphate Institute

www.ppi-ppic.org



Some good sources of information



Essential and Beneficial Elements in Higher Plants

Essential and Beneficial Elements in Higher Plants																			
H																	He		
Li	Be													B	C	N	O	F	Ne
Na	Mg													Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt											
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb				
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No				

- Essential Mineral Element
- Beneficial Mineral Element
- Essential Nonmineral Element

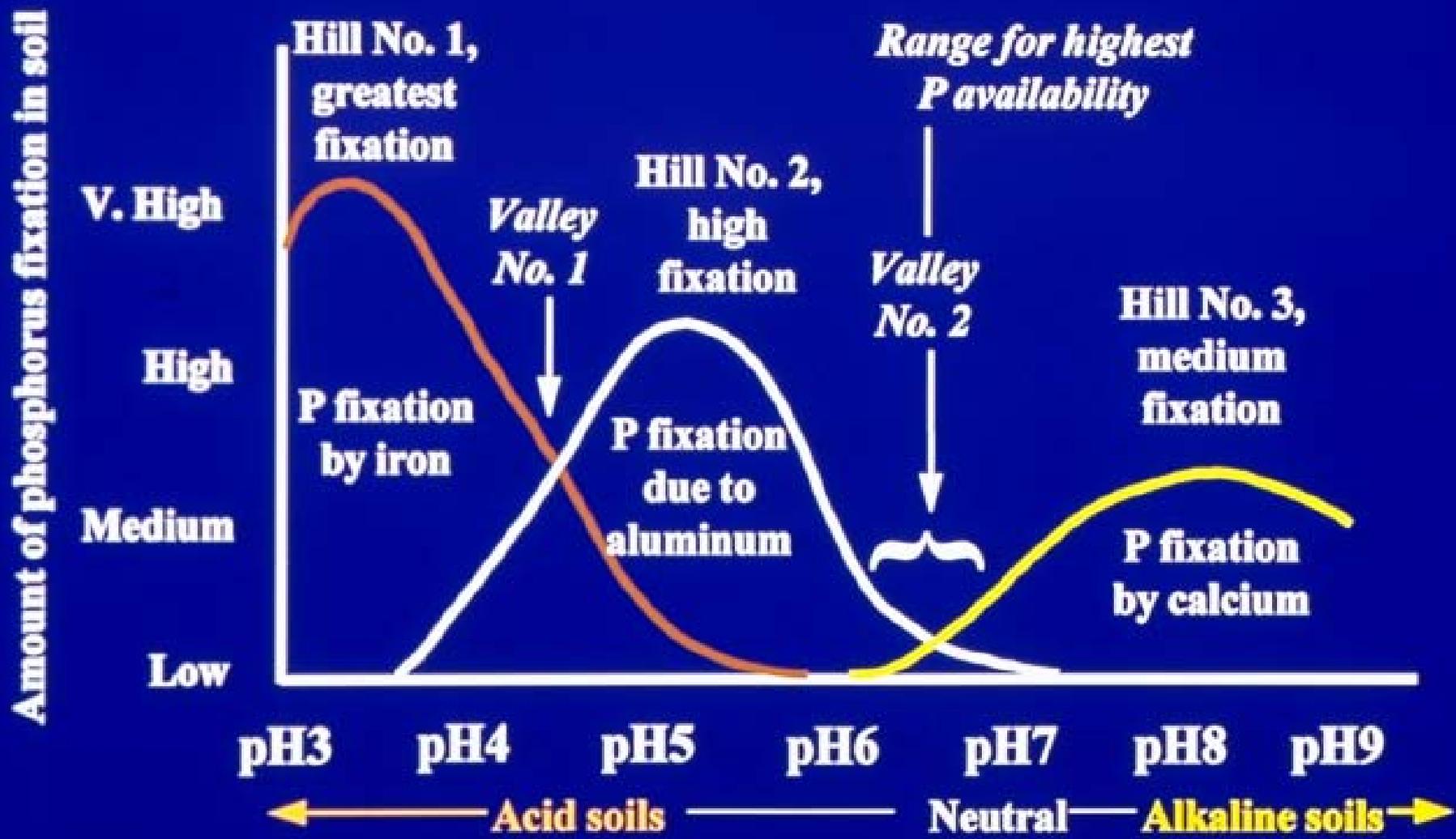
Five general types of nutrient deficiency symptoms

- **Chlorosis-** yellowing due to reduction in chlorophyll
 - Uniform or interveinal
- **Necrosis-** death of plant tissue
- **Lack of new growth or terminal growth** resulting in resetting
- **Anthocyanin accumulation** (when metabolic processes are disrupted) resulting in reddish color
- **Stunting** with either normal or dark green color or yellowing

Several factors can affect occurrence of deficiency symptoms

- **Soil test level**
 - also consider texture, CEC, OM, pH, etc.
- **Soil conditions, e.g.,**
 - temperature
 - compaction
 - moisture
 - Salinity
- **Tillage practices**
- **Root pruning**
- **Nutrient interactions**
 - P- Zn
- **Herbicide, disease, or insect damage**

The Hills and Valleys of Phosphorus Fixation



Soil pH and the secondary and micronutrients

- **Soil pH influences**
 - solubility of compounds, hence nutrient availability
 - cations on exchange sites
- **Common deficiencies on acid soils**
 - Ca, Mg, S, Mo
- **Common deficiencies on alkaline soils**
 - B, Cu, Fe, Mn, Zn

Nutrient deficiency symptoms and mobility within plants

- **Mobility**- The ease with which an element is transported to new plant parts.
 - The extent of mobility affects the appearance of deficiency symptoms.

Nutrient Mobility in the Plant

Translocated

Symptoms appear in older leaves first

- nitrogen
- phosphorous
- potassium
- magnesium

Not translocated

Symptoms appear in younger leaves first

- sulfur
- calcium
- boron, iron, manganese, zinc, copper, molybdenum, chloride

General symptoms- nitrogen

- Deficiency usually appears on older leaves first.
- Because N is a part of the chlorophyll molecule, a major deficiency symptom is chlorosis.
- Slow growth and stunted plants
- Lower protein, fewer leaves, and early maturity
- In corn yellowing begins at leaf tip and extends along midribs.
- Less tillering in small grains and other grasses
- Reduced yield potential



General symptoms- phosphorus

- Symptoms will generally appear on older leaves first.
- Purple or reddish color
- Overall stunting
- Reduced tillering in small grains
- Reduced yield potential
- In many crops symptoms can be aggravated by conditions that restrict root growth (e.g., cool, moist, and/or compacted soils).



General symptoms- potassium

- Symptoms will generally appear on older leaves first.
- Yellowing and/or scorching along leaf margins
- Weakened stalks (lodging)
- Decreased disease resistance
- Slow growth and poorly developed root system
- Small and shriveled grain or fruit
- Reduced yield potential
- In many crops symptoms can be aggravated by conditions that restrict root growth (e.g., cool, moist, and/or compacted soils).

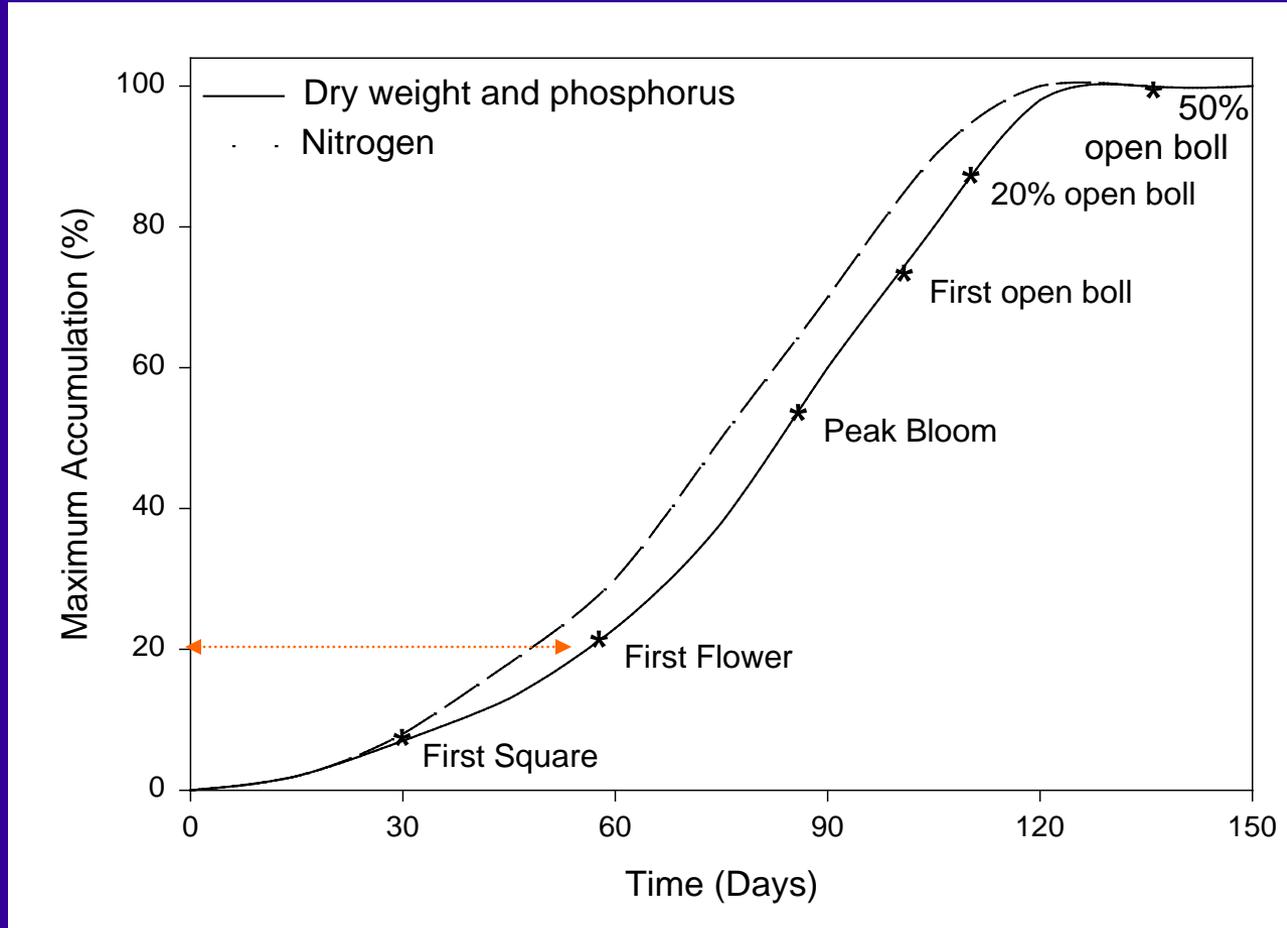


Cotton

N management of cotton

- **Uptake may reach 2- 4 lb/A/day during mid boll fill**
- **Approximately 20% of seasonal needs should be supplied pre-bloom**
- **Supply remainder of N should be supplied during boll development period**
- **Soil N should be depleted as bolls begin to open to avoid delayed maturity**

Dry Matter Accumulation, and Nitrogen and Phosphorus Uptake of Cotton



N deficient cotton

Early and mid season

- Yellowish-green leaf color and small young leaves
- Stunted plants
- Shortened fruiting branches
- Many bolls shed in the first 10-12 days after flowering

Late season

- Reddening in the middle of the canopy
- Reduced boll retention at late fruiting positions
- Shorter flowering period, accelerated leaf senescence, and early cut-out



Functions of Phosphorus in Cotton Production

- Promotes early boll development and hastens maturity
- Essential for vigorous root and shoot growth
- Helps overcome the effects of compaction
- Increases water use efficiency
- A 2 bale crop can take up more than 50 lb P_2O_5/A

P deficient cotton

Symptoms are not distinct in cotton,

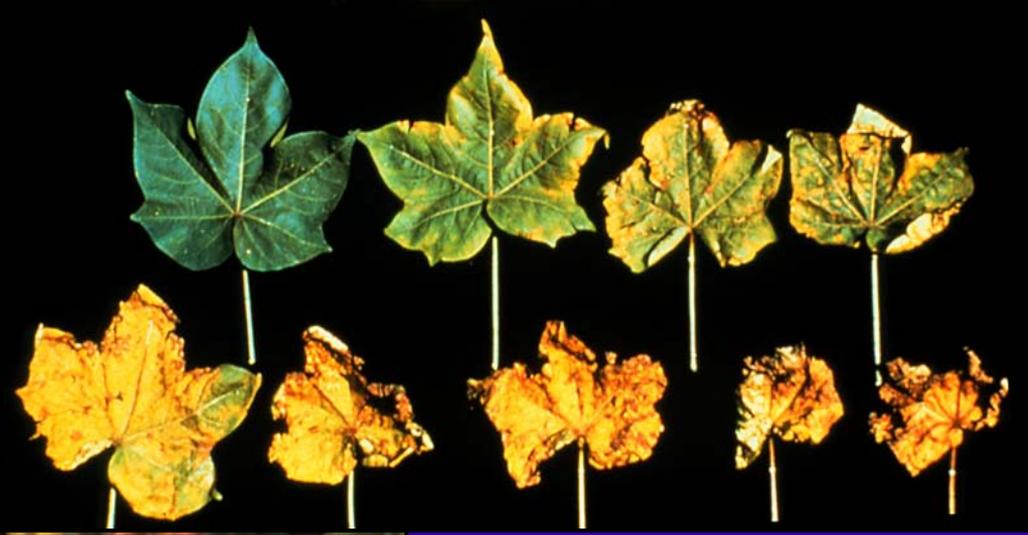
- Stunting
- Dark leaves
- Flowering delayed
- Poor boll retention
- Premature leaf senescence



Potassium in Cotton Production

- Bolls are major sinks for K, uptake may peak at as much as 3- 4 lb $K_2O/A/day$ during boll development.
- About 70% of total uptake occurs after first bloom.
- Affects quality (micronaire, length, and strength)
- Increases water use efficiency
- Reduces the incidence and severity of wilt diseases
- A 2 bale crop will take-up about 170 lb K_2O

Potassium deficient cotton



- Affects older leaves first in early season
- Begins as scorching of leaf margin
- Affects both yield and quality
- Late season affects younger leaves

Late season K deficiency of cotton



Foliar K on Cotton

- The foundation of K fertility program should be soil applications.
- Response to mid-season foliar K is likely when
 - soil K is low (low soil test level or fixation)
 - root uptake is compromised
 - petiole analysis indicates a pending shortage
- Applications at 2 week intervals should begin at or soon after 1st flower
 - 5 lb K_2O/A per application

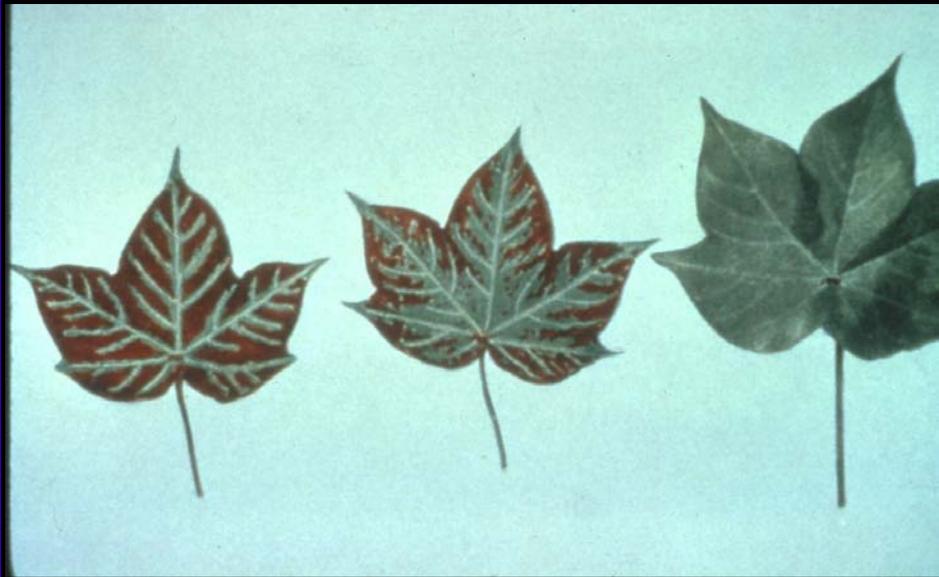
Sulfur deficient cotton

- Symptoms similar to N but occur on younger leaves in upper canopy first
- Leaf veins tend to remain green



Mg deficiency in cotton

- Appears on older leaves first
- Distinct interveinal reddish purple color



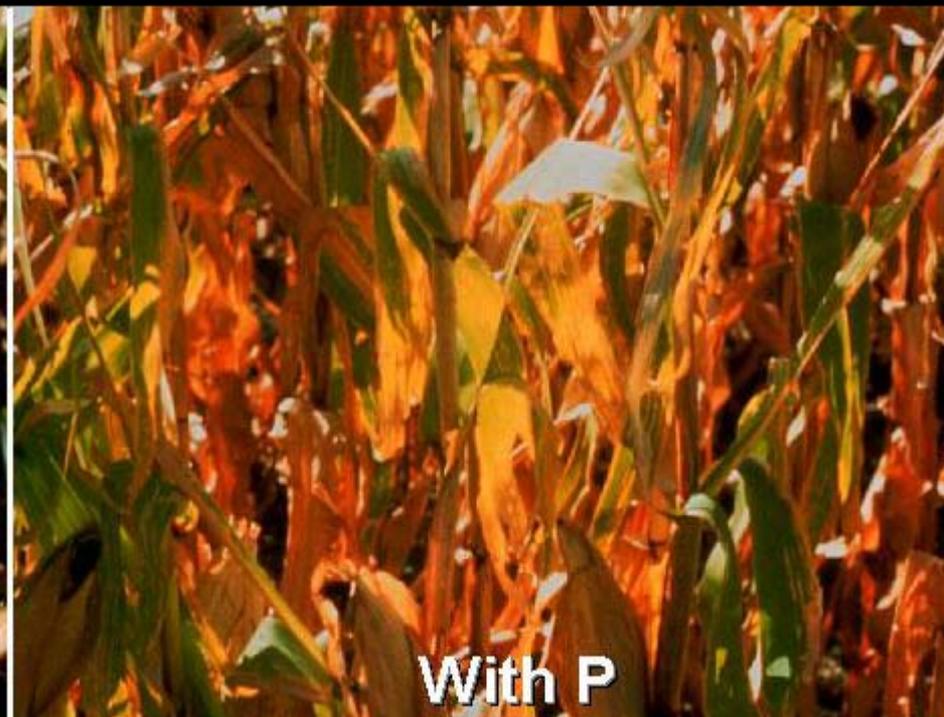
Corn

Phosphorus deficiency in corn

- Purple or reddish color in older leaves
- Most often occur in young plants
- Overall stunting that may persist throughout season
- Lower yield



Effect of P on hastening corn maturity



K deficiency in corn

- Scorching (necrosis) along leaf margins of lower leaves first
- Weakened stalks that may result in lodging
- Decreased disease resistance
- Slow growth
- Reduced yield potential



K shortages can weaken stalks and result in lodging



Sulfur deficiency in corn

- Chlorosis similar to N but occurring on younger leaves first
- Delayed maturity
- Stunting
- Favored in sandy, acid soils low in OM, and cold wet soils.



Magnesium deficiency in corn

- Yellow to white interveinal chlorosis on older leaves first
- Leaves may become reddish-purple
- In severe cases leaf tips and edges may die
- Favored by sandy, acid soils where Mg has been leached
- Deficiency can be induced by imbalance with K





Zn deficiency due to P-Zn interaction

80 lb P_2O_5
10 Zn

EFFECTS OF
P IN ABSENCE
OF SUFFICIENT $7N$
80 P_2O_5 AS 15-60-0
BANDED BROADCAST
POTTAWATOMIE COUNTY, KANS.

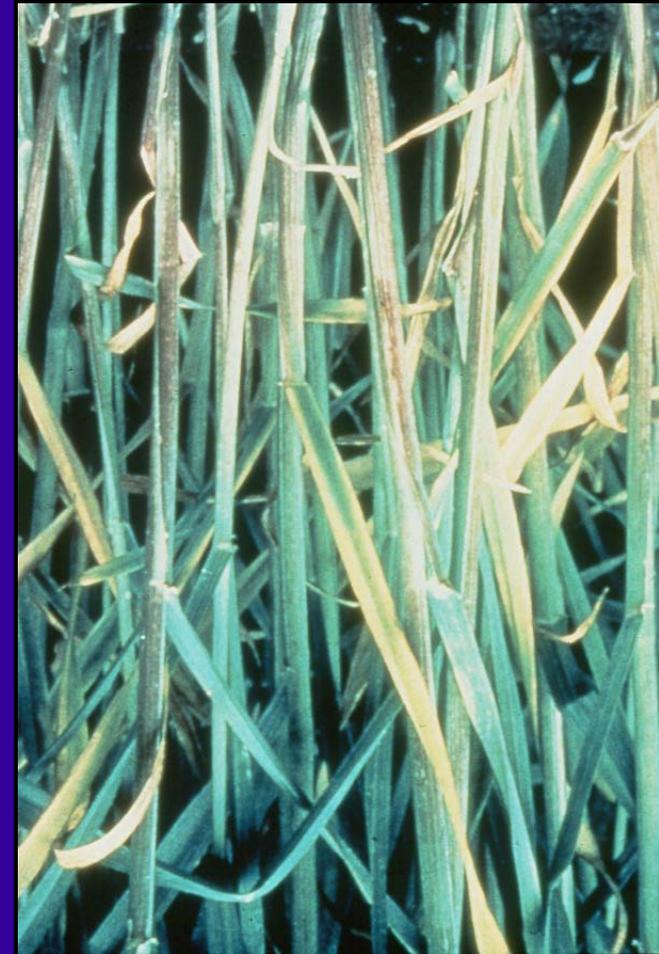
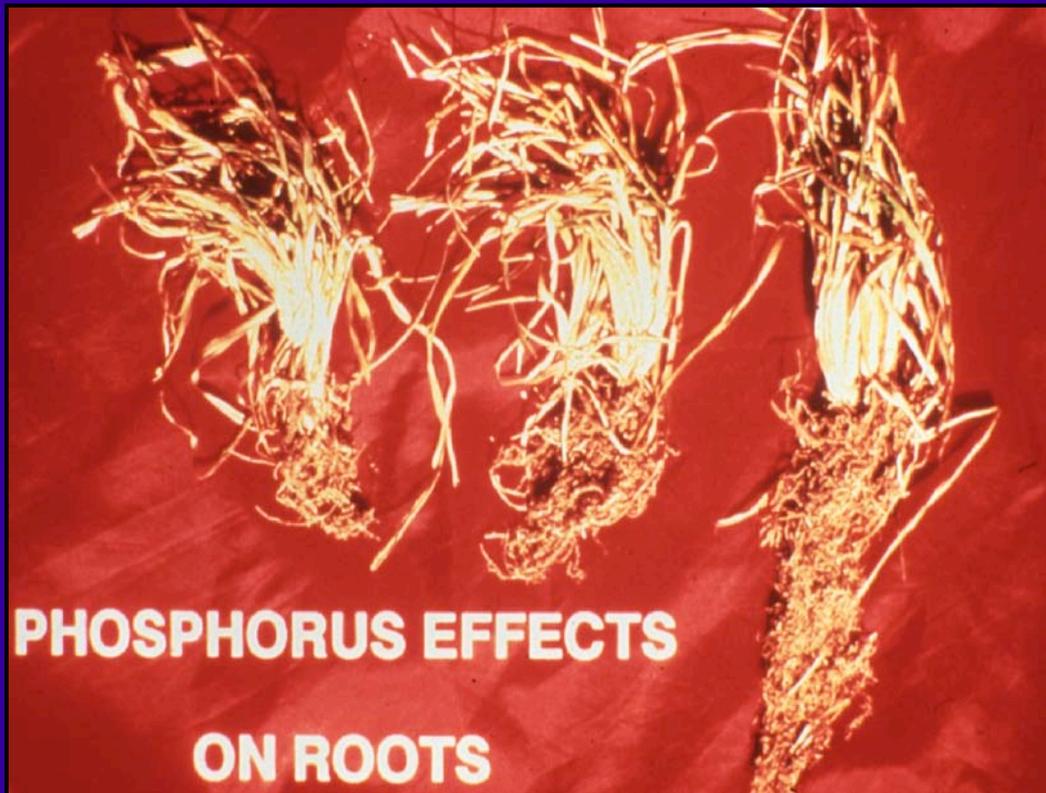
80 lb P_2O_5 -Banded
0 Zn

80 lb P_2O_5 -Broadcast
0 Zn

Wheat

P deficiency in wheat

- Slow growth and reduced tillering
- Late maturity and reduced yields
- Increased disease susceptibility



P deficiency in wheat...

reduces tillering, delays maturity, and lowers yield



S deficient wheat

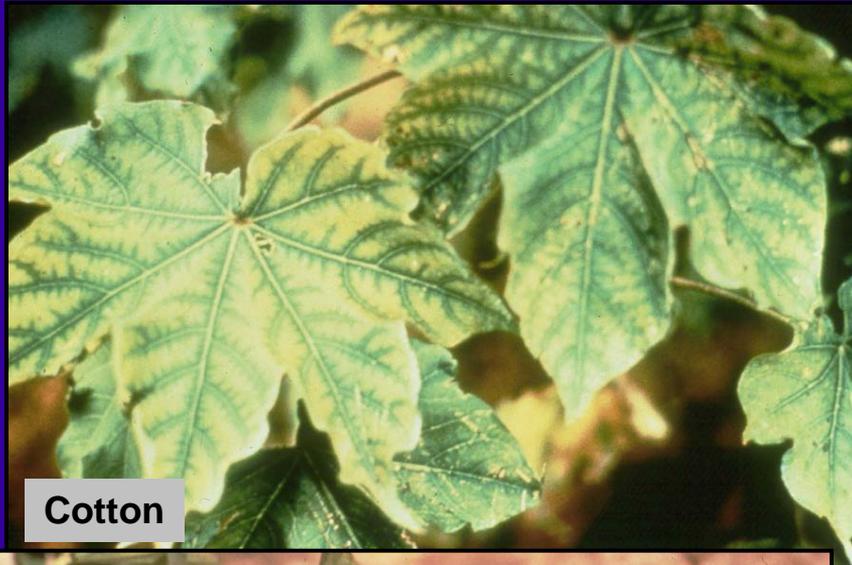
- **Brightly chlorotic, yellow-green and stunted plants.**
- **Most common on coarse, well-drained soils low in organic matter.**
- **In season deficiency best treated with sulfate source and not elemental S**



Some micronutrient symptoms

Zinc (Zn)	Corn- Broad white to yellow bands on each side of midrib. Cotton- Interveinal yellowing with distinct green veins. Soybean- Stunted stems and chlorotic interveinal areas. Slowed maturity and reduced seed number.
Iron (Fe)	Corn- Interveinal areas become pale green to white. Cotton- Interveinal yellowing with distinct green veins. Soybean- Yellowing of interveinal areas. Whole leaf finally turns white. May be induced by liming.
Manganese (Mn)	Corn- Rarely occurs. Symptoms are not clear-cut. Cotton- Rarely occurs. Leaf cupping and interveinal chlorosis. Soybean- Interveinal areas become light green to white. Veins remain prominently green.
Boron (B)	Corn- Rarely occurs. Leaves are brittle with small dead spots. Cotton- Short, thick petioles with dark concentric bands along their length. Distorted flower shape. Flower and boll shedding. Soybean- Shortened internodes and yellowing or reddening of upper leaves. Death of terminal growth. Flowers fail to develop.

Zinc deficiency symptoms



Cotton



Corn

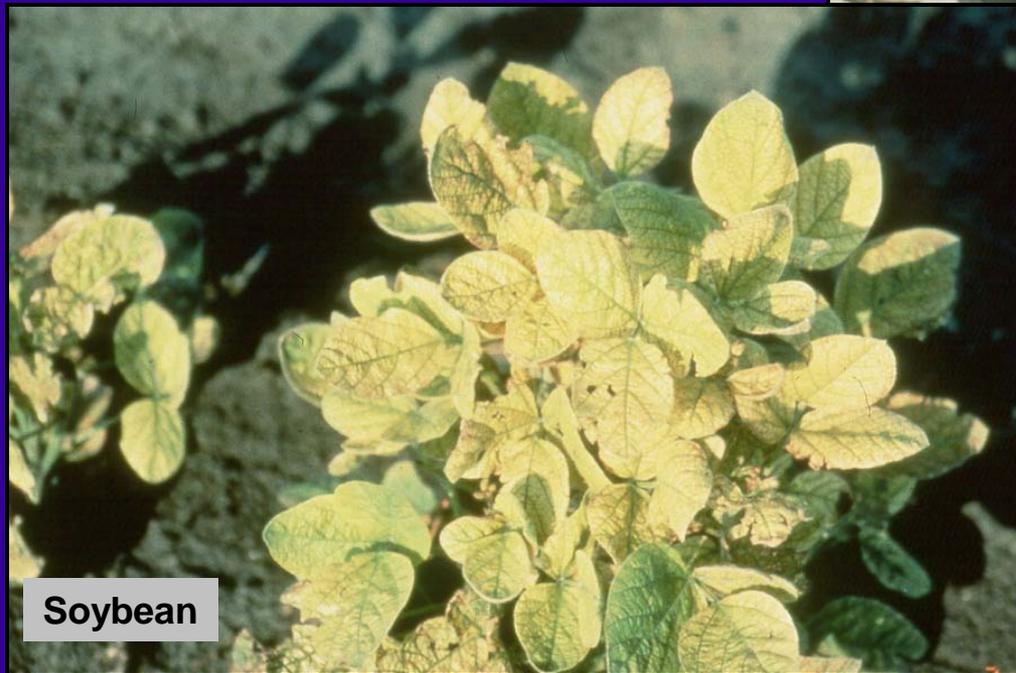


Soybean



Corn

Iron deficiency symptoms



Manganese deficiency symptoms



Cotton



Soybean



Soybean

Summary

- **The ability to accurately diagnose nutrient deficiencies is an important skill.**
- **Deficiency symptoms are often not clearly defined. Masking effects can hinder diagnosis.**
- **The entire system should be evaluated before making a diagnosis and recommendation.**
- **Use soil, irrigation water, and plant analyses to aid in diagnostic efforts.**

Summary

- **Visual symptoms indicate severe starvation. Most crops start losing yields well before deficiency symptoms occur.**
- **In most cases in-season corrective applications can avoid further yield loss.**
- **A well-planned, complete and balanced fertility program can prevent in-season yield robbing nutrient deficiencies.**
- **Improving soil quality improves crop quality**