Diagnosis Kekurangan Unsur Hara
Nutrient Deficiency Diagnosis

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17 Unsur yang dibutuhkan untuk pertumbuhan tanaman

- **Unsur Hara yang bukan Mineral**

Carbon (C) ; Hydrogen (H) ; Oxygen (O)

- **Unsur Hara Mineral**

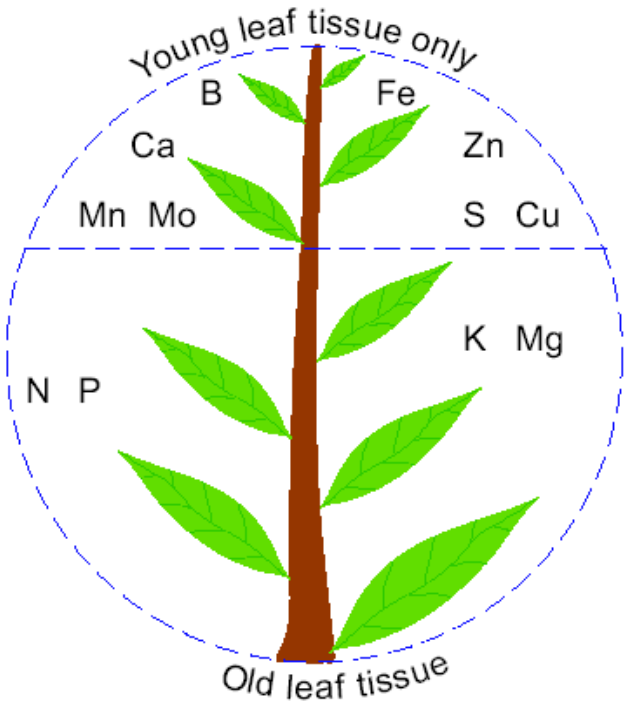
Unsur hara utama	Unsur hara mikro
Nitrogen (N) Fosfor (P) Kalium (K)	Boron (B) Chlor (Cl) Tembaga (Cu) Besi (Fe) Mangan (Mn) Molybdenum (Mo) Nikel (Ni) Seng (Zn)
Unsur hara sekunder	
Calsium (Ca) Magnesium (Mg) Belerang (S)	

Kunci untuk Mengetahui Kekurangan Unsur Hara

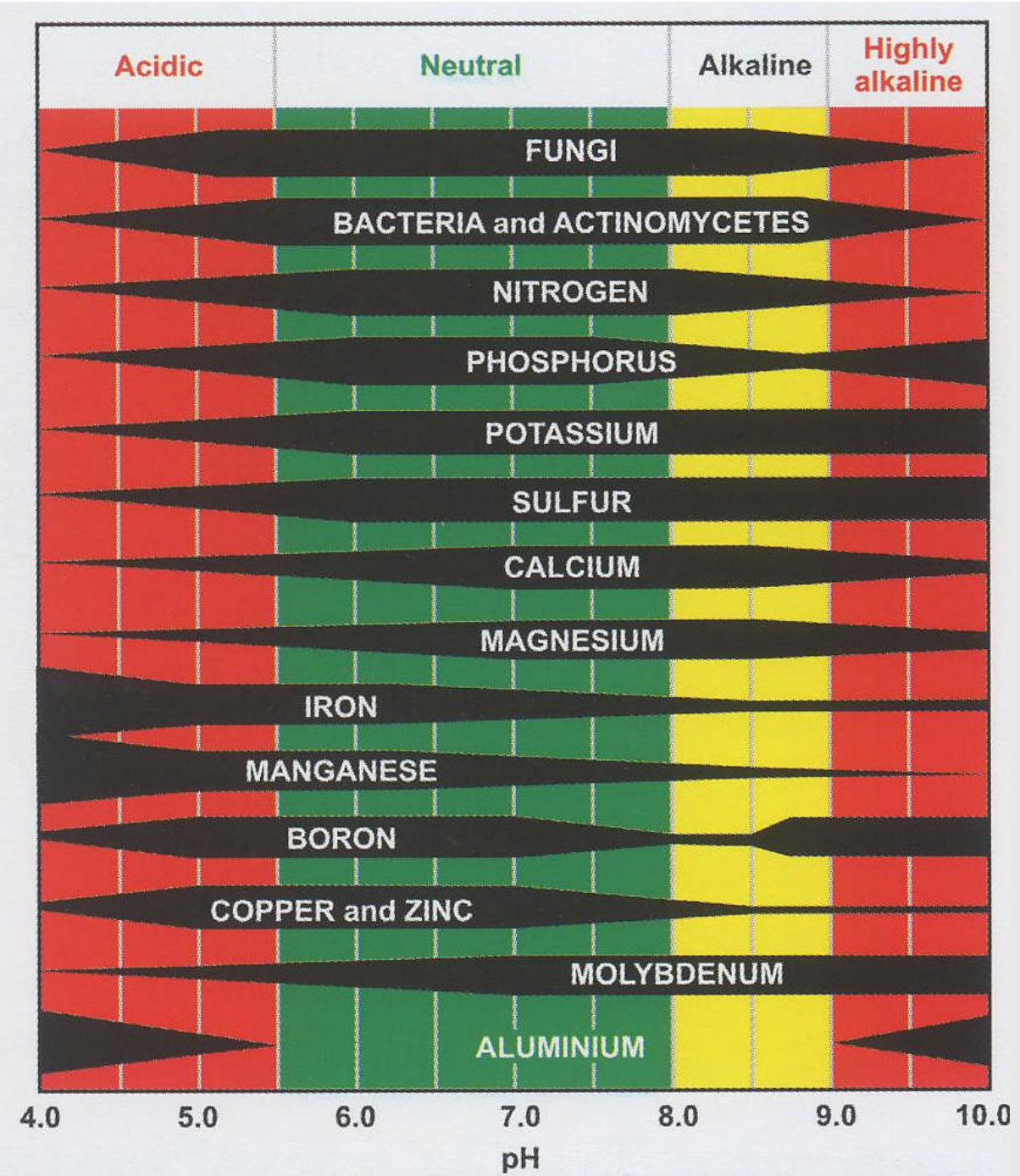
- Identifikasi posisi gejala pada tanaman – daun tua, daun mudah, atau seluruh tanaman?
- Gejalanya seperti chlorosis (kuning)?
- Pinggir daun ada necrosis (coklat)?
- Apa warnanya daun dengan gejala?
- Apa bentuknya daun dengan gejala?
- Cek pH tanah
- Gunakan jagung sebagai tanaman indikator

Gejala Kekurangan Unsur Hara

Unsur Hara	Posisi pada tanaman	Chlorosis (kuning)	Necrosis (coklat) di pinggir daun?	Warna dan bentuk daun
N	Semua daun	Ya	Tidak	Daun dan vena daun menjadi kuning
P	Daun tua	Tidak	Tidak	Bintik ungu
K	Daun tua	Ya	Ya	Bintik kuning
Mg	Daun tua	Ya	Tidak	Bintik kuning
Ca	Daun muda	Ya	Tidak	Daun kuning
S	Daun muda	Ya	Tidak	Daun kuning
Mn, Fe	Daun muda	Ya	Tidak	Kuning di antara vena
B, Zn, Cu, Mo	Daun muda	- -	- -	Bentuk daun rusak



pH tanah mempengaruhi ketersediaan kebanyakan jenis unsur hara tanaman. Kekurangan unsur hara terjadi dengan mudah dalam kasus solubilitasnya rendah dengan pH tertentu.



Sumber: Healthy soils for sustainable vegetable farms, Ute guide, Australia

Nitrogen dibutuhkan untuk:

N

Klorofil

Sintesa Protein

Photosintesa

Utilisasi sinar matahari

Penyerapan unsur hara

Vitamin-vitamin

Asam amino

Sistem tenaga

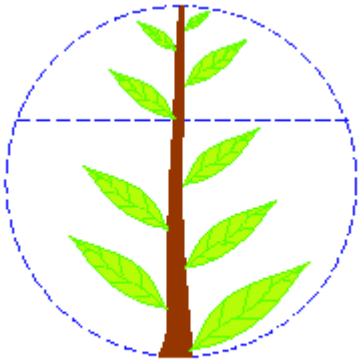
Gejala Kekurangan N
(di tanaman tomat sebagai contoh)

- Tanaman tumbuh dengan pelan-pelan
- Daun kecil dan berwarna hijau muda ke kuning kehijau-hijauan ke kuning muda
- Batang tebal dan keras
- Kuncup menjadi kuning dan gugur
- Buah-buah kecil dan berwarna hijau muda sebelum matang
- Hasil menurun

Perubahan Warna di Daun Tua (daun bawah)

N – hijau muda, kuning (chlorosis)

Jarak konsentrasi, %		
Berkurang	Cukup atau normal	Terlalu banyak atau beracun
<2.50	2.50-4.50	>6.0

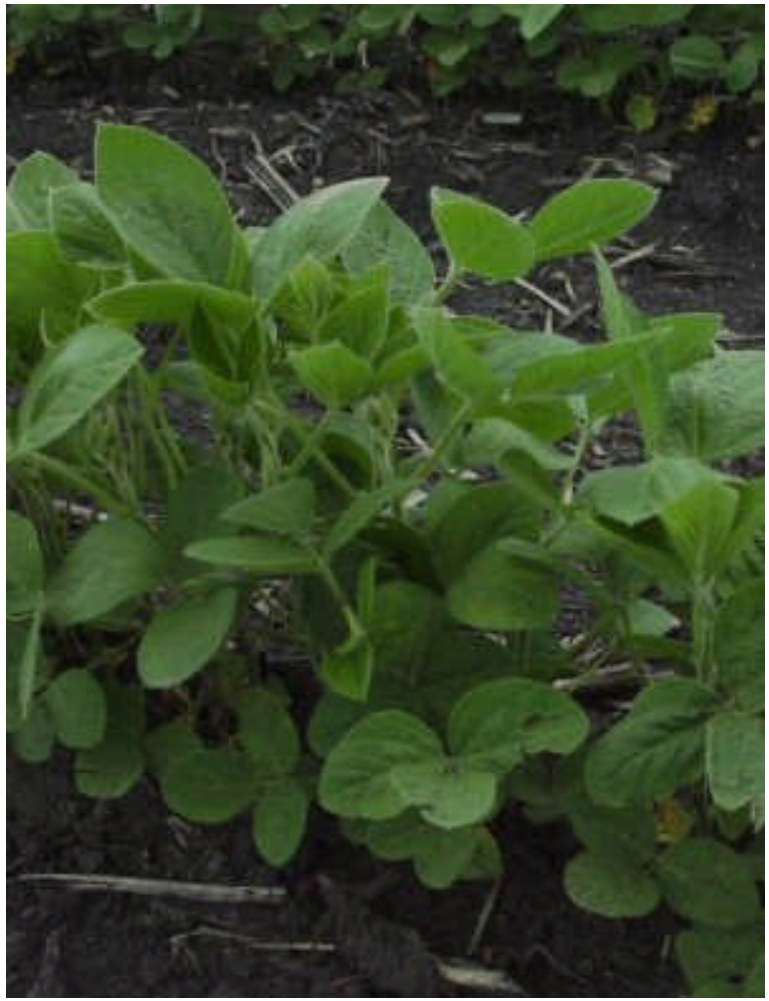


Nitrogen (N) deficiency

Some Roles Phosphorus Plays in Plant Growth

P

- Photosynthesis and respiration
- Energy storage and transfer
- Cell division and enlargement
- Early root formation and growth
- Improves quality
- Vital to seed formation
- Transfer of hereditary traits



P Deficiency Symptoms

(in tomato plant as example)

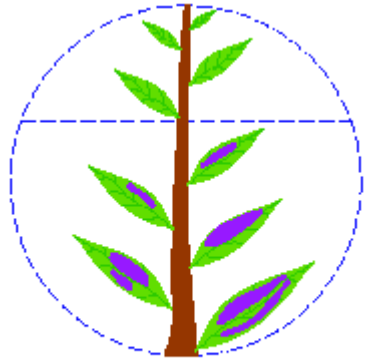
- Plants grow slowly, and maturity is delayed
- Leaves become dark green with purple interveinal tissue on the underside of the leaf
- Stems become slender, fibrous, and hard

Color Changes in Older (Lower) Leaves

P – dark green with purple cast

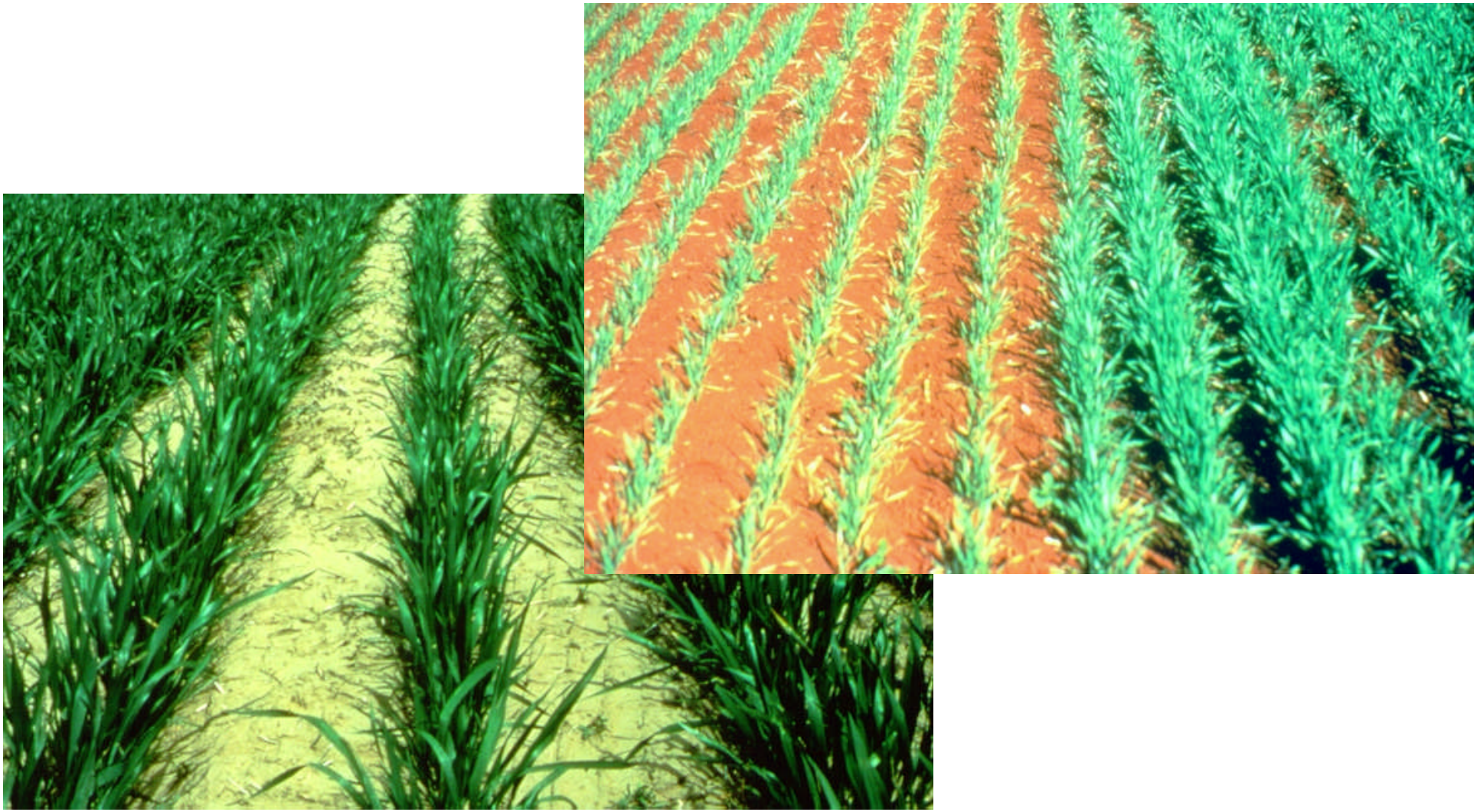
Typical range in concentration, %

Deficient	Sufficient or normal	Excessive or toxic
<0.15	0.20-0.75	>1.0



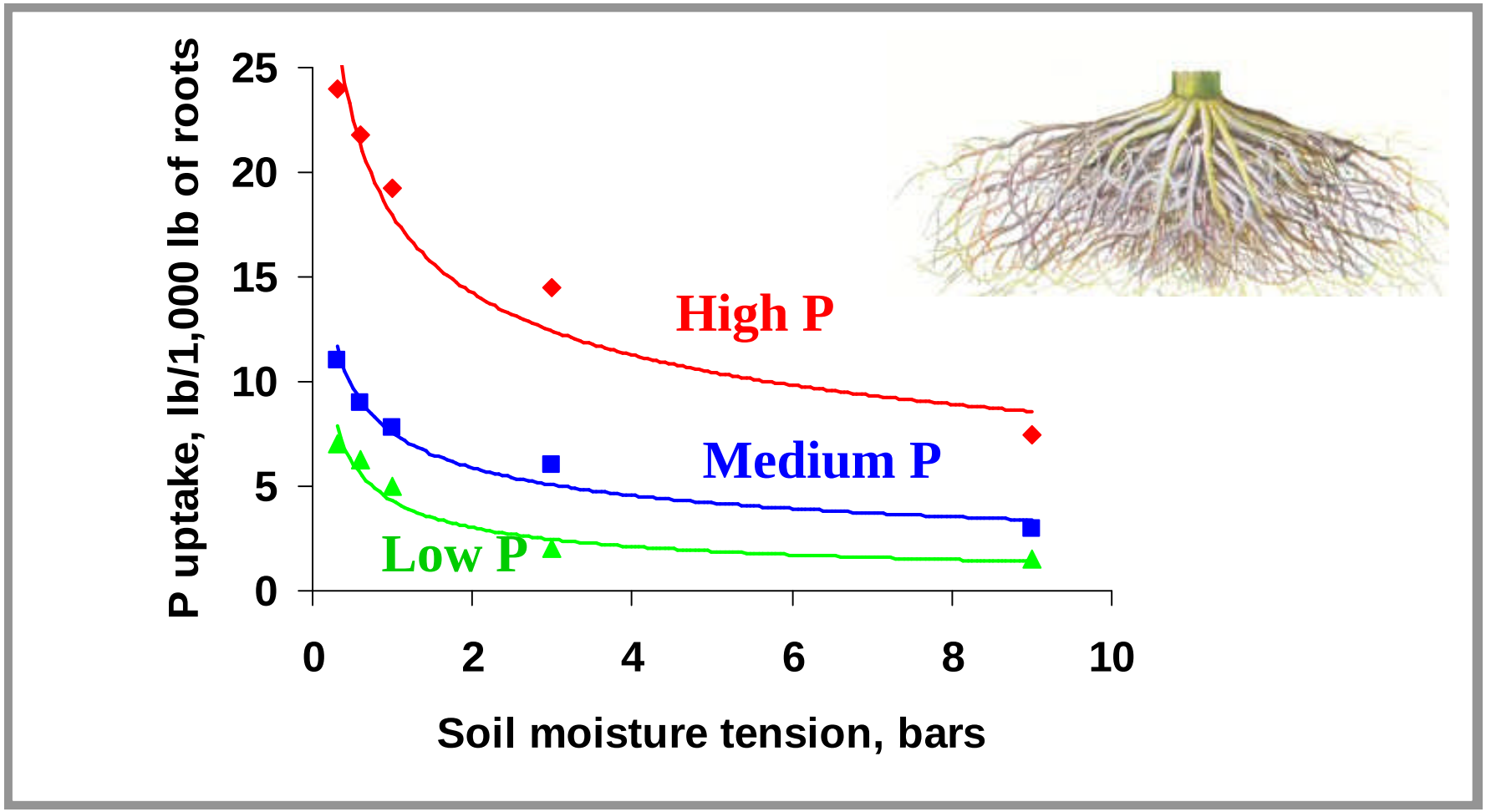
Phosphorus (P) deficiency

P Deficiency



… stunted growth, small leaves and plants

P Level Affects P Uptake by Corn during Periods of Moisture Stress

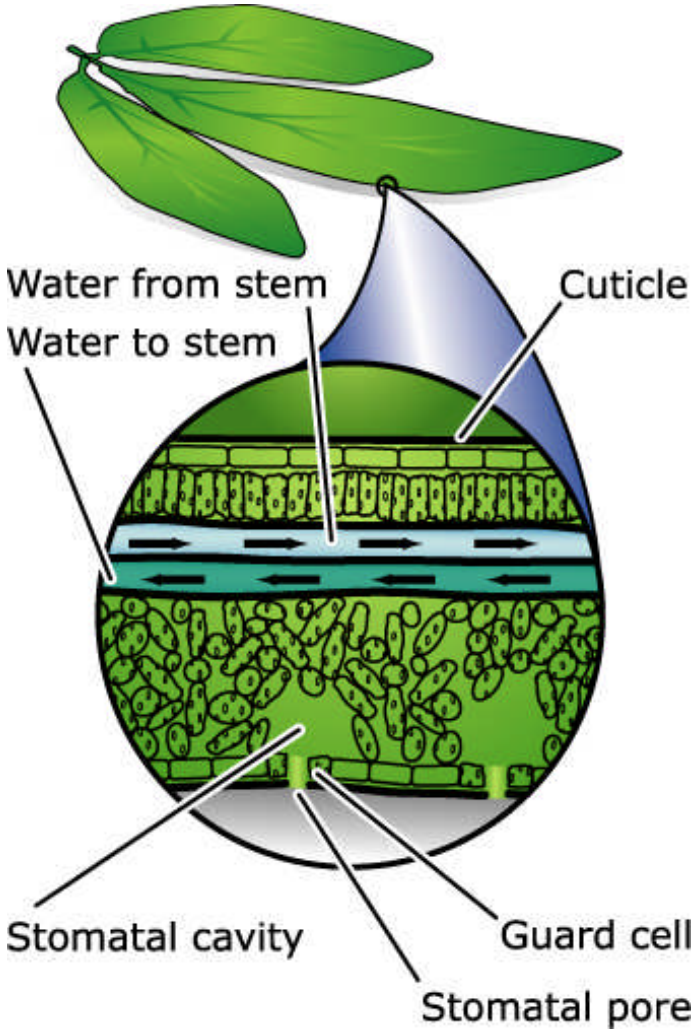


Roles of Potassium

- Taken up by the plant as K^+
- Does not form organic compounds in the plant
- Is vital to photosynthesis and protein synthesis
- Is associated with other metabolic functions

Potassium Increases Water Use Efficiency and Reduces Drought Stress

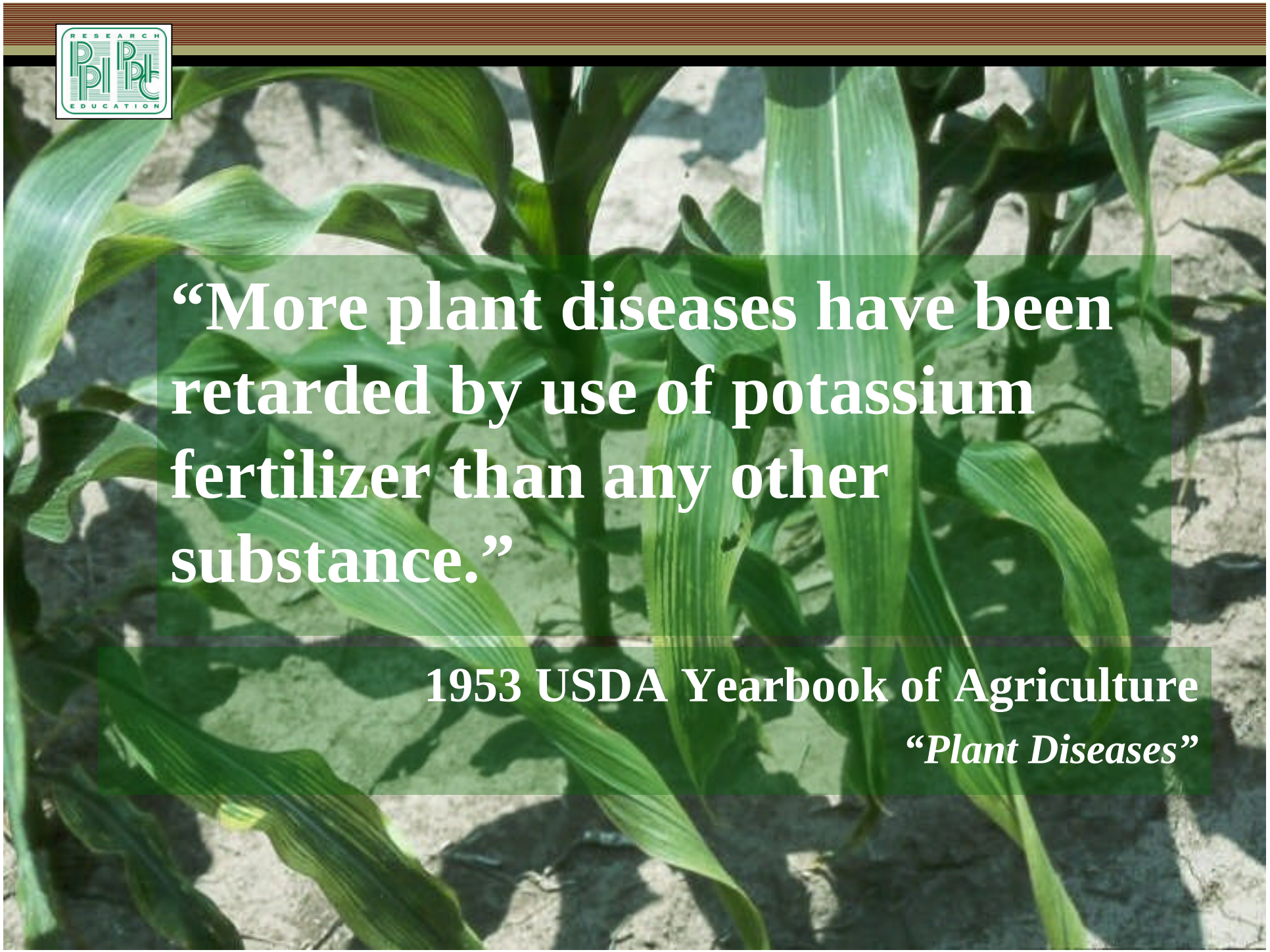
- Opening and closing of stomatal pores in plant leaves is regulated by K concentration in the guard cells surrounding the stomates



K Deficiency Symptoms

(in tomato plant as example)

- Young plants have dark green leaves with small stems and shortened internodes.
- Young leaves are dark green, becoming crinkled and curled
- Older leaves are chlorotic and bronzed; leaf margins become brown, and tissues break down between the veins
- Fruits drop off soon after ripening
- Fruits are not fleshy, ripen unevenly, and appear blotchy

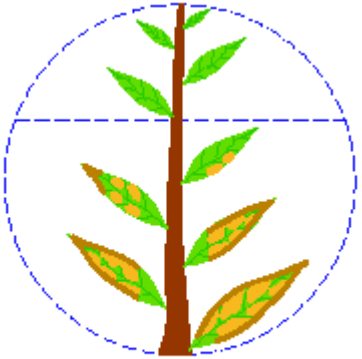

“More plant diseases have been retarded by use of potassium fertilizer than any other substance.”
1953 USDA Yearbook of Agriculture
“Plant Diseases”

Color Changes in Older (Lower) Leaves

K – scorching along outer leaf margin

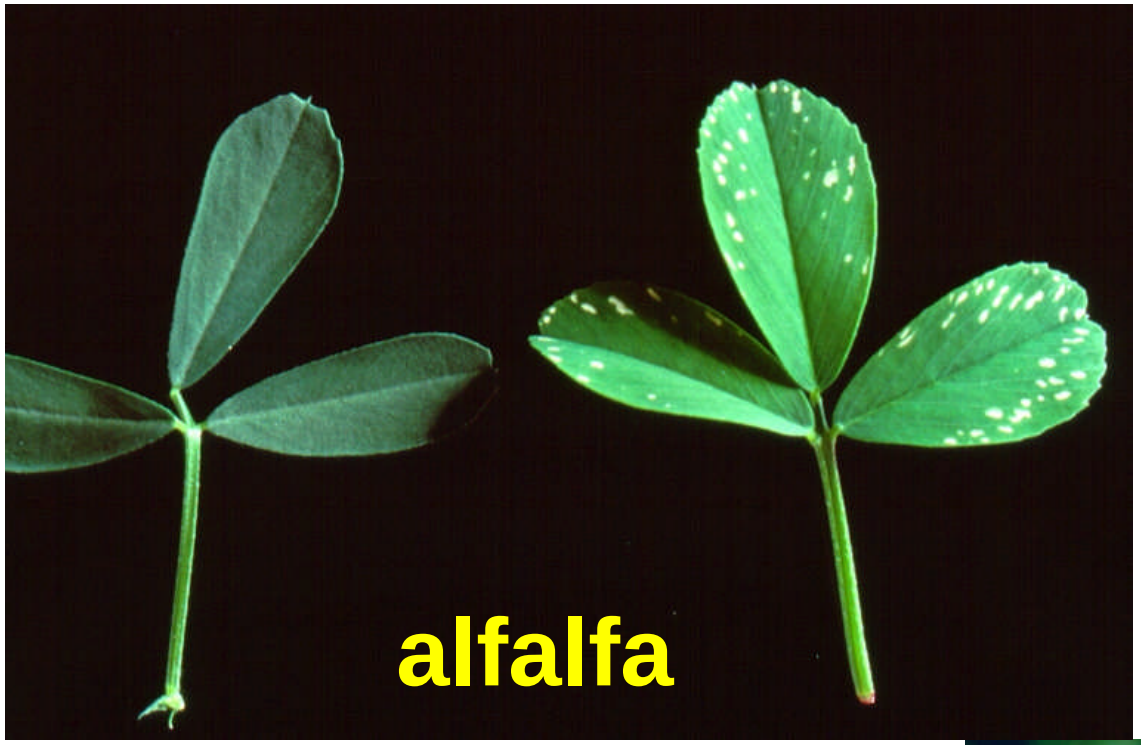
Typical range in concentration, %

Deficient	Sufficient or normal	Excessive or toxic
<1.00	1.50-5.50	>6.0

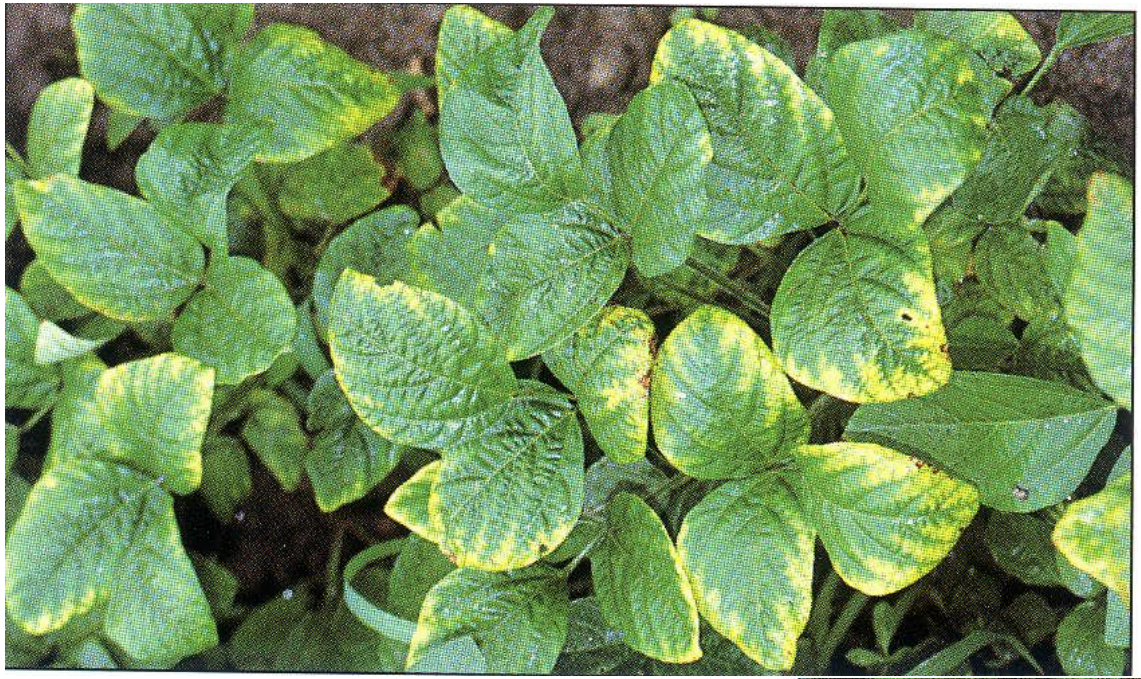


Potassium (K) deficiency

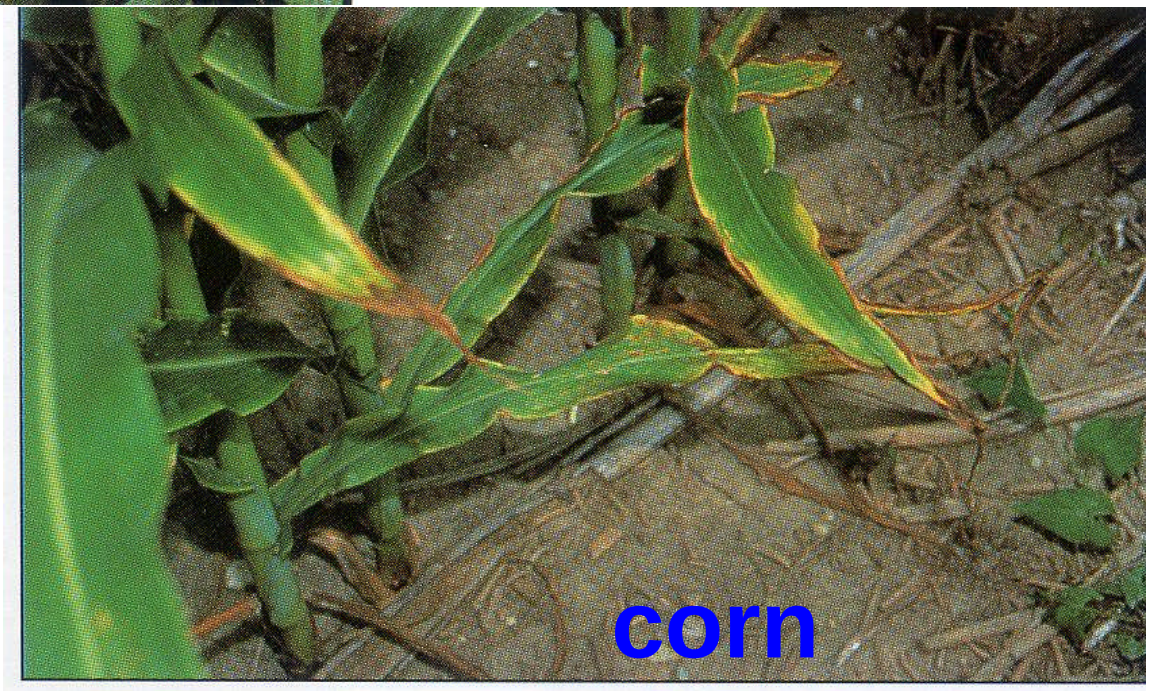
K Deficiency Symptoms



K Deficiency Symptoms

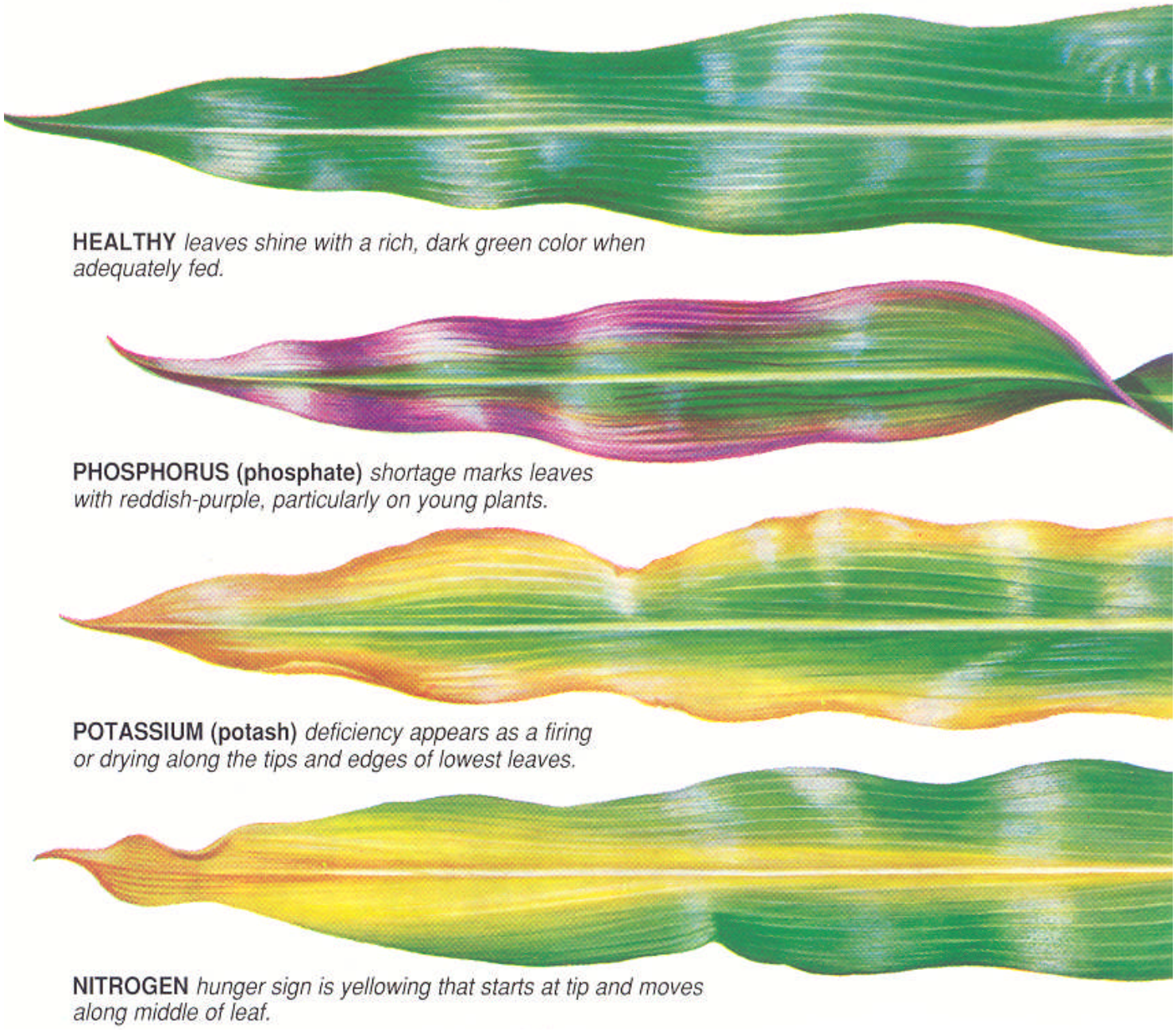


soybean



corn

Nutrient Deficiencies in Corn



HEALTHY *leaves shine with a rich, dark green color when adequately fed.*

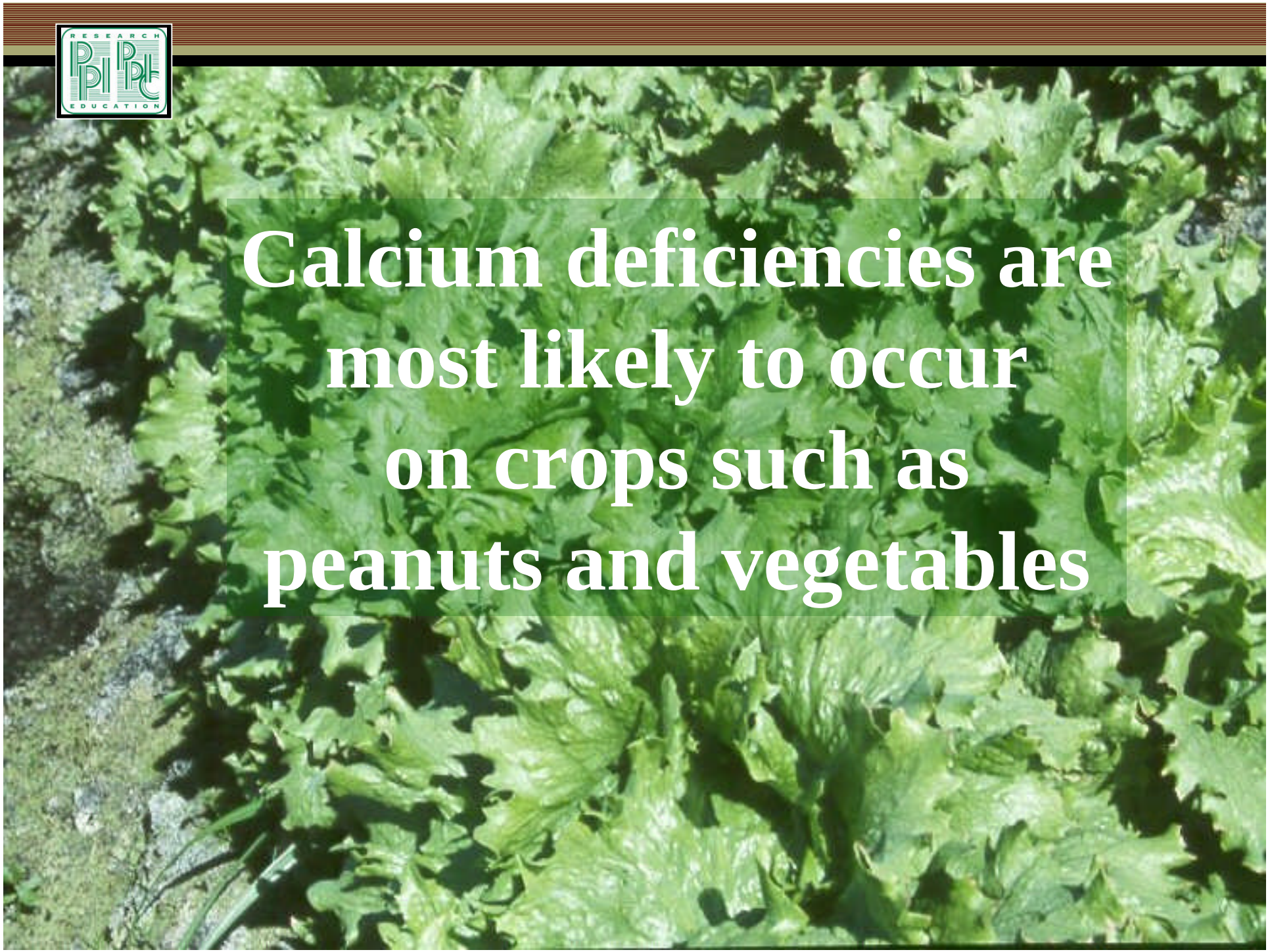
PHOSPHORUS (phosphate) *shortage marks leaves with reddish-purple, particularly on young plants.*

POTASSIUM (potash) *deficiency appears as a firing or drying along the tips and edges of lowest leaves.*

NITROGEN *hunger sign is yellowing that starts at tip and moves along middle of leaf.*

Roles of Calcium

- Taken up by the plant as Ca^{+2}
- Stimulates root and leaf development
- Forms compounds as part of cell walls, which strengthen plant structure
- Helps reduce nitrate-N in the plant
- Helps activate several plant enzyme systems
- Helps balance organic acids in the plant
- Is essential for nut development in peanuts


Calcium deficiencies are most likely to occur on crops such as peanuts and vegetables

Ca Deficiency Symptoms

(in tomato plant as example)

- Abnormal development of growing points- terminal buds and poor root growth
- Tomato seedlings show upward cupping of leaves with necrotic margins
- Plants are stunted as tip growth is reduced, root tips die, and roots turn black and rot
- Blossom-end rot of fruits- cells at the blossom end of fruits are injured when insufficient Ca translocation to the flower results in a dry-rot brown area on the expanding fruit, usually induced by water stress in the plant

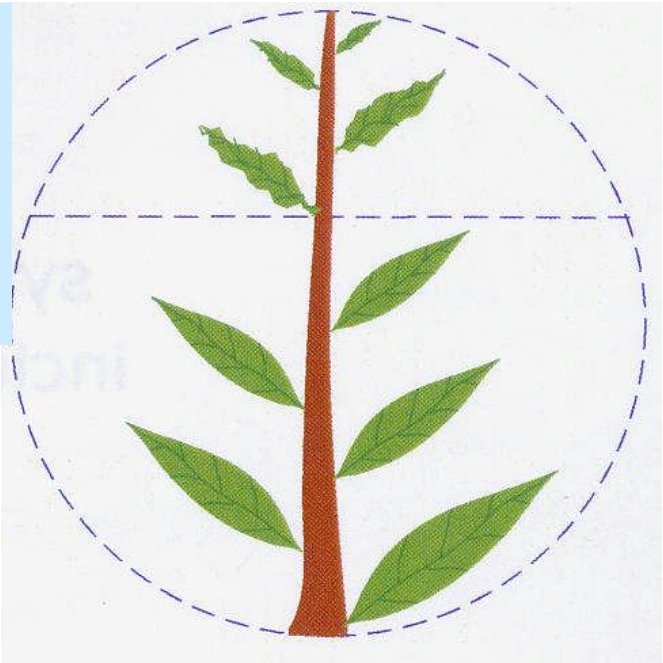
Color Changes in Young Leaves

Ca – abnormal development of growing points - terminal buds and poor root growth

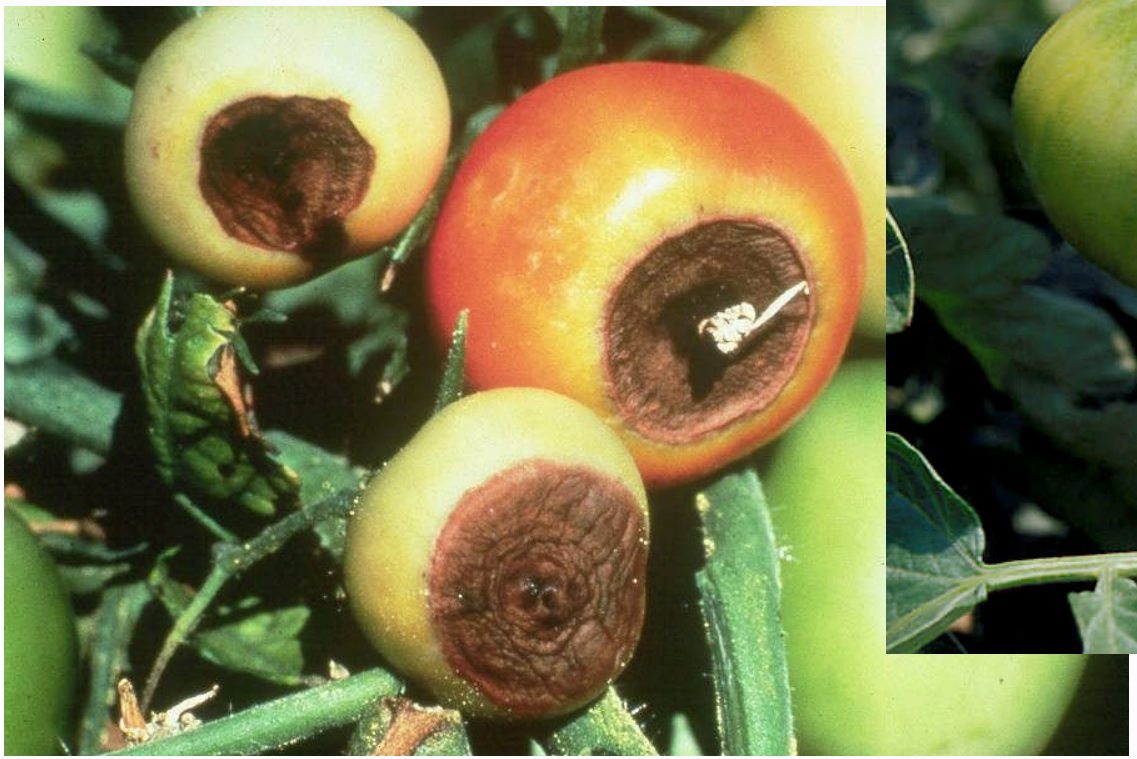
Typical range in concentration, %

Deficient	Sufficient or normal	Excessive or toxic
< 0.5	1.0- 4.0	>5.0

Blossom-end rot in chili

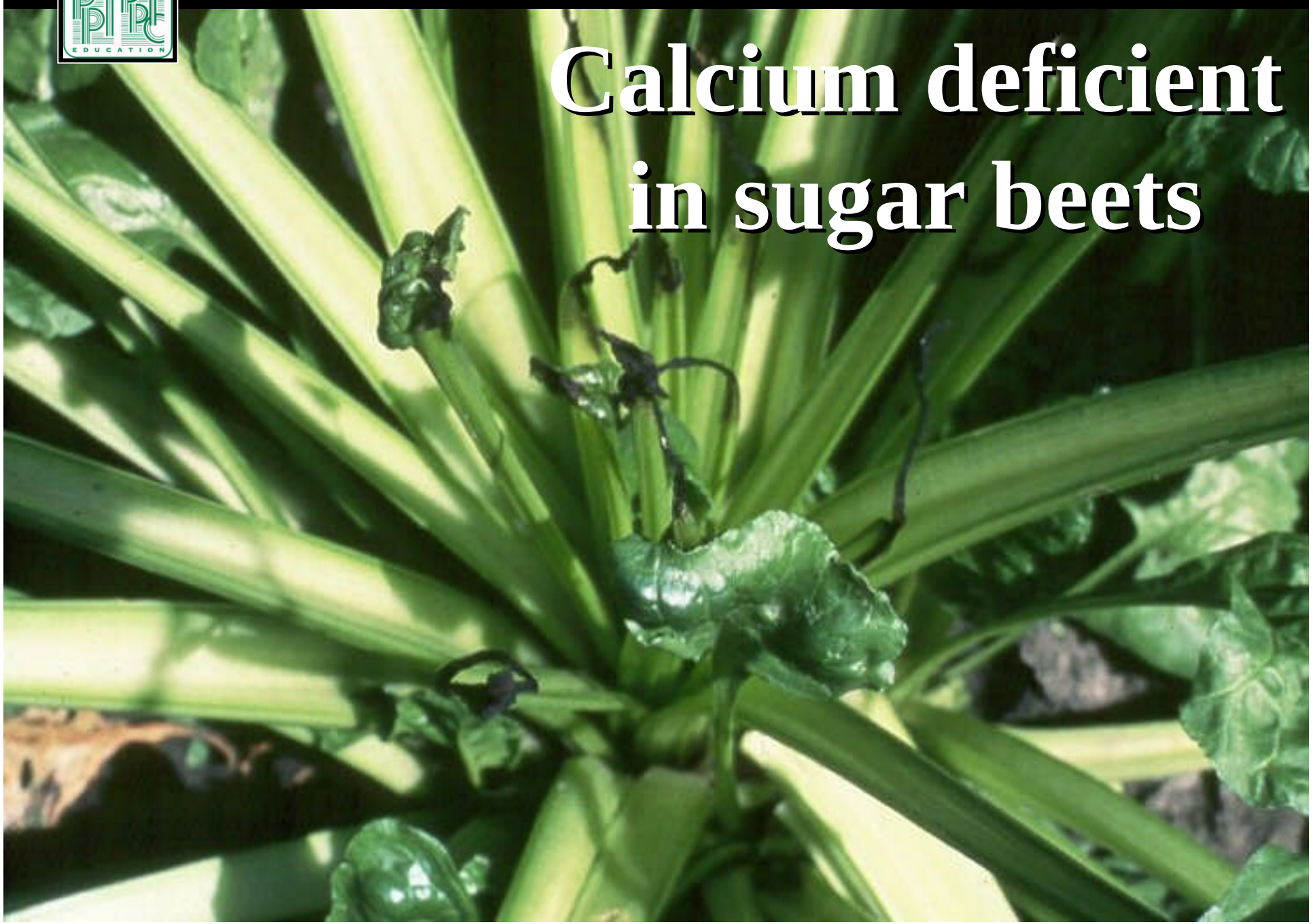


Blossom-end rot in tomatoes



Tip-burn on young leaves of cabbage and leafy vegetables (Pak-choi)

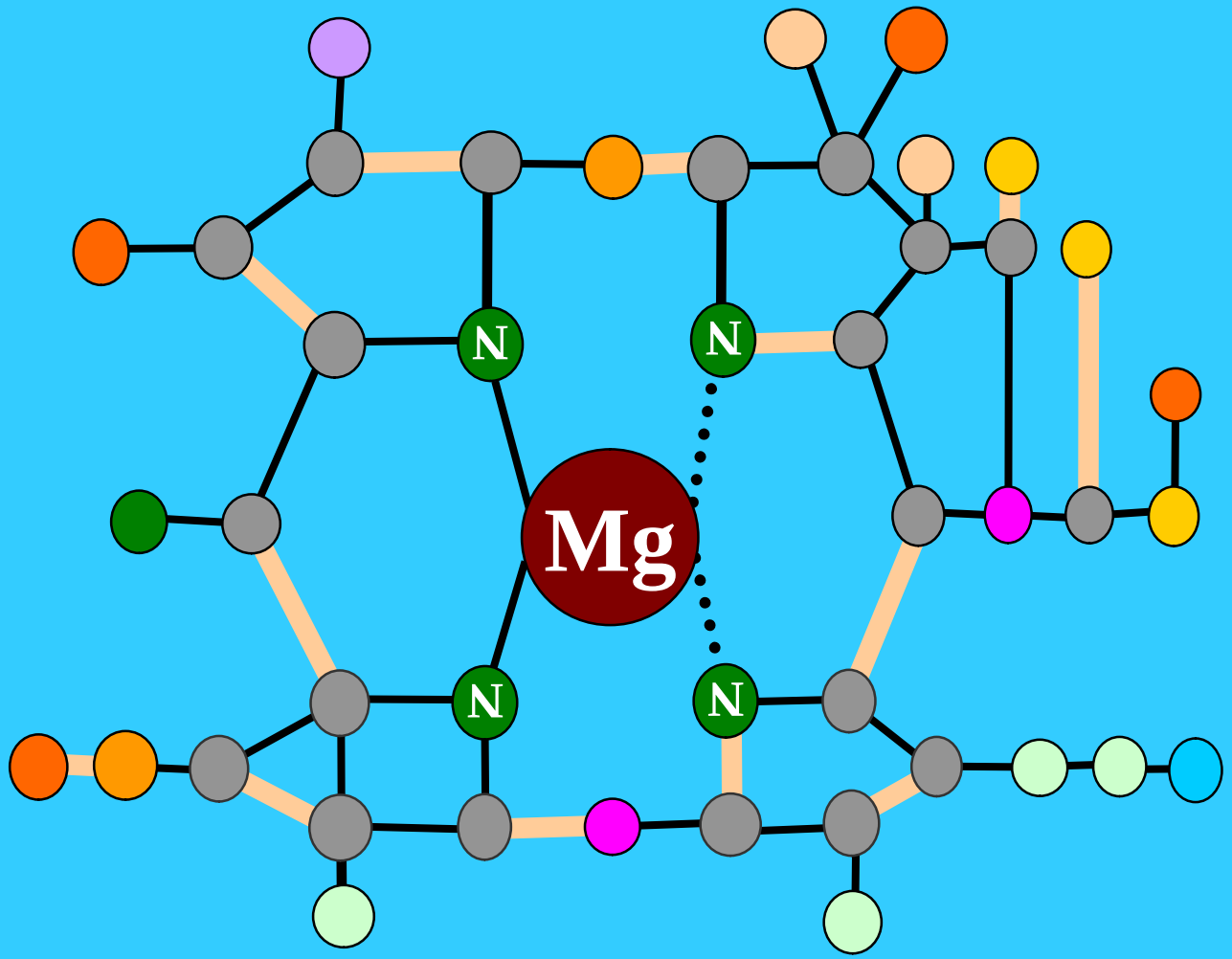
Calcium deficient in sugar beets



Roles of Magnesium

- Taken up by the plant as Mg^{+2}
- Mg is the central atom in the chlorophyll molecule, actively involve in photosynthesis
- Aids in phosphate metabolism
- Helps activation of many enzyme systems
- Helps plant respiration
- May contain relatively high content in seeds

Magnesium is the central atom in the chlorophyll molecule



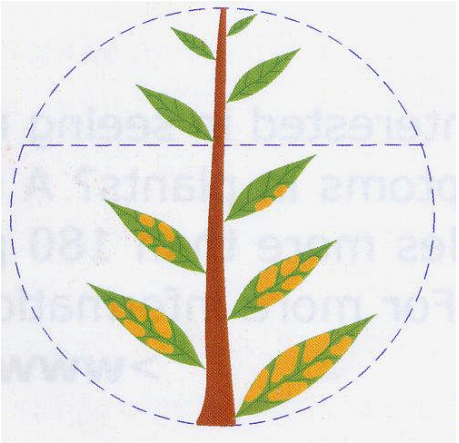
Mg Deficiency Symptoms
(in tomato plant as example)

- Lower and older leaves are first affected
- Leaf veins remain dark green, and areas between the veins become yellowish, bronze or orange-yellow color
- High Ca or K or ammonium-N may intensify the development of Mg deficiency on low-Mg soils

Color Changes in Older (Lower) Leaves

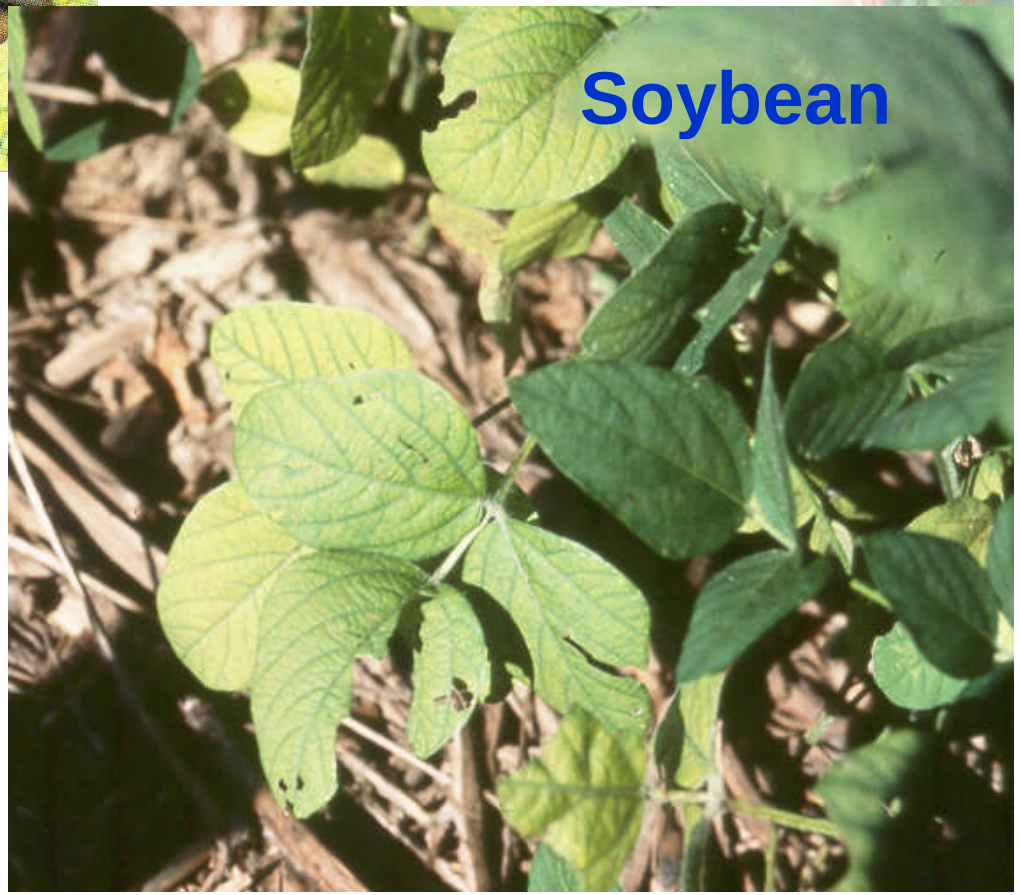
Mg – yellowish, bronze, or reddish color in leaf while leaf veins remain green

Typical range in concentration, %		
Deficient	Sufficient or normal	Excessive or toxic
< 0.2	0.25 - 1.0	>1.5



AVRDC
The World Vegetable Center

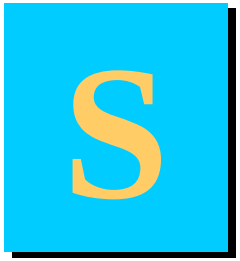
Mg deficiency symptoms



Some Facts about Soil Magnesium

- Held in exchangeable form by soil colloids
- Present in soil solution
- Most Mg deficiencies occur on coarse-textured, acidic soils
- Deficiencies on calcareous soils where irrigation water contains high bicarbonates
- Mg can be deficient on sodic soils

Roles of Sulfur:



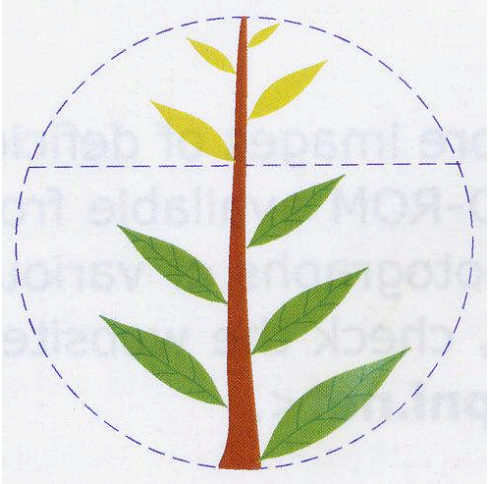
- Plants take up sulfur primarily as sulfate (SO_4^{+2}),
- Is a constituent of protein
- Helps develop enzymes and vitamins
- Promotes nitrogen fixation by legumes
- Aids in seed production
- Is necessary for chlorophyll formation

S Deficiency Symptoms

- Sulfur is not mobile in plant, so new growth suffers first. Plants show a pale green coloring of younger leaves
- The entire plant turns to pale green and stunted in severe cases
- Plants can be thin-stemmed and spindly
- Cabbage and canola may develop a reddish color, first on the underside of leaves and on stems

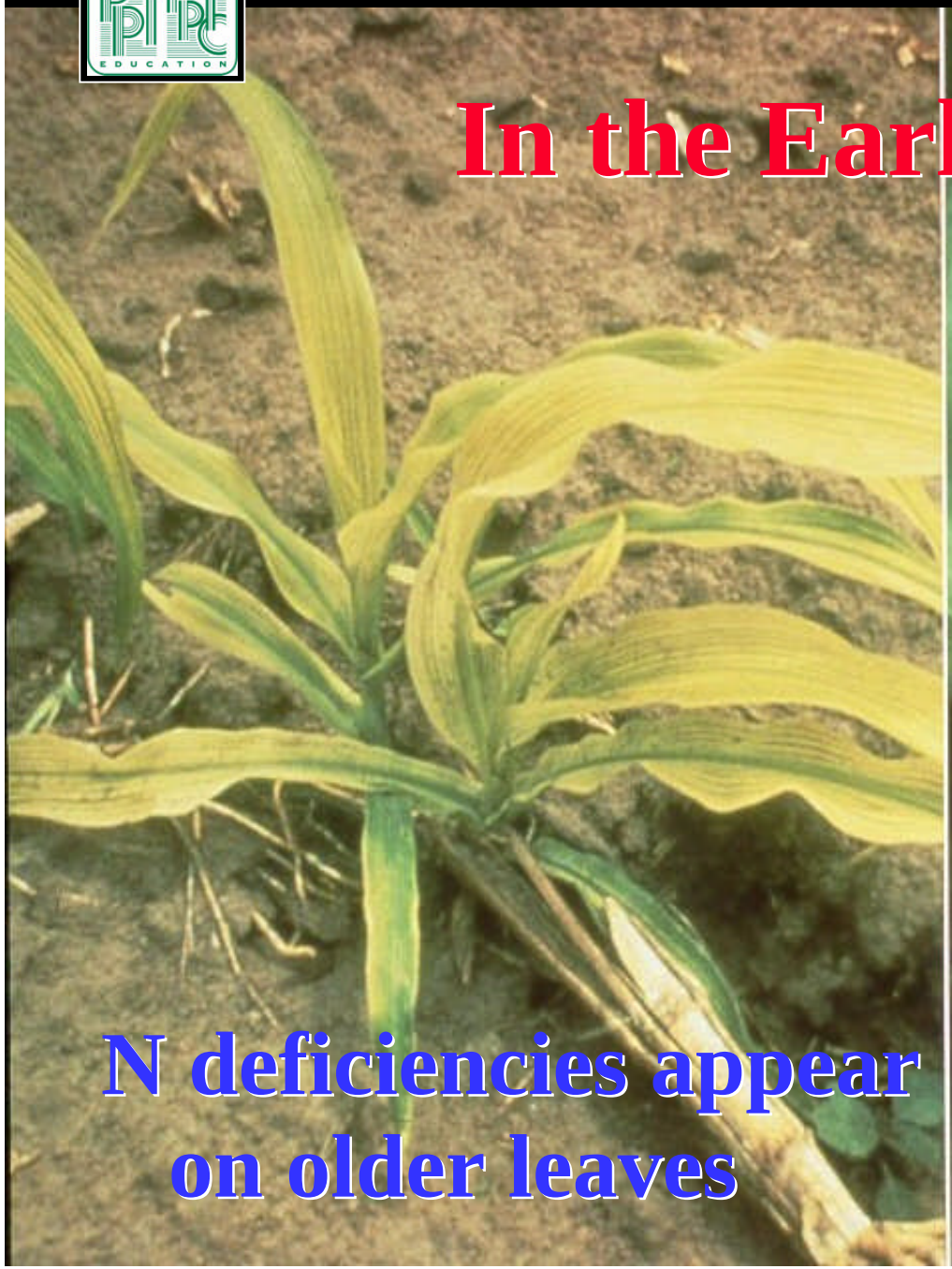
Color Changes in younger Leaves

S – Plants show a pale green coloring of younger leaves

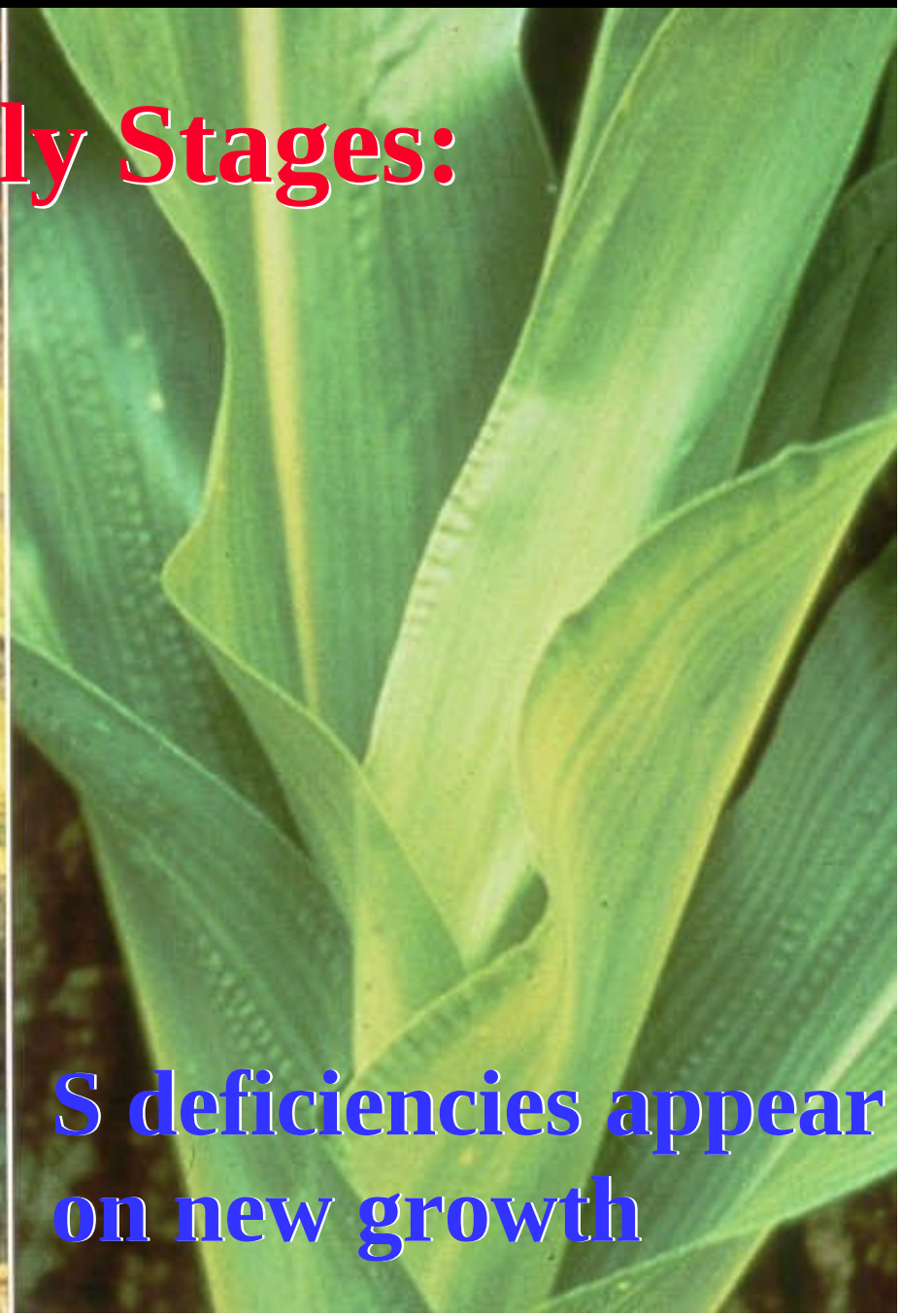


Typical range in concentration, %		
Deficient	Sufficient or normal	Excessive or toxic
< 0.2	0.25 - 1.0	>3.0

In the Early Stages:



N deficiencies appear on older leaves



S deficiencies appear on new growth

The Eight Micronutrients

- Boron (B)
- Chloride (Cl)
- Copper (Cu)
- Iron (Fe)
- Manganese (Mn)
- Molybdenum (Mo)
- Nickel (Ni)
- Zinc (Zn)

Roles of Iron

Fe

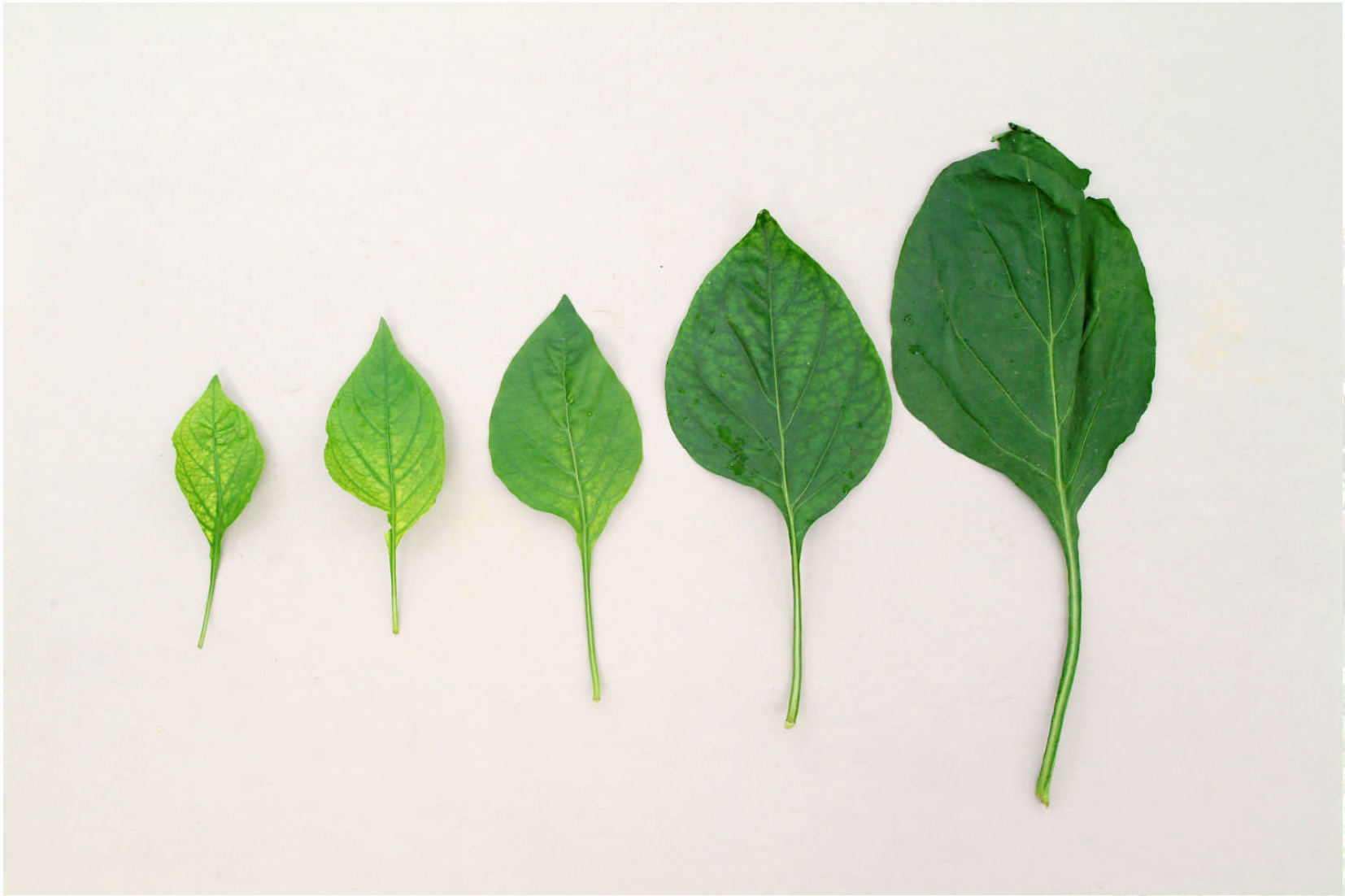
- Taken up by the plant as Fe^{+2} cation
- Is a catalyst to chlorophyll formation
- Acts as an oxygen carrier in the nodules of legume roots
- Helps form certain respiratory enzyme systems

Fe Deficiency Symptoms
(in tomato plant as example)

- Young leaves are chlorotic
- Pale yellow mottling starts at the base of the leaves and spreads upward along the midribs and outward along the vein
- Severe deficiency may turn the plant to yellow-to-bleached white and can result in the death of plant limbs


Fe deficiency
in grain sorghum

Fe deficiency in bell pepper leaves



Factors which Can Contribute to Iron Deficiencies

- Imbalance with metals such as Mo, Cu and Mn
- Excessive soil P
- Wet, cold soils
- High soil pH
- High soil bicarbonate levels
- Plant genetic differences
- Low soil organic matter

Functions of Manganese in the Plant

Mn

- Part of the plant enzyme system
- Activates several metabolic reactions
- Aids in chlorophyll synthesis
- Accelerates germination and crop maturity
- Increases plant availability of P and Ca

Mn Deficiency Symptoms
(in tomato plant as example)

- Young leaves show interveinal chlorosis with prominent green veination
- Severe deficiency results in necrosis of interveinal tissue
- Plants recover rapidly after foliar application of Mn

Some Causes of Manganese Deficiency

- High soil pH
- Imbalance with other nutrients such as Ca, Mg and Fe
- Soil moisture
- High organic matter soils during cool spring when soils are waterlogged

Mn deficiency in soybeans

Mn deficiency in celery

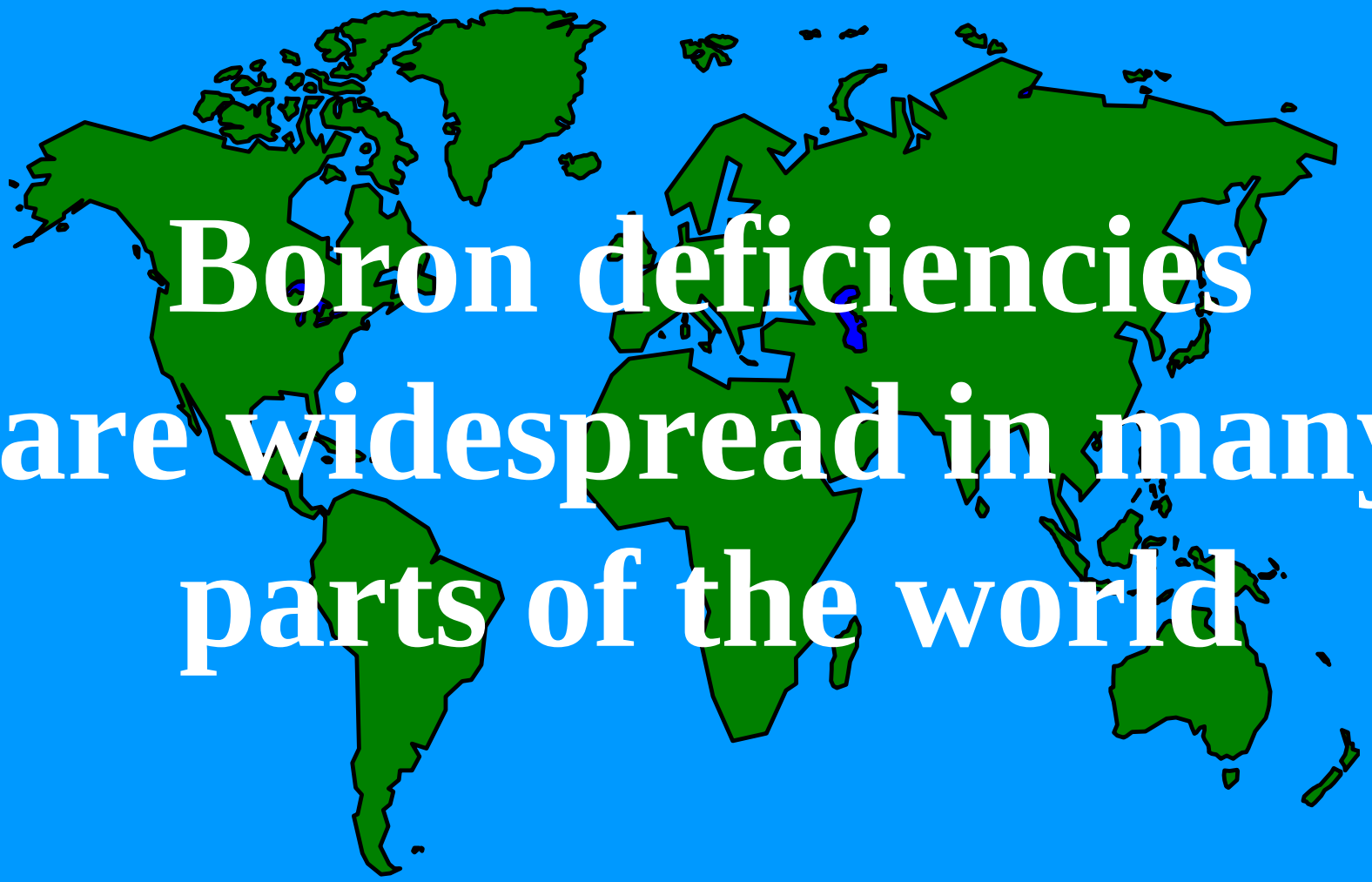
Roles of Boron in Plants

B

- In germination of pollen grains
- For growth of pollen tubes
- For seed and cell wall formation
- For protein formation
- For sugar translocation

B Deficiency Symptoms

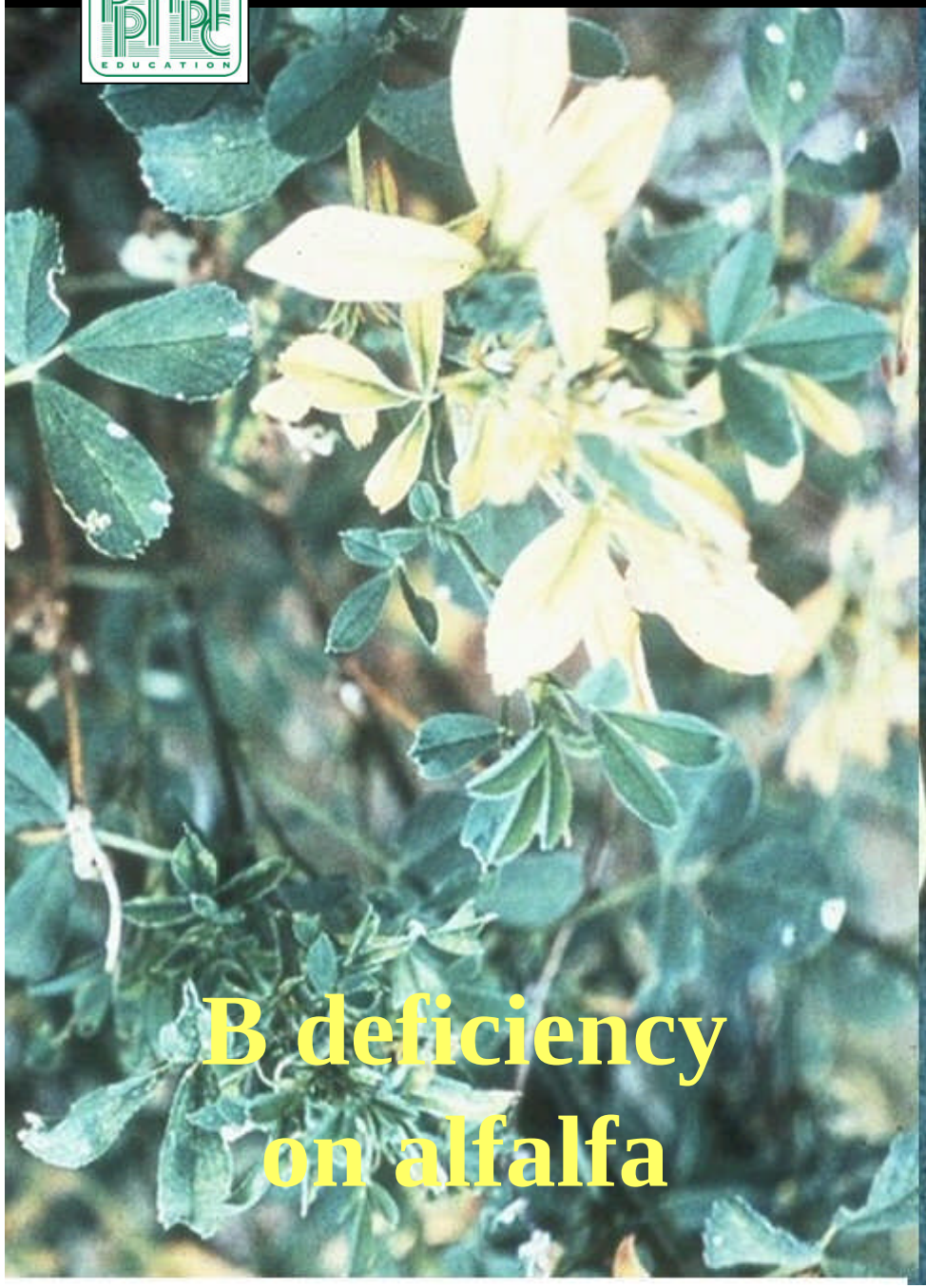
- Growth reduction from B deficiency affects the growing point and younger leaves first
- Plants have small, crinkled, deformed leaves with large irregular areas of discoloration
- The terminal shoot turns inward and dies
- Reduce flowering, soft or necrotic spots in fruits or tubers
- Tomatoes require more B than beans but much less than beets or cabbage.



Boron deficiencies are widespread in many parts of the world

Boron Deficiency Symptoms on Crops

Celery	**Crooked stem**
Peanuts	**Hollow heart**
Apples	**Corky core**
Alfalfa	**Rosetting, yellow top, death of terminal bud**
Beets	**Black heart**
Cotton	**Ruptured squares, dieback of terminal bud, rosetting**



B deficiency on alfalfa

B deficiency on peanuts

Roles of Copper in Plants

- Is necessary to chlorophyll formation
- Catalyzes several plant reactions
- Plays a role in vitamin A production
- For protein synthesis

Cu Deficiency Symptoms

- Many vegetables show Cu hunger, with leaves that lose turgor and develop a bluish-green shade before becoming chlorotic and curling
- Plants fail to flower
- Small grain crops may not head or form grain
- Common symptoms include dieback in citrus and blasting of onions and some other vegetables


Cu deficiency
in wheat


Organic soils are most
likely to be Cu deficient

Roles of Zinc

- Aids in the synthesis of plant growth substances and enzyme systems
- Promotes certain metabolic functions
- Necessary for the production of chlorophyll and carbohydrates

Zn Deficiency Symptoms

- Zn is not translocated within the plant, symptoms first appear on the younger leaves and other plant parts
- Young leaves of Zn-deficient tomato plants are small with yellow interveinal mottling,Young buds of corn turn white or light yellow in early growth
- Other symptoms include bronzing of rice, little leaf of fruit trees, and severe stunting of corn and beans


Zn deficiency
in corn

Roles of Molybdenum

Mo

- Requires for the synthesis and activity of the enzyme nitrate reductase
- Is vital for the process of symbiotic N fixation by Rhizobia bacteria in legume root nodules
- Necessary for the conversion of inorganic P to organic form in the plant

Mo Deficiency Symptoms

- Mo-deficient leaves show a leaf cupping or curling in the margins, yellowing between the veins, and death of the growing tip
- A Mo-deficiency can cause N deficiency symptoms in legume crops because symbiotically N fixation in legume root nodules require Mo

Some Functions of Chloride in Plants

Cl

- Involved in energy reactions, including the chemical breakdown of water
- Activates several enzyme systems
- Involved in the transport of cations
- Regulates stomatal guard cells, thus controlling water loss and maintaining turgor

Cl Deficiency Symptoms

- Most soils have abundant concentrations of Cl. Cl is also added in the fertilizer as in potassium chlorite. It has never been reported to be deficient in cucurbits under field condition.
- Cl toxicity is a more serious problem than deficiency in cucurbits and results in soluble salt injury.

General description of symptoms on Na and Cl toxicities

- Na-toxicity leaves show marginal chlorosis and burn. Leaves of sorghum plants become flaccid and wilt, margins and tips are initially gray and then turn brown and died, leaving green midveins.
- Cl-toxicity leaves show bronzing, chlorosis, marginal burn, premature yellowing of leaves and drop. In some species the marginal burn is accompanied by upward cupping

Some Functions of Nickel in Plants

Ni

- Ni is the most recent recognized nutrient established essential for plant growth
- Required for normal grain development
- Required for the structure and function of the plant enzyme Urease
- Ni has a wide range of effects on plant growth and metabolism, e.g. plant senescence, N metabolism, Fe uptake and plant disease resistance

Ni Deficiency Symptoms

- The importance of Ni deficiency in agriculture has not yet been thoroughly investigated . . .
- Research has clearly demonstrated Ni plays an important role in the N metabolism of legumes and the production of small grains

Typical Ranges of Micronutrient Concentrations in Mature Leaf Tissue

Nutrient	Deficient	Sufficient normal	Excessive or toxic
	---------- ppm ----------		
Chloride	<100	100-500	500-1,000
Copper	2-5	5-30	20-100
Iron	<50	100-500	>500
Manganese	15-25	20-300	300-500
Molybdenum	0.30-0.15	0.1-2.0	>100
Zinc	10-20	27-100	100-400

Soil Testing vs. Plant Analysis

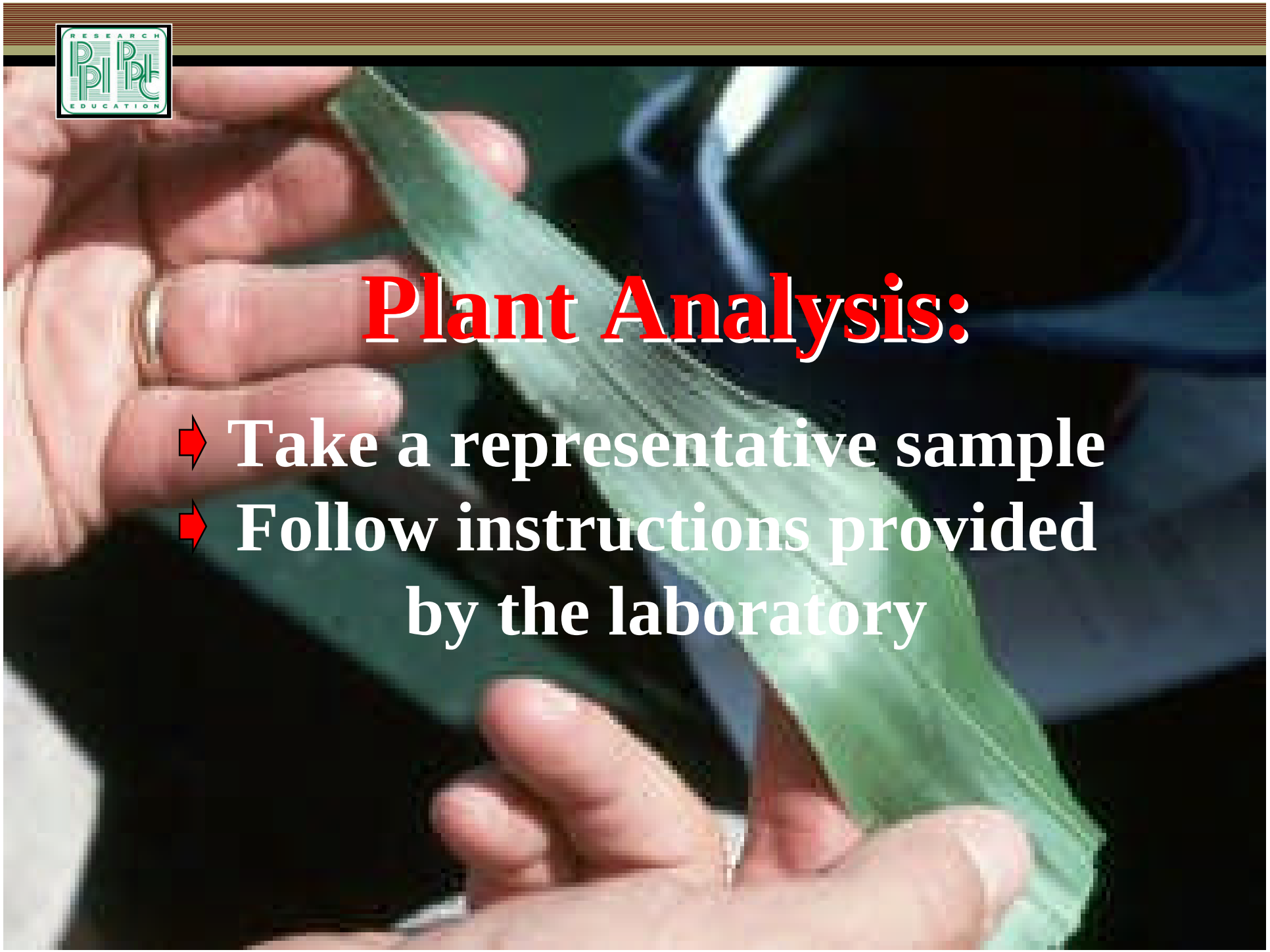
- Soil testing and plant analysis are complementary, but very different …
  - Soil tests predict nutrient availability
  - Plant analysis assesses nutrient uptake
- Soil tests are not always good predictors of nutrients that leach easily, i.e. N or S
- Plant analysis is a better tool to assess some micronutrients, e.g. B, Fe, Mo

Use Diagnostic Tools to Determine Need for Micronutrient Fertilization

- Soil testing
- Plant analysis
- Field demonstrations
- Field observations

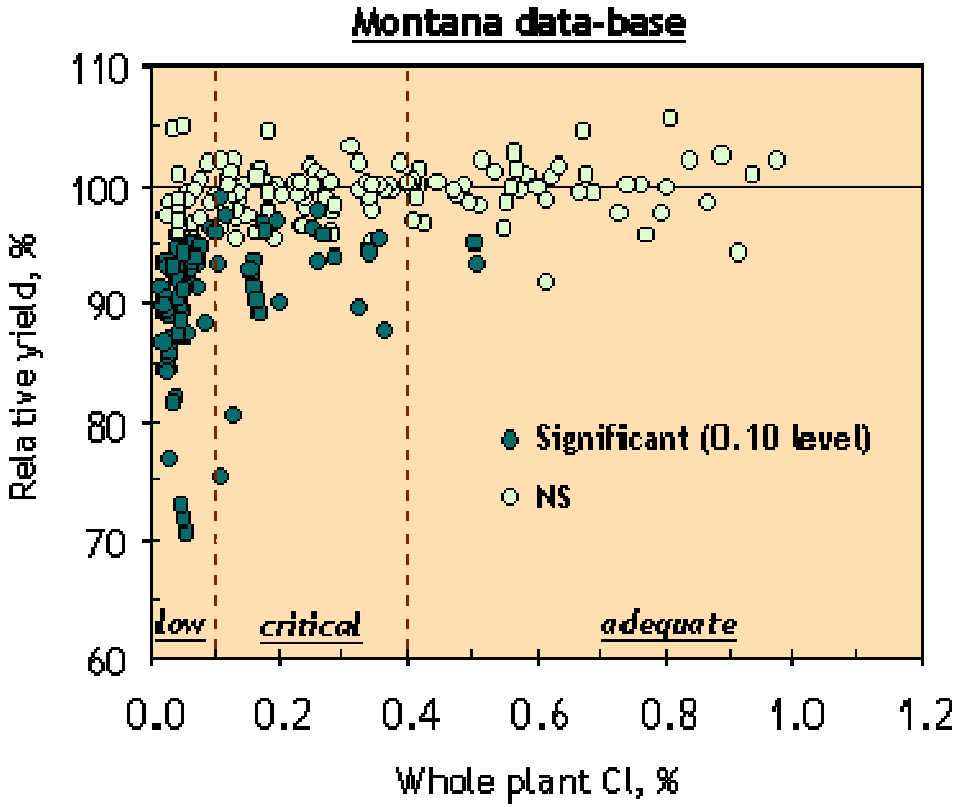
Plant Analysis Helps to Manage Crop Nutrient Status

- Confirms a diagnosis made from visual symptoms
- Identifies ‘hidden hunger’ when no symptoms appear
- Provides site-specific estimates of nutrient removal
- Pinpoints potential soil problem areas


Plant Analysis:
Take a representative sample
Follow instructions provided by the laboratory

Plant Analysis Results Should Be Interpreted by a Trained Scientist

Plant analysis data must be compared to established sufficiency ranges



Field Tissue Test vs. Plant Analysis

Tissue testing is done in the field and is a qualitative, rapid colorimetric determination of the soluble nutrient content of tissue sap

Plant analysis is a quantitative test done in a laboratory to determine the total nutrient content in plant tissue

Field Tissue Tests . . .

- Field tissues tests provide on-the-spot results
- Can be used effectively with soil tests and plant analysis
- Effective use of tissue testing requires some experience

Nutrient Deficiency Symptoms

- Are not always clearly defined
- Can be masked by other factors
- Indicate severe nutrient starvation
- Rob yield and quality before deficiency symptoms appear . . . called ‘hidden hunger’

A Successful Diagnostician Uses All Available Information

- Printed material
- Extension specialists
- Diagnostic workshops
- Field days
- Soil fertility short courses
- Internet resources

Be a Good Diagnostician

- Use soil tests
- Use plant analysis
- Use diagnostic techniques

Leaf chlorophyll reading meter

The slides with PPI/PPIC logo are cited from “Soil Fertility Manual” in CD and manual format, published by International Plant Nutrition Institute (IPNI, website:www.ipni.net).
The former names of IPNI are as :
Potash & Phosphate Institute (PPI)
Potash & Phosphate Institute of Canada (PPIC)
Most slides are modified by Dr. Ma C.H. in AVRDC-The world vegetable center, including some pictures of vegetables showing deficiency symptoms.
Tomato deficiency symptoms descriptions are cited from “Nutrient Deficiencies & Toxicities in Crop Plants”, edited by William F. Bennett. Chapter 13. Tomato, by Gerald E. Wilcox. Published by APS PRESS, USA, 1993.
The pH diagram is cited from “ Healthy soils for sustainable vegetable farms : Ute guide, Australia. Edited by Dr. A. Anderson, J. Kelly and Dr. D. McKenzie, published by Land and Water Australia and AUSVEG environmental programme.