

Mineral Nutrition

Mineral elements required by men or mice are “mined” by plants (land) and by algae (sea).

Human daily needs

Ca	1000 mg/day
Mg	400 mg
Fe	18 mg
Iodine	150 ug
Zn	15 mg
Cu	2 mg
Mn	2 mg

E. Epstein (1972)

Univ. Calif. Davis

Global Nutritional Deficiency

1. 1/2 of childhood deaths result from deficiency in minerals, like Fe, Zn, and Vitamins, e.g. A

Increasing micronutrient metals in seeds and grains of staple foods is a global effort. WHO

2. Unbalanced diet and stressed life styles can cause malnutrition.

Questions

- What are the essential nutrients of plants?
- Why do they need essential nutrients?
- How do plants get their nutrients?

Lec 6. OUTLINE : MINERAL NUTRITION of Plants

Apart from C, H, and O, all other nutrients are absorbed from the soil.

1. What are essential nutrients of plants?

Macronutrient,
micronutrient

2. What chemical forms of the nutrients are available to the plant?

3. How does each nutrient enter the plant?

Gas: via stomates

Mineral nutrients or ions: via roots

How are nutrients taken up? [later]

4. How do plants tolerate toxic levels of nutrients or toxic heavy metals? E.g. Cu, Zn, Cd, Pb.

5. What are the major function(s) of each nutrient?

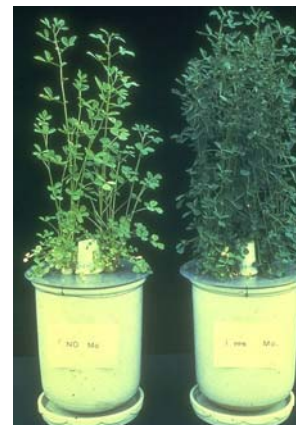
Beginning of mineral nutrition in plants

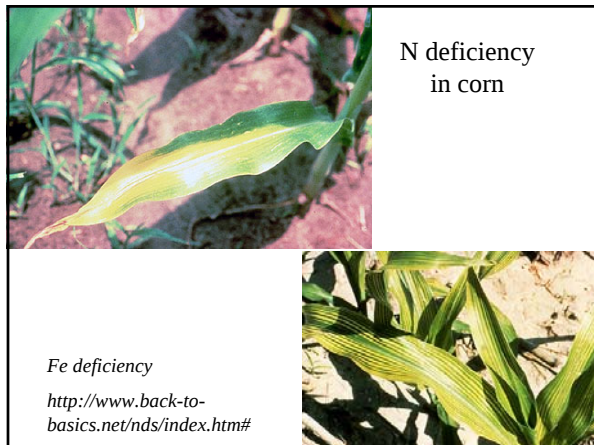
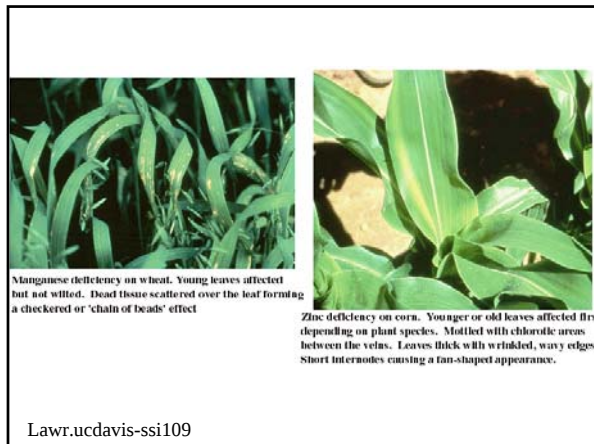
Van Helmont (1600s) planted a willow tree.

Belgian

What happens when nutrients are deficient?

No Molybdate



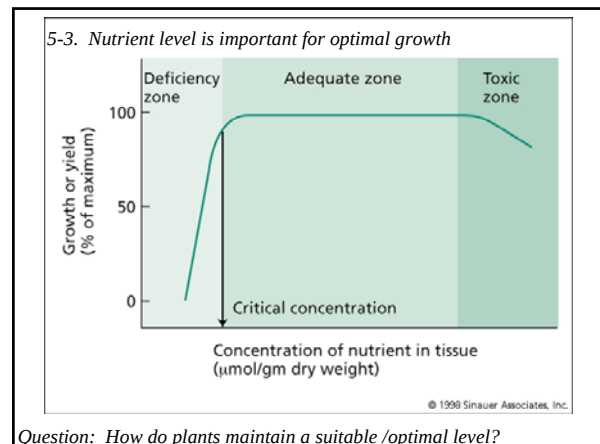


- **Essential nutrients** are those nutrients which are necessary for a plant to complete its life cycle, and for which no other element can substitute.
 - Essential nutrient must have a clear function.
-
- A. Nutrient & Conc. required**
- Macronutrients (elements): > 1 mM
C, H, O, N, K, Ca, Mg, P, S
- Micronutrient: < 1 mM (μM)
Cl, Fe, B, Mn, Zn, Cu, Mo, Ni

Table 5.1 Taiz. Essential nutrients required by plants

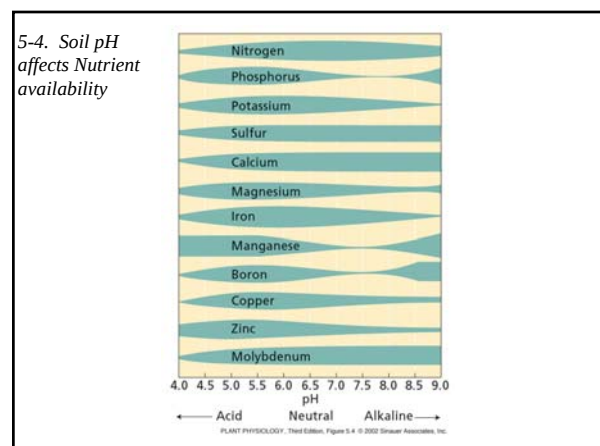
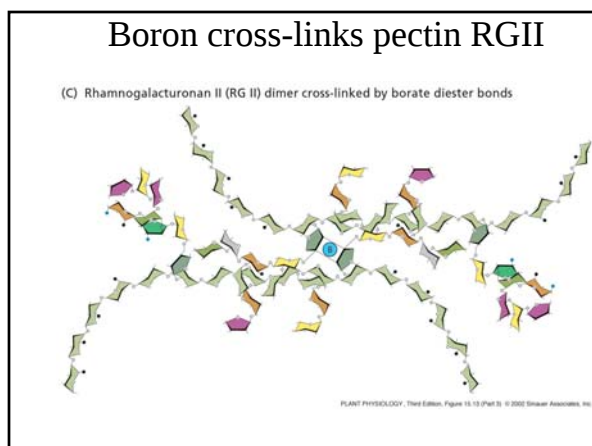
A. Macronutrient	Available	Conc in Dry matter	
	Form	$\mu\text{mol/g}$	μM [medium]
H	H_2O	60,000	
C	CO_2	40,000	
O	O_2, CO_2	30,000	
N	NO_3^- , NH_4^+	1,000	16,000
K	K^+	250	6,000
Ca	Ca^{++}	125	4,000
Mg	Mg^{++}	80	1,000
P	H_2PO_4^- , HPO_4^{--}	60	2,000
S	SO_4^{--}	30	1,000

B. Micronutrient	Available Form	umol/g	μM
Cl	Cl ⁻	3.0	50
B	BO ₃ ⁻	2	25
Mn	Mn ²⁺	1	2
Zn	Zn ²⁺	0.3	2
Cu	Cu ²⁺	0.1	0.5
Mo	MoO ₄ ⁻	0.001	0.5
Fe	Fe ²⁺	1.0-3.0	16-50
Optional			
Ni	Ni ²⁺	0.02	0.5
Si	Si	28	1,000
Na	Na ⁺		

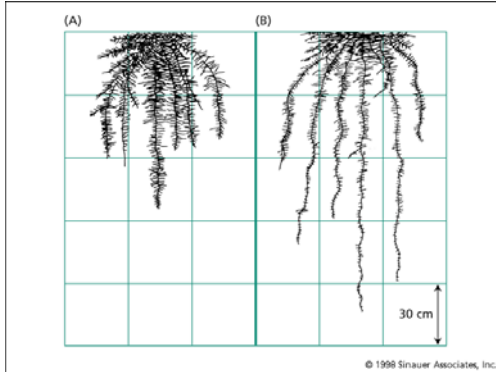


B. Biochemical Functions

- 1) carbohydrates, lipids, Proteins, nucleic acids
CHO CHO CHONP(S) CHONP
- 2) Coenzyme: Mg, Ca, Mn, Zn, Fe, Cu, Mo, Mn [redox rx]
- 3) Osmotic and electrical components: K⁺, Cl⁻, H⁺, Ca²⁺
- 4) B cross-links sugars in cell wall pectin



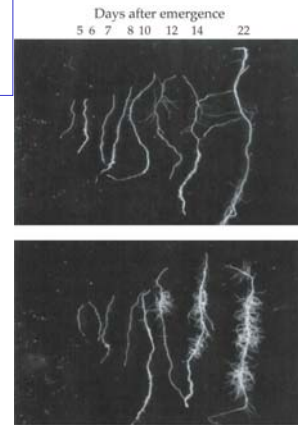
5-6. Wheat Root A. Dry soil B. Irrigated soil



Plants can sense nutrient level and then respond to it.

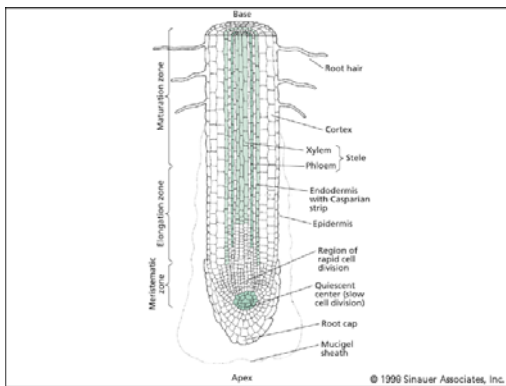
+ 1 mM Pi

-Pi
0 mM



Pi level influence Lateral root development-
Lupinus

5-8. Apex of root



Recap

1. Plants require essential nutrients at varying levels.
2. Deficiency in nutrients reduce productivity
3. Too much can cause toxicity.
4. Plants are able to adapt to soils with different levels of nutrients and can transport ions selectively.

Questions? How do plants regulate how much it takes up?
How do they get rid of excess nutrients?

5. Plants can sense nutrient level and respond to it. E.g. lateral roots induced under low Pi.

? How do plants perceive these messages and respond to it?