

BIOL 695 Nutrition of Horticultural Plants

Credits: 3 Hours

Lecture Tu: 6:30 - 9:30 PM

Lab- Tu: 6:30 -As Arranged

BIOL 695

Plant Nutrients

Chapter 1

Mengel et al., 5th Ed.

Plant Nutrients

1. Definition and classification

- a. Plant ash and lime**
- b. Liebig - plant nutrition science**
 - assumptions and observations**
- c. Nutrient content plants in soil**
 - Could be misleading**
 - Hydroponics as research tool**

Plant Nutrients, continued

- d. Analytical chemistry necessary in plant nutrition research**
- e. Essential elements**
 - Life cycle completion**
 - Not replaceable**
 - Directly involved in metabolism**
- f. Sixteen essential elements**

THE 16 ESSENTIAL ELEMENTS

- **These three come from carbon dioxide (CO₂) and water (H₂O), and are not considered mineral nutrients.**
 - Carbon
 - Hydrogen
 - Oxygen

THE 13 ESSENTIAL MINERALS

- **These are absorbed by plant roots**
- **Those required in large quantities:**
 - **Macronutrients**
 - **Primary**
 - **Secondary**
- **Those required in limited quantities:**
 - **Micronutrients**

ESSENTIAL ELEMENTS LOCATED IN THE PERIODIC TABLE

Essential and Beneficial Elements in Higher Plants																		He
Li	Be	☐ Essential Mineral Element										B	C	N	O	F	Ne	
Na	Mg	☐ Beneficial Mineral Element										Al	Si	P	S	Cl	Ar	
		☐ Essential Nonmineral Element																
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			

MACRONUTRIENTS

- | | |
|---|--|
| <ul style="list-style-type: none"> • <u>Primary</u> - needed in largest amounts <li style="margin-left: 40px;">– Nitrogen N <li style="margin-left: 40px;">– Phosphorus P <li style="margin-left: 40px;">– Potassium K | <ul style="list-style-type: none"> • <u>Secondary</u> - needed in lesser amounts <li style="margin-left: 40px;">– Calcium Ca <li style="margin-left: 40px;">– Sulfur S <li style="margin-left: 40px;">– Magnesium Mg |
|---|--|

Required Elements - Macronutrients

Carbon, Hydrogen, Oxygen*		>90%
Nitrogen	amino acids, nucleic acids, chlor	2.5 - 3.5%**
Phosphorus	ATP, storage bodies, lipids	0.15 - 0.25%
Potassium	ion balance, stomata, cofactor	2 - 3%
Calcium	cell walls, cofactor, stimuli	0.5 - 1.0%
Magnesium	chlor, cofactor, enzyme function	0.3 - 0.5%
Sulfur	amino acids, enzymes	0.3 - 0.5%

*Water alone may be from 70 - 95% of the plant fresh weight.

**Levels in *Coffea arabica* (% dry weight); from Nelson, Greenhouse Crops.

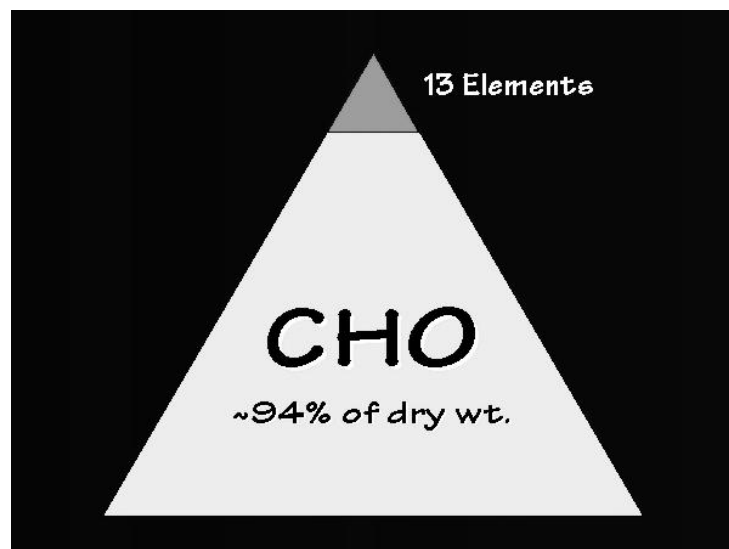
MICRONUTRIENTS

- | | |
|--|--|
| <ul style="list-style-type: none"> • Always classified as essential: <ul style="list-style-type: none"> – Iron Fe – Zinc Zn – Manganese Mn – Copper Cu – Boron B – Molybdenum Mo – Chloride Cl | <ul style="list-style-type: none"> • Sometimes considered essential: <ul style="list-style-type: none"> – Cobalt Co – Nickel Ni |
|--|--|

CLASSIFICATION OF PLANT NUTRIENTS

Nutrient Element	Biochemical Functions
1st Group: C, H, O, N, S	Major constituents of OM Involved in enzymatic processes
2nd Group: P, B, Si	Esterfication reactions
3rd Group: K, Na, Ca, Mg, Mn, Cl	Non-specific functions - osmotic potentials Anion balance; membrane permeability
4th Group: Fe, Cu, Zn, Mo	Catalytic enzyme rx'ns e ⁻ transport

PLANT COMPOSITION



NUTRIENTS USED / A - MACRO.

		<u>Pounds / Acre removed</u>				
<u>Crop</u>	<u>Yield/A</u>	<u>N</u>	<u>P</u>	<u>K</u>	<u>Ca</u>	<u>S</u>
Apple	600 bu	34	3	32	3	12
Cabbage	20 T	120	14	133	16	32
Tomato	20 T	80	9	117	16	5
Onion	1000 bu	154	26	121	18	8

MACRO:MICRO COMPARISON

- Nitrogen : Molybdenum ratio in typical plant tissue:

1,000,000 : 1

- Tomato: 80[#]N/Acre : 0.00008[#]Mo/Acre

SUPPLEMENTING NUTRIENTS

- In most soils, only N, P, K are added
- In greenhouse mixes (completely artificial media without any soil) complex mixtures of many nutrients are added
- In hydroponics (water culture) all essential elements must be provided

MINERAL CONTENT OF PLANT TISSUE

- Major elements
 - Organic comp constituents
 - Osmoregulation
- Micronutrients
 - Enzyme molecule constituents
- Sufficiency tables
 - Reuter & Robison

MINERAL CONTENT, continued

- Nutrient content influenced by
 - Nutrient availability
- Basis of plant analysis is relationship between nutrient in
 - growth medium
 - plant
- Leaves best index
 - Why?
- Growth rate - nutrient comparison

SUMMARY

- N - Proteins
- P - Energy metabolism
- K - Osmoregulation, Hydration
- S - S-Amino acids
- Ca - Middle lamella
- Mg - Chlorophyll
- Fe - Porphyrin molecules

SUMMARY (Continued)

- **Mn - Oxidative-reduction**
- **B - mobile in sp rich in sorbitol**
- **Cu - photosynthetic electron transp**
- **Zn - auxin synthesis for cell elong.**
- **Mo - nitrate reductase**
- **Cl - PS oxygen evolution**