Plant Nutrition

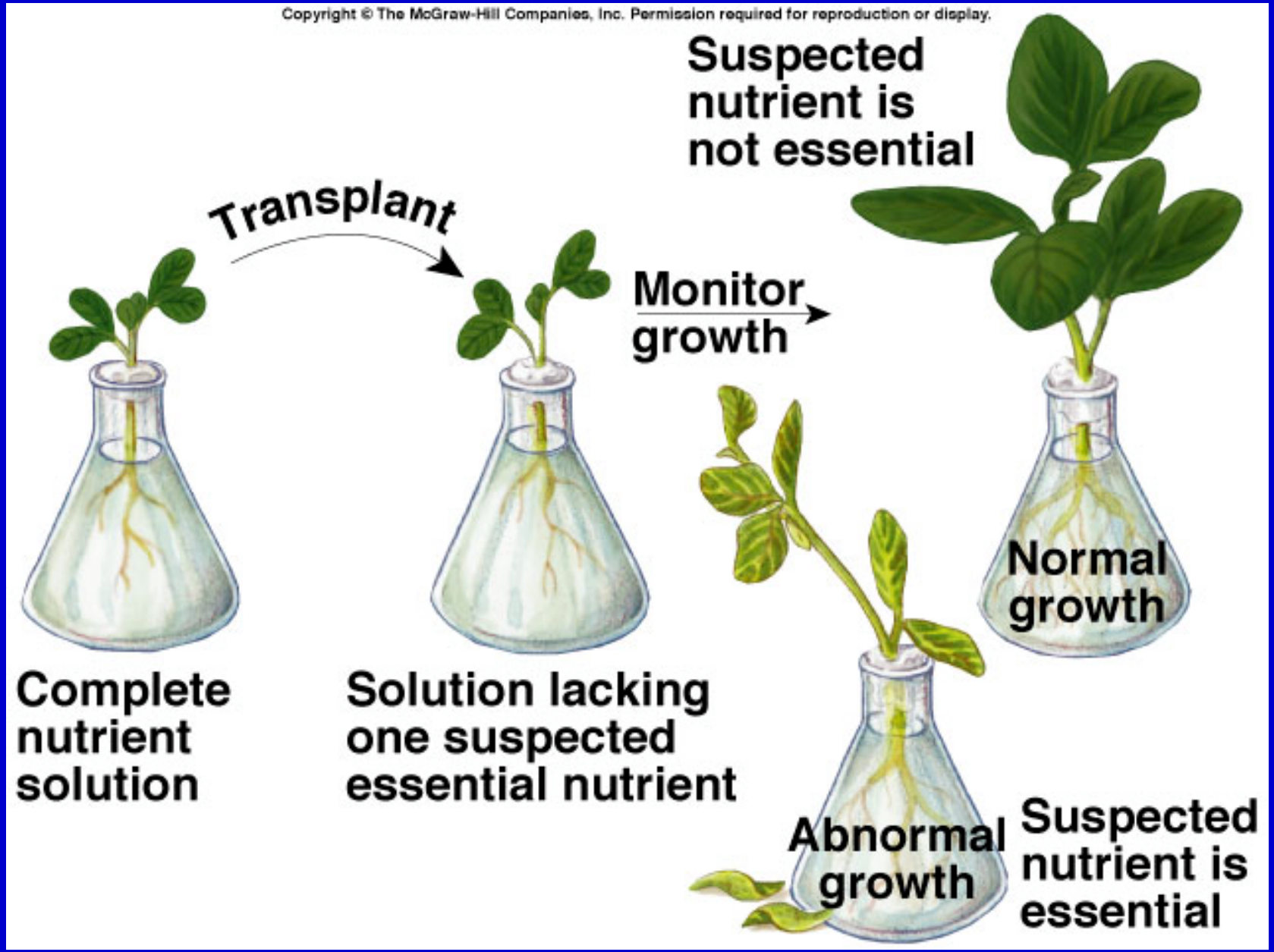
Photosynthesis is the major source of plant nutrition.
Plants also require a number of inorganic molecules.
<u>macronutrients</u>
carbon, hydrogen, oxygen, nitrogen, potassium, calcium, phosphorus, magnesium and sulfur
each may exceed 1% dry weight of plant
<u>micronutrients</u>
iron, chlorine, copper, manganese, zinc, molybdenum, and boron
constitute from less than one, to several hundred, parts per million in most plants
nutritional requirements assessed in hydroponic cultures

Elements	Principal Form in which Element Is Absorbed	Approximate Percent of Dry Weight	Examples of Important Functions
MACRONUTRIENTS			
Carbon	(CO_2)	44	Major component of organic molecules
Oxygen	(O_2, H_2O)	44	Major component of organic molecules
Hydrogen	(H_2O)	6	Major component of organic molecules
Nitrogen	(NO_3^-, NH_4^+)	1–4	Component of amino acids, proteins, nucleotides, nucleic acids, chlorophyll, coenzymes, enzymes
Potassium	(K^+)	0.5–6	Protein synthesis, operation of stomata
Calcium	(Ca^{++})	0.2–3.5	Component of cell walls, maintenance of membrane structure and permeability, activates some enzymes
Magnesium	(Mg^{++})	0.1–0.8	Component of chlorophyll molecule, activates many enzymes
Phosphorus	($H_2PO_4^-$, $HPO_4^=$)	0.1–0.8	Component of ADP and ATP, nucleic acids, phospholipids, several coenzymes
Sulfur	($SO_4^=$)	0.05–1	Components of some amino acids and proteins, coenzyme A
MICRONUTRIENTS (CONCENTRATIONS IN PPM)			
Chlorine	(Cl^-)	100–10,000	Osmosis and ionic balance
Iron	(Fe^{++}, Fe^{+++})	25–300	Chlorophyll synthesis, cytochromes, nitrogenase
Manganese	(Mn^{++})	15–800	Activator of certain enzymes
Zinc	(Zn^{++})	15–100	Activator of many enzymes, active in formation of chlorophyll
Boron	(BO_3^- or $B_4O_7^=$)	5–75	Possibly involved in carbohydrate transport, nucleic acid synthesis
Copper	(Cu^{++})	4–30	Activator or component of certain enzymes
Molybdenum	($MoO_4^=$)	0.1–5	Nitrogen fixation, nitrate reduction

Deficiencies of certain nutrients cause specific diseases

Complete lack of only one nutrient can result in lack of growth

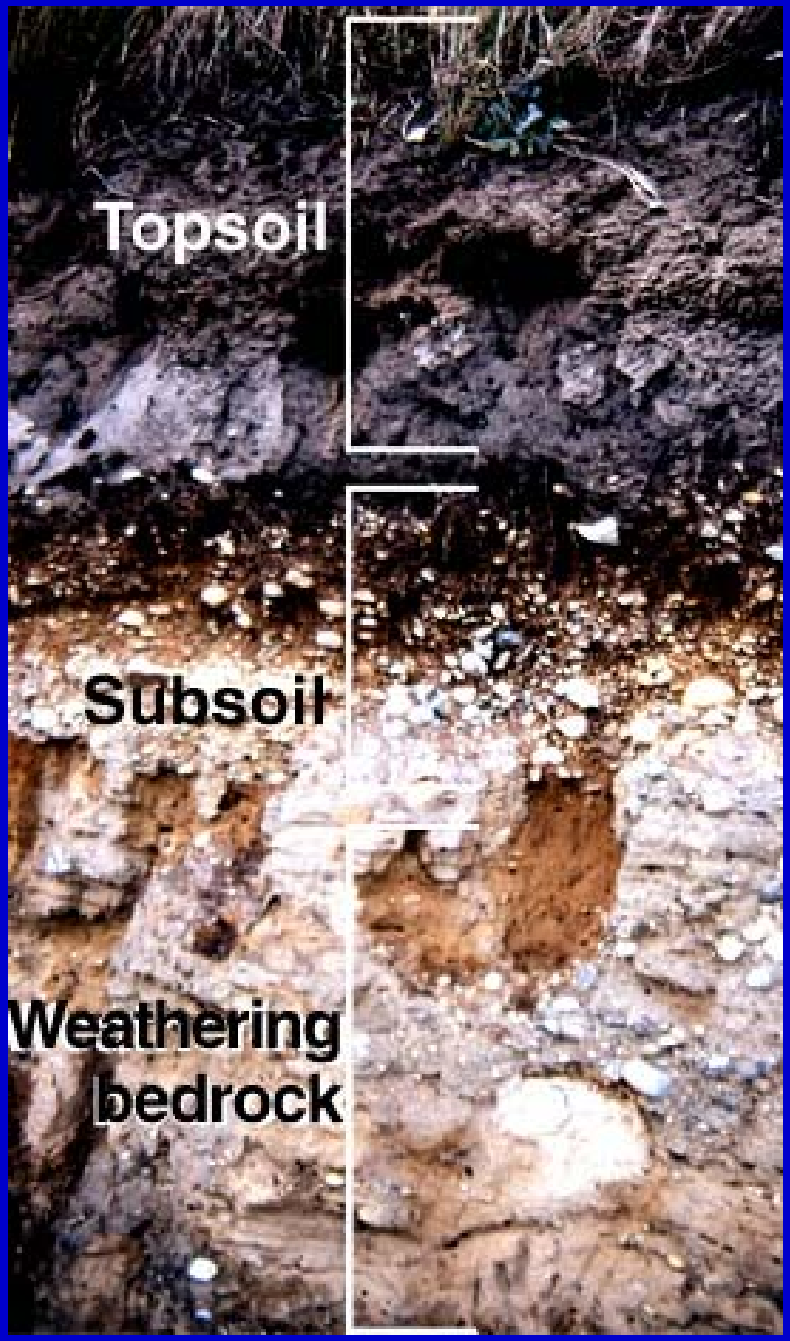
Leybig's Law of the Minimum although all other nutrients are in abundance, a deficiency of a single nutrient will stop growth



Under natural circumstances, nutrients come from soil

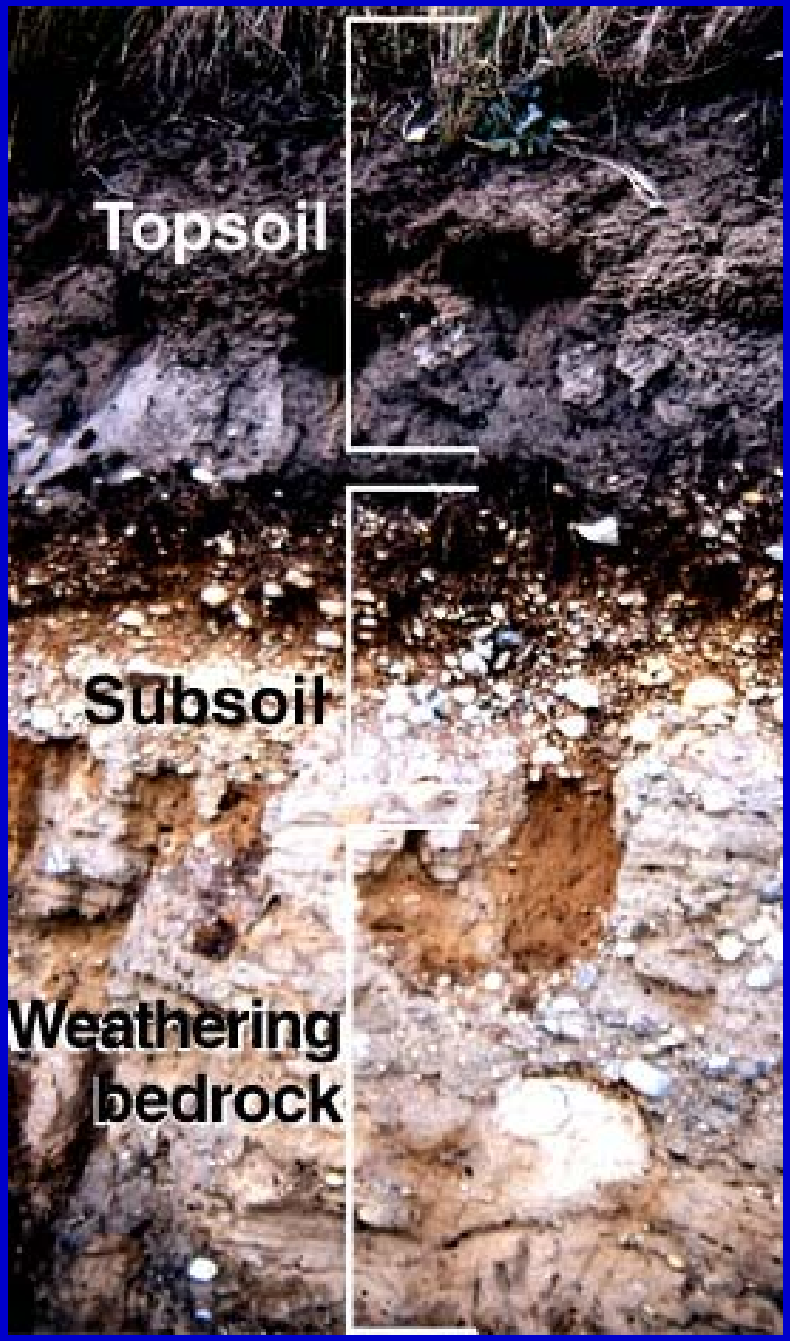
Plant growth affected by soil composition
Most roots found in topsoil
Topsoil consists of small particles of weathered rock, minerals, decomposing organic materials (humus), and living organisms

About half total soil volume occupied by spaces or pores
filled with air or water, depending on environmental conditions



weathering of bedrock releases nutrients slowly - chemical processes make mineral nutrients soluble

In natural conditions, plants remove nutrients from the soil but their death and decomposition returns nutrients to the soil



In agriculture, removal of the crop removes nutrients that the crops have taken from the soil

Agricultural land often becomes nutrient depleted

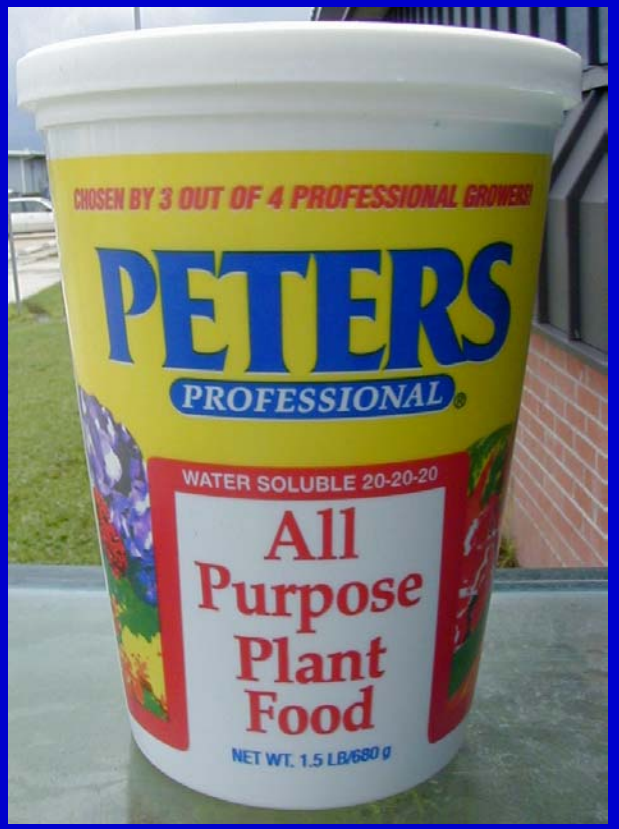
Chemical fertilizers can be used to replenish lost nutrients

Commercial fertilizers generally have Nitrogen (N), Phosphorus (P), and Potassium (K) in percentages given on the label:

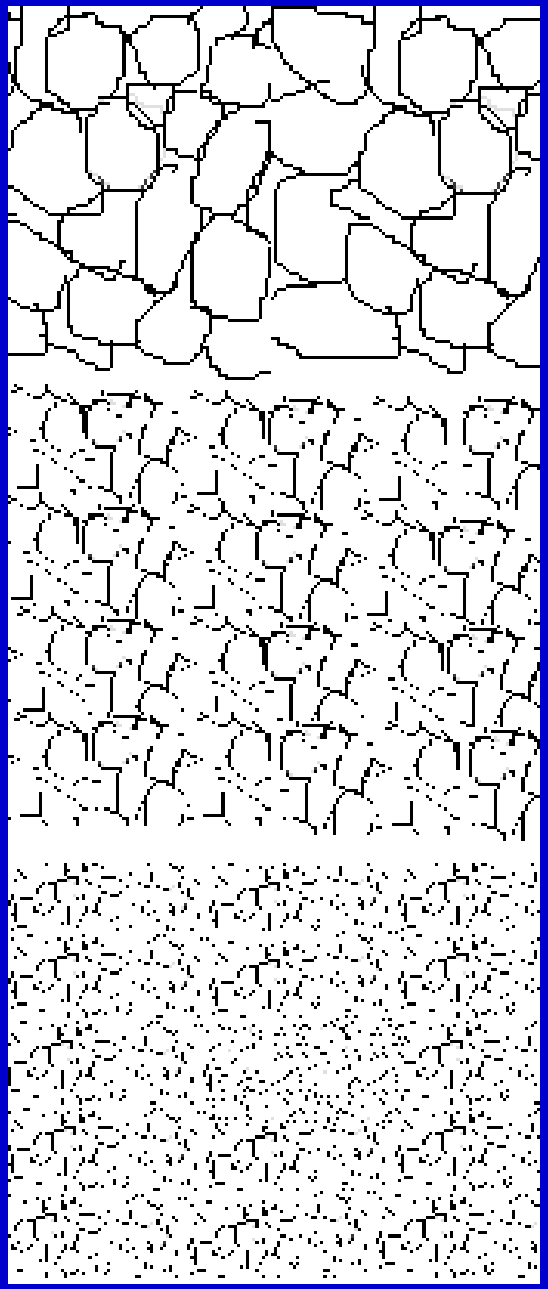
20:20:20 = 20% N: 20% P: 20% K

They often have other macronutrients and micronutrients also.

Nutrient depletion in soils can be reduced by crop rotation and plowing under of unharvested plant remains.



Large particle soils have large air spaces and little surface area They have poor ability to hold water and nutrients



Sand 200 - 2000 µm

Silt 2 - 200 µm

Small particle soils have small air spaces and large surface area They hold water and nutrients well - sometimes too well

Clay < 2 µm

The best soils have a mixture of particle sizes - “loam”

Nitrogen Fixation

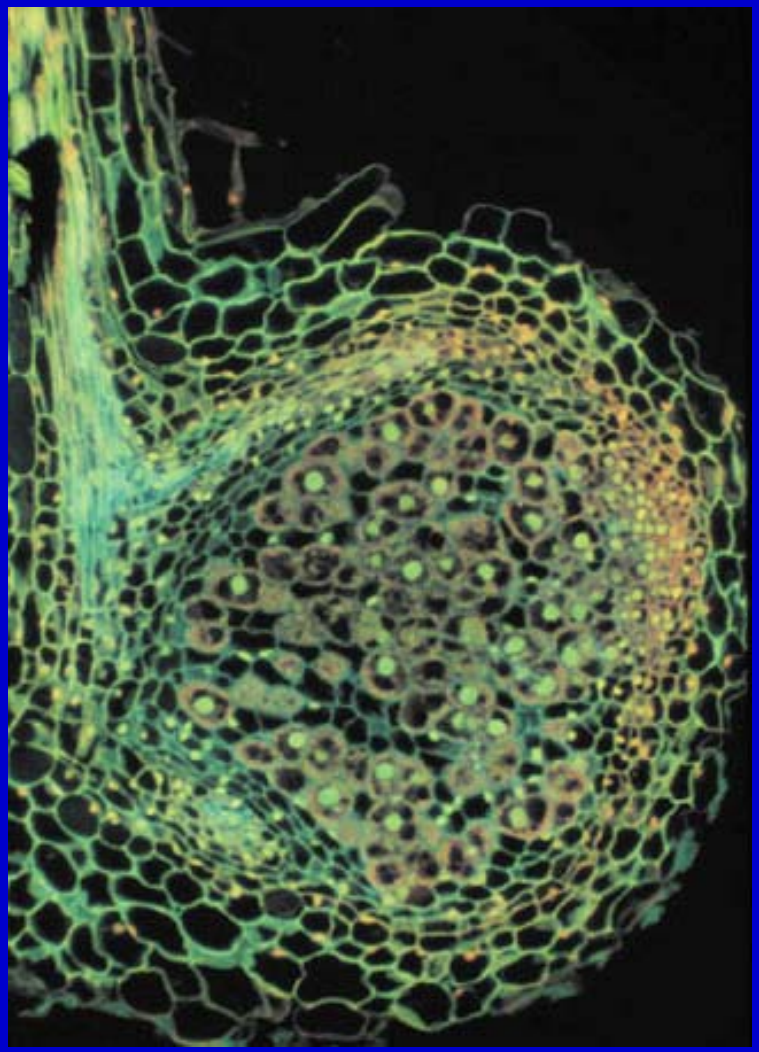
Plants need ammonia (NH_3) to build amino acids.

N_2 most common atmospheric form

Plants lack the ability to convert gaseous nitrogen to ammonia.

some bacteria have the ability

A mutualism between legumes and nitrogen-fixing bacteria allow atmospheric N to be captured and made available to the plant.



Nutritional Adaptations of Plants

Carnivorous plants

- obtain nitrogen directly from other organisms
- allows growth in N poor environments

Mycorrhizae

- extend surface area for nutrient uptake

Parasitic plants

- tap into vascular tissue of host plant for nutrients