Soil Fertility

Plant and Soil Science
Standard 4 Objective 3

Objectives

a. Describe the meaning and importance of soil fertility.

b. Explain the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity.

Plant nutrients and fertilizers
Plants do not eat! Not Food!

- Water
- Elements

Water

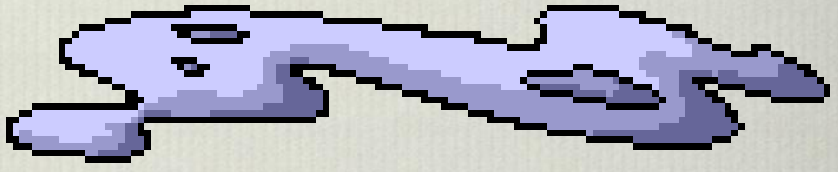
- Water is the most important plant nutrient
- Makes up 90% of the plants weight
- Water transports the other elements around the plant

Elements

- divided into two groups, macro and micro
- Major elements (macro)
  - Nitrogen – N
  - Phosphorus – P
  - Potassium - K

minor elements (micro)

- Calcium - Ca
- Magnesium - mg
- Sulfur - S
- Iron - Fe



minor elements (micro)

- Manganese - Mn
- Boron - B
- Copper - Cu
- Zinc - Zn

Plant requirements

- large amounts of major elements
- relatively small amounts of minor elements

Commercial fertilizers

- shows % or pounds per cwt. (100#) of the three major elements in large numbers on the container or bag.

Commercial fertilizers

- 5-10-5
- 5% N, 10% P, 5% K
- remaining 80% is filler
- NP&K are always listed in that order.

Soil tests

- determine amount of elements needed for various plants.

How to take a soil sample

- Take random samples from the area to represent the area you want to test.
- Mix all samples together.
- Take a sample from the mix of about 16oz of soil.
- Complete soil test info sheet.
- Mail to a reputable lab.
- Analyze results and make decisions.

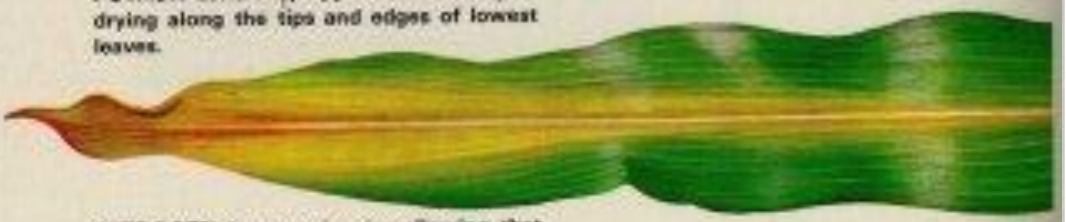
Plate IV
Figure 31

Guide to Nutrient Deficiency Symptoms

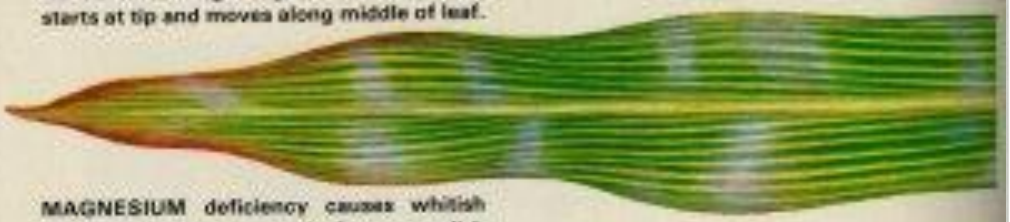
HEALTHY leaves shine with a rich dark green color when adequately fed

PHOSPHATE shortage marks leaves with reddish-purple, particularly on young plants.

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.

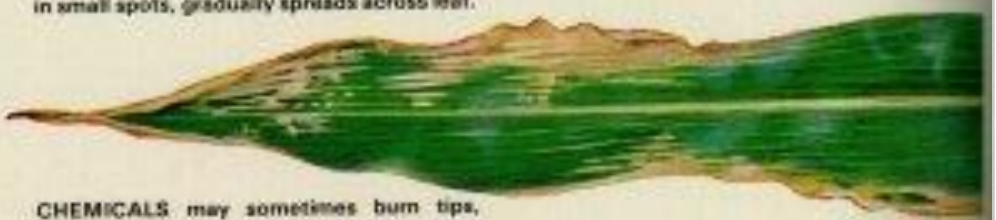


MAGNESIUM deficiency causes whitish strips along the veins and often a purplish color on the underside of the lower leaves.

DROUGHT causes the corn to have a grayish-green color and the leaves roll up nearly to the size of a pencil.

Drawings: Maynard Reece

DISEASE, helminthosporium blight, starts in small spots, gradually spreads across leaf.



CHEMICALS may sometimes burn tips, edges of leaves and at other contacts. Tissue dies, leaf becomes whitecap.

Nitrogen

- has most noticeable effect on plants
- encourages above ground vegetative growth
- regulates use of other elements

Too much Nitrogen

- lower disease resistance
- weaken stem because of long soft growth
- lower fruit quality

Too much Nitrogen

- delay maturity
- increase winter damage to plants

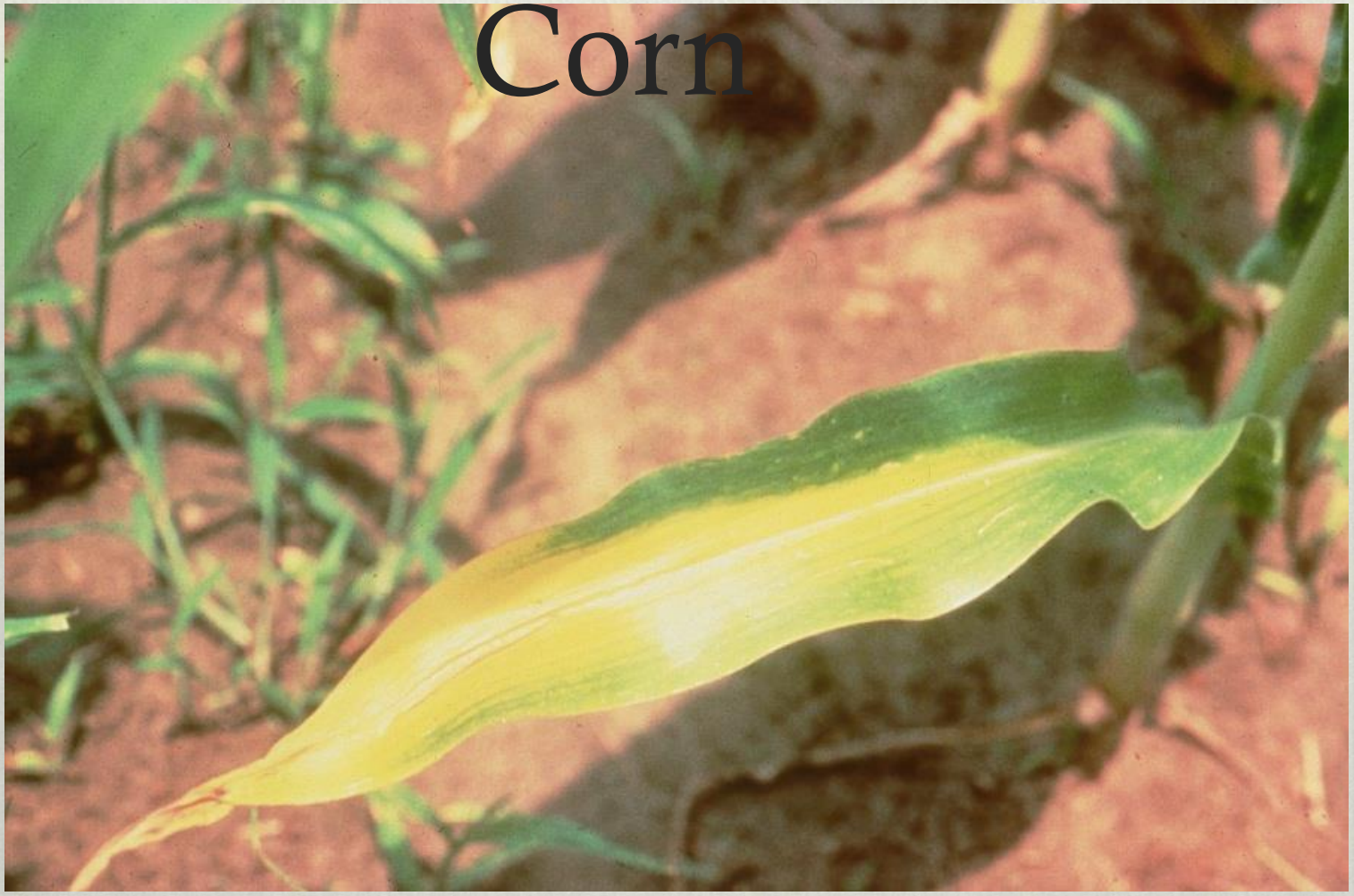
Not enough Nitrogen

- yellow or light green color
- stunted root and top growth

N lost easily from soil

- leaching - being filtered down through soil with water
- not held by soil particles, dissolved in water
- O.M. holds insoluble N for slow release

Nitrogen Deficiency in Corn



Phosphorous

- held tightly by soil particles
- not easily leached

Phosphorous

- effects plants in several ways
- encourage cell division
- flowers and seeds don't form without it
- hastens maturity, offsetting quick growth caused by N.

Phosphorous

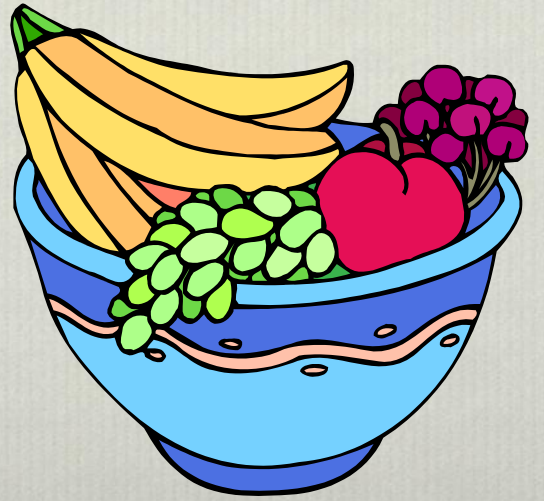
- encourage root growth
- makes K more available
- increase disease resistance
- improves quality of grain, root and fruit crops

Insufficient P

- purple color on underside of leaf
- reduced flower fruit and seed production

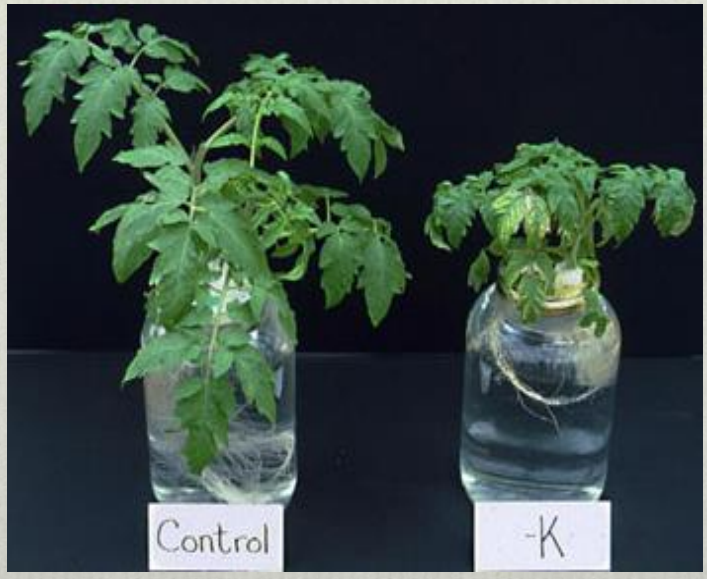
Insufficient P

- susceptibility to cold injury
- susceptibility to plant diseases
- poor quality fruit and seeds



Potassium

- modifies both fast soft growth of N and early maturity of P
- is essential

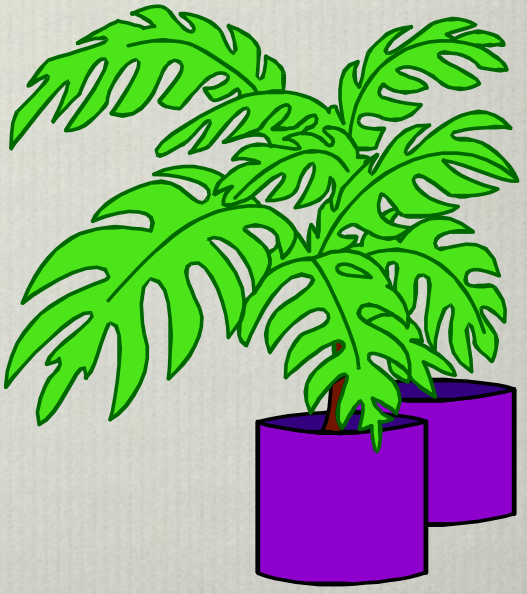


Potassium

- increase disease resistance
- encourages healthy root systems
- essential for starch formation

Potassium

- development of chlorophyll
- efficient use of CO_2



Insufficient K

- leaves appear dry and scorched with irregular yellow areas on the surface

Lime

- $CaCO_3$- Calcium Carbonate
- acts as a plant food
- affects soil acidity
- soil acidity affects availability of plant food elements

Lime

- furnishes Calcium

pH

- measure of acidity or alkalinity
- pH scale - runs from 0 - 14
- most plants grow best from 5.6-7.0

pH

- 7.0 is neutral
- pH of 7 or above is alkaline or basic
- pH below 7 is acidic

pH

- as numbers decrease, solution becomes more acidic.
- As numbers increase, solution becomes more basic or alkaline

Choosing a Fertilizer

- Complete/mixed—contain three primary nutrients
- Should be selected based on economics, market availability, other factors, not solid versus liquid
- Placement is critical—GIS/GPS systems can help

Choosing a Fertilizer (*continued*)

- Divided into 2 common types
  - Organic
  - Inorganic

Choosing a Fertilizer (*continued*)

- Alternatives to commercially made fertilizers include
  - manure: quality is affected by age/kind of animal, what it ate, amount/kind of litter/bedding used, way manure handled
  - compost: especially good for improving soils low in organic matter

Organic Fertilizers

- Derived from decomposition of animal wastes or plant products
- Also act as soil amendments or conditioners
- Nutrients are released slowly through decomposition
  - Slow and unreliable in cold soil
- Expensive for the amount of nutrients they actually contain

Garden Safe All Purpose Natural Organic Plant Food

GUARANTEED ANALYSIS **5-3-3**

Total Nitrogen (N)	5.0%
1.0% Water Soluble Nitrogen	
4.0% Water Insoluble Nitrogen*	
Available Phosphate (P_2O_5)	3.0%
Soluble Potash (K_2O)	3.0%
Calcium (Ca)	9.0%

Derived from: Poultry manure

*4.0% slowly available Nitrogen from poultry manure

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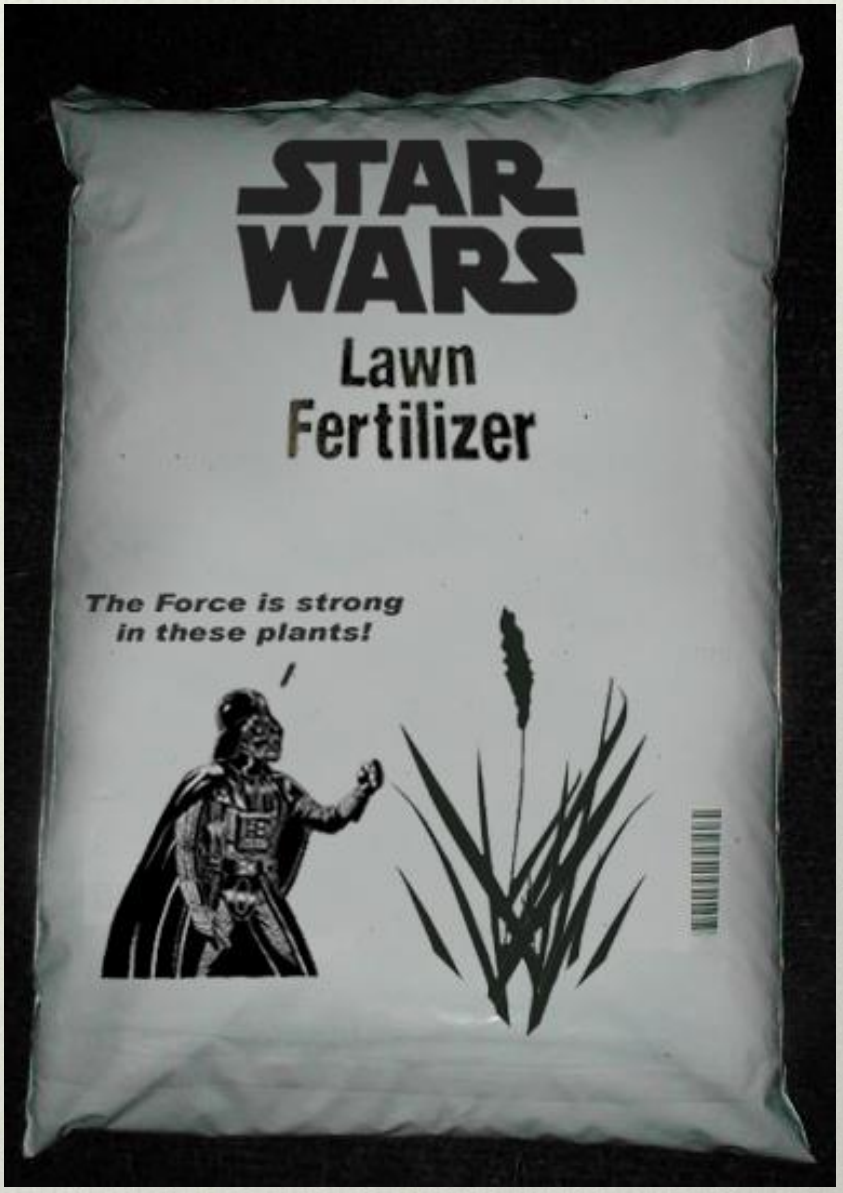

Inorganic Fertilizers

- Come from mined and manufactured raw materials
- Much more concentrated than Organics
- Can be formulated as fast-release or slow-release
- As far as N goes, most plants use the same form (NO_3^-), regardless of how it gets there
- Can cause rapid depletion of soil OM

Fertilizer Forms

- Liquids
  - Salty so they dissolve in water
  - Sprayed on root zone or as a foliar application
  - Have high tendency to ‘burn’ plants
  - Are usually short-lived
- Granules
  - Most common form
  - Heavy pellets don’t drift too far
  - Can be slow-release

Fertilizer Forms

- Tablets and Spikes
  - Large compressed items that are pushed into the soil or placed in a hole
  - Expensive for the amount of nutrient they contain
  - Release nutrients very slowly over time
    - Several months to more than a year

Is Soil Alive?

- ¼ teaspoon of fertile soil contains approximately:

- 1 Earthworm

- 50 Nematodes

- 52,000 Algae

- 111,000 Fungi

- 2,920,000 Actinomycetes

- 25,280,000 Bacteria

Earthworms

- Decompose organic matter
- Mix plant litter with soil
- Tunneling help with aeration of the soil

Nemotodes

- Example are:
  - Roundworms, threadworms, hair worms
  - Consume other microbial organisms whit help regulate the microbial population
  - Also found in the roots of the plants

Algae

- Contain chlorophyll (photo synthetic)
- Soil algae are too small to be seen with the naked eye, but in large numbers can give the surface a green color.
- They favor damp soil that is exposed to the sun.
- Formation of soil structure

Fungi

- Examples:
  - Mushrooms, mold, mildew, rusts, yeasts
- Grow on dead and decaying tissue
- Primary agent of organic matter decay
- Make nutrient available by decomposing organic matter.

Actinomycetes

- **Rod-shaped form of bacteria**
  - **Can live under drier conditions than bacteria, very abundant in sod.**
  - **One of the most important agents in the soil for decomposing and breaking down cellulose.**
  - **Its what gives freshly tilled soil its smell**

Bacteria

- **Most numerous and MOST IMPORTANT!**
- **Diverse metabolism aides in breaking down organic chemicals like pestisides.**
- **Can also degrade inorganic materials, natural and synthetic**
- **The Fix Nitrogen**

Why do we need microorganisms in Agriculture?

- **Decay plant residue (straw)**
- **Fix nitrogen**
- **Break down nutrients needed by plants**
- **Break down cellulose**
- **Finally, much of the soil is not available to the plants until the microbes break it down**