Chapter 1
Macro and Micro Nutrients

Dr. Mubarak


FERTILIZER
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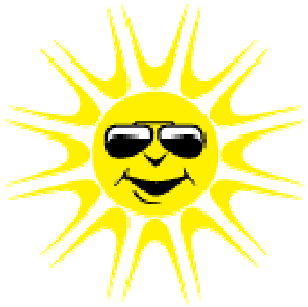
Introduction

- **Fertilizer is a substance added to soil to improve plants' growth and yield.**
- **First used by ancient farmers, fertilizer technology developed significantly as the chemical needs of growing plants were discovered.**
- **Modern synthetic fertilizers are composed mainly of the following compounds:**
  1. **Nitrogen.**
  2. **Phosphorous.**
  3. **potassium**
  4. **secondary nutrients added.**

Non-Mineral Nutrients

Hydrogen (H), Oxygen (O), & Carbon (C).



- **These nutrients are found in the air and water.**
- **In a process called photosynthesis, plants use energy from the sun to change carbon dioxide (CO_2 - carbon and oxygen) and water (H_2O- hydrogen and oxygen) into starches and sugars.**
- **These starches and sugars are the plant's food.**

Mineral Nutrients

Macronutrients	
Primary Nutrients	**Secondary Nutrients**
1. Nitrogen (N) **2. Phosphorus (P)** **3. Potassium (K)** **These major nutrients usually are lacking from the soil because plants use large amounts for their growth and survival.**	**1. Calcium (Ca)** **2. Magnesium (Mg)** **3. Sulfur (S)** **There are usually enough of these nutrients in the soil so fertilization is not always needed.**

Mineral Nutrients

Micronutrients	
1. Boron (B) 2. Copper (Cu) 3. Iron (Fe) 4. Chloride (Cl) 5. Manganese (Mn) 6. Molybdenum (Mo) 7. Zinc (Zn) 8. Cobalt (Co) 9. Nickel (Ni)	• Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities . • These elements are sometimes called minor elements or trace elements

Nitrogen (N)

- **Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy.**
- **Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis.**
- **Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops.**
- **Nitrogen often comes from fertilizer application and from the air.**

Nitrogen deficiency

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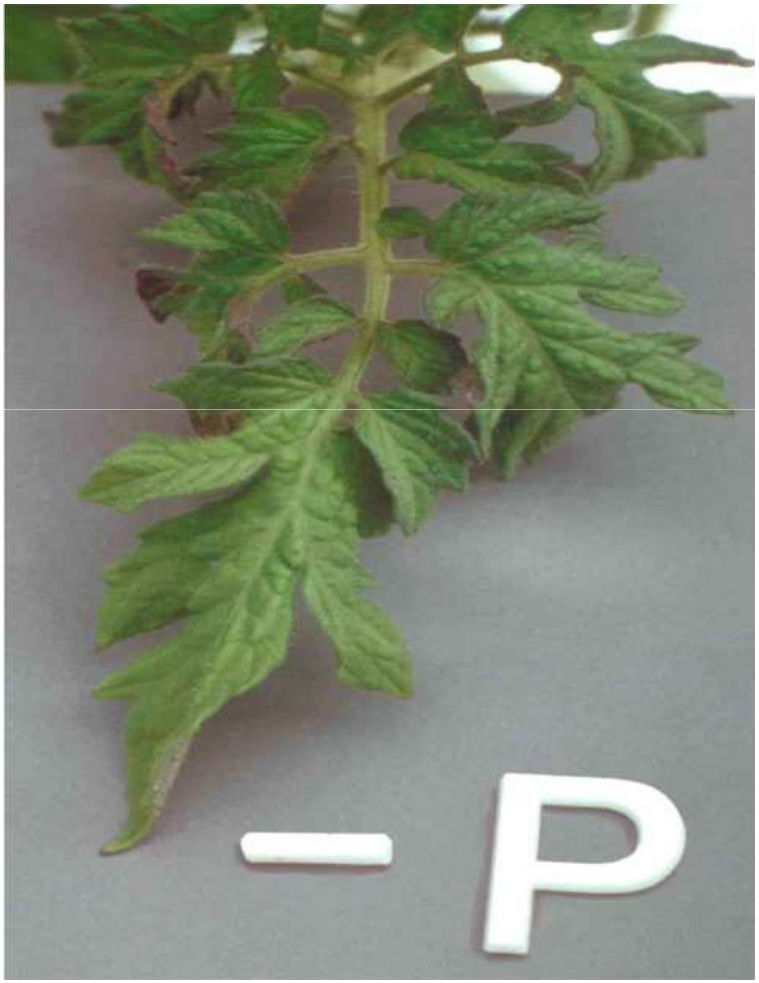
Phosphorus (P)

- **Phosphorus (P) is an essential part of the process of photosynthesis.**
- **Involved in the formation of all oils, sugars, starches, etc.**
- **Helps with the transformation of solar energy into chemical energy; proper plant maturation; withstanding stress.**
- **Effects rapid growth.**
- **Encourages blooming and root growth.**
- **Phosphorus often comes from fertilizer, and superphosphate.**

Phosphorus (P)



Potassium (K)

- **Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.**
- **Helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.**
- **Potassium is supplied to plants by soil minerals, organic materials, and fertilizer.**

Potassium deficiency

Calcium (Ca)

- **Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant.**
- **It is also thought to counteract the effect of alkali salts and organic acids within a plant.**
- **Sources of calcium are dolomitic lime, gypsum, and superphosphate.**

Calcium deficiency

Magnesium (Mg)

- **Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis.**
- **It also helps activate many plant enzymes needed for growth.**
- **Soil minerals, organic material, fertilizers, and dolomitic limestone are sources of magnesium for plants.**

Magnesium (Mg)

Sulfur (S)

- **Essential plant food for production of protein.**
- **Promotes activity and development of enzymes and vitamins.**
- **Helps in chlorophyll formation.**
- **Improves root growth and seed production.**
- **Helps with vigorous plant growth and resistance to cold.**
- **Sulfur may be supplied to the soil from rainwater. It is also added in some fertilizers as an impurity, especially the lower grade fertilizers. The use of gypsum also increases soil sulfur levels.**

Sulfur deficiency

Boron (B)

- **Helps in the use of nutrients and regulates other nutrients.**
- **Aids production of sugar and carbohydrates.**
- **Essential for seed and fruit development.**
- **Sources of boron are organic matter and borax.**

Copper (Cu)

- **Important for reproductive growth.**
- **Aids in root metabolism and helps in the utilization of proteins.**

Boron deficiency

Copper deficiency

Chloride (Cl)

- **Aids plant metabolism.**
- **Chloride is found in the soil.**

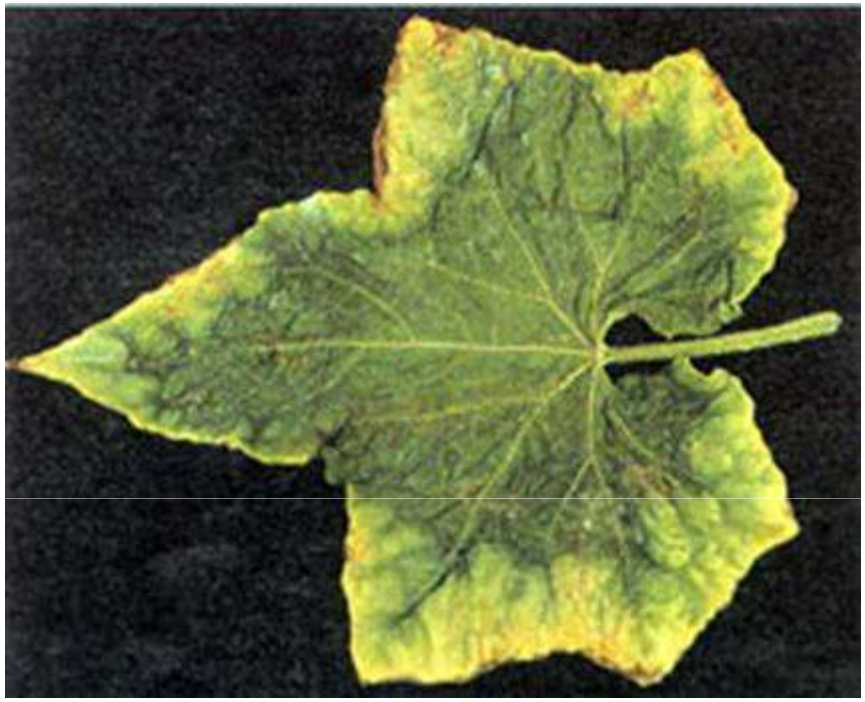
Iron (Fe)

- **Essential for formation of chlorophyll.**
- **Sources of iron are the soil, iron sulfate, iron chelate.**

Molybdenum (Mo)

- **Helps in the use of nitrogen**
- **Soil is a source of molybdenum.**

Chloride deficiency



Iron deficiency

Manganese (Mn)

- **Functions with enzyme systems involved in breakdown of carbohydrates, and nitrogen metabolism.**
- **Soil is a source of manganese.**

Zinc (Zn)

- **Essential for the transformation of carbohydrates.**
- **Regulates consumption of sugars.**
- **Part of the enzyme systems which regulate plant growth.**
- **Sources of zinc are soil, zinc oxide, zinc sulfate, zinc chelate.**

Manganese deficiency

Zinc deficiency

Fertilizer s

- **Organic:**
  carbonaceous materials mainly of vegetable and/or animal origin added to the soil specifically for the nutrition of plants.
- **Inorganic:**
  A term used by the International Organization for Standardization (IOS) for fertilizer in which the declared nutrients are in the form of inorganic salts obtained by extraction and/or by physical and/or chemical industrial processes.

Inorganic Fertilizer s

- **Straight Fertilizer:**
  A qualification generally given to a nitrogenous, phosphatic, or potassic fertilizer having a declarable content of only one of the primary plant nutrients.
- **Compound Fertilizer:**
  A fertilizer that has a declarable content of at least two of the plant nutrients nitrogen, phosphorous, and potassium, obtained by chemically or by blending, or both.

- **Mixed Fertilizer:**
  The term applied to a fertilizer that is a physical mixture of two or more of the straight fertilizer. Mixed fertilizer may be powdered or granulated.
- **Blended Fertilizer:**
  A fertilizer, obtained by dry mixing, that has a declarable content of at least two of the plant nutrients nitrogen, phosphorus, and potassium.
- **Granular Fertilizer:**
  Solid material that is formed into particles of a predetermined mean size.

- **Coated Fertilizer:**
  Granular fertilizer that is covered with a thin layer of a different material in order to improve the behavior and/or modify the characteristics of the fertilizer.
- **Slow-release Fertilizer:**
- **A fertilizer whose nutrients are present as a chemical compound or whose physical state is such that the nutrient availability to plants is spread over time.**

- **Conditioned Fertilizer:**
  Fertilizer treated with an additive to improve physical condition or prevent caking.
- **Solution Fertilizer:**
  Liquid fertilizer free of solid particles.
- **Suspension Fertilizer:**
  A two-phase fertilizer in which solid particles are maintained in suspension in the aqueous phase.
- **Powder Fertilizer:**
  A solid substance in the form of very fine particles.

Fertilizer Specifications

A well written fertilizer specification should include the following elements in detail:

1. **Nutrient contents and concentrations.**
2. **Nutrient chemical composition.**
3. **Moisture content.**
4. **Physical condition.**
5. **Particle size distribution.**
6. **Solubility.**
7. **Conditioner.**
8. **Packaging details.**
9. **Penalties or discount for deviation from stated values**

Common Fertilizer

Abbreviation	Name	Grade
AN	Ammonium Nitrate	33-34% N
AS	Ammonium Sulfate	21% N
CAN	Potassium Nitrate	13% N
CN	Calcium Nitrate	15% N
DAP	Diammonium Phosphate	18-46-0
MAP	Monoammonium Phosphate	11-55-0 to 12-61-0
KCl	Potassium Chloride	60-62% K_2O
TSP	Triple Superphosphate	44-48% P_2O_5
SOP	Potassium Sulfate	50% K_2O
	Urea	45-46% N

Fertilizer Grade

- **It is customary to refer to a given fertilizer product by a series of numbers separated by dashes.**
- **This set of numbers is called the grade of the fertilizer product.**
- **Each of the numbers indicates the amount of a nutrient that the manufacturer guarantees is contained in the fertilizer product.**
- **A fertilizer product with a grade of 18-46-0 is guaranteed by the manufacturer to have 18% N and 46% P_2O_5.**

Conversion Factors

P_2O_5	**×**	**0.44**	**=**	**P**
P	×	2.29	=	P_2O_5
K_2O	×	0.83	=	K
K	×	1.20	=	K_2O
CaO	×	0.71	=	Ca
Ca	×	1.40	=	CaO
MgO	×	0.60	=	Mg
Mg	×	1.66	=	MgO
SO_3	×	0.40	=	S
S	×	2.50	=	SO_3