

Vivekanand College, Kolhapur

(Empowered Autonomous)

DEPARTMENT OF BOTANY

B.Sc. I: Open Elective

Topic: Fertilizers

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INTRODUCTION TO FERTILIZERS

- In the same way that humans need to eat properly to stay healthy, so plants need certain nutrients to grow properly.
- Fertilizer is a substance added to soil to improve plant's growth and yield. Basically it is a chemical or natural substance is added to soil or land to increase its fertility.
- Fertilizers are food supplements for plants and need 16 nutrients to be healthy.

WHAT IS A FERTILIZER ?

A fertilizer is any material of natural or synthetic origin that is applied to soils or to plant tissues to supply one or more plant nutrients essential to the growth of plants.

COMPLETE VS. INCOMPLETE

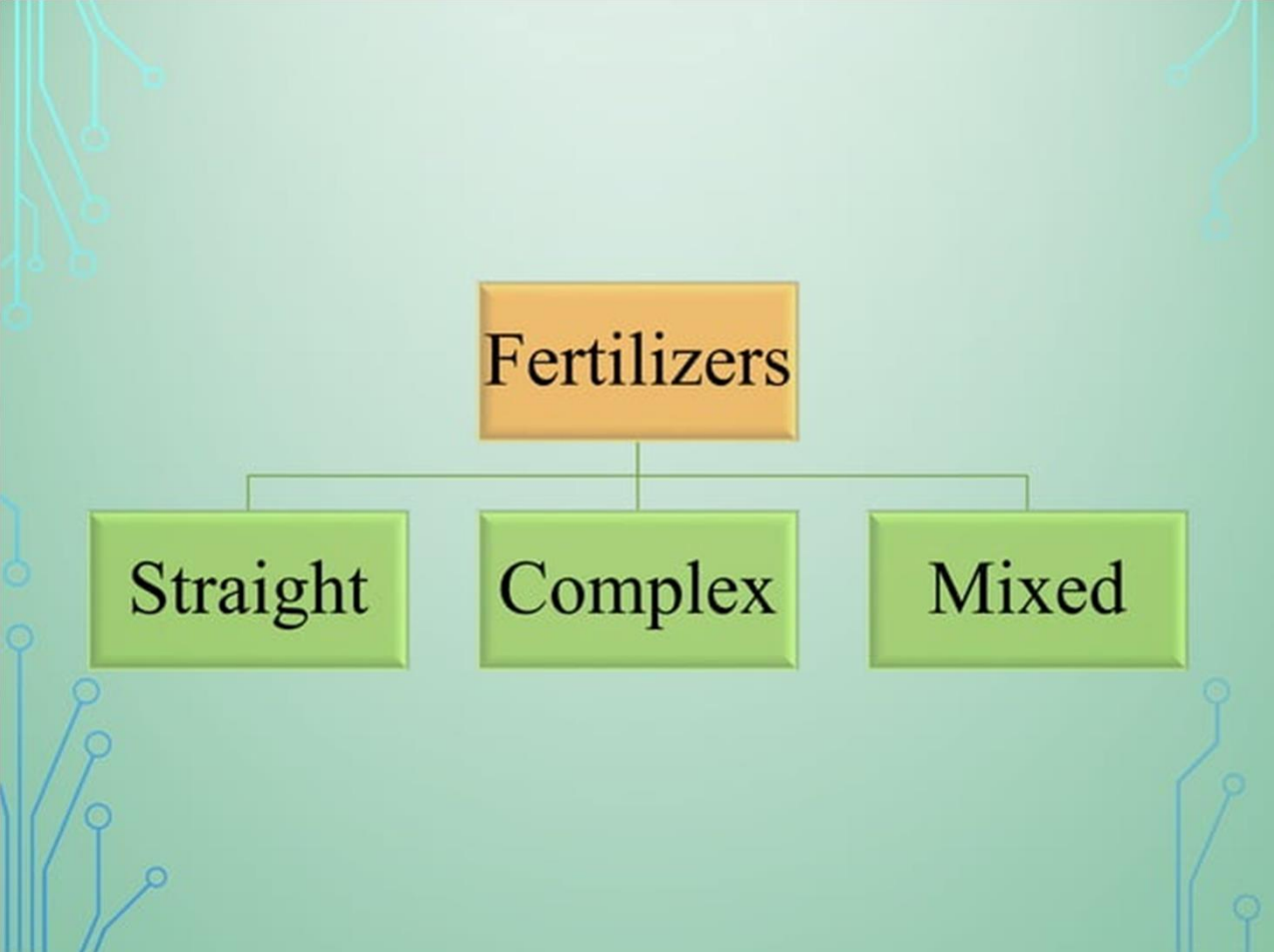
- Complete has all three primary nutrients-nitrogen phosphorous & potassium
- Examples: 10-10-10, 15-30-15, 20-5-20
- Incomplete DOES NOT have all three primary nutrients
- Examples: 20-0-0, 0-20-0, 12-0-44

BASIC FORMS OF FERTILIZERS:

- **Granular-** designed to be scratched into the soil and water soluble.
- **Powdered-** designed to be dissolved in water for liquid feeding to soil and foliage.
- **Liquid-** usually a concentrated form to be mixed with water.



CLASSIFICATION OF FERTILISERS



- **Straight fertilizers** are those which supply only one primary plant nutrient (N, P & K).
- E.g. Urea, Ammonium sulphate, Potassium chloride and Potassium sulphate.

- **Complex fertilizers** contain 2 or 3 primary plant nutrients of which two primary nutrients are in chemical combination.
- Usually produced in granular form.
- Diammonium phosphate, Nitrophosphates, Ammonium phosphate

- **Mixed fertilizers** are physical mixtures of straight fertilisers.
- They contain two or three primary plant nutrients.
- made by thoroughly mixing the ingredients either mechanically or manually.

BASED ON CONCENTRATION OF PRIMARY PLANT NUTRIENTS (N, P & K) IN FERTILISERS:

LOW ANALYSIS FERTILISERS

- Fertilisers contain less than 25% of primary nutrients.
- Example-
 - ✓ SSP(16% P_2O_5)
 - ✓ Sodium nitrate (16% N)

HIGH ANALYSIS FERTILISERS

- Total content of primary nutrients is above 25%.
- Example-
 - ✓ Urea (46% N)
 - ✓ Anhydrous ammonia (82.2% N)
 - ✓ Ammonium phosphate (20% N +20% P_2O_5)

CLASSIFICATION BASED ON PHYSICAL FORM:

SOLID FERTILIZERS

- Powder (single superphosphate)
- Crystals (Ammonium sulphate)
- Prills (Urea, Diammonium phosphate, superphosphate)
- Granules (Holland granules)
- Supergranules (Urea supergranules)
- Briquettes (Urea briquettes)

LIQUID FERTILIZERS

- Liquid form fertilizers are applied with irrigation water or for direct application.
- 2 types-
- 1- clear liquid fertilisers (when the fertilisers are completely dissolved in water)
- 2- Suspension liquid fertilisers (when fertilisers are suspended as fine particles in water)

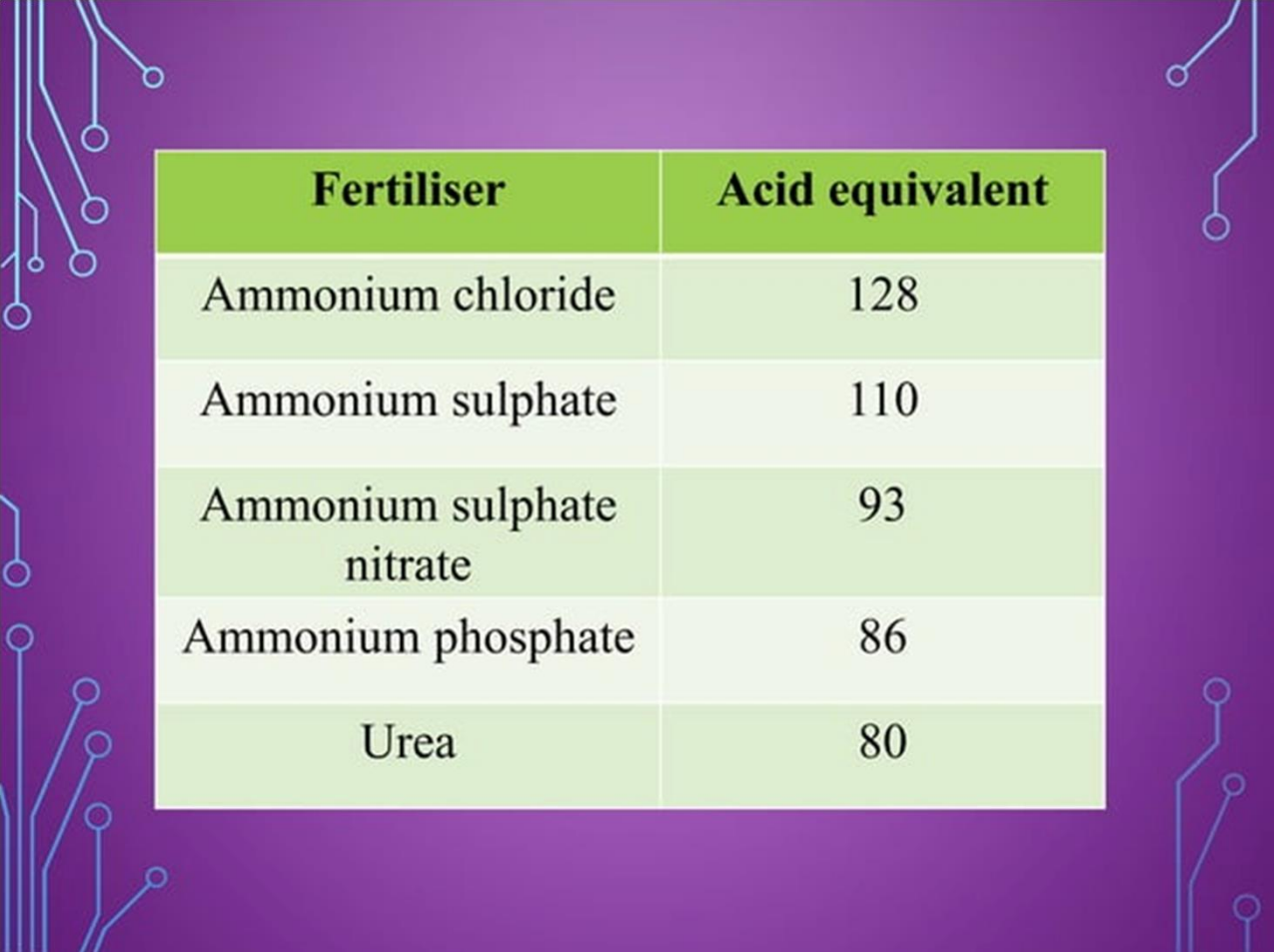
BASED ON THE NATURE OF FERTILISERS:

Acid Forming Fertilisers

- Fertilisers which leave an acid residue in the soil.
- Apply acid forming fertilisers to alkaline soil.
- The amount of calcium carbonate required to neutralize the acid residue is called its Acid equivalent.

Alkaline Forming Fertilisers Or Basic Fertilisers

- Fertilisers which leave an alkaline residue in the soil.
- Apply acid forming fertilisers to alkaline soil.



Fertiliser	Acid equivalent
Ammonium chloride	128
Ammonium sulphate	110
Ammonium sulphate nitrate	93
Ammonium phosphate	86
Urea	80

Fertilisers	Equivalent basicity
Sodium nitrate	29
Calcium nitrate	21
Calcium cynaide	63
Dicalcium phosphate	25

FERTILIZER GRADE:

- Fertiliser grade refers to the minimum percentage of nitrogen(N), Phosphorus(P_2O_5) & Potash(K_2O) present in fertilizer material.
- Fertilizer analysis expresses weight as a percent of nitrogen, phosphorus and potassium

20-10-20
N P K

Fertilizer Analysis

For Example

A 100 kg bag of fertilizer has an grade of 15-5-18.

- Nitrogen: $100 \times 15\% = 15 \text{ Kg}$
- Phosphorus: $100 \times 5\% = 5 \text{ Kg}$
- Potassium: $100 \times 18\% = 18 \text{ Kg}$

Nitrogenous fertilizers:

- The fertilizer materials containing nitrogen are called nitrogenous fertilisers.
- They may contain secondary nutrients like Calcium and Sulphur.

NITRATE FERTILIZERS

- Sodium nitrate
(NaNO_3)
- Calcium nitrate
($\text{Ca}(\text{NO}_3)_2$)

1. They are highly mobile in soil therefore suitable for top dressing.
2. Highly soluble subjected and to leaching.
3. Subjected to denitrification in waterlogged soils.
4. Increase alkalinity as they are basic in their residual effect.

AMMONIACAL FERTILISERS

- Ammonium sulphate $((\text{NH}_4)_2\text{SO}_4)$
- Ammonium chloride (NH_4Cl)
- Anhydrous ammonia (NH_3)

- Easily available to the plants as they are readily soluble in water.
- Leaching losses are less as ammonium ions are adsorbed on clay complex.
- Reduce alkalinity as they are acidic in their residual effect on the soils.
- Well suited to submerged soils.

NITRATE & AMMONIACAL FERTILISERS

- Ammonium nitrate (NH_4NO_3)
- CaNH_4NO_3 - Calcium ammonium nitrate (CAN)

- Easily available to the plants as they are readily soluble in water.
- Leaching losses are less.
- Reduce alkalinity as they are acidic in their residual effect on the soils.

AMIDE FERTILISERS OR ORGANIC FERTILIZERS

- Urea ($\text{CO}(\text{NH})_2$)
- Calcium cyanide (CaCN_2)



Fertilizers	Forms of nutrient	N%	Others	Nature
KNO_3	Nitrate	13.85	K_2O -46-47	Basic
$\text{Ca}(\text{NO}_3)_2$	Nitrate	15.5	Ca-19.4	Basic
NaNO_3	Nitrate	16		Basic
$(\text{NH}_4)_2\text{SO}_4$	Ammoniacal	20.6-21	S-24.5	Acidic
NH_4Cl	Ammoniacal	25.5-26	Cl-66	Acidic
$(\text{NH}_4)_2\text{SO}_4 \cdot \text{NH}_4\text{NO}_3$	Ammoniacal	26	S-15	Acidic
CAN	Ammoniacal and Nitrate	25-28		Neutral
NH_4NO_3 (Highly hygroscopic)	50%- Ammonium 50%- Nitrate	33-35		Acidic
Anhydrous ammonia	Ammoniacal	80-82		Highly Acidic
Urea [$\text{CO}(\text{NH}_2)_2$]	Amide	46		Acidic
CaCN_2	Amide	20.6-21		Basic

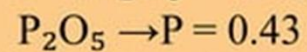
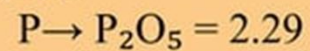


PHOSPHATIC FERTILIZERS

Phosphorus content in fertilizers is expressed in oxidized form (P_2O_5).

In soil and plant phosphorus is expressed in elemental form.

The conversion factors:



CLASSIFICATION OF PHOSPHATIC FERTILIZERS:

A: WATER SOLUBLE PHOSPHORIC ACID

- Mostly suitable for neutral and alkaline soil.
- They form insoluble iron and aluminium phosphates in acid soils.
- Mostly used in short duration crops like Wheat, Sorghum and Pulses.

	N	P ₂ O ₅	Others
SSP	-	16-20	Ca-19.5, S-12.5
DSP	-	32	-
TSP	-	46-48	-
MAP	11-12	48	-
DAP	18	46	-

CLASSIFICATION OF PHOSPHATIC FERTILIZERS:

B: CITRIC ACID SOLUBLE PHOSPHORIC ACID

- They are basic in reaction so suitable for acid soil.
- Mostly suitable for long duration crops like Sugar cane, Tapioca, Tea, Coffee, Low land rice.

	P_2O_5 %
DCP (Dicalcium phosphate)	34-39
Basic slag	14-18

CLASSIFICATION OF PHOSPHATIC FERTILIZERS:

C: CITRIC ACID & WATER INSOLUBLE PHOSPHORIC ACID

- Mostly suitable for strongly acidic and organic soil.
- Suitable for plantation crops like tea, coffee, rubber, cocoa and coconut.

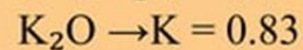
	P_2O_5 %
Rock phosphate	20-40
Raw bone meal	2-2.5
Steamed bone meal	22

POTASSIC FERTILIZERS

Potash content in fertilizers is expressed in oxidized form (K_2O).

In soil and plant phosphorus is expressed in elemental form.

The conversion factors:



CLASSIFICATION OF POTASSIC FERTILIZERS:

A: CHLORIDE FORM

- Fertiliser is suitable for acidic and heavy soils but not suitable for alkaline soil.
- Presence of chloride in the fertilisers make it unsuitable for sugar crops, tobacco and potato.

	K_2O (%)
MOP (Muriate of Potash) or POTASSIUM CHLORIDE (KCl)	58-60

CLASSIFICATION OF POTASSIC FERTILIZERS:

B: NON-CHLORIDE FORM

- KNO_3 is an excellent source of potassium and nitrogen.
- It is mainly used for fruit trees and crops such as tobacco and vegetables.

	K_2O (%)	
POTASSIUM SULPHATE	48-50	S-17.5
POTASSIUM MAGNESIUM SULPHATE	22	Mg-11 S-22
POTASSIUM NITRATE or SALT PETRE or NITRE	44	N-13

CALCIUM, MAGNESIUM AND SULPHUR FERTILISERS:

- Calcium, Magnesium and Sulphur are applied to the plants incidentally by the application of N, P & K fertilizers.
- These fertilizers are not manufactured to supply these nutrients.

Calcium, magnesium and sulphur contents of different fertilizers materials:

FERTILISERS	NUTRIENT CONTENT (%)			
	Ca	Mg	S	Others
Calcium nitrate	19.4	-	-	-
Gypsum	29.2	-	18.6	-
Rock phosphate	33.1	-	-	25.2 (P ₂ O ₅)
Single superphosphate	19.5	-	12.5	16.0 (P ₂ O ₅)
Triple superphosphate	14.0	-	1.0	43.5 (P ₂ O ₅)
Epsom salt	-	9.6	13.0	-
Potassium magnesium sulphate	-	11.1	22.3	31 (K ₂ O)
Potassium sulphate	-	-	17.5	48 (K ₂ O)

Calcium, magnesium and sulphur contents of different fertilizers materials:

FERTILISERS	NUTRIENT CONTENT (%)			
	Ca	Mg	S	Others
Ammonium sulphate	-	-	24.2	21 (N)
Ammonium sulphate nitrate	-	-	12.1	26 (N)
Basic slag	-	-	3.0	15.6 (P ₂ O ₅)
Copper sulphate	-	-	11.4	21 (Cu)
Ferrous ammonium sulphate	-	-	16.0	6 (N), 16 (Fe)
Ferrous sulphate	-	-	18.8	32.8 (Fe)
Elemental sulphur	-	-	100.0	-
Zinc sulphate	-	-	17.8	36.4 (Zn)

RANGE OF MICRONUTRIENTS CONCENTRATIONS FOR NORMAL PLANT GROWTH:

Trace element	Concentration (ppm)
IRON	0.5- 5.0
MANGANESE	0.1-0.5
BORON	0.1-1.0
ZINC	0.02-0.2
COPPER	0.01-0.05
MOLYBDENUM	0.01-0.05

MICRONUTRIENTS

- Several micronutrients salts are highly reactive and soluble make them unavailable to plants.
- Therefore micronutrients are applied into the soil in the form of **frits** and **metal chelates**.
- **FRITS:** Micronutrients salts are fused with special type of glass and shattered into small bits which are called frits.
- When the frits are applied to the soil, the glass slowly dissolves and releases the nutrient salts.
- Frits extend period of nutrient availability by reducing the reactivity and solubility.
- Examples: Borosilicate glass, manganese ammonium frits, zinc frits and copper frits

MICRONUTRIENTS

- **Metal chelates:** Micronutrients are also available in chelated form which have the ability to chelate or loosely hold metallic ions in their cyclic structure and these metal-organic complexes are called Metal chelates.
- Metal chelates are soluble in water but they do not ionize in soil solution.
- Organic compounds like EDTA (Ethylene diamine tetra acetic acid), DTPA (Diethylene triamine penta acetic acid) have the ability to chelate metallic ions.
- Iron, Copper, zinc and manganese fertilisers are available in chelated forms.

IRON FERTILISERS

- Ferrous sulphate is the most commonly used fertiliser.
- When it is applied to soil, it is oxidized to ferric sulphate which is not readily available to plants.
- To overcome this problem, iron chelates are used both for soil and foliar application.

SOURCE	IRON CONTENT (%)
Ferrous sulphate	19
Ferric sulphate	23
Ferrous oxide	77
Ferric oxide	69
Ferrous ammonium phosphate	29
Ferrous ammonium sulphate	14
Iron ammonium polyphosphate	22
Iron chelates	14
Iron frits	22

MANGANESE FERTILISERS

SOURCE	MANGANESE CONTENT (%)
<u>Manganese sulphate</u>	26
Manganous oxide	41
Manganese oxide	63
Manganese chelates	12
Manganese frits	10

ZINC FERTILISERS

- Zinc sulphate is the most commonly used zinc fertiliser.
- It is applied both to soil (@ 30-50 kg/ha) and plant (0.5 % as spray).

Source	Zinc (%)
Zinc sulphate monohydrate	35
Zinc sulphate heptahydrate	23
Basic Zinc sulphate	55
Zinc oxide	78
Zinc sulphide	67
Zinc phosphate	51
Zinc chelate	14

BORON FERTILISERS

- Borax is the most commonly used boron fertiliser.
- Because of its high solubility in water, it is lost by leaching to avoid this loss, boron frits are developed.
- Borosilicate glass can be apply in sandy soil under high rainfall conditions.
- Boric acid and solubor are used for foliar application

Source	Boron (%)
Borax	11
Sodium pentaborate	18
Sodium tetraborate	14
Boric acid	17
Solubor	20
Borosilicate glass	6

COPPER FERTILISERS

	Source	Copper (%)
Both for soil and foliar application	Copper sulphate	21
Both for soil and foliar application	Copper ammonium phosphate	30
Foliar application	Copper chelates (Cu EDTA)	Varying

MOLYBDENUM FERTILISERS

- Molybdenum fertilisers are ammonium molybdate, sodium molybdate and molybdate trioxide.
- Molybdenum fertilisers can be mixed with N P K fertilisers and applied to the soil.
- It is also applied as foliar spray.

THANK YOU

