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COURSE :- SSAC - 353, SEM - 5th (New).

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Q. 1. Define soil & write down history of soil fertilizers & plant associations.

Soil :- Soil is a dynamic natural body composed of mineral and organic material and living from which grow.

History of soil fertility

1. Theophratus (372 - 287 BC)

- He recommended heavy manuring to light soils
- Noted that urine can enrich the value of humus
- Plant grows well where dead bodies are buried.

2. Xenophon (400 BC)

- Recommended spring cropping.

3. Cato (234 - 149 BC)

- Grows green manuring crop on grape vine and buried at 50% flowering to sustain soil fertility.

4. Virgil (70 - 19 BC)

- Advocated application of legumes.

4. columella

- Listed various legume crops for improvement of soil fertility.
- Advocated spreading of lime and ashes to soil to destroy the acidity.

5. Francis Bacon (1561 to 1624)

- suggested that principle nourishment to plant was water and soil is only for supporting to plants i.e. anchor.

6. Stephen Hales (1677 - 1761)

- He is called first Plant physiologist.
- He published the book 'Vegetable Staticks'.

7. J. Priestley (1733 to 1804)

- prepared O₂ by heating mercuric oxide.

8. Francis Home (1775)

- included air, water, salts, soil, and fire to their fixed state.

9. Sir Humphrey Davy

- published 'Elements of Agril. Chemistry' in 1813 and recommended the use of oil as fertilizers.

10. Jean Baptiste Boussingault (1802 - 1887)

- He did the balance sheet of what is added and what is removed from soil.
- Also called father of field plot experiment technique.

11. Justus von Liebig (1803- 1873).

- Discovered the law of minimum and states that the growth of plant depends upon the element in shortest amount all other elements being kept optimum.
- He is also called the father of Agricultural chemistry.
- proposed separate branch of mineral nutrition of plants.

12. J. B. Lawes and J. H. Gilbert

- founders of Agricultural experiments at Rothamsted Station in England 1853.

13. Morgan (1852)

- Develop a universal soil extractant for studying inorganic composition of soil material.

14. Hoagland (1938)

He prepared a nutrient solution for plant growth.

15. Velayuthan & Ghosh (1981)

Indian scientist prepared soil fertility maps of India, concluded that soils of India are poor in soil fertility.

Q.2. Define Essential & Beneficial and write down criteria of Essentiality.

Essential Nutrients

A chemical element required for normal growth of plant without which plant cannot complete its life cycle.

e.g:- C, H, O, N, P, K, Ca, Mg, S, Fe, Mo, Zn, Cu, Br, Mn, Cl, Ni.

Beneficial Nutrients

Beneficial elements are the mineral elements which stimulate plant growth but are not essential or which are essential only for certain plant species or under specific conditions.

e.g:- silicon, sodium, aluminium, cobalt, selenium and vanadium.

Criteria of Essentiality (Ammos 1954).

- The given plant must be unable to complete its life cycle in the absence of the mineral element.
- The functions of the element must not be replace by another mineral element.
- The element must be directly involved in the plant metabolism.

OR, Q2. State the criteria of Essentiality of Nutrients

Criteria of essentiality of nutrients.

This concept was proposed by A.C. Stout (1939)

They considered 16 elements essential for plant nutrients. For an element to be regarded as an essential nutrient, it must satisfy the following criteria,

- 1] A deficiency of an essential nutrient element makes it impossible for the plant to complete the vegetative or reproductive stages of its life cycle.
- 2] The deficiency of an element is very specific to the element in question and deficiency can be corrected / prevented only by supplying that particular element.
- 3] The elements must directly be involved in the nutrition & metabolism of the plant and have a direct influence on plant & have a direct influence on plant apart from its possible effects in correcting some micro-biological or chemical conditions of the soil or other culture medium.

Q3. Enlist the various Essential & Beneficial nutrient / Element & write down their Roles.

Essential Element

The elements needed by the plant without which the plant is not able to survive and complete its life cycle are called essential nutrients.

Beneficial Nutrients

Beneficial nutrients are the mineral elements which stimulate the growth and have beneficial effects even at very low concentration.

Essential Nutrients

- | | |
|-------------------|---------------------|
| 1. Oxygen (O) | 10. carbon (C) |
| 2. Hydrogen (H) | 11. Iron (Fe) |
| 3. Nitrogen (N) | 12. Molybdenum (Mo) |
| 4. Phosphorus (P) | 13. calcium (Ca) |
| 5. Potassium (K) | 14. chlorine (Cl) |
| 6. magnesium (Mg) | 15. Nickel (Ni) |
| 7. manganese (Mn) | 16. sulphur (S) |
| 8. zinc (Zn) | 17. Boron (B). |
| 9. copper (Cu) | |

Roles & deficiency symptoms.

1. Nitrogen (N)

Role

- i) It promotes growth of leaves & stems.
- ii) Necessary to develop cell proteins and chlorophyll.
- iii) Nitrogen is required for cell division and respiration.

Deficiency symptoms.

- i) It causes drastic reduction in vegetative growth.
- ii) It causes poor root growth and young plants give spindly appearance.
- iii) slow & dwarfed plant growth.

2. Phosphorus

Role

- i) It stimulates early formation and growth of roots.
- ii) stimulates flowering & seed development.

Deficiency symptoms

- i) Decrease in Growth
- ii) slow maturity.

3. Potassium (K).

Role

- Used to form carbohydrates & proteins.
- Decreased disease resistance and Hardness.

Deficiency symptoms

- shorter & weaker plants.
- spotted, streaked or curled leaves.
- The leaves turn brown in colour and then become scorched.

4. calcium

Role

- Improve plant vigour
- Promotes leaf & root growth.
- very important for chromosome flexibility & cell division.

Deficiency symptoms

- chlorosis beginning in the leaf edges.
- It causes dwarfing of plants.
- leaves become small and show yellowing.
- Fruits, crack, root growth is restricted and root may rot.

5. Magnesium (Mg)

Role

- It is involved in photosynthesis
- It is an activator of many enzymes.

- iii) It is essential for formation of carbohydrates, fat & vitamins.

Deficiency symptoms

- Mg deficiency causes the plants may become defoliated completely, while limbs with little or no fruit may show any deficiency symptoms.
- Leaves are curl along the margins.
- Plants show a whitish colour.

6. sulphur [S]

Role

- Promotes root growth & vigorous vegetative growth.
- Essential for protein formation.

Deficiency symptoms

- stunted appearance
- slow & dwarfed plant growth.

7. copper (Cu)

Role

- Copper is associated with mechanical strength cell wall.
- It helps in respiration.

Deficiency symptoms

- It causes reduced growth & change in colour

of the foliage.

- ii) Plant show a bushy growth.
- iii) Fruits have thick peel.
- iv) Fruits may split at the blossom end.

8. Zinc (Zn).

Role

- i) Zinc is required for synthesis of tryptophan which is precursor of auxin.
- ii) It is essential for carbohydrates and phosphorus metabolism and synthesis of proteins.
- iii) It helps for hormones growth.

Deficiency symptoms.

- i) A variety of symptoms appear in the foliage due to zinc deficiency.
- ii) It deficiencies causes shortening of stem nodes, produce small & narrow leaves.
- iii) Chlorosis in terminal young leaves.

9. chlorine (Cl)

Role

- i) chlorine is involved in the evolution of O_2 .
in primary reactions of photosynthesis.
- ii) It also helps in cell multiplication.

Deficiency symptoms

- The variety of symptoms appear in the foliage.
- chlorine deficient plant shows chlorosis, necrosis, and bronze discolouration of leaves.
- plants show setting.

10. GROWTH (B)

Role

- It is immobile in plant system.
- It plays a role in flowering, pollen germination, pollen culture, pollen tube growth & fruiting.
- It helps in the translocation of sugars from leaves to enhance photosynthesis.

Deficiency symptoms

- The terminal buds fail to sprout & twigs show die back.
- leaves are dark green, boat like, brittle & fall early.
- Fruits shows gummy granules in the fruit albedo with hard fruits.

11. IRON (Fe)

Role

- Essential for chlorophyll formation.
- It help in various reaction of the

Respiration, photosynthesis & Reduction nitrates and sulphates.

- iii) It also help in N₂ fixation.
- iv) Iron are abundantly present in soil.

Deficiency symptoms.

- i) Iron deficiency causes chlorosis in terminal leaves.
- ii) In severe cases the fine network of veins is distinctively green & lamina become yellow.

12. Molybdenum (Mo)

Role

- i) play important role in nitrogen metabolism.
- ii) It is a constituent of nitrate reductase & xanthine oxidase.
- iii) It helps in the nitrogen fixation in legumes.

Deficiency symptoms

- i) The leaf blade may fail to expand in the growing leaves.
- ii) Yellow spots develop on lamina.
- iii) Large interveinal chlorotic spots appears on mature leaves.

Q. 4. Define organic manures & write down its importance sources, Recycling, composition and C:N Ratio.

Ans:- Organic Manure

organic manure is defined as the product resulting from the controlled biological decomposition of organic matter.

Importance sources of organic manure

1. Rural
2. Urban
3. Industrial waste.

- cattle shed wastes - dung, urine and gully from biogas plants.
- Human habitation wastes - night soil, human urine, town refuse, sewage, sludge & sullage.
- poultry litter, droppings of sheep and goat.
- slaughterhouse wastes - bone meal, meat meal, blood meal, hoof and hoof meal, fish wastes.
- By products of agroindustry - oil cakes, bagasse and press mud, foods & vegetable processing wastes.
- Water hyacinth, weeds & tank silt
- Green manure crops and green leaf manuring materials.

organic recycling

Returning the lost nutrients removed by crops from soil through additions of organic material of crop after harvesting crop is referred as an organic recycling.

composition

i) Chemical composition

- i) Carbohydrates - 60 %
- ii) protein - 10 %
- iii) Fat, waxes, tannins - 5 %
- iv) Lignins - 25 %

ii) Elemental composition

- i) carbon - 44 %
- ii) oxygen - 40 %
- iii) Hydrogen - 8 %
- iv) Ash - 8 %

C:N Ratio in plants & microbes in soil.

1. Legumes & farm residues - 20:1 to 30:1.
2. straw residues :- About 100 : 1.
3. saw dust :- 400 : 1.
4. microorganism :- 4:1 to 9:1.
5. soil :- 10:1 to 12:1.

Q.5. Define Bulky & concentrated organic manure and write their classification & methods of composting.

Bulky organic Manure

Supply plant nutrients to small quantities and organic matter to larger quantities.
Eg:- Fym, Biogas slurry, compost, green manure, poultry manure, etc.

concentrated organic Manure:

It is mainly derived from raw materials of animal or plant origin. Concentrated organic manures have higher nutrients than bulky organic manures.

Eg:- oil cakes, blood meal, meat meal, bone meal, etc.

Classification of Bulky organic Manure

1. Farm yard Manure (FYM)
 2. Sheep & Goat Manure
 3. Poultry Manure
1. Farm yard manure (FYM).

Farm yard manure is a mixture of the

Solid and liquid excreta of farm animals with litter and left over material from roughages or fodders fed to the cattle composition of FYM - N - 0.5%, P - 0.2%, K - 0.5%, and 76% water.

2] Sheep and Goat Manure

- The dropping of sheep & goats contains higher nutrients than FYM and compost.
- On an average, the manure contains 3% N, 1% P₂O₅ & K₂O - 2%.
- It applies in two ways the sweeping of sheep or goat sheds are placed in pits for decomposition and it is applied later to the field.

3. Poultry Manure

- The excreta of birds ferment very quickly
- If left exposed, 50% of its nitrogen is lost within 20 days. Poultry manure contains higher nitrogen & phosphorous compared to other bulky organic manures.
- The average nutrient content is 3.02% N, 2.63% P, 1.4% K.

Classification of concentrated organic manures

Some of the concentrated materials, such as oil-cakes, bone-meal, urine & blood are of organic origin. The use of manures and fertilizers is complementary and not as a substitute for each other.

Oil cakes are the best example of concentrated organic manure.

Oil cakes are richest source of plant nutrient of all organic manure.

1. Edible oil cakes
2. Non-Edible oil cakes
3. Other concentrated organic manure

1. Edible oil cakes

These types of oil cake is used for feeding cattle in the form of concentration.

Eg:- mustard oil cakes, Groundnut cake, sesame or til cake, Linseed cake, coconut cake, etc.

2. Non-Edible oil cakes

These type of oil cake is not suitable for feeding to cattle and mainly used

for managing crops, eg, castor cake, neem cake, etc.

3. Others concentrated organic manure (Animal origin)

- Bone meal, fish & blood meal are the examples of animal origin concentrated organic manures.
- Blood meal when dried and powdered can be used as manures.
- The meat of dead animals is dried and converted into meat meal which is a good source of nitrogen.

Average Nutrient content of Animal based concentrated manures.

Organic Manure	Nutrient content (%)		
	N	P	K
1. Blood meal	10-12	1-2	1.0
2. Meat meal	10.5	2.5	0.5
3. Fish meal	4-10	3-9	0.5-1.5
4. Horn & Hoof meal	13	-	-
5. Raw bone meal	3-4	20-25	-
6. Steamed bone meal	1-2	25-30	-

Methods of composting

compost

compost is a organic matter that has been decomposed & recycled as a fertilizers & soil amendments.

composting

The process of biological decomposition of organic matter.

Methods / Process of compost

1. Indore Method (Heap method)
2. Bangalore Method (pit method)
3. NADP Method
4. Vermi composting

1. Indore Method

- It is an aerobic decomposition of organic matter.
- This is an old method of compost preparation to the pit having size of $9^{\frac{1}{2}} \times 5^{\frac{1}{2}} \times 3^{\frac{1}{2}}$ feet.
- A portion of pit is filled with farm wastes layer by layer each layer is around 3' inch thick & over it a layer

of 21 (inch) of cow dung slurry mixed with urine is spread.

- The pit is filled with farm wastes and plastered with 2-4 inch thick layer of soil & dung.
- This prevents moisture loss & then allow the temperature to rise up to 60-65°C within 21 days.
- Material inside the pit is turned after 15-20 days & moisture is maintained by adding water.
- Good quality compost become ready within 3-4 weeks.

2. Bangalore Method

- In the Bangalore method of composting, dry waste material of 25 cm thick is spread in a pit & a thick suspension of cow dung in water is sprinkled over for moistening.
- composting is done in trenches of $20 \times 6 \times 3$ m³ in pits of $20 \times 6 \times 3$.
- The pit is filled alternately with dry layers of material & cow dung suspensions till it rises 0.5 m above ground level.
- After 8-9 months all material decomposition

8. NADEP Method

This compost method was developed by Narayana Rao Devadas Pandhami Pandey from Pusad.

- A brick structure measuring 10 ft x 8 ft x 3 ft is prepared with holes in the side walls to ensure adequate supply of air during composting.
- The brick tank is filled with farm waste, soil & cow dung & water is added to maintain moisture between 60-75%.
- A tank is filled with soil - 16-18 q, farm waste 14-16 q, dung - 1-1.2 q.
- After 75-90 days of composting microbial culture of Azotobacter rhizobium & phosphate solubilizing bacteria are added onto the mixture.
- Compost becomes ready for use within 110-120 days.

4] Vermicompost

- Earth worms are used to prepare compost from farm & livestock wastes.
- Earthworms continuously feed upon the organic residues & produce casts.

Vermicompost contains:- N :- 1.0 - 1.5 Nitrogen
P2O5 :- 0.2 - 1.0
K2O :- 1 - 2 %.

Q.6. Define vermicomposting & Green Manuring with types and Advantages & Disadvantages composition.

Vermicompost :- The organic matter produced by the activity of earthworm is called vermicompost.

Vermicomposting

Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better and product.

Advantages

- i). Develop root growth of plants
- ii) Improves the physical structure of the soil.
- iii) Enhance the soil quality with micro-organism
- iv) Increase the fertility & water holding in the soil.
- v) Helps with germination, plant growth & crop yield.

Disadvantages

- 1) Vermicomposting requires greater care than regular composting methods.

- ii) Vermicomposting is more expensive to set up than regular compost piles or batch composters.
- iii) It is also requires more space than required a controlled.
- iv) Earthworms require a controlled diet to survive and produce humus.

Green manures.

It can be defined as a practice of ploughing or turning into the soil for the purpose of improving the soil fertility.

Types of Green manuring

There are two types of green manuring

1. Green manuring In-situ.
2. Green leaf manuring Ex-situ.

1. Green manuring In-situ

→ In this system, green manuring crops are grown and buried in the same field which is to be green manured either as a pure crop or as a intercrop with the main crop. This is known as Green manuring In-situ.

eg:-
Sushemp (*Crotalaria juncea*)
Dhainchha (*Sesbania aculeata*)
Cluster beans (*Cyamopsis tetragonoloba*)
Green gram, black gram, Cowpea, etc.

→ To make green manuring more economical and affordable. It is being recommended to grow legumes such as cowpea, french, beans.

B. Green Leaf Manuring.

In this system, the collection of leaves and of tender twigs from shrubs & trees grown on bunds, wasteland and nearby forest areas and the incorporated them into cultivable field.

eg:- Glycicidia, karanj, wild dhainchha.

Advantages of Green Manures.

- i) It adds organic matter to the soil.
- ii) It stimulates activity of soil micro-organism.
- iii) It improves the structure of the soil.
- iv) It takes nutrients from lower layers to the soil & adds to the upper layers to which it is incorporated.
- v) It increases the availability of certain plant nutrients like P_2O_5 , Ca, Mg, Fe.

Disadvantages of Green Manuring

- i) Incidence of pest & diseases of may increase if the green manuring is not kept free from them.
- ii) Green manuring crop inclusive of decomposition period occupies the field least 75-80 days which means loss of the one crop.
- iii) Under malnourished conditions germination affected.

Types of earthworms

1. Red worms - *Lumbricus rubellus*
2. Brandling worms - *Eisenia foetida*
3. Field worms - *Allolobophora caliginosa*.

Rates of application

vermicompost is recommended @ 5t/ha!

Q7. What is sewage & sludge and write down their effect on plant growth, composition.

sewage

sewage is the mix of water and whatever wastes from domestic and industrial life are flushed into the sewage.

composition

N - 6-10 %

P₂O₅ - 3-4 %

K₂O - 3-4 %

sludge

sludge is a generic term for solid separated from suspension to a liquid.

OR The semisolid portion to sewage is called sludge.

sludge content

N :- 1.5 - 3.5 %, P₂O₅ :- 0.75 - 1.00 %, K₂O :- 0.3 - 0.6 %

Night soil

Human excreta consisting of solid portion as faeces and liquid as urine.

composition

N :- 5 %, P₂O₅ :- 4.0 %, K₂O :- 2.0 % carbon :- 45 - 50 %.

Effects of sludge on soils & crops.

1. The natural background concentration of metals in the soil is normally less available for crop uptake and hence less hazardous than metals introduced through sewage sludge application.
2. The experiments also determined the extent of transfer of metals from sludge treated soil into the leaves & edible parts of six crops of major importance and the effects on crop yields.
3. Beneficial effect on soil structure.
4. Increases in metal concentration in the soil due to sludge applications produced significant increases in Ca, Ni, Cu, Zn, concentrations.
5. The availability of metals crop was found to be lower in the soil treated with bed-dried sludge cake compared with liquid sludge.

Q 8. Define INM Integrated nutrient management and write its components & importance.

Integrated Nutrient Management (INM).

INM refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of benefits from all possible sources of an organic, inorganic & biological components in a integrated manner.

Importance of INM.

1. High price of chemical fertilizers.
2. Imbalance ratio of NPK composition.
3. Imbalance in consumption and domestic production.
4. Deterioration of soil health.
5. Pollution Hazards of chemical fertilizers.
6. Loss of chemical productivity.
7. Deterioration in soil physical properties.
8. Deterioration in biological activity.
9. Additive effect of organic and mineral fertilizers.
10. Organic materials as a source of secondary micronutrients.

COMPONENTS OF INM

1. organic manure
2. vermicompost
3. Green Manuring
4. Biofertilizers
5. crop residues
6. Crop Rotation
7. Legume Intercropping
8. Chemical Fertilizers.

1. organic manure

The dead plant residues and animal remains were traditionally used in developing countries until the 1960's when chemical fertilizers began to achieve popularity. Organic manures are of two types Bulky & concentrated manures.

2. vermicompost

Vermicomposting is one of the best processes recycling of different types of wastes available on farm, rural areas and urban settlements and may become most important component of INM system.

3. Green manuring

Green manuring is the cheapest resource for building up soil fertility and supplementing plant nutrients, especially N. The practice of ploughing in of undecomposed green plant material into the soil for improving the physical conditions as well as fertility of the soil is called green manuring.

4. Biofertilizers

Biofertilizers have been recognised as important inputs to INM systems and these are of recent origin. They are apparently environmentally friendly, low cost and non bulky agricultural inputs which play a significant role in plant nutrition as a supplementary and complementary factor to mineral nutrient.

5. Crop residues

Residue left out after the harvest of the economic portion is called as crop Residues. On an average, it contains 0.5% N, 0.6% P₂O₅, 1.5% K₂O.

16.

Q 8. Define Fertilizers & write down classification of fertilizers.

Fertilizers.

Any organic or inorganic material of natural or synthetic origin added to a soil to supply certain element essential for growth of plants.

Fertilizers classifications on basis of nutrient.

1. Nitrogenous fertilizers
2. Phosphatic fertilizers
3. Potassic fertilizers

Classification of Nitrogenous fertilizers

Nitrogenous fertilizers are classified into four groups on the basis of chemical form in which nitrogen is combined with other elements.

1. Nitrate fertilizers.

Nitrogen is in oxidised form i.e. NO_3^-

e.g.: - a) sodium nitrate (NaNO_3) 16% N.

b) calcium nitrate ($\text{Ca}(\text{NO}_3)_2$) 15.5% N.

2. Ammonical fertilizers

Nitrogen is reduced form i.e. NH_4^+ -N.

e.g.: - i) Ammonium sulphate $[(\text{NH}_4)_2\text{SO}_4]$ 20% N.

- ii) Ammonium chloride (NH_4Cl) 26 % N.
- iii) Anhydrous ammonia - 82 % N.
- iv) Ammonium phosphate ($\text{NH}_4\text{H}_2\text{PO}_4$) 20 % N.

3. Nitrate & Ammonium fertilizers

Nitrogen is in the form of $\text{NO}_3-\text{N} + \text{NH}_4-\text{N}$

- i) Ammonium nitrate (NH_4-NO_3) 34 % N.
- ii) Calcium ammonium nitrate 26 % N.
- iii) Ammonium sulphate nitrate 26 % N.

4. Amide fertilizers

organic nitrogenous fertilizers nitrogen in amide (NH_2) form

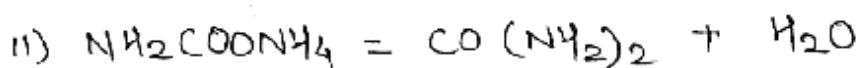
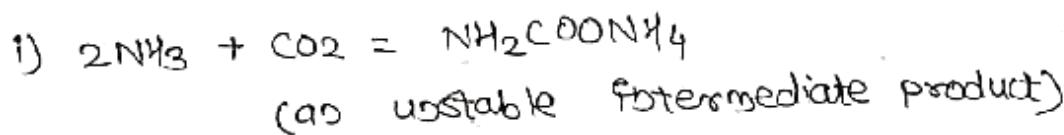
- e.g.: i) urea [$\text{CO}(\text{NH}_2)_2$] 46 % N.
 ii) calcium cyanamide (CaCN_2) 21 % N.

Source of Nitrogen

Mineral deposit, Rain water, soil organic matter, atmospheric N and industrial source.

Manufacturing of Urea

Urea is manufactured by reacting anhydrous ammonia and carbon dioxide gas under very high pressure in the presence of suitable catalyst.



The urea solution is concentrated to 99% and is spread onto a chamber where urea crystals are formed.

Fate of Nitrogen in soil.

- * Nitrate nitrogen of the soil, added or formed by nitrification, may be lost in four ways.
 - i) volatilisation loss
 - ii) leaching loss
 - iii) denitrification
 - iv) used by microorganisms and weeds.

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Q 10 Phosphatic fertilizers, Manufacturing process and properties, classification, their fate and reaction to soil.

Classification of phosphatic fertilizers

1. Water soluble / Mono calcium phosphate $\text{Ca}(\text{H}_2\text{PO}_4)_2$.

- i) single super - phosphate - 16 % P₂O₅.
- ii) Double super - phosphate - 32% P₂O₅.
- iii) Triple super - phosphate - 48 % P₂O₅.
- iv) Ammonium phosphate - 11% N + 52 % P₂O₅.

2. Citric acid soluble / Dicalcium phosphate (CaHPO₄).

- i) Basic slag - 14- 18 % P₂O₅.
- ii) Tricalcium phosphate 34 % P₂O₅. - 39 % P₂O₅

3. Insoluble / Tricalcium phosphate $\text{Ca}_3(\text{PO}_4)_2$

Acid soluble

- i) Rock - phosphate - 20 to 40 % P₂O₅
- ii) Raw bogemeal - 20 to 25 % P₂O₅.
- iii) Steamed bogemeal - 22 % P₂O₅.

General characteristics of phosphatic fertilizers

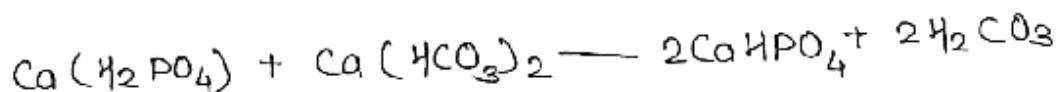
1. Water soluble / Mono calcium phosphate.
2. Citric acid soluble / Dicalcium phosphate.
3. Insoluble / Tricalcium phosphate.

Manufacturing of single super phosphate.

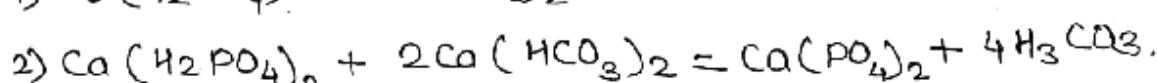
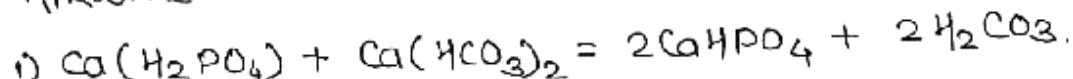
1. Approximately equal amounts of rock phosphate and conc. sulphuric acid (70%) are weighed separately and mixed for about one minute in mechanical rotatatos.
2. The warm mixture is then falls through a flap into a huge den where chemical reactions continue.
3. This mixture is left for 12 hrs to harden and cool down.
4. Then it is removed by a crane and deposited in a large shade to mature.
5. After some weeks, it become ready for use.
6. Before bagging, it is necessary to grind the fertilizer.
- * Thus, two important ingredients of superphosphate are Monocalcium phosphate & Gypsum.

Reaction of SSP in soils.

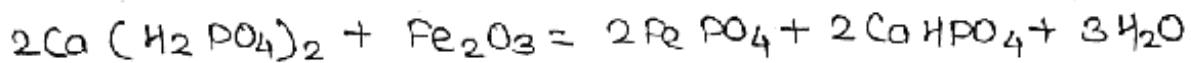
a) Neutral soil



b) Alkaline soil

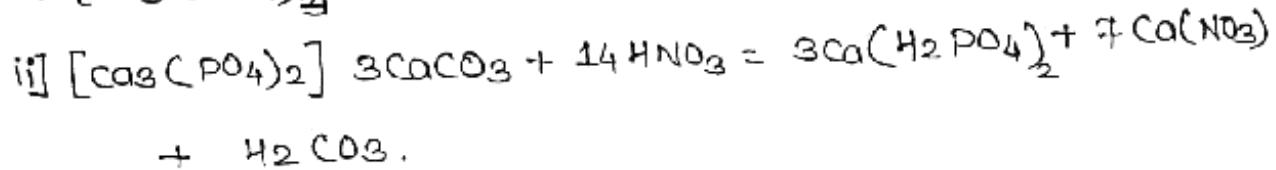
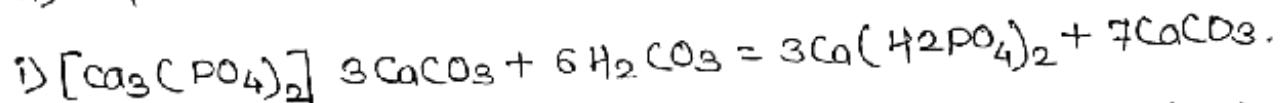


c) Acidic soils.



Reaction of Rock-phosphate to soils.

a) Acidic soils.



Properties of phosphatic fertilizers.

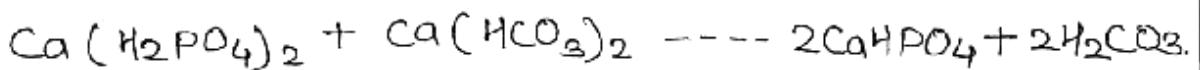
1. Water soluble phosphatic fertilizers are suitable for slightly acidic, neutral or alkaline soil.
2. WSP fertilizers are applied to soil when crop requires a quick start.
3. WSP fertilizers are suitable for short duration crops like paddy, wheat, jowar, ragi, maize, soyabean, cabbage, cauliflower, potato, gram & vegetable crops.
4. SSP should be applied to the soil just before sowing to single dose.
5. SSP is unsuitable for top-dressing due to slow mobility for short duration crops and it should not to be used to acidic soils.

Manufacturing of single super phosphate,

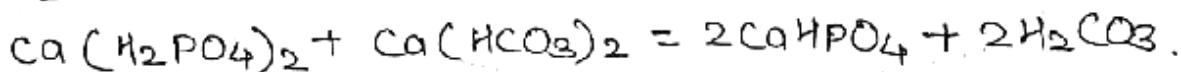
1. Approximately equal amounts of rock phosphate and conc. sulphuric acid 70% are weighed separately and mixed for about one minute in mechanical rotators.
2. The warm mixture is then falls through a flap into a huge den where chemical reactions continue.
3. The mixture is left in den for 12 hrs to harden and cool down.
4. Then, it is removed by a crane and deposited in large shade to mature.
5. After some weeks, it becomes ready for use.
6. Before bagging, it is necessary to grind the fertilizer.
7. Thus, two important ingredients of superphosphate are monocalcium phosphate and Gypsum.

Reaction of single super phosphate in soils.

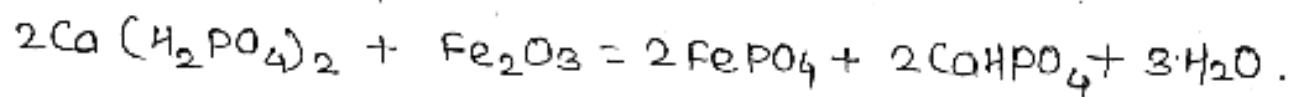
a] Neutral soils



b] Alkaline soils



c) Acidic soils.



Management / properties of phosphatic fertilizers

1. Water soluble phosphatic fertilizers are suitable for slightly acidic, neutral or alkaline soils.
2. I.S.P. fertilizers are applied to soil when crop requires a quick start.
3. I.S.P. fertilizers are suitable for short duration crops like paddy, wheat, jowar, ragi, maize, cabbage, cauliflower, potato, gram, vegetable crops.
4. Citrate soluble phosphatic fertilizers are suitable for moderately acidic soils, long duration crops like sugarcane, tapioca, tea, coffee, legume & pastures.
5. SSP should be applied to the soil just before sowing in single dose.

Q. 11. Write down classification of potassic fertilizers and manufacturing process, properties and action in soil.

Classification of potassic fertilizers.

1. Fertilizers having K in the chloride form eg:- KCl

2. Fertilizers having K in NO₃-chloride form eg:- K₂SO₄ & KNO₃.

source of potassic fertilizers.

Mainly from water soluble potash minerals, and small extent from brine. The potash containing soluble minerals are-

1. sylvite KCl 63.4% K₂O

2. carnallite KCl·MgCl₂·6H₂O 17.0% K₂O.

3. kainite KCl·MgSO₄·3H₂O 18.9% K₂O.

4. langbeinite K₂SO₄·2MgSO₄ 22.6% K₂O.

5. sylvinite (mixture) 20.3% K₂O.

Classification & properties of potassic fertilizers.

1. Potassium chloride / muriate of potash (KCl)

→ K with Cl as anion chloride containing fertilizers.

→ K contains 55-50%

2] potassium sulphate (K_2SO_4)

- NOD chloride fertilizer
- pure salt content - 54% K_2O .
- commercial salt content - 48% K_2O .
- Mineral used kaolinite and langbeinite.

3. epsomite :- $K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$

- It is double salt of SO_4 with K & Mg
- It is by product of marine salt works.
- K_2O 25-30%
- MgO 10-12%

Manufacturing of MOP

It is manufactured from potash bearing minerals mainly by two processes.

i) Crystallization

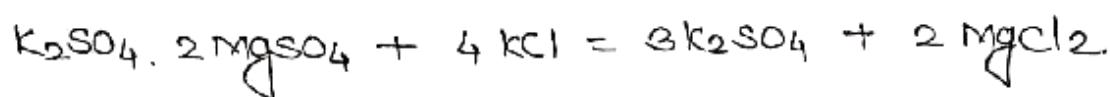
The principle involved in this process is that KCl is much more soluble in hot water than cold. While, the solubility of $NaCl$ is not vary with temperature.

ii) Flotation

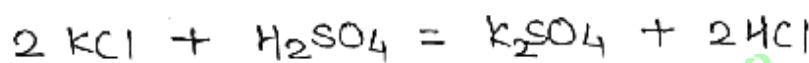
This method is based on the difference in specific gravity of KCl & $NaCl$. KCl having less sp. gravity floating on top of $NaCl$.

Manufacturing of MOP.

- By dissolving langbeinite in water and adding a conc. solution of KCl. The potassium sulphate is precipitated out and is separated by decantation.



- By treating KCl with conc. H_2SO_4



Management of potassic fertilizers.

- KCl is cheaper fertilizer and extensively used by the cultivators for all crops except where no chloride is desired in the fertilizer, e.g.: - Tobacco.
- K_2SO_4 is somewhat costlier on the basis of per unit of K as compared to KCl and used for the crops like potato, tobacco, tomato.

Q 12. Define complex fertilizers write its characteristics, advantages, manufacturing.

complex fertilizers

The commercial fertilizers containing at least two or more of the primary essential plant nutrients (N, P, K) are called complex fertilizers.

These fertilizers are manufactured in general by-

- a] chemical reaction
- b] purely mechanical mixing of straight fertilizers.

Characteristics of complex fertilizers

- 1. High analysis fertilizers
- 2. Have uniform grain size.
- 3. Cheaper on the basis of nutrient content per kg.
- 4. Transport and distribution cost is less.
- 5. Safe for storage.
- 6. Desirable as these contain balanced nutrient for applications.
- 7. No caking and no hygroscopic.

Advantages of complex fertilizers.

1. Easy application.
2. Balance crop nutrition.
3. High fertilizer efficiency.
4. Even distribution of nutrients.
5. saving of labour and time.
6. safe for storage.

Manufacture, properties & nutrient content of complex fertilizers.

Nitrophosphate - Manufacture

1. Nitro carbonic process.
2. Nitro - separation process.
3. Process involving nitric acid & phosphoric acid.
4. Process involving nitric acid.

Properties of nitrophosphates.

1. Granulated fertilizers containing stabilizer.
2. contains nitrogen as well as phosphorus.
3. Excellent physical conditions during storage & handling.

Value of complex fertilizers.

The value of complex fertilizers is dependent on the following considerations.

1. Total content of individual nutrients and ratio of N, P, K.
2. Form in which individual nutrients are present.
3. The resultant basic or acidic residual effect.
4. These contain trace elements and contamination substances like chlorides, sulphate, etc.

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Q 12. What is the concept of Nano fertilizers.

Nano Fertilizers

Agricultural scientists are facing a wide spectrum of challenges such as stagnation in crop yields, low nutrient use efficiency, declining soil organic matter, multi-nutrient deficiencies, climate change, shrinking arable land and water availability and shortage of labour beside exodus of people from farming. In spite of immense constraints faced, we need to attain a sustainable growth in agriculture at the rate of 4% to meet the food security challenges.

To address these problems, there is a need to explore one of the frontier technology such as 'Nanotechnology' to precisely detect and deliver the correct quantity of nutrients and pesticides that promote productivity while ensuring environmental safe and higher use efficiency. Nanotechnology deals with the matter at nanoscale (1-100nm) dimensions.

Q. 13. ■ What is the secondary nutrient fertilizers and micro-nutrient fertilizers & detail explanation about it.

secondary Nutrient fertilizers.

secondary elements are as important as primary elements because they help in uptake of primary elements by plants.

They are required in very little quantity as compared to primary elements. The most important secondary nutrients are Ca, Mg, and S. The fertilizers carrying secondary nutrients are -

1. Calcium cyanamide (39.57% Ca)
2. calcium Ammonium Nitrate (8.0% Ca & 4.5% Mg)
3. calcium Nitrate (1.5% Mg)
4. sulphur phosphate (20.0% Ca)
5. Bone meal (23.1% Ca)
6. Limestone (32.58% Ca)
7. Dolomite (20.0% Mg)
8. Gypsum (29.40% Ca & 21.0% S)
9. Potassium sulphate (18.5% S, 0.6-0.9% Mg)
10. Ammonium sulphate (24% S).

Micro nutrient fertilizers

micro nutrient are those which require by plant in very minute quantities by plants but they have equal role as that of primary nutrients. They govern most of the physiological as well as biochemical reactions of plant growth and development.

- * The most important micro nutrients are Iron, ~~Manganese~~, manganese, zinc, copper, molybdenum, chlorine, boron and nickel. The fertilizers carrying micro nutrients are -

Fe carrying fertilizers

1. Ferrous sulphate (19.0% Fe)
2. Ferric sulphate (23.0% Fe)
3. Ferrous ammonium sulphate (29.0% Fe).
4. Ferric and ferrous oxide 70.0 & 77.0 Fe.

Boron carrying fertilizers

1. Borax 11.0% B.
2. Boric acid 17.0% B.
3. sodium tetraborate (14.0% B)
4. Borosite (21.0% B).

Manganese carrying fertilizers

1. Manganese sulphate (20.0 - 28.0 % Mo)
2. Manganese carbonate (31.0 % Mo)
3. Manganese chloride (17.0 % Mo)

Zinc carrying fertilizers

1. Zinc sulphate (55.0 % Zn)
2. Zinc oxide (67.0 % Zn)
3. Zinc sulphide (67.0 % Zn)
4. Zinc ammonium sulphate (23.5 % Zn).

Molybdenum carrying fertilizers.

1. Sodium molybdate (39.0 % Mo)
2. Ammonium molybdate (54.0 % Mo).

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Q 14. Write down Guidelines for Handling and Storage of fertilizers.

- * This Guidance aims to raise awareness amongst the farming community of the need to ensure the safe and secure storage of fertilizers on the farm and to recommend the relevant good practice, it covers all agricultural fertilizers.
- * Fertilizers can become a major source of contamination of ground and surface water if not stored correctly, whenever possible, fertilizers should be stored at least 10 meters away from a watercourse or field drains and well away from a borehole, well, etc., to avoid contamination where, possible, fertilizers should be stored in as enclosed, secure store.
- * Store away from heating systems and other potential sources of heat such as fuel tanks and oil drums. taking account of any special features for fire control.
eg - provision of double-walled underground locations. Do not permit smoking.

Ideal storage conditions.

- i) Enclosed building capable of protecting the product from the weather and especially direct sunlight.
- ii) Clean environment, free of dust / dirt
- iii) Temperature between 5-30°C.
- iv) Protect the fertiliser from moisture, which can cause lumps and dust, influencing spreading capabilities.

Indoor Storage

- i) The store should preferably be single storey, constructed of not-readily combustible material. (eg - concrete, brick, etc.).
- ii) All buildings should have adequate provisions for ventilation to help dissipate heat and discharge fumes in a fire or decomposition.
- iii) The floor should have a level, dry and even surface, free rot-holes.
- iv) Limit the height of fertiliser stacks.

Outdoor Storage

- i) Store on a raised level, well-drained, dry and smooth surface.
- ii) Stack should not lean, if they do, rebuild them immediately.
- iii) Where pallet racking is not available construct

combinations of pallets may be double stacked.

- iv) Stack should be sheeted to prevent bags from getting dirty and the sheets should be secured to the bottom layer of the stacks to prevent damage, which may be caused by rubbing and friction.

site selection

Human & environmental safety should always be considered before locating fertilizer or pesticide facilities. Determine the potential vulnerability of the groundwaters at the site by comparing aquifer depth and the permeability of the overlying material.

safe delivery and handling

1. You will receive a phone call from the CF haulier to agree a delivery time.
2. Notify and prepare any staff.
3. Ensure correct equipment is available to offload.
4. Report any problems with delivery immediately.
5. Use the correct equipment when handling. This is especially important when storing, as any damage to packaging can have an impact on safety.

Handling

1. Limit the handling of products to avoid the deterioration of granule quality.
2. Avoid rough handling when unloading / loading with shovels and conveyor belts.
3. clean up any spills immediately and make sure that no spilled product ends up in the water or sewage systems.

safety

1. Never stand under or close to a big bag when it is being lifted.
2. Do not stack pallets or big bags more than 3 tiers high.
3. Restack any incorrectly stacked big bags immediately.
4. Always stack them to staggered tiers.
5. Use an approved lifting device to move the big bag.

Q 15 Write down the mechanism of nutrient transport to the plants & factors influencing nutrient availability to plants.

Uptake of nutrients by Plants

- Mineral uptake is the process by which minerals enter cellular material, typically following the same pathway as water.
- The most normal entrance portal for mineral uptake is through plant roots.
- During transport throughout a plant, minerals can exit xylem and enter cells that required them.
- Mineral ions cross plasma membrane by a chemiosmotic mechanism.
- Plant absorbs mineral in ionic form :- Nitrate, phosphate & potassium ions, all have difficulty crossing a charged plasma membrane.
- The uptake of nutrients occurs at both the roots & the leaves.
- Water & Minerals
- Ions may be taken up by the plant cells by - Two methods :-

1] Passive Absorption

2] Active Absorption.

1. Passive Absorption

It is the absorption of minerals without direct expenditure of metabolic energy.

Mechanism of passive Absorption

1. Mass flow theory

According to this theory ions are absorbed by the root along with mass flow of water under the effect of transpiration.

This theory failed to explain the salt accumulation against osmotic gradient.

2. Contact exchange theory.

According to this theory, the ions absorbed on the clay micelles get absorbed to the root in exchange or hydrogen ions, previously, absorbed on the root.

3) carbon Acid exchange theory.

The soil solution provides medium for exchange of ions between the root and clay ~~external~~ micelles.

carbon dioxide released by respiration of root forms carbonic acid by reacting with water of the soil solution.

4. Donnan Equilibrium

cell membrane is composed of macromolecules of proteins and lipids that have many carboxyl groups ($-COOH$) and phosphate (HPO_4^{2-}) groups, from which positively charged particles like protops of hydrogen (H^+) can dissociate, leaving the macromolecules with negative charge.

- These negatively charged ions on the membrane called fixed ions.
- The negatively charged membrane is called **Donnan phase**.

2] Active Absorption.

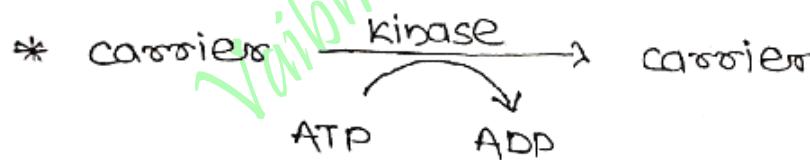
The active transport of ions from the outer space of the cell to the fiber space is generally occurs against the concentration gradient and hence requires metabolic energy, this energy is obtained from metabolism of the cell either directly or indirectly.

Mechanism of Active transport of ions are-

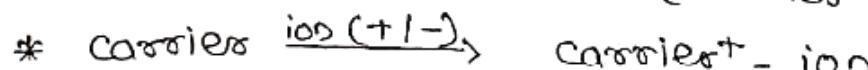
1. carrier concept :- transport by a carrier protein.

2. cytochrome pump :- transport by electrochemical gradient generated by electron transport.

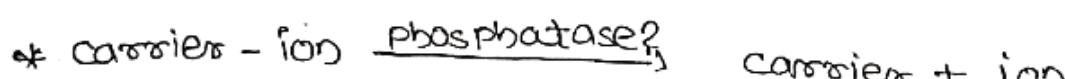
1. carrier concept Theory.



(carrier activation)



(carrier - ion complex)



[ion release].

2. cytochrome pump.

- Anions could be transported across the membrane by cytochrome system. Energy is supplied by direct oxidation of respiratory intermediates.
- The mechanism of ion transport is based on electrochemical gradient generated by electron transport.
- When hydrogen is removed from a substrate for respiration and carried along as electrons transport chain.
- * Factors influencing nutrient availability to plants.

1. Internal factors (Genetic factors)

- i) morphological characters
shoot, root, root development.
- ii) Nutrient requirement.
- iii) pH tolerance
- iv) salt tolerance
- v) Temperature requirement

2] External Factors [Environmental factors]

- i) climatic & weather conditions
- ii) Water supply
- iii) Air (components)
- iv) Light conditions
- v) soil properties
- vi) Nutrient supply
- vii) soil atmosphere, soil moisture,
water : air ratio
- viii) soil organic matter.
- ix) microorganisms.

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Q 17 Soil Amendments :- Soil amendment are the elements added to soil such as FYM, fertilizers, peat moss, to improve its capacity to support plant life.

Soil fertility

Soil fertility is the potential of the earth or inherent capacity of the soil to supply plant nutrients in quantity, forms and proportion required for the growth & development of crop.

Productivity

Productivity of soil is defined as its capacity to produce plants under specific programme of management.

Soil testing

Soil testing commonly refers to the analysis of soil sample to determine nutrient content, composition, and other characteristics such as the acidity pH level.

Q. 20 Write down methods of nutrient applications.

Methods

1. Solid form fertilizers

- i) Broadcasting (uniform spreading over whole field)
- ii) Top dressing (spreading in standing crop).
- iii) Placement (place in the soil)
- iv) Plough sole placement (contiguous band on the bottom of the furrow during ploughing).
- v) Deep placement or sub-surface placement.
- vi) Localized placement (close to plant, seeds).

2. Liquid fertilizers.

- i) Starter solutions

[applied to young vegetable at transplanting].

- ii) Foliar application

It refers to the spraying of leaves of growing plant with suitable fertilizer solutions.

- iii) Direct application to the soil.

With the help of special equipment,

anhydrous ammonia (a liquid under high pressure upto 200 PSI or more), and N solutions are directly applied to the soil.

iv) Application through Irrigation waters.

straight and mixed fertilizers containing N, P, & K, easily soluble in water, are allowed to dissolve in the irrigation stream.

Fertilizers schedule for different crops

Mango

Manure & fertilizers	1yr old (kg/tree)	Annual increase	6th year onwards (kg/tree)
FYM	10.00	10.00	50
N	0.20	0.20	1.0
P	0.20	0.20	1.0
K	0.30	0.30	1.5

Acid lime

Manure & ferti.	1 Year(kg)	Annual	from 6th yr.
FYM	10.000	5.000	30.000
N	0.200	0.100	0.600
P	0.100	0.025	0.200
K	0.100	0.040	0.300

Sapota.

Maturity & fertilizers	1 year	Annual increase (kg/tree)	6th yr onward.
FYM	10.000	10.000	50.000
N	0.200	0.200	1.000
P	0.200	0.200	1.000
K	0.300	0.300	1.500

Bee

Maturity & fertilizers	1st year	2 years onwards
FYM	20 kg	50 kg
N	500 gm	500 gm
P	100 gm	200 gm
K	200 gm	500 gm

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Q. 21. Define nutrient use efficiency & write factors influencing nutrient use efficiency.

Nutrient use efficiency (NUE).

Nutrient use efficiency is defined as the amount of dry matter produced per unit of nutrient applied or absorbed.

NUE :- Physiological efficiency \times Apparent recovery efficiency.

Classification of NUE.

1. Agronomic efficiency.

It is defined as the economic production obtained per unit of nutrient applied.

It is calculated by -

$$\text{Ag. Eff.} = \frac{(\text{Grain yield of fertilized crop in kg}) \times (\text{Unfertilized grain yield in kg})}{\text{Quantity of fertilizer applied in kg}}.$$

2. physiological Efficiency.

It is defined as the biological production obtained per unit of nutrient applied.

3. Apparent recovery efficiency.

It is defined as the quantity of nutrient absorbed per unit of nutrient applied.

$$ARE = \frac{(\text{Nutrient uptake by fertilized crop}) - (\text{N.U. by unfertilized crop})}{(\text{Quantity of fertilizer applied})}$$

Type of fertilizers application.

1. Prior to sowing
2. At sowing
3. After sowing the crop
4. split application.

Factors affecting NUE

1. leaching (NO₃)
2. Gaseous Losses (NH₃, N₂O, N₂)
3. Immobilization by chemical precipitation
absorption on exchange complex and
microbial cells.
4. Chemical reactions between various components
of fertilizers during mixing.
5. Physical properties of soil.
6. Chemical properties of soil.
7. Fertilizer characteristics.