Soil Science Important Notes for Different Agricultural Competitive Exam



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Soil Science Important Notes for Different Agricultural Competitive Exam

Soil Science

Introduction:

• The term soil is derived from Latin word “Solum” means ‘Floor’ or ‘Ground’.

• Soil is the interphase between atmosphere and the mantle of rocks making up the earth’s crust called “lithosphere”.

• Regolith: All loose material above bedrock (the unconsolidated material of weathered rock and soil material).

• Soil Survey: Systematic examination, description and classification of soils.

• Pedology: Science dealing with genesis, survey, classification and laws of geographic distribution of soils as a body in nature.

• Edaphology: It is the study of soils from stand point of higher plants.

Rocks:

• “Rocks” are defined as the aggregates of one (or) more minerals. Eg: Limestone – aggregation of calcite mineral.

• Rocks have no definite chemical, morphological composition or definite symmetrical form like minerals.

• Based on origin, rocks are classified as 1. Igneous rocks 2. Sedimentory rocks 3. Metamorphic rocks.

• I. Igneous rocks: These are the most abundant and makeup 95% of all the earth crust. Igneous rocks are “oldest rocks” and are also known as “crystalline (or) massive (or) fire rocks. These rocks mainly consist of primary minerals and more than half of the igneous rock is containing “feldspar” minerals. Igneous rocks based on their mode of formation are divided into two groups. a. Extrusive (or) volcanic rocks: These are formed at the surface from the volcanic magma. Eg: Basalt, diorite b. Intrusive (or) plutonic rocks: These are formed by the cooling of the original magma and occur below the earth crust. Eg: Granite. Igneous rocks are also classified based on their chemical composition.

a. Acid rocks – contain more than 65% silica – Granite.

b. Neutral rocks – contain 50% - 65% silica – Diorite.

c. Basic rocks – contain less than 50% silica – Basalt.

II. Sedimentary rocks: These rocks are formed through the transportation and deposition of weathered sedimens. The sedimetary rocks are mostly formed through the agency of water, which

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are called clastic, aqueous or stratified rocks. Based on origin, sedimentary rocks are classfied into 4 groups.

1. Residual sediments: These are formed from the products of weathering in situe that is at same place. Eg: Laterite, bauxite.

2. Mechanical sediments: These are formed due to the deposition of pebbles, sand and silt. Eg: Standstone, shale.

3. Chemical sediments: These are formed due to evaporation of water, precipitation and consequent accumulation of sediments. Eg: Limestone. 4. Organic sediments: These are fomred due to partial decompostion of organic remains under anaerobic conditions. Eg: Peat

III. Metamorphic rocks: These are formed from the rocks by the action of heat and pressure on pre-existing igneous and / or sedimentary rocks.

Eg: Sandstone – Quartzite, Shale – Slate, Limestone – Marble, Granite – Gnesiss, Basalt – Schist, Coal – Graphite.

Minerals: A mineral is a naturally occuring, homogenous element or inorganic compound that has a definite chemical composition and a characteristic geometric form. The minerals can be identified by many of their physical properties like colour, lustre, streak, hardness etc.

• Lustre – general appearance of mineral in reflected light. • Fracture – property of the mineral to break along an irregular surface i.e., surface produced when the mineral breaks in direction other than cleavage plane. • Streak – The colour of the powder of the mineral that is obtained by rubbing the mineral against the unglazed porcelain plate.

Soil forming minerals mainly belong to the group of alumino – silicates. Minerals are classified based on quantity (essential and accessory), origin (primary and secondary), specific gravity (light and heavy) and chemical composition (native elements, oxides, sulphates, sulphides, carbonates, halides, silicates).

Primary minerals –They are the original components of the rock, which have not been altered chemically. They are formed from crystallization of magma (molten mass). Eg: Quartz, feldspar etc.

Secondary minerals –are resulted from the decomposition and / or alteration of primary minerals. These are formed due to subsequent changes in the rocks. Eg: All clay minerals like kaolinite, illite except micas. Micas are primary minerals.

Minerals which form the chief constituent of rock and regraded as the characteristic components of the rock are known as “Essential Minerals”. Eg: Quartz and feldspars.

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Accessory minerals : The minerals which occur in small quantity in rocks They are not concerned for naming or the nomenclature of the rocks. Such minerals are called as “accessory minerals”. Eg: Apatite, pyrite, magnetite etc. These are not required for the fomration of any rock.

Primary silicate minerals:

• Quartz – SiO_2.

• Potash feldspar (Orthoclase) – $KAlSi_3O_8$, Soda feldspars (Albite) – $NaAlSi_3O_8$

• Lime feldspar (Anorthite) – $CaAl_2Si_2O_8$; Albite and anorthite combine to form plagioclase or soda lime feldspars.

• Feldspars are easily attacked by “water containing H_2CO_3”. The weathering process is called as carbonation.

• Plagioclase weathers more rapidly than orthoclase. Orthoclas is commonly occurring feldspar mineral in acid igneous rocks.

• Micas are the double silicates of K and Al with or without iron. These are plate like structures.

1. Muscovite (white mica) – $KAl_3Si_3O_{10}(OH)_2$

2. Biotite (black mica) – occurs both in acidic and basic rocks.

3. Phlogopite – Occurs as a primary mineral in igneous rocks. Biotite is easily weatherable than muscovite.

• Pyroxenes and amphiboles: These are the double silicates of Fe, Mg, Al and Ca.

• Pyroxene – Augite (dark green)

• Amphibole – Hornblende (green - black)

• Olivines are the “thin silicates of Fe and Mg”. Eg: Fayalite, forsterite.

• Sedimentary rocks have more of secondary minerals.

• Muscovite alters to “hydrous mica”.

• The insoluble residual material left behind during weathering is called as “saprolite”.

• The phenomenon of weathering of surface layer of rocks due to differential co-efficient of expansion and contraction leading to ultimate disintegration is called “exfoliation”.

• The material deposited due to melting of ice or glacier in warm regions forms a structureless mass and is termed “moraine or till”.

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• Chemical weathering of feldspar produces clay mineral.

• Basalt decomposes more easily than granite.

• Ease of weathering of minerals Quartz > Feldspar > Micas > Olivines > Hornblende.

• Weathering is a denstructive process whereas soil formation is a constructive porcess in nature.

• Relief: It is defined as the elevations and inequalities of a land surface considered collectively. "Topograpy" is similar to relief to be used on contour maps.

• The time devoted by nature to the formation of soil is known as "pedogenic time".

• The process leading to the development of "soil profile" is called "pedogenic process".

• "Humification" is the process of decomposition of raw O.M into humus. This process usually takes place in surface or O horizon.

• 'Eluviation" is the process of removal of constituents by percolation from upper layer to lower layer (wash out).

• "Illuviation" is the deposition of dissolved material in the lower layers (wash in).

• "Podzole" means ash like under. Podzolisation is humid temperate type of soil forming process. It is opposite to "calcification".

• Laterization is the process of soil formation in tropics and sub-tropics. Laterization is the process of removal of "silica" instead of "sesquioxides" from the upper layers.

• Laterization and podzolisation form soils belonging to the group of "pedalfer".

• "Calcification" occurs in areas where there is insufficient rainfall.

• The soils which are having high saturation of 'Ca' are called as "pedocals".

• "Decalcification" is the removal of 'Ca' ions (or) $CaCO_3$ by leaching.

• "Cation exchange capacity" is expressed as me/100 g of soil or cmol (p) kg-1 soil.

• Soil cations are sometimes called as "swarm ions" because they resemble swarm of bees around a beehive. • The area in which the ions are moving around root (or) clay particle in soils is called "oscillation zone". • CEC of kaolinite increases as the pH of soil increases.

$$\text{Total exchangeable bases (m.e/100 g.soil) \% of base saturation} = \frac{}{\text{CEC}} \times 100$$

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• Arid region soils have high B.S than soils of humid region. • Soils which have higher B.S one dominated by 2:1 clay minerals like montmorillonite, vermiculite, chlorite, micas. • Anion exchange is more in soils high in 1:1 clay. • Acid soils are poor in available Ca and Mg. • Availability of 'S' is not affected by soil reaction as the sulphur compounds are soluble in whole pH range. • When pH is low, solubility of Fe, Mn, Al increases. • Availability of B, Cu, Zn is reduced when the pH is increased. • Availability of Mo is reduced in acid soils. • "Buffering" refers to resistance to slight change in pH. • The power to resist slight change in pH is called "buffer action". • Horizons in a soil profile are broadly divided into 4 groups and are called A, B, C, D. • AB horizons are collectively called as 'solum'. The solum together with parent material is called "soil profile". • "Horizon" – A layer of soil approximately parallel to the land surface.

• The diagnostic surface horizons are called "epipedons".

• When larger mineral particles dominate, soil is said to be "gravelly" (or) sandy. When the mineral colloids dominate it is "clayey".

• Compact soils and sandy soils have high bulk density.

• B.D. is more in lower layers of the profile because of less O.M.

• Addition of organic matter lowers the B. D and increases the porespace.

• Due to leaching of Fe compounds due to high rainfall, "grey (or) grey brown" soils are formed.

• Hue – refers to the dominant spectral colours.

• Value – refers to the relative lightness (or) darkness of colour.

• Chroma – relative purity of a colour.

• "Soil consistence" is a dynamic property of soils which is expressed by the degree and kind of "cohesion and adhesion".

• Non – exchangeable cations in montmorillonite – Mg, illite – K.

• The organic matter on decomposition gets modified and acquires the properties of "Colloids". • "Soil survey" is the study and mapping of soils in their natural environment.

• "Remote sensing" is the science and art of acquiring the information about objects from distance without physically going in contact with the object.

• Pedalfers – Accumulation of iron – aluminium in soils under high rainfall. Pedocals – Accumulation of 'Ca' – in areas of low rainfall

1.Alfisols – They are characterized by clay enriched Bt horizon.

2. Vertisols – These soils are black soils – Inversion of soil occurs in the profile.

3. Aridisols – These are the soils of dry regions.

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4. Mollisols – These are developed under grassland vegetation.

5. Histols – These are the organic soils developed under water saturated environment.

6. Oxisols – These are very strongly weathered mineral soil.

7. Ultisols – These are the soils of low base status.

8. Spodosols – These are the mineral soils with accumulation of humus and sesquioxides.

9. Entisols – These are recently developed mineral soils horizonisation.

• In soils, bauxite is the dominant oxide of aluminium.

• Bluish and greenish colour of soil indicate ill drained condition.

• The porosity and permeability of 1:1 clay mineral is high.

• Ca & Mg have specified role of flocculation.

• Total pore space is more in “clayey soils”.

• Many fungi are soil inhabitants living as saprophytes on dead organic matter.

• A larger proportion of plant nutrient present in the soil are in organic form.

• The CEC of inorganic colloids is less than organic colloids.

• Saline woils are dominated by chlorides and sulphates.

• The hydrogen ion concentration of soil solution is called – Active acidity.

• Limonite – $2Fe_2O_3.3H_2O$.

• Climate and biosphere are the active factors involved in the soil formation.

• Humus theory was proposed by “von Liebig”.

• The number of textural classes in the textural triangle is 12.

• The steps involved in the development of soil structure are flocculation and aggregation.

• In the arid regions with imperfect drainage, the most preferred cation for adsorption on soil colloid is Na.

• The soil/parent material is said to be colluvial if it is formed due to gravity.

Soil chemistry:

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- "Soil fertility" is defined as the quality that enables a soil to provide the proper nutrient compounds in proper amounts.
- "Soil productivity" is defined as the capability of soil for producing a specified plant.
- 'Criteria of essentially of elements were proposed by Arnon in 1954..
- "D.J. Nicholas" advanced the term "Functional (or) metabolic nutrient".

1. Deficient: when an essential element is at lower concentration that severely limits yields and produces deficient symptoms.
2. Insufficient: When the level of an essential element is below that required for optimum yields (or) when there is an imbalance with another nutrient.
3. Toxic: When the conc. of either essential (or) other elements is sufficiently high to reduce plant growth severely.
4. Excessive : When the concentration of an essential plant nutrient is sufficiently high to result in corresponding shortage of another nutrient.

Establishment of essentiality of elements:

Nitrogen – Theodore de Saussure; Mo – Arnon and stout,

Na – Brownell and wood; Co-Ahmed and evans.

- Some elements like Ca and Mg counteract toxic effects of other elements – balancing function.
- Ionic forms of nutrients absorption: Nitrogen – NO_3 ; NH_4^+; Mo – MoO_4^{--}; P – $H_2PO_4^-$, 1; C – CO_3^{--}; HCO_3^-; S – SO_4^{2-}, B – BO_3^{3-}, $HB_4O_7^-$.
- Absorbed nutrients (exchangeable ions) are always in equilibrium with dissoloved fraction.
- Hydrogen ions are leased to the medium in exchange for metal cations and OH^- (or) HCO_3^- are released in exchange for anions.
- In passive absorption ions move into a cell along their electrochemical potential gradient without expenditure of energy by the cell.

1. Mass flow hypothesis – Eg: Cl^-, SO_4^{2-}, NO_3^-, Ca and Mg which occur in sufficient quantity in soil solution.

2. Diffusion: Along concentration gradient – Mulder. Eg: P, K, Zn, Cu, the concentration of which is low in soil solution.

3. Ion exchange: a. Carbonic acid theory: Na^+, K^+, Ca^{++}. b. Contact exchange hypothesis – Jenny and Over Street. It takes place between plant root and clay surface due to overlapping of oscillation volumes around the adsorption site.

4. Donnon equilibrium theory: When a different ion of similar charge is present in the external medium there will be no exchange.

Active absorption mechanisms:

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1. Lundegardh's hypothesis: Uptake of salt dependent of "anion" respiration. Transport of anions occurs through "cytochome system".

2. Carrier hypothesis: Requires ATP. kinase carrier + ATP Carrier Pi + ADP Carrier Pi + ion Carrier Pi ion Phosphotase Carrier Pi ion Carrier + Pi + ion

Nitrogen:

• Soil organic matter = organic carbon X 1.724.

• Surface soil has higher 'N' content than deeper soils.

• Organic fraction of soil nitrogen is 98%

Mineralisation :

1. Aminisation: Hydrolytic decomposition of proteins results in the release of amines and amino acids.

2. Ammonification: The amines and amino acids released are coverted to ammonium compounds.

3. Nitrification : Biological oxidation of ammonium ions to NO_3 is known as nitrification.

• Aminisation, ammonification – Heterotropic bacteria. Nitrification – autotrophic bacteria; NH_4 NO_2^- - Nitrosomonas, nitrococcus NO_2 NO_3^- Nitro bacter.

• The nitrosomonas, nitrobacter are usually refered to as the "nitrobacteria".

• High C:N ratio prevents the release of ammonia. If the ammonia is present in too high conentration, it constrains the nitrification.

• Nitrification will be appreciable at filed capacity of soil moisture content and takes place even at (or) below the wilting coefficient.

• Nitrification takes place at a pH 5.5 to 10.

• If C:N ratio is more than 30:1 favours immobolisation and less than 30:1 favours mineralization.

• Several clay minerals with 2:1 type structure have the capacity to fix ammonium and K ions. "Vermiculite" has the highest CEC and hence high fixing capacity.

• Ammonium fixation by clay mineral is greatest in subsoil than the top soil because of higher clay content of subsoil.

• Leaching losses of NO_3 is low in unirrigated, arid, and semi - arid region and high in humid areas where irrigation is practiced.

• NO_3 ion are reduced to N_2 in poorly drained and low in aeration soils by denitrification. Eg: Thiobacillus denitrificans; Pseudomonas denitrificant.

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• Volatilization: Application of ammonium containing fertilizers (or) urea which hydrolyses to NH3 gas. The escape of ammonia gas into atmosphere is called volatilization. .

• The BNF in different organisms is brought about by enzyme “nitrogenase” enzyme.

Group Rhizopium sps Alfalfa Rhizobium militoti Clover R. trifoli Soyabean R. japanicum Lupini R. lupine Bean R. phaseoli Peans & vetch R. leguminoserum

• N2 fixation by symbiosis with non - legumes.

Casuarinaceae – Casuarina; Betulaceae – Alnus

Actinomycetes – Frankia.

• Rhizobium – symbiont,

Azactobacter – free living

Azospirillum – associate symbiont in maize, sorghum, bajra, ragi crops.

BGA – Irrigated rice – Freeliving Azolla fern BGA – Rice fields.

Mycorrhizae (symbiosis) – Plant root fungus – all crops.

• The major loss of N from most soils is that removed by “crop plants”.

• In plants the total N content ranges from 0.2 to 4.0%,

• Nitrogen imparts dark colour to plants.

Phosphorus: -

• Phosphorus has been considered “key to life”.

• P contaning Ca minjerals in soils are mostly apatites – Ca10(PO4)6.

• Flour apatite – 3Ca3(PO4)2.CaF2, Carbonate apatite – 3Ca(PO4)2.CaCO3. Hydroxy apatite – 3Ca3(PO4).Ca(OH)2, Oxy apatite – 3Ca3(PO4)2.CaO. Tricalcium phosphate (TCP)– Ca3(PO4)2 OCP – Ca8H2(PO4)65H2O. Dicalcium phosphate – CaHPO4. 2H2O MCP – Ca(H2PO4)2. H2O

• Of all the above, the readily available for plant are mono calcium phosphates.

• The apatite minerals are the most insoluble and unavailable of the group.

• Phytin is a calcium – magnesium salt of “phytic acid”. Phytin is the most abundant of the known organic ‘P’ compound.

• Monovalent forms are preferred by plant than divalent (or) trivalent.

• H2PO4- proportion is high at pH 5.0, HPO4-2 is high at pH 9.0 (very alkaline soil).

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• 6.5 to 7.5 pH is considered to be best for optimum availability of 'P'.

• Phosphate fixation is more in 1:1 type of clay minerals.

• Gibbisite – Al2O3 3H2O, Goethite – Fe2O3 3H2O.

• The concentration of 'P' in the soil solution is the measure of "intensity factor" (I) of 'P' nutrition.

• The source of soil solution P replenishment is known as the quantity factor (Q) of P nutrition.

• 'P' compounds in soils are categorised in three major groups 1. Readily available – soil solution P 2. Slowly available – labile P 3. Very slowly available – non – labile P.

• Tropical clay soils high in Fe and Al need a high level of Q to assure a given I level. Potential buffering capacity (PB C) = Q/I.

• Total P content in plant ranges from 0.03 to 0.3%; In seeds upto – 1.5%.

• Excess of P causes trace element deficiency particularly Fe and Zn.

• Dificiency of P causes bronzing of leaf margins in cereals.

K

Orthoclase – KAlSiO3O8 – K Feldspar.

• 1:1 type minerals like 'kaolinite' do not fix 'potassium'.

• Illite fixes – K ions. Al+3 cations will occupy the K selective binding sites.

• All K above the optimum level is considered as a luxury . Luxury consumption becomes particulary wasteful. • K regulates water movement within plant cell.

• 'K' deficiency leads to "leaf scorching" (or) popularly known as "tip burning".

• Reduced crop yields without the appearance of definite symptoms is called "hidden hunger".

• The function of K is catalytic in nature.

Secondary nutrients include Ca, Mg & S.

Ca: -

• Ca is mostly present as primary minerals such as "basic plagioclase".

• Ca is the most dominant cation in all soils. Calcite – CaCO3.

• Light textured soils suffer greater loss of Ca than heavy soils.

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• Ca is essential for formation of cell wall.

• Deficiency symptoms:

1. Failure of terminal bud development.

2. In fruit trees “dieback”.

3. In guava cold leaves are chlorotic with red brown spots.

4. Severe loss of colour in young leaves of “brassica sps”.

Mg:

If large qualitative of Mg salts are added to soils containing montmorillonite, the minerals are altered to vermiculites.

• It is low in acid soils.

• Dolamite limesote is the richest source of Mg.

• Mg is constituent of chlorophyll and maintains dark green colour.

• In sandy soils too much ‘Mg’ may create ‘K’ deficiency.

S :-

• ‘S’ behaves like nitrogen in many respects

• Sulphates are present in subsoils that contain 1:1 clays.

• ‘S’ is present in the oils of plants of mustard and onion families.

• Sulphide production in paddy soils causes a disease known as “Akhiochi” (or) H2S injury.

• Due to H2S injury, bubbles will be coming out from the affected areas. Soil colour will be black.

• “Akhiochi” disease occurs in soils that are lacking ‘iron’.

Micronutrients: Viets classification (1962).

Pool A : Water soluble ions. It is usually non existent for Cu and Zn, very small for Fe & Mn. Low redox potential and low pH increase Mn & Fe but not Cu and Zn.

Pool B: Cations exchangeable by NH4. It is small for Cu and Zn.

Pool C: Cations exchangeable only by strong chelating agents like EDTA, DTPA.

Pool D: Micro – nutrient cations held in secondary clay minerals.

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Pool E: Cations held in primary minerals.

• Chlorides occur mostly in Pool A and Pool E. Borates – Pool E.

• Molybdates – Occur in all the pools.

• Mo – Ultra basic rocks; Cu – basic rocks.

• Micronutrients are more concentrated on the surface soil.

• Low Si/Mg ratio – Leads to fixation of Zn in soils.

• More of $CaCO_3$ percent in soil, leads to the less availability of Fe, Mn, Zn, Cu and increases the Mo availability. • Boron is available in more amounts in coarse soils.

• 'B' deficiency is commonly associated with dry areas.

• Antagonism effect: Most of the micro nutrients are not available due to the antagonism effect shown by them.

Mn vs Fe, Fe vs Zn, Cu vs Mo.

B:-

It is the only non - metal among the micronutrients.

• 'Tourmaline' is the main boron containing mineral found in most soils.

• Boron fixation is more in fine textured soils.

• Borax – $Na_2B_4O_7 . 10H_2O$.

• 'B' indicator plants – sunflower. cabbage, cauliflower, sugarbeet.

• B deficiency causes heart rot/crown rot of sugarbeet. topsickness of tobacco.

Cu:- Chalcopyrite – $CuFeS_2$ Chalcocite – Cu_2S

• 'Cu' deficiency leads to 'exaunthema', die back in citurs.

• In wheat, glumes are empty.

Fe :- Pyrite –FeS_2, Siderite – $FeCO_3$, Hematite – Fe_2O_3.

• It is structural constituents of pigments in micro – organism

• Black pigment – Clalics – Contain iron.

• Fe – EDTA – Ethylene diamine tetra acetate – for acid soils.

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Fe – HEDTA – Hydroxy ethylene diamine tetra acetate – for alkali soils. Fe – DTPA – Diethylene triamine pentaacetate – for alkaline soils. Fe – EDDHA – Ethylene diamine dihydroxy acetate – for calcareous soils.

• Deficiency causes white foliage in nurseries.

Mn:- Legumes show 'Mn' deficiency.

• Red soils contain more 'Mn'.

• It is constituent of nitrite – reductase and hydroxylamine reductase.

• It involves in 'Hill reaction and Calvin cycle'.

• Deficiency symptom: "Pahala blight" of sugarcane. "Grey speck" of oat

• Paddy is more susceptible for Mn deficiency. Symptoms develop early on 3rd emerging leaf.

• Mn toxicity is very common on acid soils.

MO: Molybdenite – MoS_2 Wulfenite – $PbMoO_4$ Powellite – $CaMoO_4$.

• It is a constituent of "nitrate reductase".

• Deficiency causes "whip tail" in cauliflower.

• The toxicity of molybdenum on animal health was "teartness" (molybdenosis).

Zn :- the retention of Zn in soils to other cations H>Zn> Cu>Mg>K. Sphaelarite – Zns

• It requires for the synthesis of 'tryptophan'.

• It is a constituent of alcohol dehydrogenase and galactose oxidase enzymes.

• Deficiency in rice – 'khaira'.

• 'Zn' deficiency is cotton – little leaf: Maize – white bud.

• Critical pH range for availability of Zn is 5.5 to 6.5.

Problem soils:

• Leaching is problem in humid regions and salt accumulation is a problem in arid and semi - arid regions.

• Soil becomes "Saline" in areas where annual evaporation exceeds annual precipitation.

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• Beans are damaged by chloride in the soil solution at equal ostmatic pressure, which sulphates do not harm the crops.

• Grasses are more tolerant to chlorides than sulphates at equal O.P.

• At very high O.P, magnesium is more toxic than 'Ca' than Na.

• A soil which does not permit the normal growth of plant is a "Problem soil".

1. Acid soils: Two types in AP.. a. Laterite soils - These are open textured with "massive structure". b. Ferrugenous red soils – derived from crystalline metamorphic rocks.

• Humus is a final product of organic matter decomposition.

• Lime as a reclaiming agent: calcite limestome – $CaCO_3$, dolamite limestone – $CaCO_3$ $MgCO_3$. Quick lime – CaO, Blast furnace slage – $CaSiO_3$ (by product of iron industry).

• Due to high soil acidity, Al, Mn, Fe, become highly solubulized and available in toxic amounts.

• In acid soils activity of bacteria and actinomycetes is adversely affected. Fungi are active in acid pH.

• All the micronutrients (Fe, Mn, Cu, Zn, Co) except Mo are available in the acid pH. Mo deficiency has been identified in leguminous crops.

• In saline soils increasing osmotic pressure result in decreasing water availability to plants.

• In alkali soils high exchangeable Na depress the availability of Ca & Mg.

• Reclamation of saline soils – By using good quality irrigation water

• Reclamation of alkali soils- use of gypsum; use of pyrites and molasses.

• Reclamation of saline alkali soils – use of good quality irrigation water.

• Salt tolerant varities. Rice – CSR 1, 2, 3, Wheat : Kalyana sona, Groundnut – TMV - 10, Kadiri. Ragi – Godavari, Sarada, Pea – P163, Sunflower – EC 68413, 68414, 68415.

• High seed rate and closer spacing have been tried under saline conditions as compared to normal conditions.

• Ammoium sulphate and CAN are superior to urea in alkali soils.

• Confusion of leaf hopper damage with boron deficiency in alfalfa.

• Yellowing (or) chlorosis is caused by deficiency of [N, Mg, Fe & Mn]

. Deficiency of N & Mg are seen in the lolder leaves while Fe, Mn deficiency are seen in the younger leaves. Mo deficiency often look like mild N deficiency in legumes.

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• Phosphate – Bray's modified test K – Sodium cobltinitrite test Indicator plants:- N – Cauliflower, cabbage K- Potato Mg – Sorghum (CSH – 1) Mn – Rice (IR – 8) Mo – Tomato, Cauliflower P – Rape seed Ca – Cauliflower Zn – Hybrid maize Cu – Wheat B – Hybrid maize, sunflower.

• Sunflower pot cultural technique for boron.

• Sackett and Stewart technique (Azatobactor test for P & K).

• The Mulder's Aspergillus niger test for Cu & Mg.

• Mehlich technique for available K2O.

• Mehlich – Cunninghamella plague mentod for 'P'.

• The fertility gradient approach of "Rammoorthy".

Nutrient estimated Method Available N Alkaline KMnO4 Available P2O5 Olsen's method – 0.5M NaHCO3 Available K2O Neutral – N ammonium acetate Readily oxidizable organic carbon Walkley and Black's rapid titration method.

• Presence of moisture reduces availability of Cu & Zn and increases Fe & Mn.

• In case of typical black soils % extractable P = 100 – Clay %.

• "Gross tetany in cattle" is caused by eating forages deficient in Mg.

• Summer drought aggravates Fe deficiency in many plants.

• Salt tolerant fruit crop – Datepalm; coconut.

• Number of salinity classes in the USDA classification of irrigation water are 4.

• Cell sap producing dark blue colour with "diphenylamine" indicates "High NO3- N".

• The number of sites on soil colloids at which exchangeable "K" held are 3.

• Use of fertilizer containing high sulphates adversely effect utilization of micronutrient Mo.

• Water containing B more than 2.0 ppm is unsuitable for irrigation.

• Ideal Ca & Mg ratio for maximum availability of Mg in the soil is 7:1.

• The less soluble compound of 'B' good for application on sandy soils to correct 'B' deficiency is colomonite.

• Soil dispersion is caused due to presence Na of in excess amount.

• Crop which needs more Ca – Soyabean.

• Elements required for nitrifying bacteria are Ca & P.

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• Ferns require 'Al' in their nutrition; green algae – Scenedesmus requires vanadium.

• Anion fixation is more in kaolinite.

• Phosphorus mineralization occurs when CP ratio of organic residue is < 200:1.

• Nutrient which impart vigour and disease resistance in plant is K.

• 'A-value' technique is used to study availability of nutrients in soils.

• In case of immobile nutrients, the deficiency symptoms first appear on young leaves.

• Application of O.M. to soil reduces 'P' fixation.

• In Jenny's pot culture test, the crop grown for assessing the fertility status of soils is lettuce.

• Divalent form of Mn exists in acid soils.

• Metallic ion capable of forming into an anion in alkaline pH is Zn.

• Zn application particularly increase crop yields in saline sodic soils

Manures and fertilizers:

• **Manuring**: It is the process of improving productive capacity of the soil by adding more plant nutrients to the soil in different forms.

• Fertilisers are inorganic salts except "urea and calcium cyanamide".

• Decomposition of manures is allowed to reduce the wide C:N ratio to about 25:1.

• The N fraction of FVM is mainly given by "Urine".

• Old and sick animals produce FYM rich in nutrients.

• "Byre system of collection" is followed in government farms and in advanced countries to collect FYM.

• **Composting**: Converting organic materials into manure in a short time by accelerating fermentative process under controlled conditions.

• **Composting earthworm** – Eisenia foetida.

• In ADCO method compost is similar to FYM and hence also called 'synthetic FYM'.

• The starter in ADCO method – ADCO accelerate – (NH4)2SO4. The compost was called 'ADCO complete'. ADCO process was developed by 'Hutchison and Richards".

• "Activated compost process" is a never ending composting process developed by Fowler and his associates

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• “Banglore method” was developed by ‘Dr. C.N. Acharya’. It is a cheaper method. In this method decompostionof O.M is not so well but N and O.M. are conserved very well.

• In rural composting over the organic wastes dung water is sprinkled as a starter.

• In urban composting starter is “night soil”.

• “CuSO4” powder is added to reduced the offensive odour which is due to the foul smelling organic compounds called “mercaptans”.

• Sewage: Drainage water that is taken out of the cities and towns through underground drainage pipe system including night soil.

• Sewerage: The pipe system laidout in municipalities and cities to take the drainage water out of the cities.

• Sullage: Refers to the drainage water takenout of the municipalities through open channels. Does not contain night soil.

• Effluent: The supernatant liquid that floats over the drainage water is allowed to settle in the tank.

• Sludge: The solid portion of drainage that settles at the bottom of the tank.

• Activated sludge: The settlement of the solid material is made fast by pumping air into the tanks.

• In activated sludge salts like FeCl2; FeSO4 are added to activate certain bacteria called “Iron bacteria”.

• The optimum time of incorporation of the green manure crop in the soil is during flowering.

• Tisdell & Oodes have given 3 binding agents.

1. Transient binding agents – like gums & mucilage.

2. Temporary binding agents – Fine roots of the plants as well as the “fungal hyphae”.

3. Presistent binding agents – Microbial secretions.

• Persistant binding agents along with inorganic substances like Fe & Al oxides act as permanent binding agent.

• “Daincha” is grown to open the hard deep layers of the soil. It is not a fodder crop and is suitable for “sodic soils” (or) “alkali soils”.

• Pourdrette – form of night soil.

• Biggest compost plant – Tel Aviv (Israil)

• Bone meal is effective in soils with more Fe & Al.

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• If inorganic fertilizers are added to the soil year after year it leads to salinity resulting in "exosmosis". This can be avoided by adding of B.M.

• Blood meal:

1. Red product: Got by drying blood in super heated steam.

2. Black product: Got by drying blood on a sand bath.

• "Guano" is a product obtained from sea birds.

• Guano is treated with H_2SO_4 in order to allow hydrolysis and convert the organic nutrients into inorganic nutrients. This is called "artificial guano".

• Lessen the oil content greater the decomposition.

• Chile saltpeter – $NaNO_3$ – rich deposit of NO_3.

• To get 1 kg of 'N' in the form of fertilizer about 40,000 kilo joules of energy is needed.

• In "Haber – Bosch" process N is made to combine with H_2 under optimum conditions of 5500C temp; 200atm pressure and activated iron oxide" as a catalyst.

• The source for N_2 is the 'atmospheric N'

• H_2O is used as a source of H_2 in countries where electricity is cheap.

• "National fertilizers Ltd" at Nangal (Punjab) uses water as a source.

• About 64% of ammonia produced in the world use "natural gas" as a source of H_2. Eg: Nagarjuna fertilizers.

• "Naptha" is a light distillation fraction of petrol (or) crude oil. About 75% of nitrogenous fertilizers produced in India use 'naptha'. Naptha is essentially a mixture of "hydrocarbons".

• The heavy distillate fraction of crude oil is called fuel oil.

• 'Ramagundam' plant used coal as a source H_2.

• Coal also can be used as a source of N_2.

• In steel industries lot of coal is burnt to melt iron and "Coke oven" gas is get as by -product.

• NH_3 contain 82% N.

• NH_3 is soluble in water to an extent of 30% by wt. This is called "liquor ammonia" (or) "aqua NH_3".

• NH_3 is a cheapest source of N fertilizer.

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• 1 kg NH3 needs 1.8 kg lime to neutralize acidity developed.

• Ammonium sulphate is manufactured by the 1. Coke oven gas process – Bituminous coal is subjected to destructive distillation. It contains 10% NH3 by volume. 2. 85% of (NH4)2 SO4 manufactured in India is by "Gypsum process".

• (NH4)2 SO4 is white crystalline salt, but commercially vary from yellow to gray due to impurities like ferric cyanide, arsenous sulphides (or) traces of tar

• "Thiocyanates" present are toxic to plants. So the (NH4)2 SO4 are periodically checked.

• 110 kg of CaCO3 is needed to neutralize the acidity created by 100 kg of (NH4)2 SO4.

• 1kg of N applied as ammonium sulphate requires 5.1kg of lime for neutralization.

• NH4Cl is very popular in Japan and S.E. Asia. It is prepared by

1. Direct neutralization process.

2. Dual salt (or) modified Salvay process. Here NH4Cl is salted out by NaCl using the principle of "common ion effect".

• CAN is a mixture of NH4NO3 and CaCO3.

• Fine granules of CAN are coated with soap stone powder i.e. MgSiO3 which improves the free flowing character of the fertilizer and it acts as a conditioner.

• "Urea (or) carbamide" has N in organic form, non-ionic form (or) amide form.

• 82% of N requirement of the crops in India is by urea.

• When temperature exceeds 1000C, urea produces a toxic product called "biuret". Biuret has less amount of 'N'. NH2 – CO – NH – CO – NH2.

• The amount of biuret cantent in urea should not exceed 1.5%; when urea is being used as a feed to cattle the biuret content should be less than 0.5%.

• When soil is acidic, ammonical fertilizers should not be recommended as they increase acidity.

• For paddy ammonical fertilizers are preferable as paddy takes N in the form of NH4+

• PO4-3 which is unavailable form after being added to soils. H2PO4- & HPO4-2 are available forms.

• Rock phosphate formed from primary minerals is "magmatic origin" and that formed due to teeth and bones is called "organogenic origin".

• "Morocco" occupies first place in deposits of P. The rock phosphate here is of organogenic origin.

• The rock Phosphate of N. Africa is very soft and finely crystalline and is called "Galsa phosphate".

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• In USA rock phosphate is present in the form of “pebbles”.

• In USSR rock phosphate is very hard and called “Kolaphosphats”.

• “Rock phosphate” is the basic raw material for manufacturing any phosphatic fertilizer.

• Rock phosphate when treated with H_2SO_4 give SSP; when treated with H_3PO_4 gives ‘TSP’.

• H_3PO_4 can directly used as a liquid fertilizer.

• “Soft earth” of R.P is best for acidic soils, for grasslands, pastures and orchards where the ‘P’ requirement is needed over a long period of time.

• “Mussoire R.P” is the raw material used for manufacture of P fertilizers in India.

• “River pebble phosphate (or) waste pond phosphate” is colloidal phosphates mineral phosphate, calphos.

• The fine powder of R.P is called “float”.

• SSP is produced by two process.

1. Dean process

2. Continuous rock acidulation process.

• The toxic compounds like ‘F’ present in R.P are eliminated as HF.

• SSP contains 2/5 of $Ca(H_2PO_4)_2$ &3/5 of gypsum by wt.

• There are 2 grades of SSP available in India. 1. 14% P_2O_5 2. 16% P_2O_5 (i.e. 7%P) [PX2.29 = P_2O_5].

• ‘TSP’ does not have gypsum so it is completely soluble in water.

• “Basic slag” is a by product of steel industry (in open hearth process) and is called “Thomas slag”.

• P_2O_5 content in basic slag is being enriched by treating with R.P. and the resultant mixture is being marketed under the trade name “Pelophos”.

• Carnalite – $KCl\ MgCl_2\ 6H_2O$, Kainite – $KCl\ MgSO_4\ 3H_2O$.

• Schoenite – $K_2SO_4\ MgSO_4$ Sylvite – KCl.

• Sylvinite – KCl NaCl Langbeinite – $K_2SO_4\ 2MgSO_4$

• Removal of clay particle form sylvinite is called “Desliming” slurry is coated with starch to prevent remaining clay to combine with floating reagents.

• Most of the KCl is prepared by “Floatation process”.

• For K_2SO_4 preparation, raw materials are langbeinite and sylvite (in Mannhein process).

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• Any fertilizer containing 3 nutrients it is a “complete fertilizer”. If there are 2, It is called “multi nutrient fertilizer”.

• Complex fertilizers are homogenous, mixed fertilizers are heterogenous among commonly used complete fertilizer.

• Ammonium phosphate – Factammophos; nitrophosphate – Suphala.

• When straight fertilizers are mixed in large quantities it is called as bulk blended fertilizer (BBF).

• All the properties of fertilizer which affect the flow of fertilizers through distribution equipment are collectively called “drillability”.

• Granular fertilizers are more easily drillable compared to pulverized fertilizers.

• Cracking in fertilizer mixture can be reduced by adding conditioners.

• Crystal knitting is a process of formation of new compounds due to crystallization with a change in temperature and moisture of the fertilizer when the fertilizer is under pressure.

• Double decomposition occurs between two compounds that do not have a common ion.

• Unit cost of N in urea is cheapest among all. 1. NO_3^- fertilizers are recommended in acid soils with a pH of 5.0. 2. Both forms (NH_4^+ & NO_3^-) for pH 5-7. 3. NH_4^+ is effective in neutral and slightly alkaline soils of pH 7.0-7.5. 4. NH_4^+ fertilizers are inferior in highly alkaline soils as NH_4^+ reacts with OH^- forming H_2O & NH_3. NH_3 is lost as a gas.

• The part of fertilizer available to succeeding crop other than for which it is applied is called “residual effect”.

• NH_4 fertilizer should be avoided in highly acidic soils.

• NO_3^- fertilizer should be avoided in “coarse soils” as more leaching is there.

• KCl has more salt index than K_2SO_4.

• Salt index is defined as the ratio of the increase in osmatic pressure produced by the given fertilizer to that produced by the same weight of $NaNO_3$. Salt index of $NaNO_3$ is given as “100”.

• Ca & Mg deficiency is seen in only acid soils & ‘S’ in alkaline soils.

• Ca is needed in large quantities for root development. Hence, called root developer.

• In delta areas silt is added to the soil indirectly called “wraping” through letting into the fields with proper bunds of the silt laden flood waters.

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