UNIT – I

FERTILIZERS

Definition: (2 Marks)

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

Fertilizers are compounds of certain element that are added to the soil to increase its fertility as also for the healthy growth of plants.

Explanation:

- Fertilizers enhance the growth of plants.
- The fertilizer must be converted into a form that the plant can assimilate by rain or water.
- It must be stable in water.
- It must be dry, finely powered and stable.
- It should not contain anything injuries to plants.
- It should not be very acidic and it should be cheap.

Mechanism:

Fertilizers enhance the growth of plants. This goal is met in two ways, the traditional one being additives that provide nutrients. The second mode by which some fertilizers act is to enhance the effectiveness of the soil by modifying its water retention and aeration. This article, like many on fertilizers, emphasises the nutritional aspect. Fertilizers typically provide, in varying proportions:

Three main macronutrients:

- Nitrogen (N): leaf growth;
- Phosphorus (P): Development of roots, flowers, seeds, fruit;
- Potassium (K): Strong stem growth, movement of water in plants, promotion of flowering and fruiting;

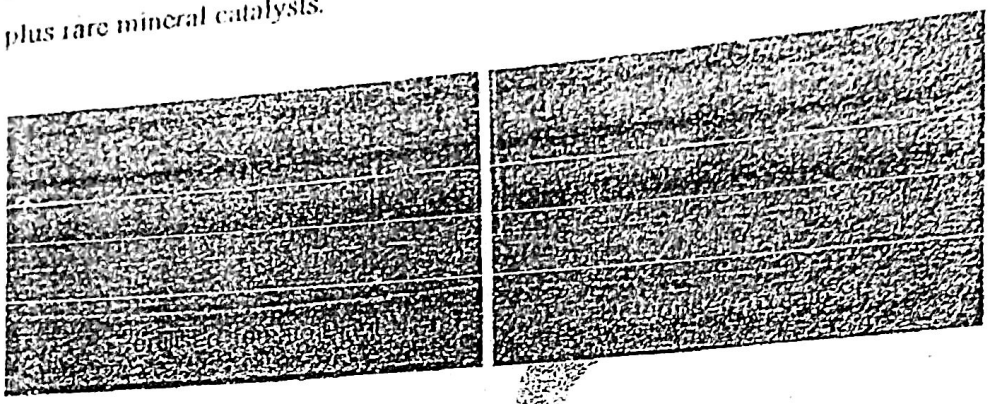
Three secondary macronutrients:

- Calcium (Ca), magnesium (Mg), and sulfur (S);

Micronutrients:

- Copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), boron (B).

and of occasional significance there are silicon (Si), cobalt (Co), and vanadium (V) plus rare mineral catalysts.



Example:

- NPK (17-17-17),
- Nitro Phosphate with Potash (15-15-15) fertilizer.

EFFECT OF NITROGEN: (5 Marks)

Definition:

Nitrogen is an essential constituent of proteins and chlorophyll and is present in many other compounds of great physiological importance in plant metabolism, such as nucleotides, phosphotides, alkaloids, enzyme, hormones, vitamins etc.,. It is thus the very basic constituents of life.

Explanation:

- Imparts dark green colour to plants.
- Promotes leaf, stem and other vegetative growth but remains small in root system.
- It produces rapid early growth.
- It improves quality, succulence of leafy vegetables and fodder crops.
- It increases protein content of food and fodder crops.
- It governs to a considerable degree, the utilization of potassium, phosphorous and other elements
- The normal amount of nitrogen usually increases the plumpness in grains.
- It is a part of in the chlorophyll molecule the green pigment responsible for photosynthesis.
- Nitrogen is a component of protein a building block of cellular tissue
- Nitrogen ions found in greater quantities in young growing parts of plants than in the older tissues and it is especially abundant in the leaves and seeds.

Example:

- Diammonium Phosphate (18-46-0)
- Nitrophosphate (20-20-0)
- Urea Ammonium Phosphate (28-28-0)

EFFECT OF POTASSIUM: (5 Marks)

Definition:

Unlike all other major nutrients potassium does not enter into the composition of any of t he important plant constituents, such as proteins, chlorophyll, fats and carbohydrates concerned in plant merabolism. It occurs in a state of solution in the cell sap. Being soluble, it can be removed with solution in water from the plant tissues.

Explanation:

- It imparts increased vigour and disease resistance to plants.
- It produces strong, stiff straw in cereals, specially paddy and wheat. Thus it reduces loading in cereals.
- It imparts winter hardness to legumes and other crops.
- It regulates water conditions within the plant cell and water loss from the plant by maintaining the balance between respiration and transpiration.
- Essential in the formation and transfer of starches and sugars. Thus potassium is required in large quantities for potato, sweet potato, turnip, banana.
- It helps in formation of protein and chlorophyll.
- It increases plumpness of grains and seeds.
- It acts as an accelerator of enzyme action (eg: for diastase)
- It counter acts the injuries effects of excess nitrogen in plant. Hence a balanced ratio of Nitrogen and Potassium is important in plant nutrition.
- It improves the quality of final products such as quality of fiber crops, size and keeping quality of fruits.

Examples:

- Potassium chloride
- Potassium sulphate
- NPK (10-26-26)

EFFECT OF PHOSPHORESON PLANT GROWTH: (5 Marks)

Definition:

Phosphorous is also an essential constituents of majority of enzymes which are of great importance in the transformation of energy in the carbohydrate metabolism, fat

metabolism and also in respiration in plants. Phosphorous is a constituents of nucleic acid, phytin and phospholipids.

Explanation:

- Stimulates early root development and growth helps to establish seeding quickly.
- Gives rapid and vigorous start to plants, strengthens straw and decreases lodging tendency.
- An adequate supply of phosphorous early in plant life is important in laying down the primordial for the reproductive parts of the plants.
- Brings about early maturity of crops, partially the cereals and counteracts the effects of excessive nitrogen.
- Stimulates flowering and aids in seed formation.
- Improves the quality of food grains and other crops.
- Excess of phosphorous may cause in some cases trace element deficiencies (particularly Fe and Zn).

Examples

- Rock phosphate
- Single super phosphate (16% P_2O_5)
- Triple super phosphate

COMMERCIAL METHOD OF PREPARATION OF UREA: (5 Marks)

Explanation:

The organic fertilizers are cheaper per kg of nitrogen than any other solid nitrogenous fertilizer. It contains (46%) of nitrogen. It has certain advantages over inorganic nitrates and NH_4 salts.

Preparation methods:

Urea is manufactured by reacting anhydrous ammonia and CO_2 gas under very high pressure in the presence of suitable catalyst.

$$2NH_3 + CO_2 \longrightarrow NH_2COONH_4$$

Unstable intermediate

This unstable intermediate is decomposed and urea is recovered.

$$NH_2COONH_4 \longrightarrow NH_2CONH_2 + H_2O$$

Urea

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

Properties:

- It is a white crystalline salt
- It contains 44-46% Nitrogen.
- It readily absorbs moisture from the air (i.e., hygroscopic).
- It is soluble in water.
- Prilled urea is less hygroscopic than crystalline urea
- Lack of corrosiveness.

Uses:

- Urea supplied nitrogen to the plants during the growing period..
- Urea can also be used in small amounts as a nitrogenous food for farm animals (cows & buffaloes).

TRIPLE SUPER PHOSPHATE: (5 Marks)

Explanation:

Super phosphate also ensure sufficient supply of phosphorous in early stages of plant growth when its requirement is high. This super phosphate contains 45-50% mono calcium (or) water soluble phosphate and 17-20% lime.

Preparation:

Triple super phosphate is manufactured by adding phosphoric acid to rock phosphate. The reaction may be illustrated as follows,

$$Ca_{10}F_2(PO_4)_2 + 12\,H_3PO_4 \longrightarrow 9\,Ca(H_2PO_4)_2 + CaF_2$$

Rock phosphate Phosphoric acid Triple super phosphate Calcium fluoride

Properties:

- It is hygroscopic.
- Odour – an acidic odour.
- It is soluble in water
- Phosphorous content is 18.9% to 22.4% Phosphorous.
- Essential elements other than phosphorous, Sulphur 1.6%, and calcium 14%.

Uses:

- It enables that short duration crop with weak root system to establish in the soil immediately on release of phosphate by its granules.

COMPLEX FERTILIZERS & MIXED FERTILIZERS: (2/5 Marks)

Definition:

Materials which contain two (or) more 'fertilizer elements' are mixed in proper proportions to furnish the desired amount of nutrient elements and they are known as complex fertilizers (or) mixed fertilizers.

Example:

NPK (17-17-17), NPK (12-32-16).

Manufacture:

- The manufacture of mixed (or) complex fertilizers can be relatively simple operation especially if the mixture is to be of grade.
- It contains essentially in mixing suitable materials in the correct proportion to give the desired grade.
- In addition to supplying nitrogen phosphorus and potassium in desired proportions a commercial fertilizer should have a good physical condition.
- Mixtures of certain materials cannot be used because of their tendency to 'set up' (or) harden of the fertilizer materials.
- In the manufacture of superphosphate after the acidulation of rock phosphate the product is allowed to stand for a considerable time to "cure" before being ground.
- Superphosphate (or) other materials which have an excess of sulphuric acid are greatly improved in their drilling qualities by the use of colorimetric lime stone as filler because it neutralized any excess acidity.
- Filler in what is needed to insure a good physical condition of the fertilizer.

Composition:

The composition of several materials containing two (or) more fertilizer elements is given in table

Fertilizer	Percentage		
	N	P	K
Uren ammonium phosphate	28	28	-
Mono ammonium phosphate	11	52	-
Nitre phosphate with potash	15	15	15
Potassium meta phosphate	0	26	33
NPK(14-28-14)	14	28	14
NPK(12-35-16)	12	32	16

- The efficiency of a fertilizer is determined by the uniformity with which it can be distributed and by its quality or its chemical composition.
- A fertilizer is said to be good quality if it does not cause injury to plants 9 High-grade mixed fertilizer which meet those requirements are being made in granular from to insure good drill ability.

Explanation:

Calculation of mixture fertilizer formula

In calculating formulas for mixtures it is necessary to decide first what percentage of nitrogen available in the fertilizers

Example:

To make 2000Kg of 6-12-12 fertilizer using the following ingredients.

1. Ammonium nitrate - 30% Nitrogen
2. Super phosphate - 20% Phosphoric acid
3. Nutriate of potash - 60% water soluble Potash

Solution:

Using equation is,

X=(A x B)/C

Where,

X = kg of carrier required

A = kg of mixed fertilizer required

B = percentage of N desired in the mixture

C = percentage of N in the carrier.

Substituting the values in the above equation,

1. The amount of Ammonium Nitrate required

   2000 * 6/30 = 400 kg

2. The amount of Super Phosphate required

   2000 * 12/20 = 1200 kg

3. The amount of Nutriate of Potash required

   = 2000 * 12/60 = 400 kg

SECONDARY NUTRIENTS: (5 Marks)

Definition:

Plants absorbs more than 90 element from soil, water and air. Of these elements 16 are essential for growth of most plants.

All among these 16 essential nutrients N,P,K are called major (or) Primary nutrients Ca, Mg, S have been given secondary importance to be supplied through fertilizers. Hence they are termed as secondary nutrient element.

Explanation:

- The 16 essential elements obtained from the soil by plants six are used in relatively large amount and are referred to as macro nutrients.
- Macro nutrients are further classified into two types.

  ie., Primary Nutrients (N,P,K)

  Secondary nutrients (Ca, Mg, S)
- These macro nutrients are used to plant growth but these elements are actually lacking in the soil.
- Primary nutrients are commonly supplied to the soil in the form of manures and commercial fertilizers.
- Ca, Mg is added to acid soils in lime stone and is called mile elements.
- In areas close to industrial centers sufficient sulphur to supply crops is brought down by rain and show from the atmosphere.
- Sulphur usually goes into the soil as an ingredient of such fertilizer as farm manure.
- Super phosphate and sulphate of ammonia (or) is applied alone as follows of sulphur.
- Sulphur increases the oil content of seeds.
- Sulphur improving baking quality of wheat.
- Sulphur improving nutritional quality of forages.

MICRO NUTRIENTS: (5 Marks)

Definition:

Among 16 essential elements six are macro nutrients. Other then 10 elements 7 nutrients namely Iron(Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Boron (B), Molybdenum (Mb) and Chlorine (Cl) are called Micro nutrients. The other 3 are Carbon (C), Hydrogen (H), Oxygen (O) plants absorbs these mostly from air and water in the forms of carbon-di-oxide and water. These elements are found sparingly in most soil and their availability to plants is often very low.

Explanation:

Micro nutrients	Requirement (ppm)	Functions in higher plant processes	Deficiency
Zinc	0.02 - 0.2	Formulation of growth hormones. Promotion of protein synthesis.	Deficiency leads to flowering fruiting and maturity can be delayed and development of light green, yellowish bleached spots on leafs.

		Seed and grain maturation	
Iron	0.5 - 5.0	Chlorophyll synthesis Constituent of certain enzymes and proteins	Deficiency leads to leaves become almost pale white due to loss of chlorophyll. Complete leaf fall may occur and shoots can also die.
Copper	0.01- 0.05	Catalyst for respiration enzyme. Chlorophyll synthesis carbohydrate Protein metabolism	Deficiency leads to visible at shoot tips in the form of narrow, twisted leaves. Inhibition of root growth.
Boron	0.1 – 1.0	Protein synthesis nitrogen. Carbohydrate metabolism. Root system development fruit and seed formation	Deficiency leads to dying of growing points and reduced buds, flowers and seed production.
Manganese	0.1 – 0.5	Nitrogen and in organic acid metabolism; carbon dioxide assimilation carbohydrate breakdown formation of riboflavin ascorbic acid etc.	Deficiency leads to alternate light green stripes between dark green veins on sugarcane
Molybdenum	0.01 – 0.05	Symbiotic N_2 fixation and protein synthesis	Deficiency leads to yellow spot disease on cauliflower. It causes cupping of leaves
Chlorine	-	Production of coconut and oil palm	Deficiency leads to overall wilting due to possible effect on transpiration.

REFERENCE BOOKS:

1. Manure and Fertility – K.S. Yawalkar, J.P.Agarwal, S.Borkde
2. Fertilizer by Ranjan Kumar

UNIT-II

MANURES

Definition: (2 Marks)

Manure is defined as excrement especially of animals (or) other refuse used as fertilizers. Manure is one of the most important agricultural by product.

ORGANIC MANURES: (2 Marks)

- Manure is perishable product and is frequently subjected to serve losses.
- Animals were largely dispersed on the land making possible they essay and economical application of manure to the near by soils.
- Animal manures produced as one of the Nations's serious air and water pollutions problems.

DIFFERENCE BETWEEN FERTILIZER AND MANURES: (5 Marks)

Fertilizers	Manures
Synthetic product	Natural product
Stable product	Perishable product
Most important inorganic fertilizer are nitrogenous, Phosphoric, and Pottassio.	The important organic manures are farm Yard manure and oil seed cakes.
It pollutes the soil.	It does not pollute the soils.
Fertilizers are compounds of certain elements.	It is agricultural by product of the farm.

BULKY ORGANIC MANURES: (5 Marks)

Definition:

Farm compost, town compost, sludge green manures and other bulky sources of organic matter. All these manures are built in nature and supply.

- Plant nutrients in small quantities.
- Organic matter in large quantities.

Explanation:

- These manures contain plant nutrients, they have a direct effect on plant growth, like and other commercial fertilizers.

- Bulky organic manures contain nutrients in small quantities. Therefore large quantities of them need to be applied per hectare. Besides the major nutrients bulky organic manures also contain traces of micro nutrients.
- Bulky organic manures improve the physical properties of soils.
- These manures increase the humus content of soils at least temporarily and consequently the water holding capacity of sandy soils is increases and the drainage of clayed soils is improved.
- Bulky organic manures provide food for soil micro-organisms. This increase activity of microbes which in turn help to convert unavailable plant nutrients into available forms.

Functions:

(a). Improvement of Physical Soil Properties:

- Improve soil structure
- Improve water holding capacity
- Improve soil aeration
- Buffering of soil surface temperature
- Reduction of soil losses

(b). Improvement of Chemical Properties:

- Supply of essential nutrients in balanced ratio
- Slow release of nutrients

(c). Improvement of Biological Activity:

- Stimulation of soil flora and fauna.

FARM-YARD MANURE: (5 Marks)

Definition:

The term Farm Yard Manure (FYM) refers to the decomposed mixture of dung and urine of farm animals along with the litter (bedding material) and left over material from roughages (or) fodder fed to the cattle.

Explanation:

- Farm Yard Manure collected daily from the cattle shed consists mainly of dung and part of the urine soaked in the refuse.
- Newly collected and stored Farm Yard Manure is fresh as against well decomposed Farm Yard Manure which has been stored for a sufficient period of time to allow its decomposition to completion.

- On an average, well-rotted Farm Yard Manure contains 0.5% Nitrogen, 0.2% P_2O_5 and 0.5 % K_2O.
- Farm Yard Manure has been used as manure and it has great value by cultivators and gardeners.
- Farm Yard Manure is one of the most important agricultural by products.

Composition:

Animals	Quantity		
	N	P_2O_5	K_2O
Cow	42.28	10.20	34.62
Bullock	56.37	13.60	46.36
Sheep and goat	5.36	1.98	5.64
Pig	5.55	3.85	4.76
Horse	80.50	27.21	64.63

- Sheep and poultry manures are richer in N, P_2O_5, K_2O than cow, horse and pig manures.
- Under ordinary conditions of storage Farm Yard Manure suffer loss of N and if any drainage is allowed to escape from the manure heap, loss of potash also occurs with bed storage, losses of plant nutrients will be still more.

HANDLING AND STORAGE: (5 Marks)

- A generation ago manures storage and application was a simple matter.
- Some farmers spread manure daily (or) allowed it to pileup until time and soil conditions permitted it to be spread.
- Good storage of manure makes provision for keeping the manure heap.
- Storage acids such as phosphoric, sulphuric and hydrochloric acid effective preservatives.
- In storing manure all practical precautions should be taken to keep losses at a minimum.
- Manure should be thoroughly compact.
- Manure needs sufficient moisture but not too wet.
- It should be stored under cover (or) shelter.

Methods:

Four general management systems are being used to handle farm manures.

- Collection and spreading of fresh manure daily.
- Storage and packing in piles and allowing the manure to fragment before spreading

- Aerobic liquid storage and treatment of the manure prior to applications.
- Anaerobic liquid storage and treatment prior to application.

(a). Applying fresh manure:

The manure is scraped or otherwise moved mechanically into spreaders. Something reinforced with super phosphate and spreads daily on the land

(b). Storage:

Manure may be allowed to accumulate or may be removed to a pile near by. If the manure is not allowed to dry out below 40% moisture fermentation will occur.

(c). Aerobic liquid treatment:

The manure is stored in a dated lagoon or it an oxidation ditch. By vigorous stirring oxygen in continuously incorporated into the system.

(d). Anaerobic liquid treatment:

This method is similar to the aeroble treatment except that no gaseous oxygen is added to encourage aerobiosis of the liquid-slurry.

OIL CAKES: (5 Marks)

Explanation:

- Oil cakes are utilized as concentrated organic manure.
- Concentrated organic manure ie., oil cakes contain not only Nitrogen, but also some Phosphorous and Potash along with a large percentage of organic matter.
- Oil cakes are the quick acting manures.
- Oil cakes are insoluble in water but their Nitrogen becomes quickly available to the plants in about a week (or) ten days after application.
- Oil cakes should be well-powdered before application, so that they can spread evenly and are easily decomposed by micro-organisms.
- Oil cakes are applied a few days prior to sowing (or) at sowing time.
- Oil cakes are also applied extensively in the form of a top-dressing to sugarcane.
- Depending on crop, oil cakes are applied broadcast, drilled (or) placed while earthling up near root zone
- Oil cakes are the richest and most concentrated of cattle foods
- It can be manufactured from oil bearing seeds after they have been crushed to extract some of the oil.
- The oil cakes are prepared form Cotton seed, Ground nuts, Sun flower seeds, Neem seeds.
- After the oil has been recover from oil seeds the cake is ground powdered and sold as feed fro dairy cows (or) as fertilizers

- Oil cakes are classified into two types
  i.e., Edible Oil cakes
  Non-edible oil cakes
- **Edible oil cakes** - Suitable for feeding to cattle. Ex. Coconut Cake, Groundnut Cake
- **Non-edible oil cakes** – Non suitable for feeding to cattle. Ex. Castor Cake, Neem Cake.

Oil Cakes	Percentage		
	N	P	K
Castor cake	4.3	1.8	1.3
Neem Cake	5.2	1.0	1.4
Coconut Cake	3.0	1.9	1.8
Groundnut Cake	7.3	1.5	1.3
Cotton Seed Cake	6.4	2.9	2.2

BLOOD MEAL: (5 Marks)

Explanation:

- Blood meal is quick acting manure and is effective for all crops on all soil types. It should be applied like oil cakes.
- The liquid blood is dried-raising its temperature by means of steam (or) hot air.
- The blood clot is first treated with commercial copper sulphate at 125 grams per 100kg of clot. It is then evaporated to dryness on a sand bath.
- Next it is spread on a concrete floor covered over by a net, and allowed to dry in sun.
- When completely dried it is powdered the bagged and sold as blood meal.
- The cost will be reduced if large quantities of clotted blood are handled.
- Dried blood meal contains 10-12% of Nitrogen and 1-2% of Phosphoric acid.
- At present slaughter houses do not take proper care in collection of the bloods. They should be dried on a concrete floor with a central drain leading into a blood storage tank.

FISH MANURE: (5 Marks)

Explanation:

- The use of fish as a manure dates back some centuries.
- Non-edible fish carcasses and fish offal are used to prepare fish meal.
- The fish is dried, crushed (or) powdered and filled in bags.
- Small machines like the fish boiler and squeezer are used to spread up the work.

- Fish manure (or) Fish meal contains 4-10 % of Nitrogen, 3-9 % of Phosphoric acid and 0.3 – 1.5 % Potash.
- Fish manure is available either as dried fish (or) as fish meal (or) powder.
- The manorial constituents present in it vary with the type of fish.
- Fish meal is quick-acting manure and it suitable for application to all crops on all soils. It should preferably by powdered before use.
- Guano is a mixture of briars excrement fish bones and other fish refuse.
- It also consists of carcasses of young brids, fragments of fish and seaweeds.

REFERENCE BOOKS:

1. Manure and Fertility -- K.S. Yawalkar, J.P.Agarwal, S.Borkde
2. Agricultural chemistry by B.A.Yogadin

UNIT – III

PESTICIDES AND INSECTICIDES

PESTICIDES:

Definition: (2 marks)

A pesticide may be defined as any substance of mixture of substances. Instead for preventing destroying repelling or mitigating any pest such as insects, rodents, nematodes, fungi, weeds or other forms of objection able plant or animal life.

Classification of Pesticides on the Basis of Chemical Nature:

- In-organic pesticides - Arsenical, mercurials borates, fluorides
- Natural organic pesticides - Nicotine, pyrethrum, petroleumoils
- Synthetic organic pesticides - Chlorinated hydrocarbons like as DDT, BHCm, Chlordane and methoxychlordane
- Organic phosphorus comounds like as Malathion, Parathion.
- Carbonates like as carbonyl, propoxur.
- Miscellaneous like as Thanite

I. Classification of Insecticides as Organic and Inorganic: (5 Marks)

INSECTICIDES:

An insecticide is a substance used to kill insects. It is harmful to man and causes great economic loss by damaging (or) destroying agricultural crops. Which spread microorganism like virus, fungi, bacteria. This causes diseases of plants and destroyed stored foods.

(a). Organic Insecticides:

Natural plant chemicals such as Nicotine, Pyrethrum has been used as insecticides for a very long time and DDT, BHC are also used as insecticides.

(b). Inorganic Insecticides:

Borates are used as inorganic insecticides.

II. Classification of Fungicides as Organic and Inorganic: (5 Marks): (5 MARKS)

FUNGICIDES:

Fungicides are biocidal chemical compounds (or) biological organisms used to kill (or) inhibit fungi (or) fungal spores. Fungi can cause serious damage in agriculture, resulting critical losses of yield, quality and quantity and profit. Fungicide are used both in agriculture and to fight fungal infections in animals.

(a). Organic Fungicides:

Organic Copper Compounds

(b). Inorganic Fungicides:

Sulphur Compounds

Copper Compounds

III. Classification of Herbicides as Organic and Inorganic: (5 Marks)

HERBICIDES:

Herbicides, also commonly known as weed killers, are pesticides used to kill unwanted plants. Selective herbicides kill specific targets, while leaving the desired crop relatively unharmed. Some of these act by interfering with the growth of the weed and are often synthetic mimics of natural plant hormones.

According To Their Chemical Nature:

- Inorganic Herbicides
- Organic herbicides.

According To Their Mode of Action:

- Selective, comprising compounds which kill weeds only, without dantaging the crop.
- Non- selective comprising compounds which kill all vegetation with which they come into contact.

(a). Organic herbicides

- Nitro compounds
- Chlorinated compounds

(b). Inorganic Herbicides

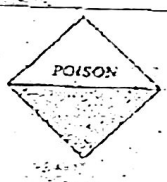
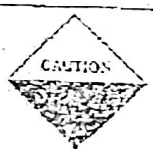
- Arsenic compounds
- Boron compounds
- Cyanamide cyanides
- Thiocyanates
- Chlorates

GENERAL METHODS OF APPLICATION & TOXICITY: (5 Marks)

- Uses of pesticides in crop protection and pest harvest care of the produce in the country is necessary to boost crop production and minimize storage loss.
- Pesticides are toxic substance with varied chemical configuration marketed in different formulations for use as placement, spray and fumigation.
- Poisoning from pesticides often happens as a result of negligence or misuse during handling.
- There is always a possibility of accidental exposure through ingestion, inhalation and contact also.

- Ingestion of pesticides through contaminated food and drinking water may also produce adverse effect on human body which prolonged and excessive exposure may lead to intoxication.
- No chemical is entirely without risk but there are safe ways of using them.
- Therefore, one should "*READ ALL LABEL*" carefully & handle them with precautions, store and apply only as recommended on the label.
- It is easier to prevent pesticide poisoning than to treat it.
- The toxicity potential is indicated by the colour of the triangle on the pesticide pack as given in the table.

CATEGORIES OF WARNING SYMBOLS

CATEGORY	LD50(oral) Mg/kg	WARNING SYMBOL	MESSAGE FOR THE MEDICAL PRACTITIONER
Extremely toxic	1-50	 Red	Most dangerous, requires best medical help
Highly toxic	51-500	 Yellow	Less dangerous, requires best medical help
Moderately toxic	501-5000	 Blue	Not an emergency situation
Slightly toxic	5000	 Green	Not at all an emergency situation

- Toxicity is the inherent capacity of a substance to cause damage.
- Hazard refers to the risk of poisoning involved in actual practice.
- Thus the most toxic compounds if handled carefully will possess little or no hazard. This also means that a chemical with low mammalian toxicity may prove hazardous if used with out precautions.
- The relationship between hazard and toxicity can be represented in the form of following equation.

$$\text{Hazard} = \text{Toxicity} \times \text{Contamination} \times \text{Time}$$

- Where Hazard is the risk of poisoning, toxicity is the ability to cause damage, contamination is the extent of exposure to the pesticides, and time involves the duration of contact with the pesticide.
- Thus hazard or the possibility of poisoning can be reduced by minimizing the variables on the right side of the equation.

Result of using Pesticides: (5 Marks)

- Direct toxic effects on man and animals.
- Disturbance of ecological equilibrium, giving rise to uninhibited growth of certain pests.
- Environmental pollution, with resultant deterioration I the quality of food, water, soil and air.
- Development of pest resistance to pesticides leading to loss of property and disease.
- These are two types of poisoning
    - Acute (or) Immediate.
    - Chronic (or) Cumulative

SAFETY MEASURES WHEN USING PESTICIDES: (5 Marks)

Explanation:

Pesticides are usually safe if properly transported, stored and handled with necessary precautions.

- The pesticides should always be stored in their original containers and kept in locked cupboards .(they should not be reach of the children and domestic animals)
- They should be kept away from food & food stuffs and medicine.
- Bags and containers of pesticides should be cut open with a separate knife.
- The empty containers should be destroyed and should not be put into some other use.
- Inhaling of pesticide sprays or dusts, and smoking chewing, eating or drinking while mixing or applying the chemicals should be avoided.
- Particles or drops of pesticides, which may accidentally get into eyes, should be flushed out immediately with large volumes of clean water.
- Protective clothing's and devices should be used while handling poisoning chemicals to avoid exposure to sprays or drifts.
- Dusting or spraying should never be done against, the wind and it is preferable to have them in cool and calm weather.
- After handling pesticides hands, face and body should be washed and clothing changed
- Persons engaged in handling pesticides should undergo regular medical check–up.

INSECTICIDES: (2 Marks)

Definition:

An insecticides is a substance used to kill insects. It is harmful to man and causes great economic loss by damaging (or) destroying agricultural crops. Which spread microorganism like virus, fungi, bacteria. Which causes diseases of plats and destroyed stored foods.

Examples:

Nicotine, pyrethrum, DDT, BHC, Borates

PLANT PRODUCTS:

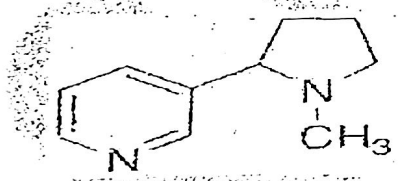
Natural plant chemicals such as nicotine, pyrethrum have been I use as insecticides for a very long time.

NICOTINE ($C_{10}H_{14}N_2$): (5 Marks)

Explanation:

It is obtained from tobacco plant of nicotinlana tobacum. This plant leaves contain 4-5% of salts of Maleic acid and citric acid. They are prepared commercially from waste tobacco by steam distillation in the presence of alkali. The predominant component of the crude alkaloid is (-) nicotine.

Structure:



Properties:

- Nicotine is a mobile colorless liquid.
- Boiling Point is 247°C
- Turning brown and finally black becoming more viscous.
- It is a well defined base.

Action:

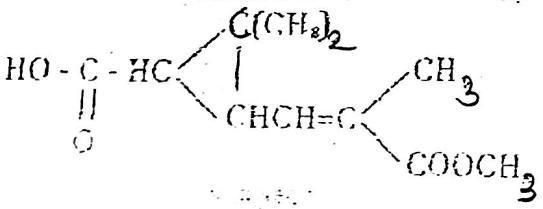
- It is a non – persistent contact poison.
- It is toxic not only to insects but to higher animals also.
- It is readily absorbed through the skin and mucous membranes causing paralysis of nerves.
- However it may be safely used to fumigate green houses as it volatilizes quickly and its effect is purely temporary.

PYRETHRIN: (5 Marks)

Explanation:

- Pyrethrum powder is obtained by crushing the flower heads of pyrethrum cineraria folium and two other species grown mainly in Japan, Kenya, and East Africa.
- Good quality pyrethrum flowers usually contain 0.5 to 1.5 % of the active ingredients
- Pyrethrins during drying the active ingredients may be lost.
- The powder formed by grinding the dried flowers is called pyrethrum.
- It retains its insecticidal property for varying periods of time.
- The loss of potency depends on the fineness of the powder and the period of exposure to sunlight and heat.
- Anti-oxidants such as tannic acid, hydroquinone, and resorcinol have been used retard this loss of activity.
- This powder is usually extracted with kerosene and the extract is concentrated.
- The extract contains all the insecticidal ingredients of pyrethrum.
- All the active ingredients are esters.
- The Pyrethrins (Pyrethin I & II) and the Cinerins (Cinerin I & II).
- These are the esters of two Ketonic Alcohols (e.g. Pyretholone) and two acids (e.g. Pyrethric acid).
- The Dicarboxylic acid in present in Pyrethrum as the mono ethyl ester is known as Pyrethric acid.

Structure:



These are unstable to sunlight, because quickly hydrolyzed by alkalis with loss of insecticidal properties.

Action:

- Most insects are killed by sprays having 0.002 – 0.004 % Pyrethrins.
- The Pyrethrins are powerful contact poisons causing a rapid paralysis or knock- down effect on insects owing to their effect o n the nervous system.
- They have the unique quality of being toxic to insects but not appreciably so to plants and higher animals. Pyrethrum is especially useful in control of cockroaches and mosquitoes.

- Also the insects do not usually develop physiological resistance to it
- However pyrethrum powder cause dermatitis in some people and the Pyrethrins can be dangerously toxic when inhaled or ingested or brought in contact they are relatively non- toxic to man

INORGANIC PESTICIDES: (2 Marks)

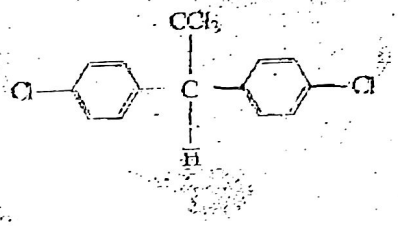
Borates:

- Borax and crude sodium borates are the most common borate containing materials used.
- Borax is sodium tetra borate $Na_2B_4O_7$ and it is useful for fly maggot control in manure pits and wounds of animals infested by maggots.
- Boric acid is used as a stomach poison for cockroach.
- Borates are not broken down in the soil and they may remain in the soil for some time. They do not involve any particular hazard as they are non- poisonous and non-corrosive.

ORGANIC PESTICIDES - *D.D.T* ($C_{14}H_9Cl_5$):

The commercial name of this compound is ***Dichloro Diphenyl Trichloro ethane***. The compound is 1, 1 –trichloro – 2, 2 – bis (chlorophenyl) ethane

Structure:



Preparation:

It is prepared by heating chlorobenzene with chloral CCl_3CHO, in prepared of conc.sulphuric acid.

(2 molecules of chlorobenzene condense with 1 molecule of chloral).

Reaction:

- DDT is a waxy solid, insoluble in water, and in most aromatic and chlorinated solvents
- The compound is stable in air and is not attacked by aqueous acids and alkalis' heating the solid compounds evolves HCl gas forming ethylene, with loss of insecticidal properties.
- It has a high and specific toxicity for various insects such as the house fly mosquito

Action:

- It is a powerful stomach and contact insecticide and larvicide

- It has little action on carpet beetles, red spiders, cotton bee weevils, some species of ants and the common cockroach.
- Poured on stagnant water, it quickly destroys mosquito larvae.
- It could eliminate with rapidly and efficiency, flies, mosquitoes, bugs, lice, caterpillars, leaf hoppers, cloth moths and their larvae.
- But with continued use, these insects are becoming immune to it. It is not ordinarily toxic to man in small concentration but tends to build up in body fats.
- When dissolved in vegetable oil, it is more readily absorbed through the skin and hence can become doubly toxic.

Formulations:

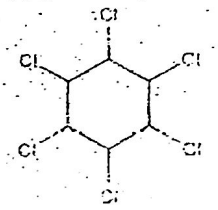
- Dusting powders containing 5 to 10 % active ingredient
- Wet powders containing 50% active ingredient
- Emulsifiable concentrates containing 25 % ingredients
- Aerosols (container with high pressure)

BHC: (5 Marks)

BHC is ***Benzene Hexa Chloride*** and the molecular formula is $C_6H_6Cl_6$, so it is otherwise called as ***666***. It is 1, 2, 3, 4, 5, 6 – Hexa Chloro Cyclo Hexane (HCH).

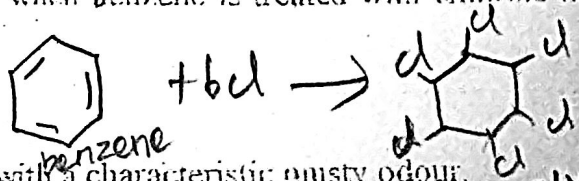
Structure:

It can exit 16 isomeric forms, but only 6 have been isolated. The gamma form is called gamexane and it constitutes roughly 13% of BHC. It is act as an insecticide.



Preparation:

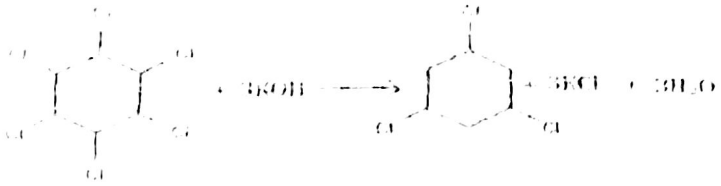
BHC is obtained as an addition product when benzene is treated with chlorine in the presence of sunlight.



Properties:

- It is amorphous buff colored substance with a characteristic musty odour.
- It is insoluble in water, but soluble in benzene and kerosene.
- It is stable towards light, air, heat, and acids, but decomposes in the presence of alkalis.
- $[C_6H_6Cl_6 + 3\ KOH \rightarrow C_6H_3Cl_3 + 3\ KCl + 3\ H_2O]$

Reaction:



The property of one molecule of BHC to liberate 3 atoms of chlorine on reacting with alcoholic potash is made use of in the determination of the compound.

Action:

- BHC is persistent stomach and contact poison
- It is effective against soil insects, grasshoppers, cotton pests, storage and house - hold pests, in the form of smoke, sprays, aerosols or dusting powders.
- At higher concentrations, it can cause root deformation and also taints certain crops seriously (e.g. potato)

Formulations:

- Dusting powders containing 5 and 10% active ingredients.
- Water dispersible powder containing 50% active ingredients.
- Granules having 6 and 10% active ingredients.

Lindane: (2 Marks)

- It is 99% pure gamma BHC.
- The compound was introduced under the trade name Gammexane
- It is prepared by the selective crystallization of crude BHC.
- It forms colorless crystal, sparingly soluble in water and in petroleum oils,
- It is readily soluble in acetone
- It stable to air, light, heat and CO_2 and is not attacked by strong acids but is dehydro chlorinated by alkalis
- It is safer to use in the home than technical BHC (or) DDT since it is more readily excreted by the human body.

REFERENCE BOOKS:

1. Manures and Fertilizers by K.S.Yawalkar, J.P.Agarwal, S.Bokde
2. Agricultural chemistry by B.A.Yagodin

UNIT-IV

FUNGICIDES AND HERBICIDES

INTRODUCTION:

The tremendous effort of man to control harmful pest gave rise to "pesticides" the "super chemicals" used to control pests around the home as well as agriculture.

Pesticides are legally classes of "**Economic Poisons**" and are defined as "***any substance used for controlling, preventing, destroying, repelling (or) mitigating any pests***".

FUNGICIDES: (2 Marks)

Definition:

- Fungicides are chemicals used for killing fungi which are responsible for producing many plant diseases. Fungicides are used primarily to control the field diseases of fruits and vegetables.
- They are also used to control seed diseases of common crops and protect harvested fruits and vegetables from decay and rot.

Classification:

(a). Inorganic Fungicides:

Sulphur Compounds

Copper Compounds

(b). Organic Fungicides:

Organic Copper Compounds

1. SULPHER COMPOUNDS: (5 Marks)

(a) Sulphur:

It is primarily a fungicides and acaricides, but may serve as diluents for insecticidal dusts.

Formulations:

- It is formulated as a fine dust 95% with 10% inert material
- The flow of the dust is also made free by the addition of 3% tri calcium phosphate
- It is also formulated as a wettable powder.
- Effectiveness increases with the fineness of sulphur particles.
- It is generally non-toxic but irritating to eyes.

(b) Lime Sulphur:

It is the aqueous solution of calcium polyphospludes.

Preparation:

- It is prepared by sulphur solution in calcium hydroxide suspensions preferably under pressure in the absence of air.

- Calcium penta sulphide and calcium tetra sulphide present in the mixture are responsible for the insecticidal activity.
- Lime sulphur is still extensively, applied as a fungicide for orchards.

II. COPPER COMPOUNDS:

Mainly compounds of copper and sulphur constitute the most important fungicides;

Examples:

- Bordeaux Mixture
- Copper Oxy Chloride
- Cuprous Oxide:

(a). BORDEAUX MIXTURE: (5 Marks)

Explanation

- It is a complex compound containing copper and calcium that has been used for many years in the control foliage diseases.
- It is a mixture of lime (CaO) and copper sulphate.
- These mixtures are used as fungicides by spraying on tomatoes, potatoes and grapes.
- On fruits the ratio is always 3 of slaked lime to every 2 of copper sulphate i.e., 4:6:100.
- Today there exist many substitutes for Bordeaux mixture that only requires stirring into water before they are ready for application.

$$CuSO_4 + Ca(OH)_2 \rightarrow Cu(OH)_2 + CaSO_4$$

- Dry Bordeaux contain 26% copper and is usually marketed as fine powder.

Applications:

- Leaf spot of beans, carrots, peas, potatoes and tomatoes has been controlled by applications of sprays containing 5 pounds to dry Bordeaux per 100 gallons of water.

(b). Copper Oxy Chloride:

- This is another fungicidal material that has been developed with success as a substitute for Bordeaux mixture.
- Blister blight of tea, hemaleia of coffee, late blight of potatoes and leaf spot of bananas and tobacco are among the foliage diseases that have been controlled by applications of this material.

(c). Cuprous Oxide:

- Potato blight, sugar beet leaf spot and downy mildew of onions are some of the diseases which have been controlled by applications of this material.

- It is usually marketed either as dusts (containing 0.25% copper) or as wettable powders (containing 50%)

ORGANIC COPPER COMPOUNDS (5 Marks)

- During the past few years, experiments have been taking place with several organic copper fungicides.
- Copper oxinate is the copper salt of oxine (8-hydroxy quinoline)
- It has been used as a wettable powder for control of many diseases, including apple and scab, certain soft fruit diseases, and also on vegetable and flowers.

HERBICIDES (OR) WEEDICIDES: (5 Marks)

Definition:

Herbicides may be defined as substances (or) mixture of substances used to destroy the unwanted weeds which complete with the main crop for food and light.

Examples:

- 2,4-D (chlorinated phenoxy acetic acid)
- Triazines
- Phenyl Ureas
- Aliphatic acids
- Carbamates
- Dinitro anilines

CLASSIFICATION:

Herbicides may be classified,

1. According to their chemical nature,

- Inorganic herbicides and
- Organic herbicides.

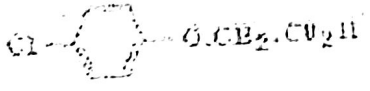
2. According to their mode of action,

- *Selective* - comprising compounds which kill weeds only, without damaging the crop
- *Non- Selective* - comprising compounds which kill all vegetation with which they come into contact.

Structure:

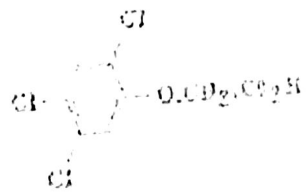
2,4-D

2,4-dichlorophenoxyacetic acid



2,4,5-T

2,4,5-trichlorophenoxyacetic acid



INORGANIC HERBICIDES:

- Arsenic Compounds
- Boron compounds
- Cyanamide cyanides and thio cyanates
- Chlorates
- Sulphamates

ORGANIC HERBICIDES:

Nitro compounds:

Dinitro herbicides are yellow staining and highly poisonous to humans animals whether by ingestion, inhalation or absorption through the skin.

Chlorinated compounds:

In 1942 it was discovered that certain phenoxy acids, which in small quantities stimulated the growth of plants, in slightly larger quantities produced symptoms which resulted in death.

- These are called synthetic growth – regulating herbicides.
- Eg, MCPA was the first of these plants – growth regulators.
- The discovery of MCPA in Britain and 2,4-D in the U.S.A., other compounds of the substituted phenoxy acid group have been discovered and developed as selective herbicides.

ACARICIDES: (5 Marks)

Explanation:

Acaricides are the chemicals used against the ticks and mites belonging to the class acarina. They kill the insects which bite the leaves of the plants. Diphenyl sulphone, Chlorofenson, dicofol are some of the important compounds of this class.

Examples: Permethrin, Dicofot.

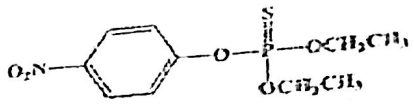
I. Fenson:

- Fenson is the common name for 4- chlorophenyl benzene sulponate it has recently shown itself to be of value in the control of red spider and other mites.
- It is particularly toxic to the eggs, Mites on beans, Cotton melon and grapbes have been controlled by applications of 5% fenson

II. Azobenzene:

- Azobenzene is an organic compound which volatilizes readily when heated. It has been used to control red spider in greenhouses.
- It is usually marketed in the form of a powder that can be heated on steam pipes (or) as smoke generators.

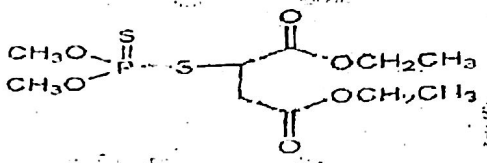
III. Parathion:



Parathion

- Parathion is O,O-Diethyl O-(4-nitrophenyl) phosphorothioate
- It is a yellow to deep-rown oily liquid with a garlic-like odour.
- It is sparingly soluble in water, but is readily soluble in alcohol, ether. Ester, oils and fats. It is a contact and stomach insecticide and acaricide. Being cheap, powerful and effective in small concentrations against a variety of pests, it is widely used in agriculture.

IV. Malathion:



- Malathion is 2-[(dimethoxy phosphorothionyl)sulfanyl]butane dioate.
- It is an organophosphate insecticide of relatively low human toxicity.
- It is a brownish liquid with an obnoxious odour. It is an insecticide and acaricide of low mammalian toxicity. Because it is both effective and safe, the U.S. Department of agriculture has sanctioned its use for controlling more than 100 pests occurring in 90 field, vegetable and fruit crops.
- In India malathion has proved to be a popular rat repellent a drawback of malathion is that it is highly toxic to bees.
- One of the most important methods of controlling insects is be means of chemicals. Application of chemicals for killing insects implies the use of insecticides.
- The word "insecticide" means insect-killer' materials which kill insects are called insecticides, and these may be inorganic or organic compounds.
- Chemicals for insect control are classified in various ways. E.g. stomach poisons, contact poisons, fumigants, repellents and attractants.

RODENTICIDES: (5 Marks)

Explanation:

- Rodenticides are chemicals which are used against rodents like rats mice, etc. several inorganic compounds are used as rodenticides.

- Not bromide is selective rodenticides for rat.
- Barium carbonates $BaCO_3$ causes haemorrhage of gastrointestinal tract and kidneys and muscular paralysis.
- Thallium sulphate, $Tl_2(SO_4)$ is a slow-acting rodenticide as well as an ant poison.
- Zinc phosphide, Zn_3P_2, has been in long use as a rat poison. It is a grey powder with garlic odour. Though a stable compound, it decomposes slowly in moist air.
- It is used as a 2% bait for the control of field rats. Zinc phosphide ingested along with the bait reacts with the hydrochloric acid of the rodent stomach and releases phosphine gas which is extremely reactive and poisonous. LD50 for rats; oral 45.7

Examples:

- Zinc phosphide,
- Barium carbonate,
- Thallium sulphate

ATTRACTANTS: (5 Marks)

Explanation:

- Chemical substances which attract insects towards their source are called attractants.
- Many substances attract insects by factory stimulation.
- Attractants are added to lure the animal to the poisoned bait.
- Fresh raw linseed oil is an example of a simple attractant, the smell of which attracts the rodents towards the bait.
- Many other essences and oils like linseed oil have been shown to possess attractant properties.
- A mixture of geraniol and eugenol (1:1) serves as food lure and attracts beetle adults.
- Moths and butterflies are attracted by fermenting syrups and sugars and molasses.

Examples:

- Lactic acid
- Floral and Methyl eugenol

REPELLENTS: (5 Marks)

Explanation:

- Control can be carried out with repellents but the effect is short lived because these compounds only keep the rodents away and do not kill them.
- Thiram, CMPA and aniline complex of TNB are generally recommended for this purpose.
- The repellent technique is very useful in the fields where rodents damage crops, seedlings and trees.

- Vital cables and electrical wiring are some times damaged by rodents.
- Repellents which can be used for coating them are.
  - i) N, N-Dimethyl-S-t-butyl sulfonyl dithio carbonate
  - ii)Tributyltin salts and
  - iii)Dodecylamine and its salts
- Many of the stomach contact and fumigant materials also possess repellent properties.
- Bordeaux mixture is very repellent to potato flea beetles and leaf hoppers.

Examples:

- P-Menthane-3.
- Soybean oil
- Citronella oil

10m

PRESERVATION OF SEEDS: (5 Marks)

The purpose of seed preservation is to maintain the seed in good. Physical and physiological condition from the time they are harvested until the time they are planted.

The following physical and chemical methods are followed in the preservation of seeds.

I PHYSICAL METHODS:

1. Cleanliness:

- The seeds must be cleaned to free them of trash which may harbours
- Insects or fungi and prevent free circulation of air.

10m

2. Dry condition:

- The seeds must be properly dried. The moisture content of the Seeds is vital factor.
- The store house should have proper ventilation and Aeration to maintain the equilibrium moisture content of the seeds.

3. Storage house:

The store house should be so arranged that the rain can not enter, and that no serious gain in moisture will occur during (The preservation Period).The storage must not be a heat trap that is allowing seed to reach excessively high temperature.

4. Prevention of birds and rodents:

Birds, rats and other rodents may destroy the seeds. All openings in the storage house should be properly sealed or screened if needed for ventilation

5. Temperature control:

- Temperature in one of the most important environmental factor which influence seeds viability and vigor. The lower the temperature, the longer the seeds maintain germination capacity.

- Thus temperature control is an important consideration in seed preservation. The temperature control may be achieved in one of the following ways.

  i) Ventilation, ii) Insulation iii) Refrigeration

- These methods are not mutually exclusive and are normally used to supplement each other.

II. CHEMICAL METHODS:

Pest control by pesticides:

- The seeds are affected by the organisms like bacteria, fungi, mites and insects.
- The activity of all these organisms can lead to damage resulting in loss of vigor or viability of the seeds.
- These pests can be controlled by seed treatment.
- An insecticide combined with a fungicide may be applied as a protectant.
- The most commonly used insecticides are DDT and BHC. Fumigation of the store house at frequent intervals is necessary to keep the insects away from the store house.

REFERENCE BOOKS:

1. Chemistry of Pesticides – N.K. Roy
2. Agricultural Chemistry First Edited by B.A. Yagodin

UNIT V

SOILS

SOILS: (2 Marks)

Definition:

Soil may be defined as the superficial loose covering of the earth surface. (Or) Soil has been defined as the shallow upper layer of earth that they formed by weathering of underlying rocks in association with organic matter and with living organisms and has become a suitable habit for plants and animals. The term soil derived from the Latin word "solum". Solum means floor (or) ground.

Soil is the most important natural resource of the earth. Soil is made up of minute particles of the disintegrated rocks. Containing minerals decomposed organic matter and bacteria

The factors responsible for influencing the soil formation are:

- Climate
- Living organism
- Nature of parent material
- Topography
- Time

Examples:

1. Clay soil
2. Loam soil
3. Sandy soil
4. Silty soil
5. Peaty soil

CLASSIFICATION: (5/10 Marks)

A number of systems of classification have been evolved for categorizing various types of soil. Some of these have been developed specifically in connection with ascertaining the suitability of soil for use in particular soil engineering projects. Some are rather preliminary in character while a few are relatively more exhaustive, although some degree of arbitrariness is necessarily inherent in each of the systems. The more common classification systems are enlisted below:

- Geological Classification
- Classification by Structure
- Classification based on Grain-size
- Unified Soil Classification System
- Preliminary Classification by soil types

(a). Geological Classification:

Soil types may be classified on the basis of their geological origin. The origin of a soil may refer either to its constituents or to the agencies responsible for its present status. Based on constituents, soil may be classified as:

1. Inorganic soil
2. Organic soil

Based on the agencies responsible for their present state, soils may be classified under following types:

- Residual Soils
- Transported Soils
- Alluvial (or) Sedimentary Soils
- Aeolian Soils
- Glacial Soils
- Lacustrine Soils
- Marine Soils

Over the geological cycle, soils are formed by disintegration and weathering of rocks. These are again formed by compaction and cementation by heat and pressure.

(b). Classification by Structure

Depending upon the average grain-size and the conditions under which soils are formed and deposited in their natural state, they may be categorized into following types on the basis of their structure.

- Soils of single-grained structure
- Soils of honey-comb structure
- Soils of flocculent structure

(c). Classification based on Grain-Size

In the grain-size classification, soils are designated according to the grain-size or particle-size. Terms such as gravel, sand, silt and clay are used to indicate certain ranges of grain-sizes. Since natural soils are mixtures of all particle-sizes, it is preferable call these fractions as sand size, silt size, etc. A number of gain-size classifications have been evolved, but the commonly used ones are:

- U.S. Bureau of Soils and Public Roads Administration (PRA) System of U.S.A.
- International Classification, proposed at the International Soil Congress at Washington, D.C., in 1927
- Massachusetts Institute of Technology (MIT) System of Classification of U.S.A.

- Indian Standard Classification (IS: 1498-1970)

Terminology of different types of soil

A geotechnical engineer should be well versed with the nomenclature and terminology of different types of soils. The following list gives the names and salient features of different types of soil, arranged in alphabetical order.

- **Black cotton soil:**
  - It is a residual soil containing a high percentage of the clay mineral - montmorillonite. It has very low bearing capacity and high swelling and shrinkage properties.
- **Clay:**
  - It consists of microscopic and submicroscopic particles derived from the chemical decomposition of rocks. It contains a large quantity of clay mineral. It can be made plastic by adjusting the water content.
  - It exhibits considerable strength when dry. Clay is a fine-grained soil. It is a cohesive soil. The particle size is less than 0.002mm.
  - Organic clay contains finely divided organic matter and is usually dark grey or black in colour. It has a conspicuous odour. Organic clay is highly compressible and its strength is very high when dry.
- **Humus:**
  - It is a dark brown, organic amorphous earth of the topsoil. It consists of partly decomposed vegetal matter. It is not suitable for engineering works.
- **Loam:**
  - It is a mixture of sand, silt and clay. The term is generally used in agronomy. The soil is well suited to tilling operations.
- **Sand:**
  - It is a coarse-grained soil, having particle size between 0.075 mm to 4.75 mm. The particles are visible to naked eye. The soil is cohesionless and pervious.
- **Silt:**
  - It is a fine-grained soil, having particle size between 0.002 mm and 0.075 mm. The particles are not visible to naked eyes. Inorganic silt consists of bulky, equidimensional grains of quartz. It has little or no plasticity, and is cohesionless. Organic silt contains an admixture of organic matter. It is a plastic soil and is cohesive.

PROPERTIES OF SOILS: (5 Marks)

Explanation:

- The soil is a complex mechanical system consisting of three phases' viz., solid, liquid and gases.
- The solid phase occupies 55% of the total and the rest of the volume is occupied by liquid and gases, whose proportions vary reciprocally to each other.
- The solid part consists primarily of organic and different types of minerals.
- The four major components of soil-inorganic particles, Organic matter, water and air.

PHYSICAL & CHEMICAL PROPERTY:

Physical Properties:

- It influences and behavior towards plant growth.
- It can be measured against some scales like intensity, strength and sizes.
- Some examples of physical properties are Size, density, temperature, soil water, colour, texture, air water relationship etc.,
- The rigidity and supporting power.
- Drainage and water-holding capacity.
- Ease of penetration by roots.
- Aeration and retention of plants nutrients.

Chemical Properties:

- The chemical properties of soils give an idea about the nature of the chemical changes taking place in them.
- The changes can be in their chemical composition, nature of organic and inorganic material.
- Some examples of chemical properties of soil are colloids, types of clays,minerals,cation exchange capacity, soil reactions, soil pH,soil acidity, soil alkalinity etc.,

Wilting Point:

The minimum point of soil moisture the plant requires not to with (available water capacity) is called wilting point.

Green Manure:

Green manure are very pleasant. Its improves the health of the soil and subsequent plants. It is crop that is grown mainly to benefit the soil

Soil Humus:

Humus is dark organic material that forms in soil, when plant and animal matter decays, when plant drop leaves and twings is known as soil humus.

Mechanical Components:

Soil may be defined as a mixture of mineral matter, organic matter, water and air. The approximate volume composition of the four major components of soil is as follows:

- mineral matter about 45%
- Organic matter about 5%
- Soil water about 25%
- Soil air about 25%

SOIL WATER: (2 Marks)

Explanation:

- All soils contain water even the dry soil contain a certain amount of water.
- How ever the amount of water present in the soils varies considerably.
- Different soils absorb and retain different quantities of water.
- Soil water plays an important role in the growth of plants.
- Water serves as a solvent and carrier of food nutrients.
- A growing plant requires large quantities of water.
- It is necessary for a plant to have optimum moisture conditions in the soil during the growth period.
- Soils obtain its water from rain, snow dew or irrigation.
- The processes of weathering and soil formation depend on water.

SOIL TEMPERATURE: (5 Marks)

Explanation:

The soil derives its heat directly from the sun and loses much of it by radiation back in the sky. The sun has an effective radiation surface temperature of 6000K.

Only a part of the incoming radiation received by the soil is absorbed.

Importance of soil heat:

The temperature of the soil affects the chemical and biological process going on the in the soil.

- Soil temperature is one of the importance factors that influence germination
- If the temperature is too low the seed fails to germinate very slowly
- If the temperature is too high it may be injured or even killed.
- Soil temperature influences the germination and initial growth of plants.
- During plant growth, the process of carbon assimilation and respiration are influenced by temperature.
- Soil temperature also affects root growth and also the growth of under portion of the plant body.

- Soil temperature also influences the various chemical reactions takes place in the soil.
- The maximum absorption of water by the roots and the maximum metabolic activities of the plants take place usually between 20nC and 30 C
- The lowering of temperature below 20 causes an appreciable reduction in the rate of absorption and transport of water and nutrient ion.
- The absorption of water is almost nil at freezing temperature.

Factors controlling soil temperature:

- Nature of soil
- Soil moisture
- Plant cover
- Topography
- Climate
- Measurement of soil temperature by using soil thermometer.
- Chemical properties of soil
- About 92 elements are known to exist in the earth crust. About 2000 minerals have been recognized.

SOIL MINERALS: (5 Marks)

Definition:

Rocks are broken down into finer particles by climatic and biological forces; these particles are often moved about before finally coming to rest to make soil.

Explanation:

PRIMARY AND SECONDARY MINERALS:

- The Original grains (Or) Crystals are called Primary Minerals.
- The minerals less resistant to weathering are usually chemically transformed to new types called secondary minerals.
- The dissolving of the minerals provides the soluble plant foods needed for growth
- There are hundreds of different minerals in the soil in varying proportions.
- These minerals have definite chemical combinations of elements such as O, Si, Al, Fe, Ca, Mg, Na & K.
- There are large amount of SiO_2.
- Commonly know as quartz another important oxide mineral is Fe_2O_3 TiO_2, Aluminium Oxide, Manganese Oxide also exist in much smaller quantities
- Mineral is a natural inorganic substance.
- Soil originates from rocks.
- When rocks weather they produce parent material.

- When the parent material weathers it produce soil.
- The weathering forces are rain, sun shine, frost and wind.
- These forces act on rocks and minerals dissolving them by heating and cooling the wetting and drying the freezing and melting them.
- The loose weathered rocks are called parent material.
- After rocks are broken down into finer particles by climatic and biological forces, these particles are often moved about before finally coming to rest to make soil.
- The international society of soil science has fixed different names for particles of different sizes.
- The relative quantities of sand silt and clay in a soil material determines its texture.

Examples:

- Micas,
- Silica,
- Iron oxide

SOIL ACIDITY: (2 Marks)

Explanation:

- Soil may be acidic, neutral (or) alkaline in reaction.
- The soil reaction is mean to express the acidity or alkalinity of the soil.
- Soil suspension of the various degrees of soil reaction are produced by the chemical condition may be favorable to the growth of some crops, unfavorable to others and in still other class they may affect the plant growth only slightly.
- Soil reaction may be considered as a symptom of the particular chemical conditions which caused it.
- Hence it may be used to indicate diagnosing the fertility of soil.

Soil PH: (2 Marks)

- The reaction of an aqueous solution represents the degree of acidity (or) basicity caused by the relative concentration (or activity) of hydrogen ions (H^+) or hydroxyl ions (OH^-) present in it.
- A neutral reaction is produced by an equal activity of H^+ and OH^- ions.
- The greater the degree of ionization the greater is activity of ions.
- Even pure water which is neutral in reaction, dissociation into H^+ and OH^- ions.

Soil PH Acidity:

Examples:

Reaction	PH	H^+ ion concentration
Extremely acidic	< 4.00	----
Strongly acidic	4.0-5.0	10^{-4} -10^{-5}
Moderately acidic	5.0-6.0	10^{-5} -10^{-6}
Slightly acidic	6.0-7.0	10^{-6}-10^{-7}
Neutral	7.0	10^{-7}

SOIL TESTING: (5 Marks)

Explanation:

It is necessary to determine the quantity of fertilizer and manures in soils. There are various methods of determining the fertilizer requirement of soil.

1. Field Experiment
2. Pot Experiment
3. Biological Test
4. Chemical Analysis

1. Field Experiment:

It is reliable method but, time consuming and expensive and conducted by research farmers.

2. Pot Experiment:

This experiment is not time consuming and the result obtained from this test are not always directly applicable to large farming.

3. Biological Test:

These tests are slow and costly and hence are not commonly uses.

This test involves the growth of seedlings or the lower forms of plants such as fungi and bacteria under specified conditions and the study of their relatives' growth or the content of needed nutrients.

4. Chemical Analysis:

The chemical analysis of soils or of plants growing on them constitutes the modern method of determining the fertility status of soil. Such analysis given information about the relative abundance or scarcity of the different nutrients required by crops from the soil, but it fails to indicate the exact quantity of fertilizers that may be applied to suffice the deficiency.

This analysis incorporation with field experiment gives better results.