32
MANURES AND FERTILIZERS

32.1 INTRODUCTION

Plants require food for growth and development, which is composed of certain chemical elements. The practice of applying manures to soil for the purpose of increasing crop yield is perhaps as old as the development of agriculture by man. With the advancement in the science of chemistry new facts about the plant growth substances were discovered. Sixteen elements are found to be essential in plant nutrition without which it is impossible for the plants to complete the vegetative or repoductive stage of its life cycle.

In this lesson you will learn about materials which are commonly used to maintain and improve soil fertility i.e. manures and fertilizers.

32.2 OBJECTIVES

After reading this lesson, you will be able to :

- describe essential plant nutrients
- list different types of manures
- explain the process of compost production
- describe vermicompost and vermiculture
- explain the role of manures in soil fertility
- classify different types of fertilizers
- state different methods of using fertilizers.

32.3 ESSENTIAL PLANT NUTRIENTS

Just as certain vitamins are necessary for good health in humans similarly certain elements

are necessary for the plant growth. The nutrients are not food for the plant; although they are often called 'plant food'. Plants are autotrophs i.e. they produce their own food by trapping the energy of the sun through photosynthesis. But they still require certain elements to build proteins, carbohydrates and all the other compounds necessary for their growth and development.

These necessary elements are divided into two categories, depending primarily on the amount necessary for adequate plant growth.

Nutrients needed in large quantities are called macronutrients; and those necessary only in small amounts are called micronutrients.

You have already read the details about these nutrients in lesson 31.

32.4 SOIL FERTILITY

It is the inherent capacity of the soil to supply nutrients to plants in adequate amounts and in suitable proportion.

All soils are not alike in respect of quantities of plant nutrients they contain. Under a given situation, the system of farming, soil management and manuring practices etc. influence the productivity of soils and the crop yields obtained from them.

Intensive cultivation with improved varieties reduces nutrients in the soil as the improved varieties draw large amounts of nutrients from the soil for their production. The materials which are commonly used to restore soil fertility are various types of manures and fertilizers.

32.5 MANURES

Manures are relatively bulky materials; and these supply plant nutrients in small quantities and organic matter in large quantities.

Manures improve the physical condition of soil and increase humus content of soil consequently the water holding capacity of the soils is increased. They provide food for soil micro-organisms which by increasing activity help in converting the unavailable plant nutrients into the available forms. Manures in general supply practically all the elements of fertility which the plants require, though not in adequate proportions.

Different types of manures are as follows :

32.5.1 Farm yard manure (F.Y.M.)

F.Y.M. is the decomposed mixture of dung and urine of farm animals, alongwith litter (bedding material) and left over materials from roughage or fodder fed to cattle.

Good quality F.Y.M. is perhaps the most valuable organic matter applied to soil and most commonly used organic manure in the country. Well rotted F.Y.M. on an average contains 0.8% Nitrogen, 0.2% P_2O_5 and 0.5% Potash.

32.5.2 Compost

Composting is a biological process in which microorganisms decompose organic matter in the presence /absence of oxygen, and lower the carbon nitrogen ratio of refuse.

The final product of composting is well decomposed manure and is known as compost. It has high organic matter content and relatively higher contents of major nutrients compared to F.Y.M. Compost helps in improving and maintaining soil fertility in crop production. It is prepared from farm refuse (farm compost) and town refuse (town compost).

(a) Why do we need composting?

The disposal of garbage in cities and towns is a big problem. Crop residues, remnants of fodder, stubbles, trash, bhusa or hey, peelings of kitchen, waste paper, vegetables, egg shells, used leaves, leaves of garden plants etc. besides creating disposal problems pollute environment. Composting helps in converting these waste materials to more useful product, the compost.

(b) Process of Compost Production

A blend of proteinaceous (dungs of cow, horse, goat, sheep, fowl etc., fish waste; all green plant materials, meat, blood and bones) and carbonaceous materials (hay, strawy, wood chips, saw dust, stalks of maize, bajra, jowar etc.) is suitable for compost making. The amount of cow dung should constitute 25% of the composting material. Composting is carried out in a heap or a pit (Fig. 32.1).

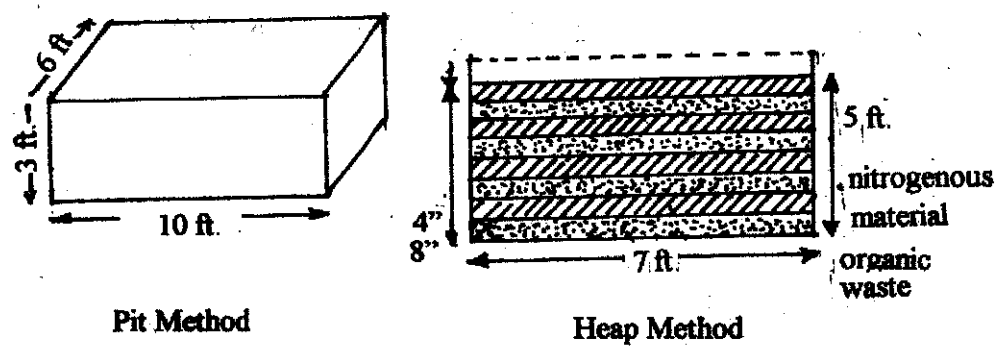

Fig. 32.1: Compost Production

In the ***heap method*** (Indore method) organic waste material is spread in 8 inch layer. This layer is covered with 4 inch of nitrogenous material. The alternate layers are put until the heap is about 5 ft. high, 7 ft. wide and 7 ft. long. In the ***pit method*** (Bangalore method/ Indore method) the pit should be 2 to 3 feet deep, with breadth 6 to 8 feet, and length 10

feet or more as per requirements. The material is spread like heap method.

The moisture in both the cases is maintained at 60%. The material is turned up three times, the first turning is 10-15 days after filling, the second 15 days after the first turning, and the third after 2 months. This helps the bacteria in fixing atmospheric nitrogen in large quantities.

Addition of 20% rock phosphate helps in quick decomposition of the waste material.

The process of composing takes 2 to 2 1/2 months. Important factors in the compost production are :

Moisture : An even moisture content throughout the heap should be maintained. The ideal optimum moisture level for aerobic composting is 50-60 per cent.

Air : Proper air circulation encourages right kind of bacterial activity.

Warmth of the heap : The optimal temperature in a heap is the result of having right amount of water, air and the other constituents. It should not be allowed to heat up. The ideal carbon/nitrogen ratio is 35-40 for maximum decomposition of waste material; and it keeps the temperature at optimal limit.

Enrichment of compost : The compost is generally low in nitrogen and phosphorus. It can be enriched in both the nutrients by inoculating with nitrogen fixing **(Azotobacter)** and phosphate solubilizing micro-organisms after one month of the start of compost manufacturing process.

32.5.3 Sewage and Sludge

The liquid wastes like sludge (solid) and sewage (liquid) contain large quantities of plant nutrients, and are used for growing sugarcane, vegetables, and fodder crops near large towns by operating sewage farms (sewage treatment plants).

32.5.4 Green Manures

It is a practice of ploughing or turning into soil undecomposed green plant tissues/parts for the purpose of improving physical structure as well as fertility of the soil.

Green manuring is the principal supplementary means of adding organic matter to soil.

The crops most commonly used for green manuring are :

Sunhemp, dhaincha, clusterbean (guar), senji, cowpea, horse gram, pillipesara, berseem, glyricida etc.

32.5.5 Vermicompost and Vermiculture

The garbage and other waste materials conserve the solar energy and can be put to use in order to check the pollution of the environment. The task of recycling of organic wastes can be undertaken through earthworms.

Conversion of organic wastes (garbage) by earthworms into compost is known as vermicomposting; and the product of the process is the vermicompost. The multiplication of earthworms is called vermiculture.

Both are simple processes and can be handled by any layman in a village.

The vermicompost is far more richer in nutrients as compared to ordinary soil. Besides it contains valuable vitamins, enzymes and hormones like gibberline.

By recycling the organic wastes in cities and towns in the form of the compost and vermicompost, the problem of sanitation will be solved; and it would facilitate in maintaining the equilibrium of nature.

32.6 CONCENTRATED ORGANIC MANURES

These manures are organic in nature and contain higher percentages of plant nutrients like, N, P and K compared to bulky organic manures like F.Y.M. and compost. These manures are made from raw materials of animal or plant origin. The common concentrated organic manures are oilcakes, blood meal, fish manure, meat meal and wool waste.

INTEXT QUESTIONS 32.1

1. What are plant nutrients ?

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2. How will you explain soil fertility ?

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3. How will you define manures ?

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4. What is farm yard manure ?

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32.7 ROLE OF MANURES IN SOIL FERTILITY AND CROP PRODUCTIVITY

All organic manures help in the crop production in two ways. Firstly, they supply nitrogen, phosphorus and potash; secondly, they improve the physical and microbiological properties of the soil and make it more fertile (enriching in nutrients) for crops to grow in.

The plant food elements contained in a manure are released in an available form after it is applied to the soil and is decomposed by soil microorganisms. Similarly, the green manures add not only substantial amounts of organic matter but also nitrogen.

32.8 FERTILIZERS

Fertilizers are inorganic materials of a concentrated nature.

Fertilizers can be defined, as any natural or manufactured material, dry or liquid added to soil in order to supply one or more plant nutrients.

The term fertilizer is generally applied to the commercially manufactured materials other than lime or gypsum. They are sometimes called chemical, artificial or inorganic manures. Most commercial fertilizers supply three micronutrients (N, P, K) required in the greatest quantity for plant growth.

They are applied mainly to increase the supply of one or more of the essential nutrients e.g. nitrogen, phosphorus and potassium. Fertilizers contain these elements in the form of soluble or readily available chemical compounds. Fertilizers may be grouped into nitrogenous fertilizers, phosphatic fertilizers, potassic fertilizers etc.

32.8.1 Nitrogenous fertilizers

They are classified into four groups on the basis of the chemical form in which nitrogen is combined with other elements within a fertilizer.

(i) **Nitrate fertilizers :** Nitrogen is present as NO_3^- or nitrate with other elements. Examples are :

Sodium nitrate or Chilean nitrate ($NaNO_3$) – 16% N

Calcium nitrate $\{Ca(NO_3)_2\}$ – 15.5% N

(ii) **Ammonium fertilizers :** Nitrogen is combined in ammonium (NH_4^+) form with other elements. Examples are :

Ammonium sulphate $[(NH_4)_2SO_4]$ – 20% N

Ammonium phospate $NH_4H_2PO_4$ – 20% N + 20% P_2O_5

or

16% N + 20% P_2O_5

Ammonium chloride (NH_4Cl) – 24 to 26% N

(iii) **Amide fertilizers :** Nitrogen is present in amide form. Examples are :

Urea $[CO(NH_2)_2]$ – 46% N

Calcium cyanamide ($CaCN_2$) – 21% N

(iv) **Nitrate and ammonium fertilizers :** Nitrogen is present in the from of both nitrate and ammonium. Examples are :

Ammonium nitrate (NH_4NO_3)	–	33 to 34% N
Calcium Ammonium nitrate	–	26% N
Ammonium sulphate nitrate	–	26% N

All these nitrogenous fertilizers are readily soluble in water and in soil quickly changed into ammoniacal nitrogen or nitrate form.

32.8.2 Phosphatic fertilizers

Phosphatic fertilizer is guaranted to contain percentage of P_2O_5 (Phosphorus pentaoxide). These fertilizers are classified into following three groups :

(i) **Phosphatic fertilizer with water soluble phosphoric acid** or monocalcium phosphate

Single superphosphate	(16 to 18% P_2O_5)
Double superphosphate	(32% P_2O_5)

Triple superphosphate	(46 to 48% P_2O_5)
Ammonium Phosphate	(20% N and 20% P_2O_5 or 16% N and 20% P_2O_5)

(ii) **Phosphatic fertilizer with citric acid soluble phosphoric acid or dicalcium phosphate**

Basic slag	(14 to 18% P_2O_5)
Dicalcium phosphate	(34 to 39% P_2O_5)
Rhenania phosphate	(23 to 26% P_2O_5)

(iii) **Phosphatic fertilizer with phosphoric acid not soluble in water or citric acid or tricalcium phosphate**

Rock phosphate	(20 to 40% P_2O_5)
Raw bonemeal	(20 to 25% P_2O_5 and 3 to 4% N)
Steamed bonemeal	(22% P_2O_5)

The form of phosphates after application to soil, undergoes a change from one category to another and vice versa.

32.8.3 Potassic fertilizers

Potassium (K) is never found in free state and is always used in compound form. The potash fertilizers can be classified as :

(i) **Fertilizers with K in chloride form.** Example is :

Muriate of potash (KCl)

(ii) **Fertilizers with K in non-chloride form.** Example are :

Sulphate of potash (K_2SO_4)

Sulphate of potash-magnesia (double salt of K and Mg) – (K_2SO_4 $2MgSO_4$)

Potassium nitrate (KNO_3)

(iii) **Wood ashes** – They are very rich in potash and are applied to crops mainly to oranges, mango, guava, bananas, potato, tomato etc.

All potassic fertilizers are equally available to plants because all of them are readily soluble in water.

32.8.4 Compound or complex fertilizers

Fertilizers containing two or more of the primary essential nutrients (N, P, K) are called compound or complex fertilizers respectively. These are desirable for a balanced treatment of soil. Examples are diammonium phosphate, calcium ammonium nitrate, urea ammonium phosphate, ammonium phosphate etc.

32.9 BIOFERTILIZERS

Biofertilizer means using living organisms as fertilizers, either to fix atmospheric nitrogen or to solubilize mineral nutrients like phosphorus.

The biofertilizers (microbial inoculants) have attained special significance in the modern agriculture, as their use helps in reducing quantities of chemical fertilizers. The important microorganisms which can be used in agriculture are *Rhizobium*, *Azotobactor* and *Azospirillum* (bacteria), vesicular arbuscular mycorrhizae (VAM-fungi), blue green algae –BGA, *Azolla* sp (fern) etc.

32.10 SOIL AMENDMENTS

Soil amendments are those substances which influence the plant growth favourably by producing in soil one or more beneficial effects.

These are materials for correcting acidic soils or alkaline soil or soil aggregating agents. Examples: lime for soil acidity; gypsum for reclaiming alkaline soils.

32.11 METHODS OF USING MANURES AND FERTILIZERS

Organic manures should be applied well ahead of sowing or anytime after seedlings have established themselves.

Nitrogenous, potassic and phosphatic fertilizers are to be applied at sowing or transplanting. Nitrogenous fertilizers may be applied in two dosages one at sowing and one after sometime of sowing.

Fertilizers can be applied in the following ways :

- Broadcasting before sowing.
- In bands on each side of rows of seed with drill.
- Mixing with F.Y.M. (in case of superphosphate)
- Foliar application

32.12 NUTRITIONAL DEFICIENCY SYMPTOMS

The deficiency symptoms in plants due to essential elements are as follows :

Nitrogen : Stunted growth, light colour, yellowing of leaves beginning with oldest foliage.

Phosphorus : Plants fail to make quick start, do not develop satisfactory root-system, remain stunted and sometimes show a reddish or purplish discolouration of stem and leaves.

Potassium : Poor shoot growth; dieback; yellow and necrotic (discoloured) spots on leaves; browning of tips and edges of leaves.

Magnesium : Symptoms appear on edges of younger tissue first and include yellowing and some times redish colour; leaves may appear cupped.

Calcium : Youngest foliage distorted and irregular; terminal buds may die; root growth poor.

Sulphur : New leaves turn yellow or pale green; fruits become light green, mis-shapen and less juicy.

Iron : Young leaves light green to yellow, especially in interveinal areas; in severe cases leaves become dry and may be shed.

Manganese	:	Interveinal yellowing; Grey or white streak; whole leaves may become brown in severe cases.
Copper	:	Multiple bud formation in leaf axils; staining of fruits; die back of shoots.
Zinc	:	Interveinal chlorosis; reduction in shoot growth; shortening of internodes;
Boron	:	Yellows and rosetting; hollow stem and bronzing of curd in cauliflower; corking and pitting of fruits.
Molybdenum	:	Whip-tail in crops; reduction in the activity of symbiotic and non-symbiotic nitrogen-fixing microorganisms.
Chlorine	:	Wilting of leaf tips; chlorosis; bronze discolouration.

INTEXT QUESTIONS 32.2

1. How is compost produced ?

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2. Differentiate between vermicompost and vermiculture.

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3. What are fertilizers ?

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4. Give the significance of biofertilizers.

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32.13 DISADVANTAGES OF USING FERTILIZERS

Imprudent use of chemical fertilizers has been responsible for deterioration of soil health. Use of chemicals destroys micro-organisms which inhabit the soil; and they keep it an alive media for agricultural purposes. These micro-organisms fix the atmospheric nitrogen, solubilize phosphorus fixed in soil and help in decomposition of organic matter to humus. Humus improves the water holding capacity of the soil.

Indiscriminate use of chemical fertilizers without F.Y.M./compost/green manure lead to the degradation of soil. In India about 60% of the cultivated area suffers from erosion, water logging and salinity problems.

32.14 WHAT CAN WE DO ?

Permanent and cheapest solution to overcome the dangerous effects of modern agriculture and to develop a farming system which is economic, productive and long lasting is called ***sustainable farming*** or ***organic farming*** or ***natural farming***.

Organic farming is the agriculture system which aims at cultivation of the land in a way so that the soil is kept dynamic with living activities and in good health, at the same time keeping the environment clean. In this method use of chemicals is kept at its minimum. Intergrated nutrient management (INM) is an important component of organic farming where use of organic manures, green manures, and biofertilizers is more with minimum of chemical fertilizers.

32.15 FERTILIZER MANAGEMENT

In the context of limited supplies available and urgent need to step up food production, fertilizers should be used (increased, decreased or even be saved where possible) after soil tests. Soil tests reveal the soil supply position (deficient, adequate or very well supplied) so that the maximum overall benefit from fertilizers use is achieved. Quantities of fertilizers can be adjusted accordingly. This is known as fertilizer management.

There are 463 soil testing laboratories functioning all over India. The institutes like Indian Agricultural Research Institute, New Delhi, Agricultural Universities in different States and manufactures of fertilizers who advice on various aspects of fertilizer use are engaged in soil testing programme.

For proper use of fertilizers, their recommendations should be based on soil test values.

32.16 WHAT YOU HAVE LEARNT

- Organic matter, such as manures and composts, can be returned to land to lower the need for inorganic fertilizers.
- Fertilizers are a mainstay of agricultural production in the country.
- Manures and other organic materials are slow-releasing fertilizers because the nitrogen becomes available to plants gradually as the organic materials decay and nitrogen is converted to inorganic forms.
- Manures and composts provide macro-and micro nutrients to plants in the decay process and improve soil structure.
- The nutrients are not food for the plant, although they are often sold as plant food. Certain nutrients are essential for growth and development.
- Major fertilizer groups are nitrogenous fertilizers, phosphatic fertilizers and potassic fertilizers.
- Green manures improve physical structure as well as fertility of the soil.
- The important micro-organisms which can be used in agriculture are *Rhizobium*, *Azotobactor* and *Azospirillum*. VAM, blue green algae etc. They either fix atmospheric nitrogen or solubilize phosphorus.
- Nitrogenous fertilizers added to agricultural soils also pollute surface waters and ground waters, through runoff and percolation.

- Generally, a relatively narrow range separates deficiency and toxicity levels of micronutrients.
- Organic farming is the agricultural system which aims at cultivation of the land in a way so that the soil is kept dynamic with living activities and in good health, at the same time keeping the environment clean.

32.17 TERMINAL EXERCISE

1. Name different kinds of manures.
2. What do you know about composting?
3. What is vermicomposting ?
4. How recycling of organic waste takes place ?
5. Differentiate between compost and vermicompost.
6. What is green manuring ?
7. List important plants used for green manuring.
8. What is the important function of nitrogen in plants ?
9. Describe biofertilizers.
10. What are different types of fertilizers?
11. How will you classify nitrogenous fertilizers ?
12. Give broad classification of phosphatic fertilizers ?
13. What are compound fertilizers ?
14. Explain soil amendments.
15. Describe methods of using manures and fertilizers.
16. What are nutritional deficiency symptoms of nitrogen and phosphorus.
17. Give the disadvantages of using fertilizers.
18. Explain organic farming.
19. Tick mark (ü) the correct answer.

i. Humus content of soil increases by

   a) Fertilizer
   b) Nitrogen
   c) Manure
   d) None of the above

ii. Soil fertility declines by

   a) Intensive cultivation
   b) Mannures
   c. Fertilizers
   d. None of the above

20. How will you explain fertilizer management?

CHECK YOUR ANSWERS:

KEY TO INTEXT QUESTIONS 32.1

1. See Section 2.3
2. See Section 2.4
3. See Section 2.5
4. See Section 2.5.1

KEY TO INTEXT QUESTIONS 32.2

1. See Section 2.5.2.2
2. See Section 2.5.5
3. See Section 2.8
4. See Section 2.9

TERMINAL EXERCISE

1. Refer Section 2.5
2. Refer Section 2.5.2
3. Refer Section 2.5.5
4. Refer Section 2.5.5
5. Refer Section 2.5.2 & 2.5.5
6. Refer Section 2.5.4
7. Refer Section 2.5.4
8. Refer Section 2.3
9. Refer Section 2.9
10. Refer Section 2.8
11. Refer Section 2.8.1
12. Refer Section 2.8.2
13. Refer Section 2.8.4
14. Refer Section 2.10
15. Refer Section 2.11
16. Refer Section 2.12
17. Refer Section 2.13
18. Refer Section 2.14
19. (i) c
    (ii) a
20. Refer Section 2.15