**PLANT NUTRIENTS AND SOIL TILLAGE PRACTICES.**

**Plant Nutrients**

Adequate plant growth requires a regular supply of plant nutrients. Plants absorb a large number of elements from the soil, air and water during their growth period, but not only 16 elements of elements these have been found to be essential for growth of all plants.

Essential Elements

An element can be classified as essential if it fulfills the following criteria:

1. A deficiency of the element makes it impossible for the plant to complete the vegetative or reproductive stage of its life cycle.

2. The deficiency symptom of the element in question can be prevented or corrected only by supplying that element.

3. The element must have a direct influence on the plant, and must be directly involved in the nutrition of the plant.

Sixteen nutrients are essential for plant growth and they include; carbon, hydrogen, oxygen, nitrogen (N), phosphorus (P) and sulphur (S), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), molybdenum (Mo), copper Cu), boron (Bo), zinc (Zn), and chlorine

(C). Sources of Nutrients

The following elements are derived:

a. from air; carbon (C) as CO2 (carbon dioxide);

b. from the water: hydrogen (H) and oxygen (O) as H2O (water);

c. others can be derived from the soil and fertilizers. Additionally, a considerable amount of nitrogen is fixed by leguminous plants through root nodule inhabiting bacteria

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Essential elements are grouped into two categories based on the quantity needed by plant for adequate growth. These are Macro and Micronutrients

Macronutrients are needed by the plants in large quantities and within this group we have (a) Primary nutrients which includes N, P and K. These should be applied if the soil is deficient in one or more of them. Calcium, magnesium and sulphur are sometimes called secondary nutrients due to their secondary importance in plant nutrition. In contrast with macronutrients, micronutrients or trace elements are required in only minute amounts for correct plant growth and have to be supplied in tiny quantities when they are deficient in the soil.

Functions of nutrients

Nitrogen (N)

1. Nitrogen is the motor of plant growth. It makes up to 1 to 4 percent of dry matter of the plant. It is taken up from the soil in the form of nitrate (NO3-) or ammonium (NH4+).

2. In the plant it combines with compounds produced by carbohydrate metabolism to form amino acids and proteins.

3. N is an essential constituent of proteins and is involved in all the major process of plant development and yield formation.

4. A good supply of nitrogen for the plant is important also for the uptake of the other nutrients.

Phosphorus (P)

1. It constitutes 0.1 to 0.4 percent of dry matter of the plant.

2. It plays a key role in the transfer of energy.

3. It is essential for photosynthesis and other chemical-physiological process in the plant.

4. It is indispensable for cell differentiation and for the development of the tissues, which form the growing points of the plant

Potassium (K)

1. Potassium makes up 1 to 4 percent of the dry matter of the plant.

2. It activates more than 60 enzymes.

3. It plays a vital part in carbohydrate and protein synthesis.

4. Potassium improves the water regime of the plant and increases its tolerance to drought, frost and salinity.

5. Plants well supplied with K are also less affected by diseases

Secondary Nutrients include Mg, S, and Calcium. They are taken up in considerable or moderate quantities or amounts

Magnesium (Mg)

1. It is a central constituent of chlorophyll, the green pigment of the leaves which functions as acceptor of the energy from the sun, thus, 15 to 20 percent of the magnesium found in plant is contained in the leaves.

2. Mg is also involved in enzyme reactions related to the energy transfer of the plant.

Sulphur (S)

1. It is an essential constituent of protein and also involved in the formation of chlorophyll.

2. In most plants it makes up to 0.2 to 0.3 percent of dry matter.

Calcium (Ca)

1. Calcium is essential for root growth

2. It is a constituent of cell wall materials

Micronutrients or Trace Elements

These are iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), chlorine (Cl) and boron (B). They are part of the key substances in plant growth. they are taken up in minute amounts, their range of optimal supply is very small.

Sources of Plant Nutrients to

Plant nutrients can be supplied to the soil by adding the following: Organic manure , Green manures and other crop residues, Chemical or inorganic fertilizers, Soil amendments

a. Organic Fertilizers/Manures

These include farm yard manure, compost, sludge, green manures and others. These manures supply plant nutrients in small quantities and organic matter in large quantities. They have direct effects on plant growth, on the humus content of the soil as well as influence the physical properties and microbial activities in the soil.

i. Farmyard manures

Farmyard manure (FYM) refers to the refuse from all farm animals. The richest and most concentrated manure is poultry manure which is particularly good for vegetable production. Farm yard manure consists of two components- solids and liquids in a ratio of approximately 3:1. The solid portion is made up straw that has been used for bedding and dung. Dung is mostly undigested food and urine is a fluid waste product. More than 50% of the organic matter in dung is in form of complex products, often of lignin and protein, which are similar to humus. FYM contain on the average 0.5%N, 0.25% P205, and 0.5% K20. Generally, 30% of N, 30% of the P205 and 50% of the K205 in farm manure are available to plants.

Importance of Farmyard Manure

1. Farmyard manure is source of nutrient especially nitrogen, potash and some trace elements.

2. It influences the physical properties of the soil.

3. Farmyard manure increases the humus content and consequently the water holding capacity of the soil.

4. It improves the structure of the soil by making it more granular, better aerated and better drained. The manure also tends to reduce soil compaction which is often associated with continuous cultivation.

ii. Compost

Compost is well-rotted vegetable matter which is prepared from farm and town refuse. Compost is prepared in trenches of various sizes and shapes. The accumulated refuse is well mixed and then spread in the trench in a layer of about 0.3 m. this layer is then well moistened by sprinkling over it slurry of cow dung and water, or earth and water.

Subsequent layers of the same thickness of mixed refuse are then spread on the heap and moisten. After about three month it is now fully decomposed and should be taken out of the trenches formed into conical heaps above ground and covered with earth. After one or two months, the compost will be ready for use. The N, P and K contents of farm compost are on the average 0.5%, 0.15%, 0.5%, respectively, while those of the town compost are 1.4%, 1.0%, 1.4%, respectively.

Advantages of Composting Organic Matter

1. The carbon: nitrogen ratio is improved because carbon dioxide is released to the air by micro-organisms.

2. Improve the structure of the soil by making the soil friable, crumbly and easier to handle and work upon.

3. The heat generated may kill weed seeds and other pathogenic organism.

4. It is the cheapest source of organic manure.

iii. Green manures

This is the practice of growing and Ploughing in green crops to increase the organic matter content of the soil. Green manure crops are usually fast growing annual legumes and grasses. They are usually incorporated in the soil when they are green and succulent. Crops which grow rapidly even on poor soils and produce an abundant mass of green leaves and tops can be used as a green manure crop.

Advantages of Green Manure

1. It increases the organic matter content of the soil.

2. It improves soil structure.

3. Makes phosphorus and certain trace elements available to plants.

4. Checks erosion and leaching.

5. Helps to control weeds by acting as a smother crop.

b. In-organic/ Chemical fertilizers

A fertilizer is any natural or manufactured material, which contains at least 5 percent of one or more of the three primary nutrients (N P K). Industrially manufactured fertilizers are called mineral fertilizers. Fertilizer may contain one or more of the essential nutrients. Those that contain only one of the major elements are described as single, simple or straight fertilizers. Those that contain two or more of the major elements are classified as mixed or compound fertilizers. Nitrogen, phosphorous, and potassium are the main plant nutrients and these three provide the basis for the major groups of fertilizers.

With the rapid increase in population and rise in standard of living there is increasing demand for food and feed grains. To meet up with the food demand it is necessary to intensify field crop production. Achieving and sustaining high crop yield of desired quality is only possible through the use of commercial fertilizers.

Although there have been tremendous increases in fertilizer using in tropical Africa over the years, utilization is still on a very small scale relative to the total needs. There is a wide gap between the national requirements for fertilizers and their actual use by farmers.

Methods of Fertilizer Application

The method of application of fertilizers (organic manure or mineral fertilizers) is an essential component of good agricultural practices. A fast start and continued nutrition is essential for sustained maximum profit. It is important to place some of the fertilizer where it will intercept the roots of the young plant and to place the bulk of the nutrients deeper in the soil.

Nitrogenous fertilizers are easily soluble in water and have mobility, so they can be applied on the soil surface.

Phosphorus fertilizers moves slowly from the point of placement, it should be placed closer to the plant roots. To reduce phosphate fixation, phosphorus fertilizers should be so placed that they come into minimum contact with the soil particles and are close to the plant roots.

Potassium fertilizer moves slowly in the soil, they should also be placed near the root zone.

Based on these principles, the following methods are used to apply fertilizers.

i. Broadcasting

The fertilizer is spread over the entire soil surface to be fertilized with the objective of distributing the whole quantity of fertilizer evenly and uniformly and incorporating it in the plough layer. It is used mostly on dense crops not planted in rows or in dense rows and on grassland. It is also used when fertilizer should be incorporated into the soil after application to be effective (phosphate fertilizers), or to avoid evaporation losses of nitrogen (urea, diammonium phosphate).

ii. Row or Band Placement

This refers to the application of fertilizers into the soil close to the seed or plant and is employed when relatively small quantities of fertilizers are to be applied. When fertilizers are placed along with, or close to the seed or plant in bands or pockets, the roots of the young plants are assured of an adequate supply of nutrients and this promotes rapid early growth. This method of placement also reduces the fixation of phosphorus and potassium.

When seeds or plants are sown close together in a row, the fertilizer is put in continuous band on one or both sides of the row. This method of application is referred to as row placement, and is used for potatoes, maize, tobacco, cotton, sugarcane etc.

iii. Top dressing

Top-dressing (broadcasting the fertilizer on standing crop) is mainly used for small and large grain crops and for crops such as forage, wheat and barley.

Top dressing of additional nitrogen is done when:

i. a single application of the total nitrogen needed at sowing might lead to losses through leaching and run-off.

ii. Where crops show a special need for nitrogen at certain stages of growth.

Top dressing of potassium, which does not move in the soil to the same extent as nitrogen, might be recommended on light soils, i.e. applying the total amount divided into a basal dressing and top-dressing.

Phosphate hardly moves in the soil at all. Hence, it is usually applied before or at sowing or planting time (basal application), preferably in combination with potassium and part of the nitrogen.

Side dressing: this is also another form of top dressing where fertilizer is spread between the rows or around the plants. Maize, cotton, sugarcane, trees and other perennial crops are normally side-dressed.

iv. Foliar application of fertilizer

Foliar application refers to the spraying of the leaves of growing plants with suitable fertilizer solutions. It is used mainly to correct micronutrient deficiencies. To minimize the risk of leaf scorch, the recommended concentration has to be respected and spraying should preferably be done on cloudy days and in the early morning or late afternoon.

v. Application through irrigation water (Fertigation)

Straight or mixed fertilizers which are easily soluble in water are allowed to dissolve in the irrigation stream. The nutrients are thus carried into the soil in solution. The fertilizers most commonly applied through irrigation water are nitrogenous fertilizers.

**TILLAGE PRACTICES**

Tillage is defined as changing the soil condition with a tool for the benefit of man. After the land has been cleared and plant debris removed, it is often necessary to subject it to some form of tillage before the crop is planted. Various forms of tillage may be carried out while the crop is growing on the field.

Purposes of Tillage

Tillage is carried out for one or a combination of the following reasons: Seed bed preparation, Control of weeds, Incorporation of organic matter into the soil, Soil and water conservation, Improvement of the soil’s physical condition

i. Seed bed preparation

Tillage loosens the soil and results in a seed bed suitable for seed germination and development of the young seedlings. A good seed bed should be moist and should not contain large lumps of soil that may prevent close contact between the planted seed and soil particle. It should not contain large quantities of un-decomposed organic matter.

ii. Control of weeds

Often weeds growing on a fallow plot can be controlled by being ploughed under. Ploughing prior to cropping may also serve to kill the weeds present. Tillage between rows of growing crop can be an important method of weed control.

iii. Incorporation of organic matter into the soil

Organic matter and crop residues can be incorporated into the soil through tillage. Once in the soil, they decomposed rapidly thus releasing the nutrients they contain to the growing plants. The incorporation of plant residues in the soil through tillage also serve to improved soil structure.

iv. Soil and water conservation

Tillage often serves the purpose of breaking up the surface layers of the soil so that water is able to infiltrate more rapidly into the soil. This has the dual benefit of increasing the amount of water available in the soil for the crops and decreasing the amount of soil erosion caused by excessive run-off. For these reasons, land that is not to be cropped immediately may even be occasionally ploughed or tilled as a soil and water conservation measure.

v. Improvement of the soil’s physical condition

The physical condition of the soil can be improved by tillage. For example, where the surface layers of the soil have formed a hardpan, it may be beneficial to break up the hardpan through tillage so that plants roots can penetrate more deeply and water could percolate into the lower layers of soil more easily.

vi. Increases soil aeration

Tillage opens up the soil, thus improving soil aeration which increases the oxidation of chemical compounds in the soil and make them more soluble and available for the plants roots to absorb. Improved aeration is also beneficial to soil inhabiting organism.

Types of tillage

i.Ploughing

This is one of the most ancient and most universal forms of tillage. A shear, which is pulled along by some power device, slices its way under the soil as it goes along, thereby loosening the soil and turning it over. The soil is left in lumps of various sizes and may require other operations in order to make a suitable seed bed. Implements used for Ploughing include moldboard plough and disc plough

ii. Harrowing

Planting may be done on the field after Ploughing, but if the lumps of soil left after Ploughing are too large, they must be broken up before planting. The conventional way of breaking up soil lumps is through harrowing. There are various kinds of animal-powered and tractor powered harrows but they all function by breaking up the lumps of soil and leaving an even soil surface.

iii. Mounding

This involves the collection of the soil into more or less conical heaps or mounds. The mounds usually vary in height from 30-100cm, but are usually of approximately the same height on a particular farm. The distance from one mound to the next also varies but it is the distance that determines how much cropping can occur in the lower-lying spaces between the mounds.

Mounding is the most common form of soil collection tillage in tropical Africa and is often associated with intercropping since it simultaneously permits two or more kinds of seed bed on the field; the top of the mounds is used for crops such as tubers which requires a deep layer of loose soil, the low-lying furrows are used for crops that have high requirement for water such as rice while the slopes of the mounds are used for intermediate crops.

Advantages of mounding

1. Providing a deep, loose seed bed which is particularly suitable for the development of roots and tubers.

2. Providing a variety of seed bed types on the same field, which may be advantageous to intercropping.

3. Elevating the seed bed and plant roots above the water table in fields with a high water table.

4. Mounding improves aeration for roots and facilitates the growth and development of underground tuber and root crops and the pods of groundnuts.

5. Mounding makes harvesting of tuber crops and pods of groundnuts easier.

Disadvantages of mounding

1. The major disadvantage of mounding is that it has not been mechanized and would probably be extremely difficult to mechanize.

2. Mounds impede the free movement of men and machinery through the field. For these reasons, mounding is mostly confined to traditional agriculture to which it is well suited.

iv. Ridging

This involves the collection of soil into elongated heaps called ridges. The distance between the ridges is variable, but is usually about one meter. Growing crops on ridges is quite common in tropical Africa. In the traditional settings, hoes and human labour are used to make ridges, but mechanical ridgers are also available and permit large areas to be ridged in a relatively short time.

Advantages

Ridging has the same advantages as mounding, but in addition ridging is an extremely useful measure for controlling erosion, particularly on sloping land. In such cases, ridging is done along the contour so that the flow of water down the slope is impeded. The water then flows along the furrows between the ridges. In order to further discourage the rapid flow of water within the furrows, cross ridges (also called cross bunds or tie ridges) are made across the furrows at intervals to connect one ridge to the next. Thus, ridging, when properly done, can decrease surface run-off, thereby reducing soil erosion and promoting water infiltration into the soil.

Since it has been completely mechanized, ridging finds a place in modern agriculture, where it is the most common form of soil collection tillage.

v. Bed making

This is a form of land preparation which is more often discovered in horticultural and nursery practices than in field crop production. A bed is like a ridge in that it is elongated raised portion of the field. It is, however, usually much broader than a ridge, its top is flat and its length is usually not more than 20 m. Bed making is most commonly done with hand tools.

vi. Terracing

These

Terracing is one of the methods of managing extremely sloping land for crop production. It creates a series of relatively flat horizontal portions alternating with vertical portions very similar to a flight of stairs. The flat portions are used for cropping. Terracing provides erosion control measures and permit cropping on land that would have otherwise remain useless for cropping,

viii. Minimum tillage

There has been a realization in recent years that frequent tillage operations tend to impair the soil structure thus exposes the soil to adverse effect of rainfall and strong wind. These observations have led many scientists to develop the concept of minimum tillage. This means

that crop production could be carried out with as little tillage or soil disturbance as possible as tillage is seen as a necessary evil which should only be sparingly indulged in.

Advantages of minimum tillage

1. Preserve the soil structure.

2. It is economical, since the labour and cost normally incurred in tillage operations can be saved.

Tillage Implements

The hand hoe is still the most common tillage implement among small scale farmers.

Ploughing implements

Plowing buries green or dried material, loosens the soil so that other implements can operate removes or delays competition with weeds and roughen the soil surface so as to check runoff of rainfall.

The moldboard plow Breaks loose or shears off furrows slice by forcing a triple wedge through the soil. This action inverts the soil and breaks it into lumps. Some soil pulverization takes place.

The disk plows

These are important for use in loose soil but also in those soils too dry and hard for easy penetration of moldboard plows. The disks vary in size from 50 to 75 cm while the depth of plowing may be varied from 10 to 25 cm.

i. Implements for seed bed preparations

Tillage to prepare a seed bed after the land has been plowed is accomplished with harrows, field cultivators or other machines equipped with disks, shovels, teeth, spikes, sweeps, knives, etc.

Harrows

Harrows smoothen and pulverize plowed soil, compact it and destroy weeds.

The disk harrow cuts, moves, and pulverizes the soil and destroys weeds.

The spike-tooth harrows breaks soil clods, levels the land, and kills small weeds.