Unit 5

Plant Nutrition and Irrigation

Introduction

Nutrition

The elements necessary for normal metabolic activities in the body of an organism are known as nutrients. The process of nutrient supply and their intake is known as 'nutrition'. It has been observed that at least 16 plant food elements are necessary for the growth of plants. These nutrients are called 'essential elements'. In the absence of any one of these, a plant fails to complete its normal life cycle, though the disorder caused can be corrected by adding that element. These 16 elements are carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Molybdenum (Mb), Boron (B), and Chlorine (Cl). Green plants draw carbon from atmospheric carbon dioxide, hydrogen from water and oxygen from atmosphere and water, whereas, the remaining elements are taken from the soil. According to the amount present in the plant, they are grouped as macro- and micronutrients. The elements present in large amount are called macro-elements and those found in small quantities are termed as micro-elements. Iron, manganese, copper, zinc, boron, molybdenum

and chlorine are micronutrients, as only traces of these elements are required. However they are as important as macronutrients, which are required in abundance.

Role of water in plants

Water near the root zone is more important for plants as it creates a favourable ecosystem around the root zone. Water is a good conductor of minerals and nutrients. It maintains turbidity of cell and helps in various biochemical changes within the cell. Water is required for photosynthesis, in which carbohydrates are manufactured and oxygen is released. It is also needed for transpiration and different metabolic activities. Plants, generally, utilise the water present in the soil around the root zone. The deficiency of water near the root zone of a plant can be corrected by irrigation. Rain is the natural source of soil water, but sometimes, rhizospheric moisture has to be maintained through irrigation. For irrigation, different sources of water can be utilised as per convenience. Irrigation water may be taken from surface water as rivers, canals, lakes, ponds, etc., or may be pulled out of the soil (wells and tube wells). Percolation of rains, to improve the soil water level, can be obtained by the construction of soak pits in the field, bunds across the slope of land and planting crops across the slope (contour planting).

SESSION 1: PLANT NUTRIENTS

Role of nutrients in plants

Plant nutrients can be classified according to their function or importance in plant life development and production. This classification includes structural nutrients; accessory nutrients; regulators and carriers; and catalyst and activators.

Structural nutrients

These are of vital importance and required in large quantities and mostly available naturally. These nutrients include Carbon (C), hydrogen (H) and oxygen (O_2).

Accessory structural elements

These are also called 'macro-elements', which can be supplied through manures and fertilisers. These are essential for the growth and production of plants and formation of proteins. These are nitrogen, phosphorus and sulphur.

Regulators and carriers

These elements are potassuim (K), calcium (Ca) and magnesium (Mg), which regulate plant growth and build resistance against crop pests.

Catalysts and activators

Although these are required in very small quantities, they are equally important. These activate various chemical changes within the cell. These are iron (Fe), boron (B), manganese (Mn), molybdenum (Mo), zinc (Zn), chlorine (Cl) and copper (Cu).

Manures and fertilisers

Manures

Manures are decomposed organic matter derived from plants and animals. Besides providing supplement of plant nutrients, manures are beneficial in many ways. They enhance biological activities in the soil, and also improve structure, colour, aeration and water-holding capacity of the soil. Manures are slow in decomposing, hence, they release plant nutrients gradually, which can be used as organic fertilisers in agriculture.

Classification of organic manures

Manures can be classified in three groups as manures of plant origin, animal origin and composite derived from both plants and animals.

1. Manures of plant origin

Oil cake: The solid platy residue left after the extraction of oil from seeds is known as 'oil cake'. These oil cakes are applied to add nutrients to the soil, as well as, to improve the soil structure. The cake formed during the

extraction of oil from seeds may be:

- edible oil cakes: Groundnut cake, linseed cake, rapeseed cake, sesamum cake, etc.
- non-edible oil cakes: *Karanj* cake, neem cake, castor cake, etc.

Plant residues: Straw, husks, stalks, saw dust and wood ash also add nutrients to the soil.

Green manures: Green manure crop is raised and turned into the soil for decomposition. Green manures improve the physical structure of the soil, as well as, soil fertility. Crops, like *dhaincha* and sunn hemp are used as green manure.

2. Manures of animal origin

This includes animal's settled sludge, (dry) dried blood, night soil and sludge manure, fish manure bonemeal, cattle dung and urine mixed, sheep dung and urine mixed, pig manure, poultry manure, etc.

3. Composite manures

Manures are composed of material from both plant and animal origin.

Farmyard manure (FYM): It is well-decomposed dung of cattle, urine along with litter. Usually, dung and urine of animals along with their litter and waste feed are collected and placed in trench daily and when filled in, it is covered with soil. It decomposes in two–three months when it is considered usable in the field. It contains, on an average, 0.5% N, 0.2% P and 0.5% K. Only about 30 per cent of nitrogen, 60 to 70 per cent of phosphorus and 70 per cent of potassium content of the FYM are available for uptake by the first crop.

Compost: The mass developed after the rotting of organic matter is called 'compost'. Nowadays, super compost is also in vogue. It is developed using superphosphate @ 10–15 kg/t of raw material used. Farm waste, like sugarcane trash, paddy straw, plant debris, weeds or other waste materials are, generally, used by farmers to get compost. Such types of compost are called 'farm compost'. In contrast, compost made from street sweepings, night soil, dustbin refuse is known as town

compost. The composition of compost varies according to the base material used for decomposition. Farm compost contains 0.5% N, 0.5% p and 0.5% K. Town compost contains 1.4% N, 1.00% p and 1.4% K

4. Vermicompost

Vermicompost is developed using earthworms. Earthworms consume organic matter and excrete it as cast. This cast is used as vermicompost. It is rich in plant nutrients and beneficial bacteria and vescular arbuscular micorrhiza (VAM) fungi. Depending upon the types of base material used, vermicomopst, on an average contains 3% nitrogen, 1% phosphorus and 1.5% potassium.

Vermiwash is drained out extract of vermicompost. To prepare vermiwash, a vermicomposting unit is arranged with water trickling arrangement. This is used as a vermiwash for crop production. It contains more nutrients than vermicompost and finds favour for use as liquid manure.

Table 5.1: Nutrients supplied by manures (%)

S. No	Manure	N (%)	P_2O_5 (%)	K_2O (%)
1.	**Manures of animal origin**			
	a. Dried blood	0.5 – 1.5	0.4 – 0.8	0.5 – 1.9
	b. Fish manure	1.2 – 2.0	1.0	1.5
	c. Bonemeal	0 – 0.7	0.1 – 0.2	0.8 – 1.6
	d. Settled sludge (dry)	3.9 – 4.0	1.8 – 1.9	1.6 – 1.7
	e. Night soil	3.9 – 4.0	0.9 – 1.0	1.3 – 1.4
	f. Cattle dung and urine mixed	5.2 – 5.3	1.0 – 1.1	1.4 – 1.5
2.	**Manures of plant origin**	3.9 – 4.0	1.8 – 1.9	1.6 – 1.7
	a. Cotton seed cake	3.9 – 4.0	0.9 – 1.0	1.3 – 1.4
	b. *Karanj* cake	5.2 – 5.3	1.0 – 1.1	1.4 – 1.5
	c. Neem cake	5.5 – 5.6	1.4 –1.5	1.2 – 1.3
	d. Linseed cake	10.0–12.0	1.0 – 1.5	0.6 – 0.8
	e. Green manure			
	Wood ashes			
	a. Ash coal	0.73	0.45	0.53
	b. Ash babul	0.1 – 0.2	2.5 – 3.0	3.5 – 4.5
	Plant residue			
	Groundnut husk	1.6 – 1.8	0.3 – 0.5	1.3 – 1.7
3.	**Composite manures**			
	a. Farmyard manure (FYM)	0.5 – 0.7	0.4 – 0.8	0.5 – 1.9
	b. Compost (urban)	1.0 – 2.0	10 – 1.2	1.2 – 1.5
	c. Compost (rural)	0.4 – 0.8	0.3 – 0.6	0.7 – 1.0

Fertilisers

They are plant nutrients manufactured commercially from inorganic chemicals. They are ready-to-use nutrients in concentrated forms and contain much higher amount of nutrients than manure and are, therefore, used in small quantities. These chemicals get washed off through irrigation or rainwater and become unavailable at many instances. Chemical fertilisers being the source of a single nutrient is called a 'sole fertiliser'. Fertilisers that supply more than one nutrient are called 'mix' or 'complex fertilisers'.

Advantages

(i) Easily available anywhere
(ii) Calculated amount of nutrients can be applied
(iii) Required nutrient can be specifically applied
(iv) Fertilisers can be carried easily because of packing
(v) Easy to apply in different ways
(vi) Fertilisers are available in different formulations and concentrations
(vii) Nutrients are available at low cost

Disadvantages

(i) Leaches out or infiltrated with rains or irrigation water
(ii) Harmful if applied more than the the required quantity
(iii) Responsible for air and water pollution
(iv) Sometimes, may have adverse effect on soil properties
(v) Have to be stored carefully

Type of fertilisers

Sole fertilisers

These are the fertilisers that supply only a single nutrient. Sometimes it may be accompanied by a minor element. Sole fertilisers are further grouped according to the nutrients they supply.

Nitrogenous fertilisers: These are prepared and applied as a source of nitrogen to the crop. Commonly available nitrogenous fertilisers are urea, ammonium sulphate, calcium ammonium nitrate, etc.

Phosphorus or phosphatic fertilisers: These fertilisers are the main source of phosphorus only. Some commercially available phosphatic fertilisers are single superphosphate, triple super phosphate, dicalcium phosphate.

Potassic fertilisers: These are applied as a source of potassium. Commonly used potassic fertilisers are muriate of potash and potassium sulphate.

Mixed fertilisers (complex fertilisers)

Fertiliser with a source of more than one macro-nutrient for the plant is known as mixed fertiliser. Commonly used mixed fertilisers are di-ammonium phosphate (18:46:0), nitro-phosphate (20:20:0), ammonium phosphate (28:0:0), ammonium phosphate sulphate (16:20:0), calcium ammonium nitrate (8% Ca and 21–27% N), etc.

Almost all fertiliser companies are making soluble and field applicable mixed fertilisers. Now, NPK complex fertilisers are available in varying nutrient contents (19:19:19, 20:20:20, 20:40:0, etc.).

Fertiliser containing micronutrients

Chemical compounds used as a source of micronutrients are of two types, viz.

1. Chelates chemical compounds in the form of heterocyclic ring having a metal ion attached by coordinate bonds to at least two non-metal ions, such as EDTA, DTPA HEDTA, EDDHA, NTA, common chelated micronutrients being Zn-EDTA and Fe-EDTA.
2. Inorganic salts, such as zinc sulphate ($ZnSO_4$), copper sulphate ($CuSO_4$), ferrous sulphate ($FeSO_4$), manganese sulphate ($MnSO_4$), etc., are commonly used as micronutrient fertilisers. All these are soluble in water and can be used as soil application or foliar spray.

Practical Exercises

Activity

Identify various types of manures and fertilisers.

Material required: Samples of different manures and fertilisers

Procedure

1. Observe the given samples carefully.
2. Identify and write the names of the manures or fertilisers.
3. Write in brief their characteristics.
4. Note down the nutrient content of the manures or fertilisers.

Check Your Progress

Fill in the Blanks

1. The elements necessary for metabolic activities of an organism are referred to as _____.
2. The process of supplying nutrients and their intake is known as _____.
3. Green plants draw carbon from atmospheric_____.
4. Accessory structural elements are also called _____.
5. The mass developed after rotting of the organic matter is termed as _____.

Multiple Choice Questions

1. _____ elements are necessary for the growth of plants.
   (a) 16 (b) 14
   (c) 10 (d) 12
2. The elements required by plants in large amount are called _____.
   (a) micro-elements (b) macro-element
   (c) Both (a) and (b) (d) None of the above
3. Accessory structural elements are _____.
   (a) K, Ca, Mg (b) Cl, Br, I
   (c) N, P, S (d) C, H, O
4. The application of manures in soil increases the _____.
   (a) biological activities of soil
   (b) physiological activities of soil
   (c) moisture retention capacity of soil
   (d) All of the above

5. The solid platy residue left after the extraction of oil is known as _____.
   (a) oil (b) oil cake
   (c) essence (d) None of the above
6. Plant manures are composed of material from _____.
   (a) plant origin (b) animal origin
   (c) Both (a) and (b) (d) None of the above
7. Plant nutrients manufactured commercially through chemical process are _____.
   (a) fertilisers (b) biofertlisers
   (c) manure (d) green manures
8. Fertilisers that supply more than single nutrients are called _____.
   (a) sole fertilisers (b) manures
   (c) biofertiliser (d) mix fertilisers

Subjective Questions

1. How can plant nutrients be classified according to their functions in plants?
2. How are manures different from fertilisers?
3. Write down the advantages and disadvantages of fertiliser application.
4. What are the different types of fertilisers?

Match the Columns

A	B
1. Structural nutrients	(a) Fe, B, Mo
2. Accessory structural	(b) K, Ca, Mg
3. Regulators and carriers	(c) N, P, S
4. Catalysts and activators	(d) C, H, O

SESSION 2: APPLICATION OF MANURES AND FERTILISERS

Methods of manure application

In order to get maximum benefit from fertiliers and manures, they should be applied at proper time in proper quantity and in the right manner. The method of manure application depends on its type.

Types of manure

Bulky manures

FYM or other bulky manures should be broadcasted over the entire area and mixed well with the soil by

harrowing. The application of manures depends on the season to avoid leaching of nutrients. In light rainfall areas, the manures may be applied during monsoon, whereas, in heavy rainfall areas after monsoon.

Concentrated manures

Oil cakes, fish manure and bloodmeal are known as concentrated organic manures. These manures should be applied well in advance because they are not available quickly as they have to be broken down by soil microbes and made available to plants.

Farmyard manure (FYM)

Well-rotten FYM can be applied just before sowing and partially rotten FYM has to be applied 20–30 days before sowing. Usually, 10–20 tonne per hectare FYM is applied. It must be made sure that FYM is applied at least two weeks before sowing to avoid immobilisation of nitrogen. FYM is, generally, carried to the field in a cart and dumped all over the field in small heaps. It is then spread all over the field. However, care should be taken that the heaps are not left in the field for a long time as volatilisation loss of nitrogen might take place. The FYM should be preferably incorporated in the soil by deep ploughing or harrowing immediately. It improves the physical, chemical and biological properties of the soil.

Fertiliser application

Time of application

Generally, organic manures are applied while preparing the land so that they improve the structure and water-holding capacity of the soil. Fertilisers are normally applied just before or soon after planting. The frequency and amount of application depends on the crop, soil and season.

Application of fertilisers in solid form

It includes the following methods:

Broadcasting

Basal application

Depending on the crop, broadcasting of fertiliser is carried out prior to sowing and planting just before the last ploughing is incorporated in the field.

Top dressing

When fertilisers are broadcast in the standing crop, it is known as top dressing. In this method, usually, nitrogenous fertilisers and micronutrients are applied in dense sown flower crop.

Placement

Place the fertiliser in well-prepared soil before sowing, irrespective of the position of seeds. There are two types of fertiliser placement techniques.

Plough furrow and single band placement

Application of fertiliser in narrow bands beneath and by the side of crop row/furrow is called 'band placement' of fertilisers. This is done during the process of ploughing. This method can be adopted

- when soil has low fertility,
- when fertiliser reacts with soil constituents leading to the fixation of nutrients, and
- where volatilisation loss is very high. In single band placement, fertilisers are applied on the side of the planted row.

When the fertiliser is applied in two bands, i.e., on both the sides of the planted rows, it is called 'double band placement'. Placement of fertilisers is commonly used for the application of NPK fertilisers in an orchard.

Deep placement

Placement of the fertiliser is, generally, practised for the application of nitrogenous and phosphatic fertilisers and in paddy fields. It is commonly recommended in dry land agriculture.

Ring placement

The quantity of fertiliser per plant is calculated and applied at some depth around the plant circle,this method is mostly practised in orchard crop.

Application of fertilisers in liquid form

Foliar application

It can be used with fertiliser nutrients readily soluble in water. It is also used when there is a soil fixation problem. In this method, it is difficult to apply sufficient amount of major elements. Nutrient concentration of 1% to 2% can be applied without injury to foliage. Foliar application, therefore, is commonly used only to apply minor elements or to supplement the major elements.

Fertigation

This application of fertilisers is through the irrigation water. Nitrogen is the principle nutrient commonly used for this purpose. Potassium and highly soluble forms of zinc and iron can also be readily applied this way. When an element forms precipitate with another substance commonly found in the irrigation water, it is not advisable to use this method. Phosphorus and anhydrous ammonia may form a precipitate in water with high calcium and magnesium content. So they are not used in fertigation. Normally, this system is used through drip irrigation, and liquid fertilisers containing all three major nutrients are normally used.

Green manuring

Some plants, after decomposing, add plant nutrients to the soil and improve the soil condition. Such plants

are called 'green manure crops'. Manuring of the soil by this method is called 'green manuring'. Some green manuring plants at immature or flowering stage are buried as a whole into the soil, while in some cases, only leaves are added to the soil. Selection of the practice depends upon the soil, climatic conditions and availability of green manuring crop.

Plants are grown in the field for 6–8 weeks, and then, they are ploughed and turned in the soil where they have grown. This type of green manuring is called *in situ* practice. These plants are fast-growing, having short life period, and hence, decompose early when added to the soil at a tender stage. Manuring crops are exclusively grown for the purpose and buried before the planting of the main crop or grown as an intercrop along with the perennial crop. This system of manuring is common in northern India. Plants used as a whole for green manuring are *dhaincha*, sunhemp and cluster bean.

In some cases, shrubs or trees of manuring plants are grown on field bunds or in wasteland. This system is common in eastern and central India. Leaves and tender twigs of these plants are collected and turned on while ploughing the main field. The leaves from trees and shrubs used as green manure are *Sesbania speciosa*, *Glyricidia maculata*, *karanj*, etc. These plants are commonly found in the wild, as well as, grown for this purpose.

Advantages of green manure

(i) It improves the soil structure.
(ii) Due to slow decomposition, once applied, it releases gradually.
(iii) It adds organic matter to the soil.
(iv) It lowers the runoff and facilitates the infiltration of rainwater.
(v) Nutrients that otherwise may leach out are held up by plants.
(vi) Leguminous crop when used as green manure fixes nitrogen to the soil through root nodules.

(vii) It stimulates the activity of soil microorganisms.
(viii) It checks the growth of weeds when grown as an intercrop.
(ix) Nutrients at the deeper layer may be brought up by the manure crop.

Bio-fertilisers

They are preparations containing microorganisms, such as bacteria, fungi, and algae in sufficient quantity, helping plant growth and nutrition. Bio-fertilisers help to add, conserve and stimulate plant nutrients in the soil. Some microorganisms fix atmospheric nitrogen symbiotically, some convert insoluble phosphates to soluble phosphates in the soil. They decompose the complex organic matter and make them easily available to plants. Microorganism activities in the soil are significant in improving the soil fertility. Following are the different types of bio-fertilisers.

1. Rhizobium
2. Azotobacter
3. Azospirillium
4. Blue-green algae
5. Azolla
6. Phosphate-solubilising microorganism
7. Mycorrhiza

Bio-fertiliser supplying plant nutrient

Nitrogen

There are three types of nitrogen-fixing bacteria, besides a group of algae. They are:

(a) Symbiotic nitrogen-fixing bacteria, e.g., *Rhizobium*
(b) Associative nitrogen-fixing bacteria, e.g., *Azospirillium*
(c) Free living nitrogen-fixing bacteria, e.g., Azotobacter, Bacillus, etc.
(d) Free-living blue green algae, e.g., *Anabaena, nostoc.*

Phosphorus

There are two types of phosphorus mobilising microorganism:

(a) Phosphate-solubulising microorganism, e.g., Phospho-bacteria
(b) Microorganism helping in phosphorus uptake, e.g., Mycorrhizal fungi.

Use of bio-fertiliser in flower crop

Different types of bio-fertilisers, such as *Azotobacter*, *Azospirillum*, phosphorus solubilising bacteria (PSB) and Mycorrhiza fungi are applied in various flower crops, i.e., tuberose, rose, carnation aster, marigold and jasmine, etc. These bio-fertilisers not only have a limited role in improving the nutrient uptake by plants but also help in enhancing the quality produce of flowers along with reducing the cost of cultivation. These are a potential source of nutrients for sustainable systems of horticulture and floriculture.

In India, commercial use of bio-fertilisers in flower crops is limited. It is used for research and academic purposes only.

Practical Exercises

Activity

Demonstration of application of fertilisers in ornamental crops.

Material required: Fertilisers

Procedure

1. Identify and select the fertilisers for application.
2. Select a crop or a plot for the application of fertiliser.
3. Apply fertiliser, i.e., broadcasting placement.
4. Note the care and precautions to be taken while dealing with chemical fertilisers.

Check your Progress

Fill in the Blanks

1. Nitrogen in ammonia form takes _____ days after application to be available to plant.
2. A fertiliser is readily soluble and easily available to the plant _____.
3. Uniform spreading of manure or fertilisers by hand over the entire surface of field is termed as _____.

4. Spreading or broadcasting of fertilisers in the standing crop is known as _____.
5. When fertiliser is placed in bands to the side of seedling, it is called _____.

Multiple Choice Questions

1. In heavy rainfall areas, the manures may be applied _____.
   (a) after the monsoon
   (b) during monsoon
   (c) before monsoon
   (d) None of the above
2. What about plant nutrient is true?
   (a) Requirements differ with crop and stages of growth
   (b) Efficiency depends on time and methods of application
   (c) Crop response to fertiliser application
   (d) All of the above
3. Nutrients in manures are _____.
   (a) readily available
   (b) not available
   (c) slowly available
   (d) partially available
4. Fertilisers are applied mainly _____.
   (a) to supply nutrients to the crops
   (b) to correct deficiency
   (c) for proper growth and development of crop
   (d) All of the above
5. In which form nitrogen is easily available to plants?
   (a) Nitrate
   (b) Nitrite
   (c) Ammonia
   (d) None of the above
6. Manures and fertilisers can be applied _____.
   (a) during the cultivation of land
   (b) after the seed is sown
   (c) in standing crop
   (d) All of the above

Subjective Questions

1. What are bio-fertlisers? How can they be classified?
2. Write down the precautions that need to be taken while applying bio-fertilisers?
3. What is green manure? What are its advantages and disadvantages?
4. Compare the advantages of green manure and bio-fertilisers.

Match the Columns

A	B
1. BGA	(a) Obligate symbiont
2. PSBF	(b) Bacteria fix nitrogen in leguminous crops
3. *Azolla*	(c) Bacteria also increase mineral and water uptake
4. *Azotobacter*	(d) Cyanobacteria
5. *Azospirillum*	(e) Fern plant, suitable for flooded rice
6. *Rhizobium*	(f) Convert insoluble soil phosphate into soluble forms
7. VAM	(g) Non-symbiotic bacterium

SESSION 3: IRRIGATION AND DRAINAGE

The artificial supply of water to support plant growth and production in the absence of adequate supply of water through rainfall is known as irrigation.

Methods of irrigation

There are three methods of irrigation, viz. surface, sub-surface and aerial, overhead or sprinkler irrigation.

Surface irrigation

There are four ways of applying surface irrigation.

1. Flood irrigation
2. Furrow method
3. Basin method
4. Ring method

Flood irrigation method

It is a traditional practice of irrigation. In this method, water is delivered through pipe or open water channel in a field so that the irrigated water can move freely in all directions and cover the surface of the land in a continuous sheet as in case of flood. The entire field is brought under water through the available irrigation source.

Features

(i) It is followed in densely planted crops.
(ii) It is practised in areas with ample and easily available water.
(iii) It is applied in soils not eroding easily.
(iv) It is given to soils, which are permeable.
(v) It is given in land, which is well-levelled having systematic gradual slopes.

Advantages

(i) It is useful for shallow soil.
(ii) Operation costs are very low.

Disadvantages

(i) As compared to other systems, the water requirement is more.
(ii) Due to runoff and deep percolation, the loss of water is very high.
(iii) There is excessive soil erosion on steep land.
(iv) Loss of manure and fertiliser are eroded from the soil.
(v) It is not recommended in highly spacious crops.
(vi) It enables more weed population in the field.

Border irrigation method

The land is levelled and divided into different strips by making soil bunds of 30 cm height in between each strip. Strips of 3–10 m width and 30–90 m length with 0.5% slope are formed. The width is adjusted so as to permit the water to flow evenly and wet the land uniformly. This system is appropriate for broadcast or crop plant sown lines. Apart from sandy soil, this method is the most suitable of the soil textures.

Advantage

(i) It is suitable to irrigate crops on steep slopes, up to 7 per cent slopes.

Disadvantages

(i) Larger flows are required for irrigating border strip.
(ii) For laying out strip, the land is to be graded uniformly. The water requirement is more.

(iii) It is suited only for soils that do not readily disperse
(iv) To avoid waterlogging, proper drainage system is required.

Furrow (ridges) irrigation method

In this method, water is applied to the field in furrows between two ridges. These furrows are lined among rows of the crop according to the slope of the land. Furrows, 3–6 metres in length, are spread in such a way that water reaches to every nook and corner of the cultivated land. Planting is done in the side of the ridges and water is given through the adjoining furrow. Here, the plant stem does not come in direct contact with water. Irrigation furrows may run straight according to the slope of land, so there is great economy in the use of water.

Advantages

(i) High water efficiency
(ii) Entire land surface is not covered with water so weed problem is minimised
(iii) Can be used in any row crop
(iv) Alternate furrow irrigation may be adopted to save water
(v) Relatively easy in stalling
(vi) Not expensive to maintain
(vii) Adapted to most soils

Disadvantages

(i) More skilled persons are required.
(ii) It is essential to provide drainage system.
(iii) Excess water penetrates at the opening and at the end.
(iv) It is not applicable on uneven land.

Basin method

This method is widely used in orchards. A basin is a small patch of land bunded around a tree. The soil, gradually, slopes down from the base of the tree to the edge of the basin.

Sub-surface method

In this system, the water is led into underground perforated pipes. By the upward capillary movement, the water slowly reaches the root regions of the plant. This method of irrigation is not commonly practised in orchards and plantations.

Sprinkler or overhead irrigation

In this method, water is sprinkled over the crop, as well as, on soil in a circular fashion as rain does. Water with pressure is forced with revolving sprinkler nozzles through pipes fitted with stand. The nozzles revolve due to pressure of water and spread water in the form of thin spray. Water can be applied at controlled rate and distributed uniformly. This is a more efficient system as compared to the other methods. It is an ideal system for hilly and undulating regions, where other systems cannot be used.

Advantages

(i) It ensures uniform distribution of water up to a depth of 10–15 mm.
(ii) It is adaptable to most kinds of soil and useful in plains, as well as, in undulated land.
(iii) This method saves water up to 30–35 per cent
(iv) An increase in yield up to 20–25 per cent has been reported.
(v) Fertilisers and pesticides can also be applied by this method.
(vi) There is no obstacle during the use of farm implements.
(vii) Fertilisers may be applied uniformly through sprinklers.
(viii) More area of land can be covered for irrigation.
(ix) Costly land levelling operations are not necessary.
(x) Amount of water can be controlled to meet the needs of young seedlings or mature crops.
(xi) This system is useful for controlling frost during freezing temperature.

Disadvantages

(i) The installation cost is very high.
(ii) High wind velocity influences the distribution pattern of water
(iii) Regular maintenance of system is required to avoid clogging of nozzles.
(iv) Skilled labourers are required for operation and maintenance of the system.
(v) Water should be free from salts and other suspended matter.
(vi) It requires regular supply of water
(vii) It is not useful in case of tall growing crops with more spacing.

Drip or trickle irrigation

In this system, water is led through plastic pipes, and finally, let out through mechanical devices called 'emitters'. There is a direct and continuous wetting of the root region. This system ensures highest efficiency in the use of water.

Advantages

(i) There is minimum loss of irrigation water by percolation and evaporation.
(ii) Water is supplied as per the requirement of the crop and optimum moisture is always maintained.
(iii) This system also facilitates the supply of liquid fertilisers directly to the roots of the plant through venturi assembly.
(iv) It saves water up to 40–60 per cent.
(v) An increase in yield by 10–25 per cent has been reported in several crops.
(vi) Problem of weed and cost of labour are minimised.
(vii) Low humidity in the field, coupled with weed-free environment, minimises pest attack.
(viii) It is ideal for slopes or undulated land, especially hills.

Disadvantages

(i) The initial cost for the installation of the unit is very high.
(ii) Skilled human resource is required for frequent maintenance.
(iii) It is not suitable where water or sub-soil contains an appreciable amount of salt.

Drainage

Removing excess water by artificial means from the soil is known as drainage.

Drainage problems

(i) Regular drainage avoids accumulation of water around plants. It facilitates the availability of moisture and aeration to roots.
(ii) It eases tillage and other intercultural operations.
(iii) Proper drainage improves the structure of the soil.
(iv) Bacteria that convert organic matter into plant food, get necessary air and warm temperature in well-drained soil.
(v) It improves root development and absorption of nutrients by plants.
(vi) Favourable conditions facilitate seeds to germinate faster.
(vii) Healthy and fast growth crop plants escapes many diseases and pest attack.
(viii) Draining water leached many soluble toxic salts from surface to deep layers of soil.

Advantages

(i) Drainage avoids accumulation of water around the plant. It facilitates availability of moisture and aeration to the roots.
(ii) It eases tillage and other intercultural operations.
(iii) The structure of the soil improves.
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Practical Exercises

Activity

Draw a layout of border irrigation method on a piece of land.

Procedure

1. Level the land and divide it into different strips.
2. Make soil bunds of 30 cm height in between each strip.
3. Make strips of 3–10 m width and 30–90 m length with 0.5% slope.
4. The width is adjusted so as to permit the water to flow evenly and wet the land uniformly.
5. For high value crops or in water scarcity areas, the beds may be still smaller.

Check your Progress

Fill in the Blanks

1. The artificial supply of water to support plant growth and production in the absence of adequate supply of water through rainfall is known as _____.
2. Surface irrigation is irrigation through _____ of the surface, bed or border method, ring and basin method and furrow method.
3. Basin method of irrigation is suitable for _____ crop.
4. An irrigation method that involves slow application of water to the root zone is called _____.
5. Water with pressure is forced through revolving nozzles is _____ system of irrigation.

Multiple Choice Questions

1. Flood irrigation is followed in _____.
   (a) highly spaced crops
   (b) densely planted crops
   (c) Both (a) and (b)
   (d) None of the above

2. Waterlogging (bad drainage) is a problem that arises due to _____.
   (a) excessive or continuous use of water
   (b) hard pan to lower strata
   (c) slow-permeable soils
   (d) All of the above
3. What about the sprinkler system of irrigation is true?
   (a) It saves water up to 30–35 per cent.
   (b) It distributes water up to a depth of 10–15 mm.
   (c) Both (a) and (b)
   (d) None of the above
4. Addition of sulphuric acid or sulphur _____ the pH of irrigation water.
   (a) increases (b) reduces
   (c) neutralises (d) None of the above

Subjective Questions

1. Why is irrigation important for plant life?
2. What are the different methods of irrigation? Describe sprinkler irrigation.
3. Give the merits and demerits of border irrigation system.
4. What is drip irrigation? How is it useful?

Match the Columns

A	B
1. Flood irrigation	(a) Slow application of water to the root zone
2. Border irrigation method	(b) Size of the plot to be irrigated is very small
3. Basin irrigation	(c) Suitable to irrigate crops on steep slopes
4. Furrow (ridges) method	(d) Followed in densely planted crops
5. Sprinkler irrigation	(e) High water efficiency
6. Drip or trickle irrigation	(f) Water is forced through revolving nozzles