14 WATER LOGGING AND FIELD DRAINAGE

For optimum growth and yield of field crops, proper balance between soil air and soil moisture is quite essential. Except rice many of the cultivated plants cannot withstand excess water in the soil. The ideal condition is that moisture and air occupy the pore spaces in equal proportions. When the soil contains excess water than that can be accommodated in the pore spaces it is said the field is water logged.

Causes of water logging

1. Excessive use of water when the water is available in abundance or cheaply due to the belief that more water contributes better yield.
2. Improper selection of irrigation methods
3. Percolation and seepage from lands canals and reservoir located at nearby elevated places
4. Improper lay out and lack of outlets
5. Presence of impervious layer with profile impeding percolation
6. Upward rise of water from shallow ground water table or aquifer.

Effects of water logging

Direct effects

Replacement of soil air which is the main source of oxygen for the roots as well as soil microbes.

Due to high amount of CO_2 in soil air high CO_2 concentration under water logged condition will kill plant roots.

Sometimes superficial root system or air space in root system will develop.

Due to poor aeration intake of water and nutrient will be reduced.

Indirect effects

Nutrients are made un-available due to leaching

Toxic elements will be formed under anaerobic condition

Composition of organic matter under anaerobic condition results in production of organic acids like butyric acid which is toxic to plants.

Reduces the availability of N, Mn, Fe, Cu, Zn, mb,

Reduces soil temperature

Reduces the activity of beneficial microbes

Destruct soil structure

Difficult for cultural operations

Incidence of pest, disease and weeds

Changes for some elements in water logged condition

Elements	Normal form	Reduced form water logged soil
Carbon	Carbon di oxide	Methane (H4) complex aldehyde
Nitrogen	Nitrate No_3	Nitrogen (N) and NH_2 amides, ammonia
Sulphur	Sulphate So_4	Hydrogen sulphide (H_2S)

Drainage

It is the process of removal of excess water as free or gravitational water from the surface and the sub surface of farm lands with a view to avoid water logging and creates favourable soil conditions for optimum plant growth.

Need for drainage

It is generally assumed that in arid region drainage is not necessary and water logging is not a problem. Even in arid region due to over irrigation and seepage from reservoirs canals etc., drainage becomes necessary.

Irrigation and drainage are complementary practices in arid region to have optimum soil water balance.

In humid region drainage is of greater necessity mainly due to heavy precipitation.

Drainage is required under the following condition

a) High water table
b) Water ponding on the surface for longer periods
c) Excessive soil moisture content above F.C, not draining easily as in clay soil
d) Areas of salinity and alkalinity where annual evaporation exceeds rainfall and capillary rise of ground water occurs
e) Humid region with continuous of intermittent heavy rainfall
f) Flat land with fine texture soil
g) Low lying flat areas surrounded by hills

Characteristics of good drainage system

1. It should be permanent
2. It must have adequate capacity to drain the area completely
3. There should be minimum interference with cultural operated
4. There should be minimum loss of cultivable area
5. It should intercept or collect water and remove it quickly within shorter period

Methods of drainage

There are two methods

1. Surface method
2. Sub surface method

Surface drainage

This is designed primarily to remove excess water from the surface of soil profile. This can be done by developing slope in the land so that excess water drains by gravity.

It is suitable for

(i) Slowly permeable clay and shallow soil

(ii) Regions of high intensity rainfall

(iii) To fields where adequate out lets are not available

(iv) The land with less than 1.5% slope

It can be made by

a) Land smoothing

b) Making field ditches

The surface drainage can be further classified as

a) Life drainage

b) Gravity drainage

c) Field surface drainage

d) Ditch drainage

Lift drainage

To drain from low lying area or areas having water due to embankment, life drainage is used. Water to be drained is lifted normally by opened devices unscoops or by pumping or by mechanical means. This method is costly, cumbersome and time consuming but effective and efficient to drain standing water over the soil surface.

Gravity drainage

Water is allowed to drain from the areas under higher elevation to lower reaches through the regulated gravity flow through the out let of various types. This system is practiced in wet land rice with gentle to moderate slope.

This method is less costly, easy and effective however the area to be drained should be leveled smooth and slightly elevated from the drainage source.

Field surface drainage

The excess water received from the rain or irrigation is drained through this method. The irrigated basins or furrows are connected with the drainage under lower elevation which is connected to the main out let and to the farm pond used for water harvesting. If the slope of the land is sufficient to drain excess water from the individual plot, this drain water may be collected and stored locally in reservoir for recycling for life

saving irrigation. This drainage method is cheap and effective but there is possibility of soil erosion and distribution of weed seeds along the flow of drainage water.

Ditch drainage

Ditches of different dimension are constructed at distances to drain the excess water accumulated on the surface and inside the soil upto the depth of ditch. Such ditches may be interceptors or relief drains. This method is adopted in nurseries, seed beds and rainfed crops. This is an effective and efficient method but requires smoothening of surface and construction of ditches. This involves cost and wastage of crop lands. Shifting of soil, restriction for the movement of farm machineries reconstruction and renovation of ditches during the crop duration and harvesting of crops and the problems in this method. In flat land, bed or parallel field ditches may be constructed. The collector ditches should be across the field ditches.

Advantages	**Disadvantages**
Low initial cost	Low efficiency
Easy for inspection	Loss of cultivable land
Effective in low	Interference to cultural operation
Permeability area	High maintenance cost

Sub surface drainage system

Sub surface drains are under ground artificial channels through which excess water may flow to a suitable outlet. The purpose is to lower the ground water level below the root zone of the crop. The movement of water into sub surface drains is influenced by

1. The hydraulic conductivity of soil
2. Depth of drain below ground surface
3. The horizontal distance between individual drains

Underground drainage is mostly needed to the

Medium textured soil

High value crop

High soil productivity

The are four types of sub surface drainage

1. Tile drainage
2. Mole drainage
3. Vertical drainage
4. Well Drainage / or Drainage wells

Advantage of sub surface

1. There is no loss of cultivable land
2. No interference for field operation
3. Maintenance cost is less
4. Effectively drains sub soil and creates better soil environments

Disadvantage

1. Initial cost is high
2. It requires constant attention
3. It is effective for soils having low permeability

1. Title drainage

This consist of continuous line of tiles laid at a specific depth and grade so that the excess water enters through the tiles and flow out by gravity. Laterals collect water from soil and drain into sub main and then to main and finally to the out let. Tile drains are made with clay and concrete, Tiles should be strong enough to withstand the pressure and also resistant to erosive action of chemicals in soil water.

2. Mole drainage

Mole drains are unlined circular earthen channels formed within the soil by a mole plough. The mole plough has a long blade like shank to which a cylindical bullet nosed plug is attached known as mole. As the plough is drawn through the soil the mole forms the cavity to a set depth. Mole drainage is not effective in the loose soil since the

channels produced by the mole will collapse. This is also not suitable for heavy plastic soil where mole seals the soil to the movement of water.

3. Vertical drainage

Vertical drainage is the disposal of drainage water through well into porous layers of earth. Such a layer must be capable of taking large volume of water rapidly. Such layers are found in river bed.

4. Drainage wells

The wells are used for the drainage of agricultural lands especially in irrigated areas.

Systems of drainage

There are five systems of drainage

1. Random 2. Herringbone 3. Grid iron 4. Interceptor

1. Random

This is used where the wet area are scattered and isolated from each other. The lines are laid more or less at random to drain these wet areas. The main is located in the largest natural depression while the submains and laterals extend to the individual wet areas.

2. Herring bone

In this system the main are in a narrow depression and the laterals enter the main from both side at an angle of 45^0 like the bones of a fish.

3. Gridiron

The gridiron is similar to herringbone but the laterals enter the main only from one side at right angles. It is adopted in flat regularly shaped fields. This is an efficient drainage system.

4. Interceptor

Ditches of different dimension are constructed at distance to drain the excess water accumulated on the surface and inside the soil upto the depth of ditch. Such ditches may be interceptors or relief drains. This method is adopted in nurseries, seed beds and rainfed crops. This is an effective and efficient method but requires smoothening of surface and construction of ditches. This involves cost and wastage of crop lands. Shifting of soil, restriction for the movement of farm machineries reconstruction and renovation of ditches during the crop duration and harvesting of crops are the problems in this method. In flat land, bed or parallel field ditches may be constructed. The collector ditches should be across the field ditches.