Irrigation - Time and methods - Modern techniques of irrigation - Drainage and its importance

IRRIGATION

Irrigation is defined as the artificial application of water to the soil for the purpose of crop production in supplement to rainfall and ground water contribution.

Importance of water to plants

1. Plants contain 90% water which gives turgidity and keeps them erect
2. Water is an essential part of protoplasm
3. It regulates the temperature of the plant system
4. It is essential to meet the transpiration requirements
5. It serves as a medium for dissolving the nutrients present in the soil
6. It is an important ingredient in photosynthesis

TIME OF IRRIGATION

Crops draw water from the moisture stored in the soil. When the moisture present in the soil is low, then the plant requirements are not met with. When the soil is supplied with moisture in excess the supply of air is reduced that limits the plants growth. In between, there is a range of moisture content that is called as optimum soil moisture range for plant growth.

The upper limit of the optimum soil moisture range is the field capacity (-0.01 to -0.03 Mpa) and the lower limit is just above the wilting point (-1.5 Mpa). The objective of irrigation is to store the moisture in the soil between these limits. Immediately after irrigation, all the macro and micropores will be filled with water. All the water present in macropores will drain to subsoil within 48 hours and moisture in micropores will be available to plants.

As the soil dries due to loss of water by evaporation and transpiration, the plant wilts during day time to conserve moisture and become normal at night. When the same condition continues, the plant will wilt without dieing. This condition is called as wilting coefficient. The irrigation is given whenever plants require water. This is decided by the crop and soil appearance.

IRRIGATION METHODS

1. Surface 2. Sub-surface 3. Pressurized irrigation

Criteria for selection of irrigation method

- Water supply source
- Topography
- Quantity of water to be applied
- The crop
- Method of cultivation

Surface irrigation methods

Oldest (4000 years back) and most common method. 90% of world's total irrigated area is under this method. In USA also, 66% is by surface irrigation. This method is most suitable for low to moderate infiltration rates and leveled lands and having <2-3% slope. It is labour intensive.

Surface is grouped as Border, check basin and furrow irrigations. Border is again classified in to two as straight and contour. Check basins may be of rectangular, contour or ring, furrow irrigation is classified as deep furrow and corrugated furrows. These may be again straight or contour according to direction and leveled and graded as per their elevation.

1. Border irrigation

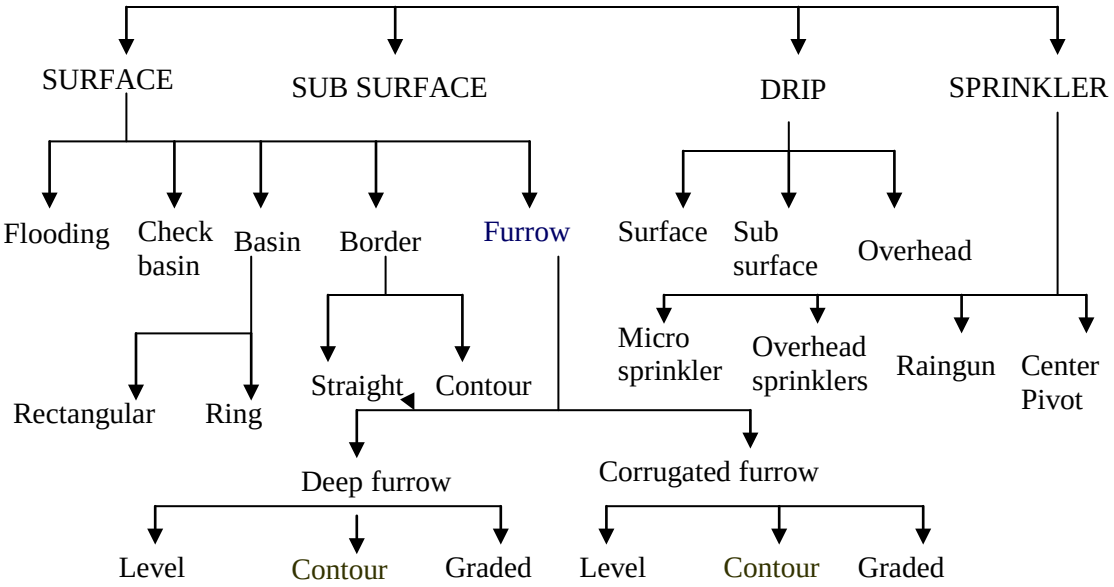
The land is divided into number of long parallel strips called borders. These borders are separated by low ridges. The border strip has a uniform gentle slope in the direction of irrigation. Each strip is irrigated independently by turning the water in the upper end. The water spreads and flows down the strip in a sheet confined by the border ridges.

***Suitability*:** Suitable to soils having moderately low to moderately high infiltration rates. It is not used in coarse sandy soils that have very high infiltration rates and also in heavy soils having very low infiltration rate. Suitable to irrigate all close growing crops like wheat, barley, fodder crops and legumes and not suitable for rice

Advantages

a) Border ridges can be constructed with simple farm implements like bullock drawn "A" frame ridger or bund former.
b) Labour requirement in irrigation is reduced as compared to conventional check basin method.
c) Uniform distribution of water and high water application efficiencies are possible.
d) Large irrigation streams can be efficiently used.
e) Adequate surface drainage is provided if outlets are available.

IRRIGATION METHODS



2. Check basin irrigation

It is the most common surface irrigation method. Here, the field is divided into smaller unit areas so that each has a nearly level surface. Bunds or ridges are constructed around the area forming basins within which the irrigation water can be controlled. The water applied to a desired depth can be retained until it infiltrates into the soil. The size of the basin varies from 10 m^2 to 25 m^2 depending upon soil type, topography, stream size and crop.

Adaptability

- Small gentle and uniform land slopes and soils having moderate to low infiltration rates.
- Adapted to grain and fodder crops in heavy soils and suitable to permeable soils

Advantages

- Check basins are useful when leaching is required to remove salts from the soil profile.
- Rainfall can be conserved and soil erosion is reduced by retaining large part of rain
- High water application and distribution efficiency.

Limitations

- The ridges interfere with the movement of implements.
- More area occupied by ridges and field channels.
- The method impedes surface drainage
- Precise land grading and shaping are required
- Labour requirement is higher.
- Not suitable for crops which are sensitive to wet soil conditions around the stem

3. Furrow irrigation

It is used for row crops. The furrows are formed between crop rows. The dimension of furrows depend on the crop grown, equipment used and soil type. Water is applied by small running streams in furrows between the crop rows. Water infiltrates into soil and spreads laterally to wet the area between the furrows. In heavy soils, furrows can be used to dispose the excess water.

Adaptability

- Method used for wide spaced row crops including vegetables.
- Suitable for maize, sorghum, sugarcane, cotton, tobacco, groundnut, potatoes
- Suitable to most soils except sandy.

Advantages

- Water in furrows contacts only 1/2 to 1/5 of the land surface.
- Labour requirement for land preparation and irrigation is reduced.
- Compared to check basins, there is less wastage of land in field ditches

There are three types of furrow irrigation, they are, all furrow irrigation, alternate furrow irrigation and skip furrow irrigation

4. Surge irrigation

- Surge irrigation is the application of water into the furrows intermittently in a series of relatively short ON and OFF times of irrigation cycle.
- It has been found that intermittent application of water reduces the infiltration rate over surges thereby the water front advances quickly. Hence, reduced net irrigation water requirement.
- This also results in more uniform soil moisture distribution and storage in the crop root zone compared to continuous flow.
- The irrigation efficiency is in between 85 and 90%.

II. SUB-SURFACE IRRIGATION

In subsurface irrigation, water is applied beneath the ground by creating and maintaining an artificial water table at some depth, usually 30-75 cm below the ground surface. Moisture moves upwards towards the land surface through capillary action. Water is applied through underground field trenches laid 15-30 m apart. Open ditches are preferred because they are relatively cheaper and suitable to all types of soil. The irrigation water should be of good quality to prevent soil salinity.

Advantages

- Minimum water requirement for raising crops
- Minimum evaporation and deep percolation losses
- No wastage of land
- No interference to movement of farm machinery
- Cultivation operations can be carried out without concern for the irrigation period.

Disadvantages

- Requires a special combination of natural conditions.

- There is danger of water logging
- Possibility of choking of the pipes lay underground.
- High cost.

III. PRESSURIZED OR MODERN IRRIGATION SYSTEMS

a. Drip irrigation system

Or trickle irrigation is one of the latest and modern methods of irrigation. It is suitable for water scarcity and salt affected soils. Water is applied in the root zone of the crop. Standard water quality test needed for design and operation of drip irrigation system.

Drip components

- A drip irrigation system consists of a pump or overhead tank, main line, sub-mains, laterals and emitters.
- The mainline delivers water to the sub-mains and the sub-mains into the laterals.
- The emitters which are attached to the laterals distribute water for irrigation.
- The mains, sub-mains are usually made of PVC (poly vinyl chloride) pipes and and laterals of LLDPE tubes. The emitters are also made of PVC material.
- The other components include pressure regulator, filters, valves, water meter, fertilizer application devices etc.

Advantages of drip irrigation

- High water use efficiency (~95%, compared to less than 50% in surface)
- Flexibility of wetted area
- Versatile selection of emitters: type, discharge rate, position
- Economy in weed control
- Low interference with cultivation
- Day and night irrigation
- Prevention of leaf wetting
- Energy saving
- Salinity control
- Irrigation at variable topographic conditions.

Limitation of drip Irrigation

- High investment
- High level of knowledge for optimal and economical operation
- Susceptibility to mechanical damage
- Large number of emitters
- Long application time
- High level of filtration and other controls
- Maintenance.

b. Sprinkler irrigation system

This is another important modern irrigation techniques followed all over the globe. Sprinkler irrigation is application simulating rainfall overhead so overhead sprinklers. The sprinkler (overhead or pressure) irrigation system conveys water to the field through pipes (aluminium or PVC) under pressure with a system of nozzles. This system is designed to distribute the required depth of water uniformly, which is not possible in surface irrigation. Water is applied at a rate less than the infiltration rate of the soil hence the runoff from irrigation is avoided.

Types of sprinkler system

On the basis of arrangement for spraying irrigation water, they are classified as, rotating head (or) revolving sprinkler system and perforated pipe system

Based on the portability, sprinkler systems are classified as, portable system, semi permanent system, solid set system and permanent system.

Advantages of sprinkler

- Suitable for undulating topography (sloppy lands)
- Water saving (35-40%) compared to surface irrigation methods.
- Fertilizers and other chemicals can be applied through irrigation water
- Saving in fertilizers, even distribution and avoids wastage.
- Reduces erosion
- Suitable for coarse textured soils (sandy soils)
- Frost control - protect crops against frost and high temperature
- Drainage problems eliminated
- Saving in land

Limitations

- High initial cost
- Efficiency is affected by wind
- Higher evaporation losses in spraying water
- Not suitable for tall crops like sugarcane
- Not suitable for heavy clay soils
- Poor quality water can not be used (Sensitivity of crop to saline water and clogging of nozzles)

Drainage

Drainage is the artificial removal of water in excess of the quantity required for the crop. Drainage includes removal of excess water of both surface and subsurface in the root zone of crops. Irrigation and drainage go together and are not mutually exclusive. Irrigation aims at supplying optimum quantities of water throughout the crop period, whereas, drainage aims at removing excess quantity of water in a short time. Often, both may be required together to assure sustained and high level production of crops.

Role of drainage

- Draining the land provides conditions favorable for crop production.
- The greatest benefit of drainage relates to aeration. Good drainage facilitates the ready diffusion of oxygen to the root zone and escape of carbon dioxide from the root zone into the atmosphere. Several harmful gases also escape from the root zone into the atmosphere.
- The activity of aerobic organisms which influence the availability of nutrients such as nitrogen and sulphur to plants depends on soil aeration and hence, drainage improves aerobic organisms.
- Toxicity in acid soils due to excess iron and manganese is decreased by drainage (due to presence of oxygen in the root zone).
- Drainage permits roots to grow deeper and spread wider thereby increasing the volume of soil from which nutrients can be extracted.
- The removal of excess water helps in drying of the soil quickly and optimum soil temperature permits timeliness of field operations.
- The provision of a good drainage system permits the removal of excess salts in the soil or irrigation water and prevents their build up in the upper soil layers.