Practical-9

Methods of Irrigation and Drainage for the Cultivation of Vegetable Crops

EXERCISE

9.1 To Study the irrigation methods used in cultivation of vegetable crops.

9.2 To study the effect of water logging on vegetable crops and the methods of drainage in crop production.

OBJECTIVE:

- Acquaintance with different irrigation methods used in vegetable production.
- To know the effect of water stagnation on vegetable crops and drainage methods.

Delivery schedule: 02 sessions

Student expectations/learning objective:

- Familiarization with different irrigation methods used in vegetable production through practical demonstration.
- The impact of drainage systems on vegetable production.
- The ill effects of water logging in crop production.

Pre-learning required: Water management in vegetable crops and critical stages of irrigation in different vegetable crops.

Handouts/material /equipment's and tools required: Paper sheet and pen to note down the steps, spade, drip system, sprinkler irrigation system *etc.*

Exercise 9.1: To Study the irrigation methods used in cultivation of vegetable crops.

Introduction

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

Importance of irrigation

Irrigation is one of the most important components of the vegetable production and it should be need based. It is essential to maintain sufficient moisture in the soil for obtaining the optimum yield and quality of the produce. The aim of irrigating the crops should be to provide proper moisture in the entire root zone without allowing any wastage of water beyond the root zone. The irrigation system has to be selected carefully so that the water requirement of the crop is met out by incurring minimum expenditure without any wastage of water, time and energy. Various types of irrigation techniques differ in obtaining the water from the source and its further distribution within the field. In general, the goal is to supply uniform water to the entire field, so that each plant meets its optimum requirement *i.e.* neither too much nor too little. The modern methods are efficient enough to achieve this goal.

In addition, irrigation can also be used for protecting plants against frost and prevention of soil consolidation. In contrast, raising crops with total dependence on rainfall is referred to as rain-fed or dry land farming. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a particular area.

Many factors determine the suitability of irrigation system for a particular crop. Several methods are employed for the application of irrigation to the vegetable crops depending upon the soil topography and the availability of irrigation water. Thus, the system of irrigation must be decided keeping in view the existing field conditions. Choose the correct system for a particular crop and situation.

Methods of irrigation

The following methods of irrigation are generally used for irrigating vegetables:

A) Surface irrigation: In surface irrigation systems, water moves over and across the land by simple gravity flow in order to wet it and to infiltrate into the soil. Surface irrigation can be subdivided into furrow, border strip or basin irrigation. Surface irrigation is often called flood irrigation when the irrigation results in flooding or near flooding of the cultivated land. Historically, this has been the most common method of irrigating agricultural land.

1. **Flood system:** In this system, whole of the area is irrigated through one head *i.e.* without sub-division of the unit area into small plots. Irrigation water used in this case is excessive as the entire field is to be wetted and the water reaches the deep root system. Thus, this system saturates the root zone. In this system, the wastage of water is more and this also leads to excessive weed growth.

2. **Border method:** In this method, borders are formed by making number of strips which are separated by ridges. An irrigation channel runs along the upper end of the borders.

3. **Furrow method:** This method is applicable where land has variation in slope, crop and topography. Ridges and furrows or broad ridges or raised beds are made in this method to irrigate the crop.

Flooding
www.blogs.ei.columbia.edu

Border method
Source: www.fao.org

Furrow method
Source:www.sustainingriverlife.org.au

4. **Basin method *(ring and basin):*** This method consists of running water into relatively level plots surrounded by small ridges. The basins are especially suitable for heavy soils with low infiltration rate or highly permeable sandy soil.

Basin method

B) Sub-surface/pipe irrigation:

- In this system, perforated or porous pipes or clay pipes are buried beneath vegetable beds below the root zone and the water is channelized into the pipes by suitable means.
- In either case, the idea is to raise the water by capillary movement.
- One end of pipe is blocked and other is tilted out of the soil to allow filling.
- Water gradually escapes from the cracks between the pipe sections and through the pores in the clay to provide a continuous supply of water to the vegetables.
- Optimum pipe size is 75mm inside diameter and 300mm long.

C) Localized irrigation: It is a system where water is given under low pressure through a network of pipes in a pre-determined pattern. The irrigation is given as a small discharge drop by drop or in the form of a spray through the emitters. Sprinkler and drip irrigation belong to this category of irrigation methods.

1. Overhead or Sprinkler irrigation:

- It supplies water to the field from the source through pipes under pressure in the form of spray of "rain like" droplets.
- It is more efficient than the surface irrigation as runoff and deep percolation losses can be minimized and uniformity of application is assured.

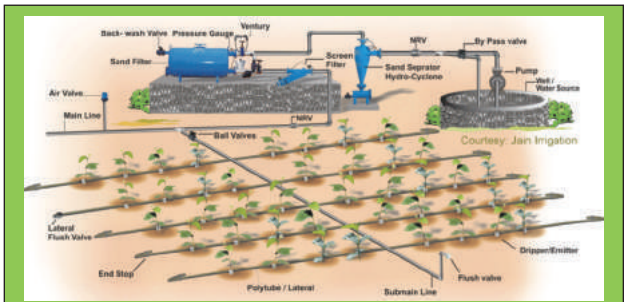
- The system consists of sprinkler heads or nozzles, which are mounted on raisers in lateral pipe lines taken from main pipe line which is further connected to a pumping unit.
- The water is pumped with pressure through the sprinklers attached to pipes and these sprinklers are adjusted in such a manner to overlap upto one fourth area covered by the other sprinklers. These are then moved to the next point after sufficient irrigation has been given.

Sprinkler method
Source: www.extension.org

- In this method, water saving to the tune of 30-50 per cent has been reported in comparison to surface method of irrigation.
- Evaporation losses may be only 2-8 per cent of the total sprinkler discharge.
- This method is highly suitable for sandy, shallow and steep soils.

2. Drip or trickle irrigation:

- In this system, water is delivered near the plant, drop by drop.
- Water is directed though plastic pipes and finally supplied with pressure through mechanical devices called emitters designed to supply water in drops. This method ensures direct and continuous wetting of the root zone.
- Drip irrigation system consist of main pipe line, sub mains, laterals, drippers or emitters, a rise valve, pressure gauges, filters, ventury, pressure regulator *etc.*
- This system of irrigation is very costly and most useful in areas with scanty rainfall for high density plantation.
- This system requires regular water supply.
- In this system, the loss of water due to evaporation and erosion of soil are negligible but percolation and seepage losses are appreciable.



Drip system
Source: earthfriendlylandscapes.blogspot.com

- It is the most efficient method of providing irrigation water and fertilizers near the plants.
- It permits the effective utilization of fertilizers, pesticides and other water soluble chemicals.
- High cost of operation, damage to pipelines due to clogging and infestation of diseases in the underground parts starting from collar regions of the plants are the major disadvantages of this system.

Scheduling of irrigation:

The schedule of irrigation means when to irrigate and how much to irrigate? In order to avoid water stress in plants and to obtain good quality yields of vegetables, proper irrigation schedule should be followed. Scheduling of irrigation in plants is governed by soil, climate and plant factors. Some practical approaches used to determine schedule of irrigation are soil moisture depletion, cumulative pan evaporation and sensational *etc.*

Critical period for irrigation:

Assured supply of water is required at certain stages of plant growth, which are referred to as critical period for crops. If water is not available at critical stages, yield potential of the crop gets reduced. In the beginning, seed germination and later on, flower initiation and fruit development are the most critical stages for irrigation to achieve optimum yield potential of a particular vegetable crop. Head/curd development in cole crops, fruit formation in solanaceous vegetables and okra, pod development in pea and beans, tuberization in potato, bulb development in onion and garlic, and root development in root crops are the critical stages for the application of irrigation.

Exercise 9.2: Effect of water stagnation in vegetable crops and methods of drainage in crop production

Introduction

Water stagnation occurs when water stops flowing. Stagnant water can be a major environmental hazard. Stagnant water may be classified into water body stagnation (stagnation in swamps, lakes, lagoons, rivers, *etc.*), surface and ground water stagnation (puddles) and trapped water stagnation (discarded cans, plant pots, tires, hollow tree trunks and leaf sheaths).

Drainage of surface and subsoil is advised to avoid ground and surface water stagnation. Areas with a shallow water table are more susceptible to ground water stagnation due to lack of natural soil drainage. Excessive watering may cause ground or surface water stagnation.

Effects of water stagnation on crops

- Poor aeration resulting in anaerobic conditions *i.e.* depletion of oxygen and excess of carbon dioxide in the root zone generally known as hypoxia.

- Post-stagnation ill effects due to sub optimal oxygen diffusion rate (ODR).
- Leaching of essential plant nutrients resulting in lower uptake.
- Decrease in redox potential resulting in reduced uptake of certain elements and release of toxic elements in the root zone.

What is drainage?

Drainage is the provision of a suitable system for the removal of excessive irrigation or rain water from the land surface so as to provide optimal soil conditions for better plant growth.

Importance of drainage

- With the proper drainage system, land can be used for a long time without any deterioration in the physical properties of the soil.
- Provision of drainage also facilitates early sowing of the crop.
- Drainage lowers underground water table so as to facilitate increased root zone depth.
- Drainage improves soil aeration and increases soil temperature and thus reduces the effects of water logging in the crop.

Drainage is achieved by digging open drains at suitable intervals and depth. Irrigation channels also serve as drainage channels.

Types of drainage system

1. Field (or internal) drainage system
2. Main (or external) drainage systems.

The function of the field drainage system is to control the water table, whereas the function of the main drainage system is to collect and dispose off the water through an outlet. Field drainage systems are differentiated into surface and subsurface drainage systems. In vegetable crop production, surface drainage system is employed which is the simplest and the most common method.

1. Surface drainage systems

Surface drainage system is employed to remove the surplus surface water from the land in areas with heavy rainfall or low soil percolation. Commonly used surface drainage systems include shallow ditches, open channels, and sloped bank. These drainage systems drain away surface water quickly and efficiently, but

not the groundwater. Drainage problems due to groundwater can be checked by employing the sub-surface drainage system. The regular surface drainage systems operate entirely by gravity and start functioning as soon as there is an excess of rainfall or irrigation. They consist of reshaped or reformed land surfaces and can be divided into:

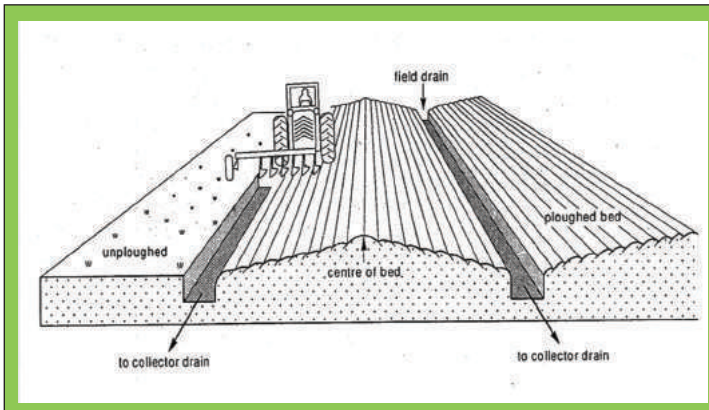


Figure 1: Development of bed

- Bedded systems, used in flat lands
- Graded systems, used in sloping land: The slope should not be made uniform, while grading land for surface drainage.

The bedded and graded systems may have ridges and furrows.

Bed formation: To ensure good drainage in a bedding system, the beds should have narrow width not more than 10 m. The bed width should be a multiple of the effective width of farm equipment. Figure 2 shows the construction of bedding system. It often takes several years of ploughing to obtain an adequate bedding system. During the first ploughing, care should be taken to make beds of uniform width and to drain water in the direction of the steepest slope. Low points in the field should be eliminated as it may lead to water stagnation and loss of crops. The collector drain

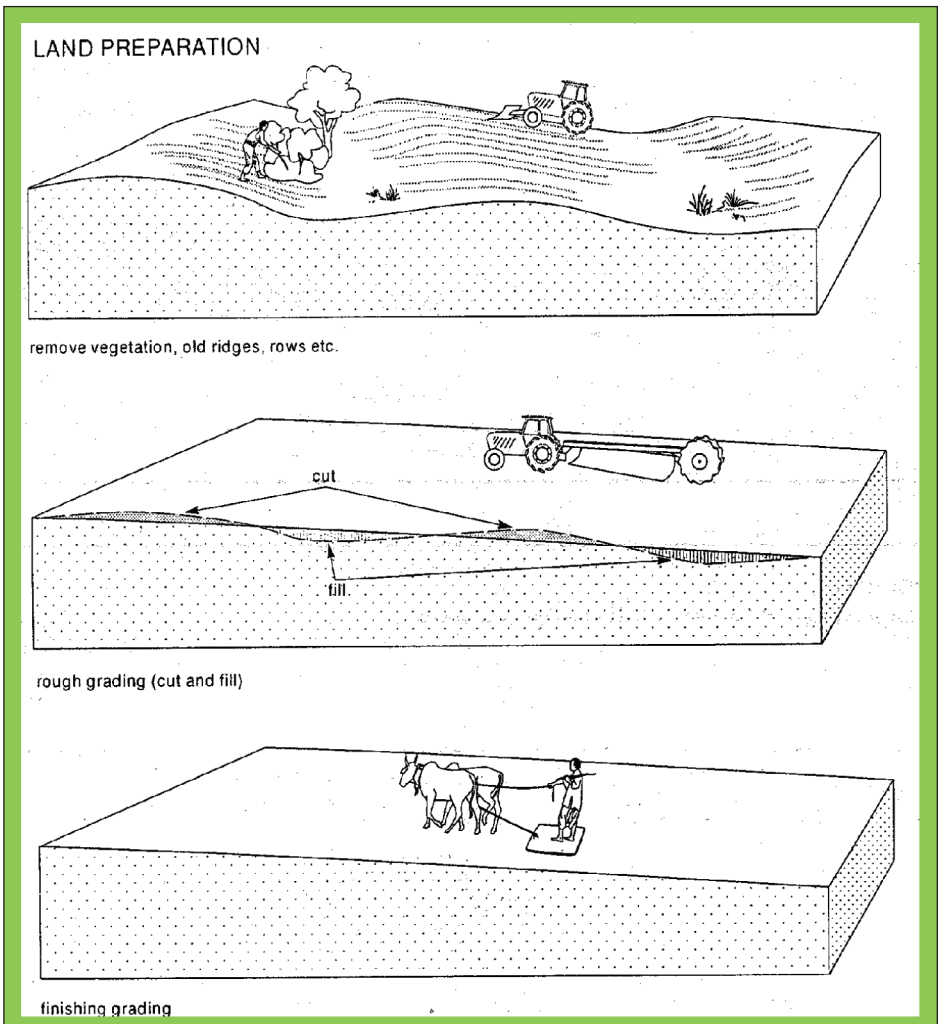


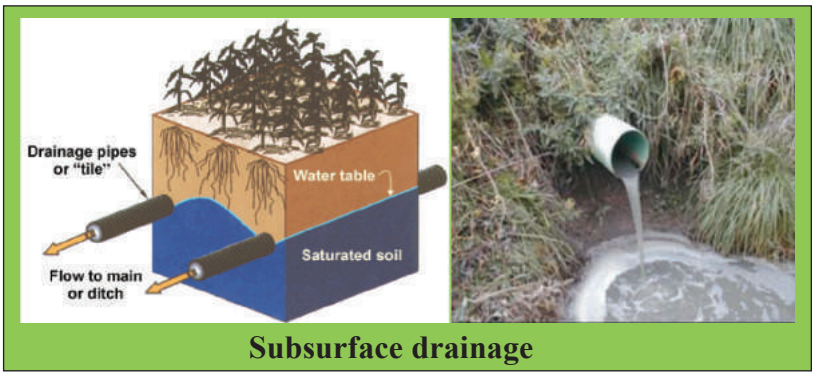
Figure 2: Land preparation

Source: ftp://ftp.fao.org/docrep/fao/010/ai587e03.pdf

should be laid out in the direction of the lesser field slope, and should be properly graded towards the main drainage system.

2. Subsurface drainage systems:

The main aim of sub-surface drainage is to control the water table which can be achieved by tube well drainage, open drains or subsurface drains (pipe drains or mole drains). Tube well drainage and mole drainage are applied only in very specific conditions. The usual choice for subsurface drainage is therefore between open drains and pipe drains.



Subsurface drainage

The classical method of pipe installation consists of marking the alignments and levels, excavating the trenches by manual labour, placing the pipes and enveloping material and backfilling the trenches. Nowadays, field drains are installed by drainage machines, either trenchers or trenchless machines. Modern buried pipe drains often consist of corrugated, flexible and perforated plastic (PE or PVC) pipe lines wrapped with an envelope or filter material to improve the permeability around the pipes and to prevent entry of soil particles, which is especially important in case of fine sandy and silty soils.

Applications of drainage system

- Surface drainage systems are usually applied in relatively flat lands that have soils with a low or medium infiltration capacity, or in lands with high-intensity rainfalls that exceed the normal infiltration capacity leading to frequent water logging on the soil surface.
- Subsurface drainage systems are used when the drainage problem is mainly due to shallow water table. When both surface and subsurface water logging occur, a combined surface/subsurface drainage system is required.

Benefits of Drainage

- Better soil aeration which permits deeper and more extensive development of root system and provide favourable environment for beneficial soil microorganisms and earthworms.
- Better soil moisture conditions facilitate various operations like land preparation, planting and harvesting both manually and mechanically.

- Longer growing seasons can be achieved with good drainage as crops can be raised and harvested at early dates.
- An increased supply of nitrogen due to lowering of water tables. This can reduce the amount and rate of nitrogen fertilizer application.
- Soils warm more quickly in the spring when free water is removed by a drainage system.
- Elimination of certain toxic substances and disease organisms due to better drainage and better aeration.
- Reduction in soil erosion

Exercises

1. Visit a field where sprinkler and drip systems of irrigation have been installed. Study the different components of these systems and also try to operate and handle these systems.
2. Compare the efficiency and effectiveness of modern methods of irrigation with surface irrigation methods.
3. Grow vegetables in plots with no drainage system and other with proper surface drainage by providing furrows. Observe differences in growth and development of vegetable crop raised under both systems.