Chapter-5

VEGETABLE CROPS MANAGEMENT

OBJECTIVES

After studying this chapter, students will be able to understand:

- Basic of crop management practices for successful vegetable crop production
- Fertilizer management practices such as manuring and fertilizer application including green manuring and integrated nutrient management
- Irrigation and its various methods including micro irrigation techniques
- Importance of intercultural operations such as tillage, mulching and weed management

Introduction

For optimum growth and development of vegetable crops, various field and crop management practices play a very important role. There are various components of crop management *viz.,* fertilizer management, water management, and weed management. In this chapter, you will learn about these management practices and intercultural operations to harness optimum yield of vegetable crops. In order to get maximum benefit from manures and fertilizers, they should be applied at proper time and in right manner. In addition, it is essential to understand that different soils react differently with fertilizer application. Similarly, the N, P and K requirements of different vegetable crops are different. The other important aspect is weed management. Weeds are the most costly category among the vegetable pests, causing more yield losses and add labor costs than either insect-pests or diseases. Adequate water supply at right time and right proportion is very crucial factor in vegetable production. Now, certain questions may arise in your mind. What are the different methods of fertilizer application? Is there a choice to practice a particular method of fertilizer application? What is weed? How will we identify the weeds and what will happen if weeds are allowed to grow? How can we control the weeds? Why irrigation is crucial for vegetable production? What are the critical stages for the application of irrigation? What are the different methods of application of irrigation and which one is the best? You can face several questions of this category. This chapter will try to answer all these questions step by step.

Nutrient management:

Vegetable crops require nutrients for their growth and development which are absorbed through soil. You have learnt about essential plant nutrients and their deficiency symptoms in chapter IV, let's revise it. Plant require 17 elements for its growth which are divided into (1) **macro-**nutrients (required in relatively large amounts by the plants) namely, nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), sulfur (S) and calcium (Ca), (2) **micro-**nutrients (required in relatively small amounts) *viz.,* iron (Fe), manganese (Mn), boron (B), copper (Cu), zinc (Zn), molybdenum (Mo), chlorine (Cl) and nickel (Ni). The hydrogen (H), oxygen (O), and carbon (C) are taken from water and air and partly from the soil pores. Manures and fertilizers are major nutrient supplying sources to plants. A deficiency of any of these nutrient elements can limit plant growth and development and, ultimately, yield. Most soils contain sufficient amounts of the micronutrients needed to support plant growth. However, soils may be lacking in some of the macronutrients, particularly nitrogen, phosphorus and potassium. Therefore, it becomes important to ensure the presence of all the essential elements supplied by the soil in the right quantities and the right chemical forms for plant use. This is done by supplying organic matter and by the judicious use of fertilizers and manures in order to supplement the nutrients required by the plants from soil to increase crop yield *vis-a-vis* to maintain/ improve the soil fertility. Vegetable crops are short duration and hence more number of crops can be grown annually per unit area with high yield and net returns. Therefore, high cropping intensity and several other factors necessitate the use of manures and fertilizers.

What are organic and inorganic manures?

Organic manures: These are plant and animal wastes that are used as nutrients after decomposition. Manures are complex compounds from plant, animals, and human residues that are used by plants as source of nutrients. Manures are low in nutrient content and have longer residual effect. Nutrients from manures are released only after decomposition of manure by micro organisms. Organic manures and leguminous green manures are most valuable from crop nutrition point of view. In addition, farmyard manure, crop residues and composts are most important from utilization and organic recycling point of view. Organic resources reduce the mining of soil nutrients and improve physical property of the soil by improving soil tilth, aeration, water-holding capacity and activity of microorganisms. Manures are classified into two groups depending upon nutrient content they contain *e.g.*

1. Bulky manures: Farmyard manure, compost, vermicompost, sewage and sludges
2. Concentrated manures: Oil cakes, Blood meal, Meat meal, Fish meal

What is farmyard manure (FYM)?
The decomposed mixture of dung and urine of farm animals along with litter and left over materials from roughages or fodder fed to cattle is farmyard manure.

Sources of manures: The different sources of manures are as under:

1. Cattle shed wastes- dung, urine and slurry from biogas plants
2. Human habitation wastes- night soil, human urine, town refuse, sewage, sludge and silage
3. Poultry litter, droppings of sheep and goat
4. Slaughterhouse wastes such as bone meal, meat and fish blood meal, horn and hoof meal and fish wastes.
5. Byproducts of agro industries like oil cakes, bagasse and press mud, fruit and vegetable processing wastes *etc.*
6. Crop wastes namely, sugarcane trash, stubbles and other related material
7. Water hyacinth, other weeds and tank silt,
8. Green manure crops and green leaf manuring material

What is compost?
Composting is a process in which both aerobic and anaerobic micro-organisms decompose organic matter under medium to high temperature and low carbon-nitrogen ratio of refuse. Farm compost is mass of rotted organic matter made from farm waste.

Vermi-compost: It is the compost prepared with the help of earthworms. It is a rich mixture of major and minor plant nutrients. It increases total microbial population of nitrogen fixing bacteria, actinomycetes and symbiotic association of mycorrhiza on plant root system and thus improves soil phosphorus and nitrogen availability.

Inorganic manures:

These are industrially manufactured chemicals containing higher nutrient contents in comparison to organic manures and are called as fertilizers. Composition of different fertilizers commonly used in vegetable crop production is given in Table 1. Nutrients are lost from the soil through leaching, runoff, volatilization, fixation by soil or consumption by weeds, *etc.* Compound fertilizers supplies more than one plant nutrient usually two such as N and P or N and K. Mixed fertilizers are mixtures of N, P and K in different proportions such as 12-32-16, 15-15-15, 10-20-20 *etc.*

Table 1: Composition of some important organic and inorganic inorganic manures

Fertilizer	Composition (%)			
	N	P_2O_5	K_2O	Other
Organic manures				
Farmyard manure	0.75	0.20	0.50	**Contain other nutrients in traces**
Vermicompost	3.0	1.0	1.5	**Contain other nutrients in traces**
Nitrogenous fertilizer				
Calcium Ammonium Nitrate (CAN)	25	-	-	
Urea	46	-	-	
Anhydrous ammonia	82	-	-	
Phosphatic fertilizers				
Single superphosphate	-	16	-	12 (S)
Potassic fertilizers				
Muriate of Potash	-	-	60	
Potassium sulphate	-	-	48	
Compound fertilizers				
Ammonium phosphate	20	20	-	
Mixed fertilizers				
NPK (12:32:16)	12	32	16	

Difference between manures and fertilizers

S.No.	Characteristics	Manures	Fertilizers
1.	Origin	Plant, animal, human residue	Chemically manufactured
2.	Type	Natural product	Artificial product
3.	Nutrient content	Low/less concentrated	High / more concentrated
4.	Availability of nutrient	Slow releasing	May or may not be readily available
5.	Effect on soil health	Improves physical property of soil	Do not improve physical property of soil

Time and method of application of manures and fertilizers

Organic manures are complex organic compounds which need microbial degradation before the release of nutrients in an available form. Generally, the manures are applied in the field just before the ploughing operation so that they get mixed up well with the soil during ploughing operation. Method of fertilizer application depend on physical forms, solubility and mobility of fertilizer. Fertilizers are applied either as basal or in split applications depending on mobility of plant nutrients in the soil. Liquid fertilizers are applied with

The basic principle of fertilizer application is to make the nutrients readily available to the plants as per their requirement without much wastage and harmful effects on soil.

irrigation water alone or mixed with herbicide/ pesticide sprays. Soluble fertilizers are applied as foliar spray. In fertilizers, nutrients are present in a soluble form. In vegetable crops, N, P and K containing fertilizers are applied as basal dose at the time of sowing/planting. Also, nitrogen containing fertilizers leach easily, thus split applications are recommended at vegetative/flowering/ fruit initiation stage. For higher returns per unit of fertilizer input, placement of fertilizers near to root zone at the right stage of crop growth is essential.

Methods of application

The methods by which fertilizers can be applied to the soil include:

1. **Broadcasting:** This is the spreading or tossing to the fertilizers all over the ground. The fertilizers must not touch the plant.

2. **Ring Method:** This is the placement of fertilizers in a circular hole, the size of the hole depends on the type of roots of the plants and the size of the canopy of the plant.

3. **Row or Side Placement:** This is the process of making long lines along the farmland or ridge beside the cultivated crops and fertilizers are later applied inside the line.

Row placement

4. **Top Dressing:** This is a supplementary application of fertilizers in order to supplement the earlier ones.

5. **Foliar Leaf Spray:** This is mostly used for leafy crops. The fertilizer is dissolved and later sprayed on the leaves of plants. This fertilizer is non-toxic to plants.

Bio-fertilizers: These are micro-organisms containing inputs which are capable of mobilizing nutrients from non-usable form to usable form through biological processes. They are less expensive, eco-friendly and sustainable. They improve plant growth and development by producing plant hormones. Some of the beneficial microorganisms are capable of fixing atmospheric nitrogen are *Rhizobium*, *Azotobacter, Azospirillum etc.* On the other hand, some can increase the availability of P *e.g. Pseudomonas, Bacillus, Aspergillus etc*.

Green manuring: It is a practice which constitutes growing crops for the purpose of restoring or increasing the organic matter content in the soil. The crops are called Green manure crops. A fast growing legume crop is grown in the field prior to the cultivation of

Ploughing under green manure crop in the field

vegetable crop and is ploughed under to incorporate it into the soil. Example: Dhaincha (*Sesbania canabina*), sunhemp (*Crotolaria juncea*), cowpea (*Vigna unguiculata*), horse gram (*Macrotyloma uniflorum*), barseem (*Trifolium alexandrium*), cluster bean (*Cyamopsis tetragonolaba*), lentil (*Lens culinaris*) *etc.* The green matter ploughed under gets properly decomposed. The field can be green manured in rainy season followed by cultivation of a regular winter season vegetable crop. Sunhemp is widely adapted to almost all areas throughout the country whereas Dhaincha is suitable for alkaline and waterlogged soils. Leguminous green manuring crops have ability to acquire and fix atmospheric nitrogen from the air with the help of its root-nodule bacteria (*Rhizobium*). Green manure also adds and increase the availability of several other plant nutrients through its favorable effects on chemical, physical and biological properties of the soil. The green manure crops enrich the soil by adding green matter and nitrogen to the extent 15-20 t/ha and 74-91 kg/ha, respectively.

Crop	Green matter (t/ha)	Nitrogen (kg/ha)
Sunhemp	21	91
Dhaincha	20	86
Cow pea	15	74

Integrated nutrient management:

Integrated nutrient management refers to the integrated approach to maintain soil fertility and supply nutrient at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components. Integrated nutrient management practices enhance the availability of applied as well as native soil nutrients. It improves and sustains the physical, chemical and biological functioning of soil.

CHECK YOUR PROGRESS

Match the followings

A	B
1. Free living biofertilizers	a. Sunhemp
2. Symbiotic	b. *Bacillus*
3. Phosphorus Mobilizing Biofertilizers	c. Vascular Arbuscular mycorrhiza
4. Solubilizing biofertilizer	d. *Rhizobium*
5. Green manuring	e. *Azotobacter*

Long answers

1. What do you understand by organic and inorganic manures? List one inorganic manure each containing N, P and K along with their content.

2. What is vermi-compost? How does it differ from farm yard manure?
3. What is the principle of fertilizer application? Enlist the different methods of fertilizer application.

Irrigation

Adequate water supply is important for plant growth. Irrigation is essential to the production of most vegetables for good yields and high quality. Irrigation may be defined as artificial supply of water to support plant growth and production in the absence of adequate supply of water through rainfall. Most vegetables are rather shallow rooted and even short periods of two to three days of stress can hurt marketable yield.

Water requirement of a crop is the quantity of water needed for normal growth, development and yield and may be supplied by precipitation or by irrigation or by both. Water is needed mainly to meet the demands of evaporation (E), transpiration (T) and metabolic needs of the plants. The water requirement of any crop is dependent upon the following factors:

1. Crop factors like variety, growth stage, duration, plant population and growing season.
2. Soil factors like texture, structure, depth and topography.
3. Climatic factors like temperature, relative humidity and wind velocity.
4. Crop management practices like tillage, fertilization, weeding etc.

Methods of irrigation

Irrigation is generally applied to vegetable crops by flooding on the field surface (surface irrigation), applying beneath the soil surface (sub surface irrigation), spraying under pressure (sprinkler irrigation) or by applying in drops in the crop root zone (drip irrigation). Several water application methods are practiced to suit different soil types, the topography of the land, crops to be irrigated and costs. These are the following method of irrigations which are generally used for irrigating vegetables:

A. Surface irrigation: In this method, water is applied to the crop by flooding it on the soil surface. This method is simple in layout and operation. More than 90 % of irrigated area in India is under surface irrigation. This method may be classified as border, furrow and basin.

(1) 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.

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

(3) 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 soils.

B. Sub-surface irrigation: In this system, perforated or porous pipes are laid out underground below the root zone and water is led into the pipes by suitable means. In either case, the idea is to raise the water by capillary movement.

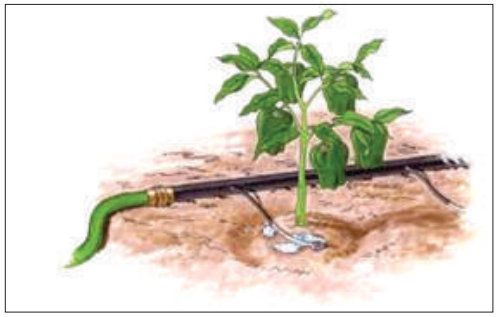
C. Overhead or Sprinkler irrigation: This system consists of application of water to soil in the form of spray, similar to rain. By using this method, run off and deep percolation losses can be minimized and uniformity of application is assured. The system consists of sprinkler heads or nozzles, which are mounted on raisers in lateral lines taken from main line, which is further connected to a pumping unit.

Sprinkler irrigation
Source: www.meghaarotech.co.in

This method is suitable for areas having uneven topography and where erosion hazards are more. In this method saving of water upto 30 to 50% is reported in comparison to surface method of irrigation.

D. Drip or trickle irrigation: In this system, water is led though plastic pipes and finally led out through mechanical device called emitter; there is a direct and continuous wetting of the root zone. Drip irrigation system consists of main pipe line, sub mains, laterals, drippers or emitters, a rise valve, pressure gauges, filters, pressure regulator *etc.* This method is useful in areas with water scarcity and salt problem. **Drip irrigation has the following benefits:**

- Increased water saving/water use efficiency.
- Enhance plant growth and yield
- Saving labour and energy
- Uniform and better quality of produce.
- Efficient and economic use of fertilizers
- Check weed growth.



Drip irrigation
Source:
www.home.howstuffswork.com

Fertigation is the process of application of water soluble solid fertilizer or liquid fertilizers through drip irrigation system. Through fertigation, nutrients are applied directly into the wetted volume of soil immediately below the emitter where root activity is concentrated. Fertigation is practiced only in drip irrigation system. However, fertilizer solution can be added with sprinkler irrigation system also.

Critical growth stages for irrigation in different vegetable crops:

Most vegetable crops have different critical growth periods for harnessing their maximum yield potential. If water stress occurs during the critical stages of growth, there is drastic reduction in yield.

Table: Critical growth stages for soil water stress

Crop	Critical stage
Tomato	Flowering, fruit setting and enlargement
Egg plant/ brinjal	Flowering and fruit enlargement
Pepper	Transplanting, fruit setting and development
Potato	Any growth period under water stress from planting to harvest.
Cauliflower	Frequent irrigation is essential from planting to harvest
Cabbage and Broccoli	Head formation and enlargement
Pea	Flowering and pod filling
Onion	Bulb formation and bulb enlargement
Carrot, Radish, Turnip, Beet Rood	Root enlargement
Beans (all) Cucumber, muskmelon,	Flowering and pod formation
Pumpkin, summer squash	Flowering and fruit enlargement/development
Water melon	Flowering to harvesting
Sweet	Tasseling, silking and ear filling
Asparagus	Fern growth
Lettuce	Head development

Factors other than rainfall and/or irrigation affecting the plants ability to use available moisture: There are factors within most plants that resist the flow of water from the roots. Water absorption is closely linked to the rate of transpiration and the movement through the vascular system. There are factors resisting the flow of water into the root hairs due to soil structure, salt concentration in the soil and availability of water in the soil. Poor soil drainage prevents good percolation, causing root hair to die for the lack of oxygen and thus reduce yield and quality.

Therefore, knowledge of physical distribution of the plant root system will assist in the management of water balance in vegetables. Vegetables can be categorized as

1. Shallow rooted
2. Medium rooted
3. Deep rooted

Table : Average feeder root depth of vegetable crops.

Deep rooting 1.1-2.0 m or more	Medium rooting 0.68-1.0 m	Shallow rooting 0.67 m or less
Tomato	Bean (bush and pale)	Cauliflower
Pumpkin	Beet	Cabbage
Muskmelon	Carrot	Broccoli
Water melon	Cucumber	Chinese cabbage
Winter squash	Egg plant	lettuce
Sweet	Pea	Garlic
	Pepper	Onion
	Summer squash	Potato
	Turnip	Radish
		Spinach
		Sweet corn

Soil preparation and water supply should match the needs of the root system. Plants in general obtain 70% of the moisture and nutrient requirement from the top half of the root system. For most vegetable crops, total dependence upon irrigation has the tendency to keep the main feeder roots closer to the surface than in the case without irrigation. Plants that remain for the most part shallow to medium rooted are quicker to develop water stress symptoms.

Soil quality or management keeps surface evapotranspiration minimal (plastic mulches or close row space will reduce direct water loss due to solar transpiration of the soil). Direct loss of water due to transpiration will cause serious water stress. Irrigation is essential if rainfall is insufficient or erratic.

CHECK YOUR PROGRESS

Write short notes on the following

1. Drip irrigation
2. Sprinkler irrigation
3. Fertigation

Intercultural operations for Vegetable crops management

The main objective of intercultural operations in vegetable production is to keep the soil loose and destroy weeds. Tillage is primary activity before taking up seed sowing or planting of seedlings. Physical manipulation (deep ploughing) of soil with tools or implements for obtaining ideal conditions for better seed germination, seedling establishment and growth of plants is called tillage.

Advantages of tillage for crop production

* Facilitate adequate soil aeration for gaseous exchange in the seed and root zone.
* Help in seedling emergence
* Create an environment that provides adequate light to the seedling.
* Destroy weeds and create pathogen free environment
* Mixes the applied basal dose of manures and fertilizers with the soil
* Remove the hardpan, if any to increase the soil depth for water absorption

Mulching

Mulching is another important intercultural operation in which soil / ground is covered with organic (leaves, compost, grass, straw *etc.*) or inorganic materials (plastic) to make more favourable conditions for plant growth, development and efficient crop production. Mulch technical term means 'covering of soil'. Mulching helps to reduce evaporation losses and moderates soil temperature in the root zone environment. It is a system of farming in which the organic residues are not ploughed but are left on surface.

The main function of mulching is to control first stage of drying, which helps in improving the moisture status and reduces the soil temperature, besides checking seedling mortality and improves crop stand. It also suppresses weed-flora and reduces weed competition with crop for water and nutrients.

Advantages of mulching

* It prevents water from evaporating and runoff and hence conserves moisture.
* It protects the soil from erosion.
* Suppresses weed growth.
* Improves quality of produce.

Types of mulching:

1. **Organic mulches:-** These include plant residues such as straw, leaves, corncobs, peanut hulls and pine needles, animal manures, peat moss and wood products. These reduce temperature and provide excellent moisture control. Besides, they also improve soil tilth and enhances biological activity as they decompose.
2. **Synthetic mulch:-**These includes clear and black polythene sheet, metal foils *etc.* They increase soil temperature.

When to Apply Mulch?

Time of application depends on the purpose of mulching. In vegetable garden, it is best to apply after the soil has warmed up in spring. Cool and wet soils likely to slow down the seed germination and increase the decaying of seeds and seedlings. The additional layer of mulch to the existing perennial beds should not be applied until the soil has warmed completely.

(b) Organic mulch

Mulches used to help moderate winter temperature can be applied before the arrival of cool winter temperature. Mulches used to protect the plants over winters should be loose material such as straw, hay, or pine needles which help to protect the plants without compacting under the weight of snow and ice.

Plastic mulch
Http://www.extension.org/pages/6203

How to Apply Mulch?

It is advisable to make the area weed free before applying mulch material. A layer of mulching material is spread over the entire plant bed keeping away from the stems of the plant. This will prevent decaying caused by wet mulch and the rodent damage during winter too. The amount of mulch to be applied depends on the texture and density of the mulch material. The thickness of wood and bark mulches should not be more than 5-7.5 cm, grass clippings or shredded leaves should never be thicker than 5 cm.

Weed Management

Weeds are the plants growing where and when they are not desired. They compete with crop for soil moisture, nutrients, sun light and space. Due to this competition, main crop

yield is reduced. Weeds also act as host for various pests, diseases and other micro-organisms. In some crops, the yield is reduced by more than 50% due to weed infestation. In order to reduce the negative implications of weeds on crop growth and yield, weeds need to be controlled efficiently.

Classification of weeds: There are different methods of classification of weeds. Broadly, the weeds can be classified and characterized on the basis of their life cycle, growing season, number of cotyledons, morphology, *etc.*

A) Based on life cycle: On the basis of life cycle, the weeds have been classified as annuals, biennials and perennials.

1. **Annuals:** Weeds which complete their life cycle in one season or year are called annual weeds. They are usually small herbs with shallow root and weak stem. Most of the common weeds are annual. They are further divided into two groups based on their occurrence in different season.

   a) **Monsoon annuals (***Kharif season*): Weeds emerge with the onset of rains and complete their life cycle before winter season or so. The seeds remain dormant in the soil during cooler months and germinate with favourable temperature and moisture conditions during *kharif* season. Examples are *Echinochloa colomum* (water grass/Jhanda), *Euphorbia hirta(*Badi dudhi) *etc.*

   b) **Winter annuals** (*rabi season):* Weeds grow during winter season and produce seed during spring or summer. Examples are *Phalaris minor* (Canary grass/Guli-danda), *Vicia sativa (Common vetch/RoriRewari) etc.*

2. **Biennials:** Those weeds that grow in the first season and complete their life cycle in the following season are referred as biennials. In general, during first year, plants grow vegetatively and reproduce or form seeds in the second year *e.g.* Wild carrot (*Daucus carota*). These weeds are difficult to control by removing aerial parts as roots help in regeneration.

3. **Perennials:** Those weed plants that live for more than two years. These are very well adopted to withstand adverse conditions. These weeds grow not only by seeds but also by underground stem and root suckers. These are difficult to control without consistent efforts. The weeds are further classified into herbaceous (without woody tissues) and woody perennials.

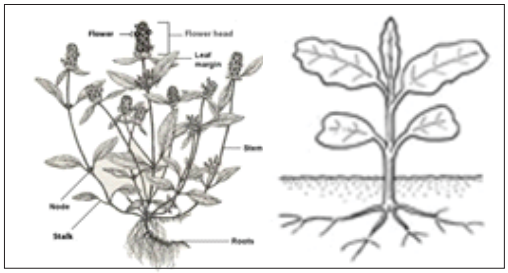
a) **Herbaceous perennials:** They propagate through seeds (*Sonchus arvensis*) or vegetative parts. The vegetative parts cut during cultivation and spread in the field and give rise to new weed plants. Examples are roots (*Convolvulus arvensis*) or crown. (*Timothy* spp.) or bulb (*Alliums spp.*) or rhizome (*Sorghum halepense*) or tubers (*Cyperus spp.*).

Lantana camara

b) **Woody perennials:** They are generally shrubs and bushes. Some common examples are *Lantana camara*, *Eupatorium adenophorum, Cannabis sativa* etc.

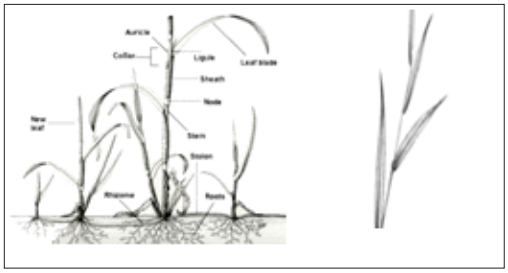
(B) Based on morphology: This is the most widely used classification. The weeds are classified into three categories as under:

1.Broad leaved weeds: Leaves are wide, veins branch out in different directions. This is the major group of weeds and include all dicotyledonous weeds e.g. *Euphorbia hirta(*Badi dudhi).



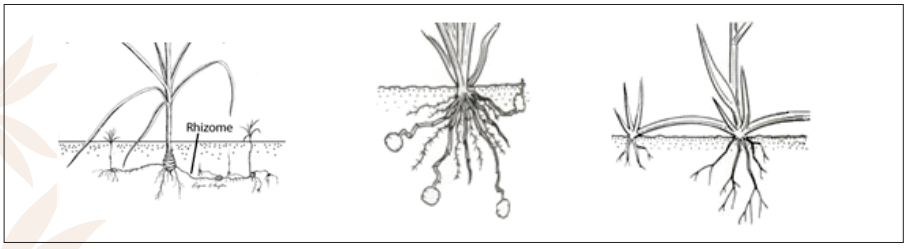
Broad leaved weeds

2. Grasses: Leaves are narrow, arranged in sets of two; stems are rounded or flattened. All the weeds belong to family Graminae are called as grasses e.g *Echinochloa colomum* (water grass/Jhanda).



Grasses

3. **Sedges:** Leaves are narrow, arranged in sets of three; stems are triangular in cross section. They resemble grasses and often grow in thick clusters. Sedges have a fibrous root system and may spread by underground rhizomes and/or aboveground stolons. Many sedges have tubers from which new plants can form. The weeds belong to family Cyperaceae come under this group *e.g.* Cyperus *spp*



Sedges

Source-http://www.ipm.Ucdavis.edu/PMG/weeds_intro.html

How does weed affect crop production?

Weeds are unwanted plants in crop field and its surroundings. They can easily establish and flourish under non-ideal conditions of growth and may affect human welfare adversely. They compete with crop for water, soil nutrients, light and space resulting in decreased crop yield and quality. Weeds also act as host for insects, pathogens and nematodes.

Direct seeded vegetable crops like radish, carrot, peas, beans, palak, amaranth, okra and fenugreek are more vulnerable to weed competition before emergence and during establishment of young plants. Weed seeds germinate easily under varied conditions and have long seed viability. They have prolonged seed dormancy in some cases where they do not germinate for years under unfavorable conditions.

Losses caused by weeds

1. **Reduction in crop yield:** The annual economic losses by weeds are about 33%. Vegetables are high value crops in terms of total calorific, nutritional security, export market and food consumption. The weeds cause 70-80% losses in vegetable yield if not controlled timely. The Reduction in economic yield in different crops has been reported to the extent as given below:

Potato - 6-82%,
Peas - 25-30%,
Tomato - 42-71%,
Cauliflower - 61%
Onion - 67%,
Carrot - 72-80%,
Sugarbeet - 70%

Therefore, it is necessary to control weeds. The problem of weeds is more in vegetable crops than field crops because they have slow initial growth, more frequent requirement of nutrients, wider plant spacing, frequent tillage and absence of effective crop canopy during the critical period of crop weed competition.

2. **Loss in quality of crop produce:** The leafy vegetables suffer much due to weed problem as the leafy weed mixture spoil the economic value.
3. **Alternate host for diseases and pests:** Because of their close association with the crop, they may serve as important reservoir or alternate host for many diseases and insect-pests.
4. **Smother the growth of crop:** They compete with crop for water, soil nutrients, light and space and thereby suppress the growth of the crop.
5. **Interference in crop handling and performing agricultural operations** *e.g.* Heavy infestation of *Cynodon dactylon* (Doob grass) cause poor ploughing performance.

6. **Loss of human efficiency:** They cause allergies and poisoning to human beings *e.g.* Congress weed

Methods of Weed Control

Prevention: It involves processes that inhibits or delay weed establishment in a particular area. Preventive measures include cultural practices such as seed cleaning, use of weed free seed, controlling weeds on field bunds and irrigation channel *etc*.

Eradication: Eradication is complete eradication of weed species from the field or area. It is attempted only in small area (vegetable nurseries) or areas where high value crops are to be grown because of high cost and technicality. Soil sterilants or fumigations as carbon disulfide, *etc*. are used for eradication of weed or weed seeds including pathogens.

Mechanical or Physical Methods: Removing the weeds physically with hands or by using tools/ implements is called mechanical method. Common mechanical methods of weed control are:

1. **Tillage:** Tillage is done with implements drawn by animals or mechanical engines (tractors, tillers *etc*.) rather than by man. Extensive tillage operations which includes ploughing, discing, harrowing and leveling are undertaken to prepare the soil. These operations promote the germination of weeds through soil turn over and exposure to sun light which can be destroyed effectively later. With the gradual industrialization, pre-planting or post planting tillage is practical and has been found as an economical method of controlling weeds.

2. **Hoeing** is widely used weeding tool for centuries. It is quite effective in row crop. It is useful for annuals and biennial weeds. In case of perennials, it destroys aerial growth with little effect on underground plant parts resulting in regrowth.
3. **Hand weeding**: It is done by physical removal or pulling of weeds or removal with the help of *Khurpi,* hand hoe, spade, *etc*. but it is labour intensive, time consuming and costly.
4. **Digging** is practiced especially for the removal of shrubby and stumpy woody perennials. It is time consuming and costly and hence restricted for the removal of very hard perennial woody stem.
5. **Sickling:** It is done to remove the top growth of weeds to prevent seed production and to starve the underground part.
6. **Mowing** is cutting of uniform growth of weeds from entire area at ground level. It is practiced to keep the growth of weeds under check. It has limited value as a mean of weed control and is used to reduce seed production. It is commonly practiced in meadows and pastures, along road side and in waste lands.

7. **Burning** is very powerful technique of weed control in uncultivated land. It destroys aerial portion of the weed directly through flame of the fire and underground portion through the heat effect.

8. **Flooding** kills the weeds by depriving plants of air, thus, they die because of suffocation and inability to carry out photosynthesis. It is an effective method of weed control when roots and shoots of weeds are completely covered or surrounded by water sufficiently for longer period. The perennial weed *Convolvulus arvensis* can be effectively controlled by this method.

Chemical weed control: In this method, chemicals are used for weed control. The chemicals used for weed control are called weedicides or herbicides. It is less time consuming and less expensive than hand weeding. Selective and non selective herbicides are used. Soil fumigants like carbon dioxide, methyl bromide, chloropicrin, cynamide *etc.* and soil sterilants like, Simazine, Atrazine, Formaldehyde *etc.* are applied to soil to kill weeds.

Advantages of chemical weed control:

1. It eliminates early crop weed competition.
2. Herbicides give quick response in terms of checking the growth of weed
3. Hand weeding may lead to injuries to the root system of crop and thus damage the crop
4. It is easier, less time consuming and less costly
5. Tillage is minimized and thus farm power.
6. It conserves soil moisture and nutrients as weed emergence is prevented during initial crop growth.
7. It is an economical method.
8. Weeds similar in morphology to that of crop can effectively be controlled.

Table: Critical period for crop-weed competition in different vegetable crops

S.No.	Crops	Critical period after sowing/planting (days)
1.	Potato	30-50
2.	Peas	30-40
3.	Cole crops	35-40
4.	Solanaceous vegetables	35-40
5.	Onion and garlic	20-30
6.	Okra	20-30
7.	Root vegetables	20-30

Table : Herbicides used for control of weeds in vegetable crops

Crop	Herbicide	Rate (kg/ha)	Time of application
Solanaceous crops	Fluchloralin (Basalin)	1.25	Pre plant incorporation
	Metribuzin (Sencor)	0.25	Pre-emergence
	Alachlor (Lasso)	1-3	Pre-plant incorporation and 8 days after transplanting
	Pendimethalin	1-1.5	4-5 days after transplanting
Potato	Simazine (Princep)	0.25	Post-emergence
	Nitrofen	2-2.5	Pre-emergence
	Alachlor (Lasso)	2.5	10 days after sowing
	Metribuzin (Sencor)	0.5	Pre-emergence
	Oxadiazon (Ronstar)	1.5	Pre-emergence
Peas	Linuron (Afalon)	0.5	Pre-emergence
	Alachlor (Lasso)/Nitrofen	2.0	Pre-emergence
	Pendimethalin (Stomp)	1.5	Pre-emergence
	Fluchloralin (Basalin)	1.5	Pre emergence and pre plant incorporation
Root vegetables	Nitrofen (TOKE-25)	2.0	Pre-emergence
	Linuron (Afalon)	0.5	Pre-emergence
	Oxadiazon (Ronstar)	1.5	Pre-emergence
	Alachlor (Lasso)	1.5-2.0	Pre-sowing incorporation
Okra	Trifluralin (Treflan)	1.0-1.5	Pre-sowing incorporation
	Alachlor (Lasso)	1.25	Pre-emergence
	Fluchloralin (Basalin)	1-1.5	Pre-sowing
Cauliflower	Fluchloralin (Basalin)	1.25	Pre-plant incorporation
	Alachlor (Lasso)	1.5-2.5	Pre-plant incorporation
	Pendimethalin (Stomp	0.75-1.0	Pre-plant incorporation
Cabbage	Trifluralin (Treflan)	1-1.5	Pre-plant incorporation
Onion	Trifluralin (Treflan)	1-1.5	Pre-plant incorporation

In vegetables, integrated weed management practices should be used to control the weeds *i.e.* during the initial stages, herbicides can be used which is followed by hand weeding.

References

1. Handbook of Horticulture, ICAR, New Delhi
2. Handbook of Agriculture, ICAR, New Delhi
3. Fundamentals of Soil Science. Published by Indian Society of Soil Science, Bhopal.
4. Jayakumar R and Jagannathan R. Weed Science Principles. Kalyani Publishers.
5. Singh CM, Angiras NN and Kumar S. Weed Management. M D Publications Pvt. Ltd, New Delhi.

CHECK YOUR PROGRESS

Fill in the blanks

1. ……..are the plants growing where and when they are not desired.
2. …….is the process of application of water soluble solid fertilizer or liquid fertilizers through drip irrigation system.
3. ……..method of irrigation is suitable for areas having uneven topography and where erosion hazards are more.
4. Water is needed mainly to meet the demands of ……, ……..and…… needs of the plants.
5. Farmyard manure is example of…….manure and oil cake is example of ……..manure.

Match the following

	A		B
1.	Woody perennials weed	a.	Wild carrot
2.	Biennial weed	b.	*Lantana camara*
3.	Kharif season weed	c.	*Sorghum halepense*
4.	Herbaceous perennial weed	d.	*Echinochloa colomum*
5.	Grass	e.	*Euphorbiahirta*

Short answers

1. Integrated nutrient management
2. Selective and non selective weedicide
3. Sub surface method of irrigation

1. Mulching of vegetable crops
2. Green manuring and vermicomposting

Long answers

1. Define manure and fertilizer with example. Differentiate between manure and fertilizer.
2. Discuss the methods of application of fertilizer.
3. What are biofertilizers? Discuss it with examples.
4. Discuss different methods of irrigating vegetable crops.
5. Classify weeds on the basis of life cycle. Give two examples of each class.
6. How weeds affect the vegetable crops? Discuss weed management in vegetable crops with examples along with critical stage of crop weed competition.