Unit 2

Weed Management in Vegetable Crops

Introduction

Weeds are wild plants growing where they are not wanted, especially among crops or garden plants. Weed propagules remain viable for a long time and survive in the field even under odd conditions. Based on their life cycle, weeds can be classified as annuals, biennials or perennials. They can be reproduced by seeds or through cuttings, bulbs, corms, rhizomes or tubers. Weeds are harmful as these compete with the main crop for nutrients, water, light and space and badly affect the growth and production of the main crop. They also play an important role as alternative hosts for various stages of insect-pests and pathogens.

They may also produce certain toxins and chemicals that are harmful for the crop as well as to humans and animals in the vicinity. Weeds occupy land, spread fast and hence, require regular eradication. It requires a lot of energy and resources to control them.

Session 1: Weeds in Vegetable Crops

Weeds may be defined as a plant that grows in another plant's space and uses mineral and fertiliser that is meant for the desired crop. It is an unwanted plant in the crop field or its surrounding areas.

Characteristics of weeds

- Weed seeds germinate early, grow fast, and being hardy compete with the main crop for light, moisture and nutrients.
- Weeds are unwanted plants that are harmful to crops, livestock and human beings.
- Weeds can survive under unfavourable conditions.
- They have a very high and prolific capacity to reproduce.
- Even under a deeper layer of the soil, the weed seed can remain viable.
- Some specific structures like wings, hooks, spines, sticky hairs, etc., are present in the seeds, which can help in easy dissemination over longer distance.

Types of weeds

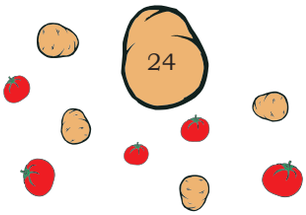
Some of the most common weeds are as given below.

- **Monocot weeds** have a hollow and round stem, internodes are short and hard, and the leaves are slender, long and have parallel veins. Most of the grasses, such as *doob* grass (*Cynodon dactylon*), *motha* (*Cyperus rotundus*) and crab grass (*Digitaria sanguinalis*) belong to this group.
- **Dicot weeds** have a taproot system with broad leaves. The veins on its leaves are netted and they produce flowers, such as *bathua* (*Chenopodium album*), Amaranth (*Amaranthus* spp.).
- **Sedges** have hard triangular stems and look like grass. The leaves extend from each side of the stem in three directions. Sedges have sharp edges.

Also, weeds can be categorised as follows:

Broadleaf weeds

These weeds have two seed leaves (first leaves or cotyledons) when they emerge from the soil. The leaves of this type of weeds are generally wider than the grassy weeds. The veins on the leaves are netlike or branched. Stems of this weed are oval, round or



square and are often branched. They may have showy flowers (Fig. 2.1).

Grassy weeds

They have only one seed leaf and are also called narrow leaf weeds. The leaf blades of this type of weeds are narrow and have parallel veins. The stems are oval or round. The ends of the stems may develop seed heads and have unseen flowers (Fig. 2.2)

Fig.2.1: Broadleaf weeds
Camphor grass (Chromolaena odorata)

Fig.2.2: Grassy weeds
Johnsongrass (Sorghum halepense)

Difference between broadleaf weeds and narrow leaf weeds

Broadleaf Weeds	Narrow Leaf/Grassy Weeds
They have two seed leaves (cotyledons).	They have only one seed leaf.
The leaves are broad.	The leaves are narrowing.
The veins on the leaves are branched or netted.	The leaves have parallel veins.
The stems are often branched.	The stems are unbranched.
They have showy flowers.	They have inconspicuous flowers.

There are some parasitic weeds, which absorb nutrients and water through the roots of the crop plants. For example, broomrape (*Orobanche cernua* and *Orobanche indica*), dodder (*Cuscuta*) and witchweed (*Striga*).

Classification of weeds

Based on their life cycle weeds can be classified into three groups: annuals, biennials and perennials (Fig. 2.3).

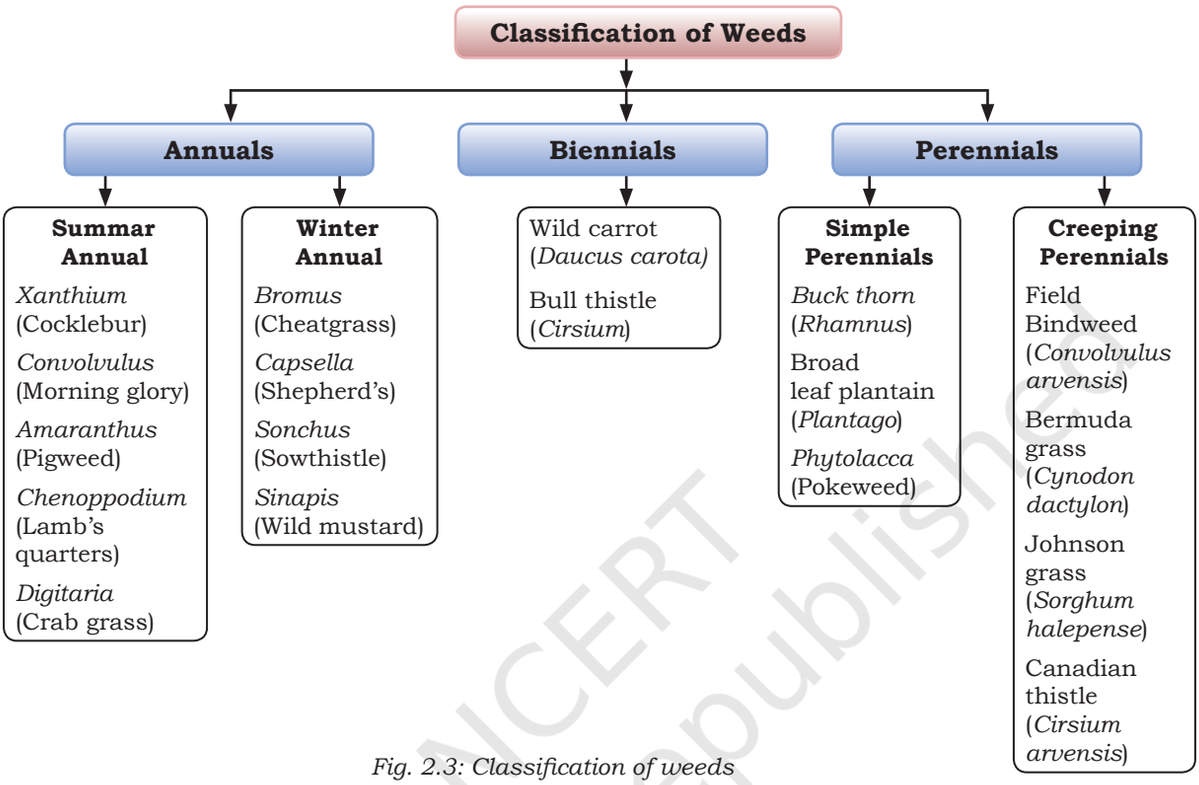


Fig. 2.3: Classification of weeds

Annuals

In annuals, a weed grows from a seed and completes its life cycle within one year. Generally, such weeds are considered comparatively easy to control. However, due to their large numbers and large quantity of seeds and fast growth, these are very constant. They incur higher cost to control than perennial weeds. Vegetable crops are largely affected by these weeds. These are further grouped into:

Summer Annuals

These annual weeds germinate during the spring season and make most of their growth during the summer. A summer annual usually flowers, produces seed and dies. The seeds remain dormant in the soil until the next spring. The common summer annual weeds include *Xanthium* (cocklebur), *Convolvulus* (morning

glory), *Amaranthus* (pigweed), *Chenopodium* (lamb's quarters) and *Digitaria* (crab grass). These weeds are most problematic in summer cropslike tomato, okra, peppers, cucurbitaceous crops and other spring planted vegetable crops.

Winter Annuals

They germinate during late summer and winter, usually flower and produce seeds in the spring or early summer before dying.

During summer months, the seed remains dormant in the soil because the high temperature of the soil restricts their germination.

The winter annual weeds include *Bromus* (cheatgrass), *Capsella* (shepherd's purse), *Sonchus* (sow thistle) and *Sinapis* (wild mustard). These weeds are mostly problematic in winter and early spring for grown crops like carrots, radish, beetroot, onion, garlic, cole, lettuce, etc.

Biennials

These weed plants complete their life cycle in more than one year but do not take over two years. The troublesome weeds that fall in this group are wild carrot and *Cirsium* (bull thistle), etc.

Perennials

These weeds take more than two years to complete their life cycle and may live for many years. They reproduce by seed and also spread vegetatively. They are further classified into:

- Simple perennials spread only by seed and not by vegetative means. However, the cut pieces of plants may also produce new plants. The roots of these weeds are fleshy and may grow very large, for example, *Rhamnus* (buckthorn), *Plantago* (broadleaf plantain) and *Phytolacca* (pokeweed).
- Creeping perennials multiply through creeping roots (creeping above the ground stems, stolens, or creeping below ground stems, rhizomes) and seeds. The examples are *Convolvulus arvensis* (field bindweed), *Cynodon dactylon* (doob grass), *Sorghum halepense* (Johnson grass) and *Cirsium arvense*

(Canadian thistle). Some weeds also propagate by means of tubers, which are modified rhizomes, such as *Helianthus tuberosus* (Jerusalem artichoke) and Cyprus (nut sedge or nut grass). Once a field is infested with these weeds, it becomes very difficult to control them. The weeds associated with different vegetable crops are given in Table 2.1.

Table 2.1: List of common weeds associated with different vegetable crops

S.No.	Name of Weed	English Name	*Botanical* Name	Crops Associated
1.	*Chulai*	Slender amaranth	*Amaranthus viridis*	Chili, onion and garlic
2.	*Satyanashi*	Mexican prickly poppy	*Argemone mexicana*	Chili and potato
3.	*Bathua*	Lamb's quarter	*Chenopodium album*	Tomato, brinjal, chili, cabbage, cauliflower, potato and radish
4.	*Kandai/Lehli*	Canadian thistle	*Cirsium arvense*	Tomato, potato and chili
5.	*Doob*	Bermuda grass	*Cynodon dactylon*	Tomato, brinjal, chili, onion, garlic, potato and radish
6.	*Motha*	Nut grass/Nut sedge	*Cyperus rotundus*	Tomato, cabbage, cauliflower, onion, garlic andcarrot
7.	*Takri Ghas*	Crab grass	*Digitaria sanguinalis*	Cabbage and cauliflower
8.	*Badi Dudhi*	Garden spurge/ Asthma plant	*Euphorbia hirta*	Chili, potato and cassava
9.	*Hiran Pug*	Field bindweed	*Convolvulus arvensis*	Radish and sweet potato
10.	*Sabuni*	Horse purslane	*Trianthema portulacastrum*	Potato, carrot and tomato

Figs 2.4–2.13 show weeds associated with major vegetable crops.

Fig.2.4: Common Crabgrass (Digitaria sanguinalis)

Fig.2.5: Asthma Plant (Euphorbia hirta)

Fig. 2.6: Field bindweed or Hirankhuri (Convolvulus arvensis)

Fig. 2.7: Amaranth (Amaranthus viridus)

Fig.2.8: Satyanashi or Mexican poppy (Argemone mexicana)

Fig.2.9: Bathua or Pigweed (Chenopodium album)

Fig.2.10: Creeping thistle (Cirsium arvense)

Fig.2.11: Doob grass or Bermuda (Cynodon dactylon)

Fig.2.12: Purple nut sedge or Motha (Cyperus rotundus)

Losses caused by weeds

In India, weeds cause the highest loss followed by pathogens, insects, storage pests, rodents and others. The various losses caused by weeds have been described below.

Fig.2.13: Bishkhapra (Boerhavia difusa)

Increase in cost of cultivation

Tillage operations are required to remove the weeds from vegetable fields, which is about 25-30 per cent of the total expenditure of crop production. In case of severe infestation of weeds, more labour is required for manual weeding to remove the weeds. This increases the cost of cultivation and reduces the net return from the crop.

Reduction in quality of crop produce

Weed infestation reduces the quality of crop. Especially leafy vegetables suffer a lot from the infestation of weeds as the seeds of *Euphorbia hirta* (leafy vegetables) are very small, which increases chances of seed mixing.

High infestation of pests and diseases

Weeds serve as an alternative host for diseases and pests. When a particular host dies, the pests and diseases remain and survive on weeds. When the season becomes favourable again, they start their life cycle and damage the main crop.

Reduction in crop vigour and health

Weeds compete for space, light, nutrition, moisture, etc., with the main crop. They deprive the main crop from essential elements required for growth and development. Once the main crop growth is affected, the yield obtained from infested field is very low.

Interference in agricultural operations

Heavy weed infestation in vegetable fields creates problem in field operations like tillage, earthling up, bed preparation, preparation of irrigation channel, etc. All these factors affect crop performance, ultimately reducing the yield.

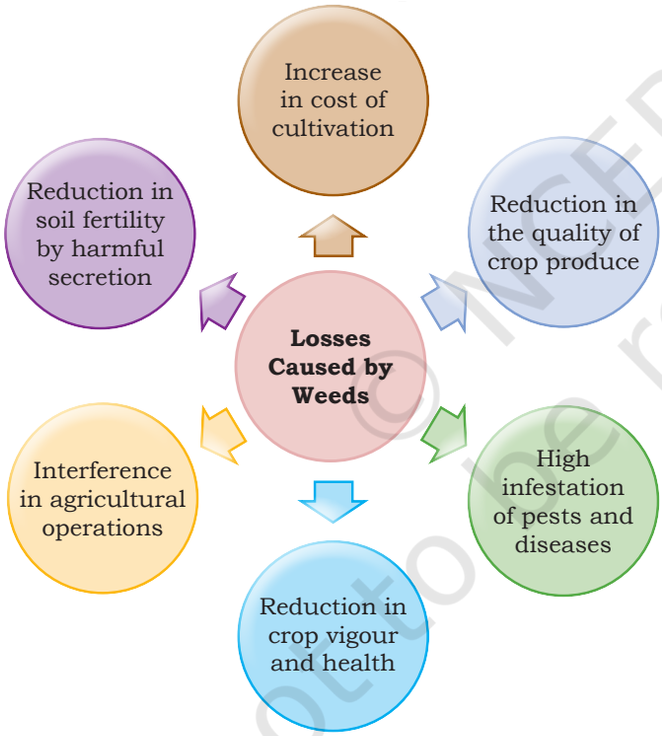


Fig. 2.14: Losses caused by weeds

Reduction in soil fertility

The root exudates of *Cyperus rotundus* (*Motha*) reduce the germination of seeds and causes great losses in terms of yield as well as degradation of soil fertility by harmful secretion.

Critical stages of weed control

Vegetable crops are sensitive to weed infestation. Therefore, critical stages must be kept in mind for effective weed management. Critical stages of vegetable crops for control of weeds are given in Table 2.2.

Table 2.2: Critical stages of vegetable crops for control of weeds

S. No.	Crop	Critical stages of weed control in vegetable crops
1.	Tomato and brinjal	2–6 weeks after transplanting
2.	Potato	3–6 weeks after planting

3.	Onion	2–9 weeks after transplanting
4.	Chili	4–6 weeks after transplanting
5.	Radish, turnip and beetroot	2–4 weeks after sowing
6.	Cabbage	2–4 weeks after transplanting
7.	Okra	2–4 weeks after sowing
8.	Carrot	2–8 weeks after sowing
9.	Garlic	2–8 weeks after planting
10.	French bean	2–6 weeks after sowing

Practical Exercise

Activity 1

Prepare a chart of weeds associated with vegetable crops

Material required

Writing material.

Procedure

1. Visit a nearby vegetable field to collect weeds.
2. Note down the crop associated with the weed collected.
3. Note down the local names of the collected weeds.
4. Note whether the weed has broad or narrow leaves.

Observations: The students should prepare a chart like the one given below and record their observations.

General familiarity chart of weeds

Date of collection _____

Site of collection _____

Specific vegetable plot from which weed is collected	Vegetable crop	Local or common name of the weed collected	Whether weed is broadleaved or narrow leaved

Activity 2

Collection of weeds and the preparation of a herbarium

A herbarium is a perennial collection of the most representative specimen of weeds. It is very good learning material not only for students who prepare it, but also for others who want to know the flora of a particular area.

Material required

field notebook, blotting paper, collection bag, herbarium sheets, pressing device, adhesive or cello tape, scissors or knife, magnifying lens, forceps

Procedure

1. Select a fresh specimen of a plant with all the important parts.
2. Spread the specimen in its natural form on a sheet of paper that can absorb moisture (blotting paper) and place under a press (or tightly press between two smooth surfaces).
3. Change the paper frequently to avoid fungal attack and keep the specimen pressed.
4. Repeat the operation till the specimens are dry.
5. Paste the specimen on a herbarium sheet.
6. Note down the following information on the right side of the bottom of the herbarium sheet.
   - Common/local name
   - Botanical name
   - Family
   - Growth habit
   - Date of collection
   - Site of collection or crop association or soil type
   - Name of the crop associated

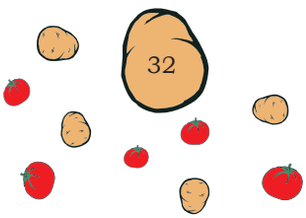
Check Your Progress

A. Fill in the blanks

1. Unwanted plants that grow in the crop field or its surrounding areas are called _____.
2. Broad leaved weeds have _____ as they germinate.
3. A weed that completes its life cycle in less than a year is known as _____ weed.
4. _____ weeds spread only by seed and vegetative means.
5. Parallel veins on the leaves are found in _____ weeds.

B. Multiple choice questions

1. Dodder (*Cuscuta*) is _____.
   (a) an annual weed
   (b) a parasitic weed
   (c) a narrow leaf weed
   (d) a road leaf weed



2. The botanical name of nut grass is _____.
   (a) *Argemone mexicana*
   (b) *Euphorbia hirta*
   (c) *Chenopodium album*
   (d) *Cyprus rotundus*
3. The most common weeds found in vegetable crops are _____.
   (a) annual
   (b) biennial
   (c) perennial
   (d) None of the above
4. Bermuda grass is also known as _____.
   (a) doob grass
   (b) field bindweed
   (c) lamb's quarter
   (d) crab grass
5. The critical stage of weed control for potatoes is _____.
   (a) 1-2 weeks after planting
   (b) 3-6 weeks after planting
   (c) 7-9 weeks after planting
   (d) 10-12 weeks after planting

C. Subjective questions

1. Define weed. How are weeds harmful for a crop?
2. Classify weeds based on their life cycle and morphological features.
3. Distinguish between broad leaved and narrow leaved weeds.

D. Match the columns

A	B
1. Monocot weeds	(a) Consists of/ has a hard triangular stem
2. Dicot weeds	(b) Completes life cycle in more than two years
3. Sedges	(c) Leaves are slender, long and have parallel veins
4. Perennial weeds	(d) Completes life cycle within two years
5. Biennial weeds	(e) Has taproot system with broad leaves

NOTES

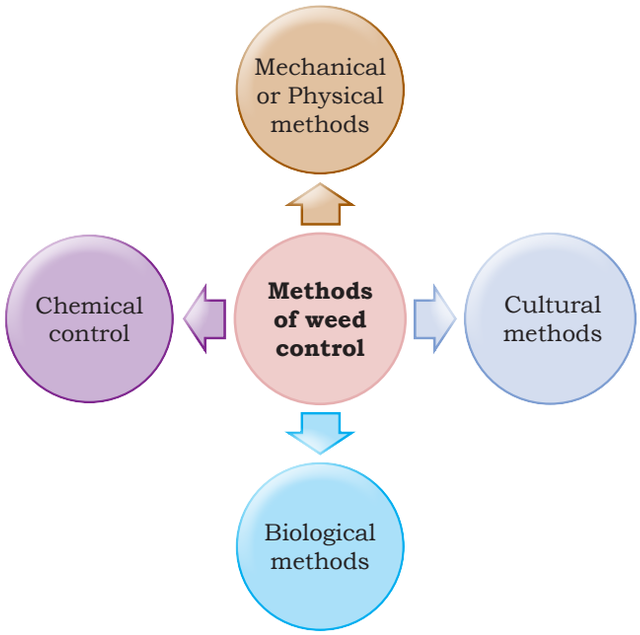


Fig. 2.14: Methods of weed control

Session 2: Weed Management

Methods of Weed Control

Minimising infestation so that the crop can be cultivated successfully is called weed control. The various methods of controlling weeds are given in Fig. 2.14.

Mechanical or physical methods

Mowing the weed is superficial trimming of succulent and herbaceous weeds. This inhibits the formation of seeds on the weed. Mowing keeps the growth of weeds under check,especially in a lawn. It should be followed by other methods of weed control to stop spread of perennials or the low-growing weeds can become a problem. **Mulching** the field is a practice of covering the open soil between the rows and plants of the crop. The soil is covered by organic matter, crop residues, polythene or paper. The exposed areas between the crops get no sunlight when they are covered with mulch. Due to this the weeds are unable to germinate. **Hoeing** is effective in controlling weeds in row crops. It has been widely used as a weeding tool for centuries.

Hand weeding is effective against annual and biennial weeds. Pulling out weeds from the field with the help of a *khurpi* is called hand weeding. This facilitates the loosening of soil and improves its drainage and aeration.

Cultural methods

Various agronomic practices, such as crop rotation, intercropping, soil solarisation, etc. have been found to be effective on weed management.

Crop rotation

It is growing different types of crops in the same field in sequenced seasons. In mono culture, a particular type of weed grows with a particular type of crop. Crop rotation helps to break the life cycle of weeds and prevents any weed species from becoming dominant.

Intercropping

It is growing of two or more crops next to each other at the same time. Intercropping suppresses weeds better than the mono cropping system. It provides the advantage of utilising crops themselves as tools for weed management.

Transplanting

It is when healthy and disease free 4-6 weeks old seedlings are transplanted from one area to another. They have the ability to compete with weeds.

Soil solarisation

It is the method of increasing soil temperature through absorption of sunlight, so that it destroys the seed and other propagules of a weed. Solarisation is done by covering the soil with black polythene during extreme summer for 4 to 6 weeks. The soil temperature may reach up to 40–55°C depending upon the intensity of sunlight. Many annual weeds can be controlled by this method.

Biological method of weed control

Living organisms, such as fungi, bacteria and insects are used to control weed population. Such herbicides are broadly known as bio-herbicides. When fungal spores or fungi are used to control the weeds it is known as myco (fungi) herbicide. The fungi, such as Pythopthora sp., Colletotrichum sp. and Bipolaris sp. are used as myco-herbicide. Insects, such as pallister beetles and flea beetles also damage weeds by feeding on the tender parts. Cochineal insects eradicate the weeds in the prickly pear. Sometimes the pests used for controlling weeds may remain in dormant stage in soil for a longer period. Root borers, stem borers or fruit borers are more destructive than foliage feeders. This method is uncommon as it needs technical knowledge. Bio-herbicides and weed insect-pest may infect or infest the main crop along with weeds.

Chemical control

Labour being uneconomical and also because hand weeding takes longer time, certain chemicals are

used to control the weeds. These chemicals are called herbicides. Chemical control of weeds is an economical method, requires less time and labour and controls weeds uniformly. There are ample pre-emergence, post-emergence, selective and non-selective herbicides available.

Types of Herbicides

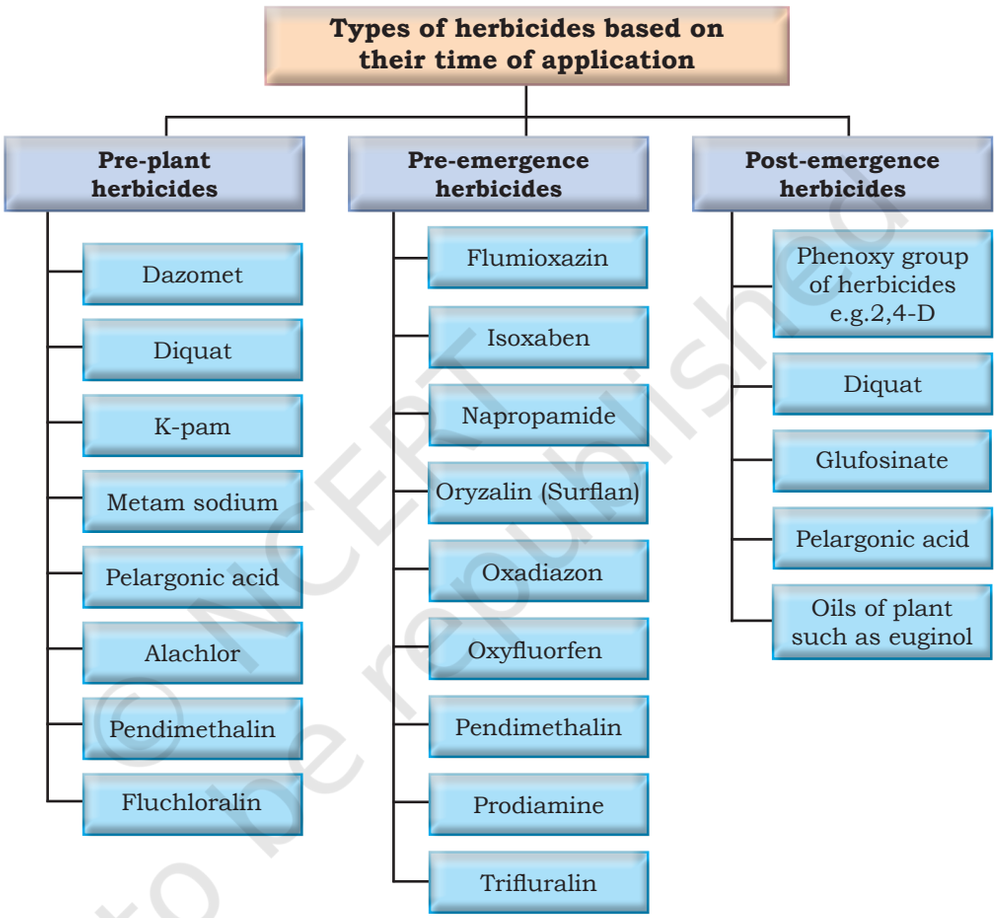


Fig. 2.15: Types of herbicides

Pre-plant herbicides

This is a group of herbicides that is applied before planting the main crop. These herbicides may be fumigants or non-selective chemicals and are lethal to all the plants that come in their contact. These are useful in controlling pre-emerged as well as emerging weeds. Most of these are applied to the soil. Some may be sprayed onto the weeds,

in case of perennial weeds. Pre-plant herbicides include Dazomet, Diquat, K-pam, Metam sodium, Pelargonic acid, Alachlor, Pendimethalin, Fluchloralin, etc.

Pre-emergence herbicides

This is another group of herbicides that attack the weeds at the seedling stage. These herbicides are generally selective. These are applied to soil after removing the existing weeds. Pre-emergence herbicides must be applied before the germination of weed seeds. Since there are various germination periods of weed species and a selection of herbicides, it is generally essential to use different herbicides at different times of the year to achieve best control. For example, Flumioxazin, Isoxaben, Napropamide, Oryzalin (Surflan), Oxadiazon, oxyfluorfen, Pendimethalin, Prodiamine and Trifluralin are included in this group.

Post-emergence herbicides

Post-emergence herbicides are applied onto weeds at the seedling stage. These are very selective and control only a narrow range of weed species. Fluazifop-p-butyl and Sethoxydim control most annual grasses and Clethodim controls annual bluegrass as well as other grasses.

These products include the phenoxy group of herbicides, such as 2,4-D, which selectively control broad leaved weeds. The group of non-selective herbicides includes diquat, glufosinate and pelargonic acid, and oils of plants, such as euginol.

Selective herbicides

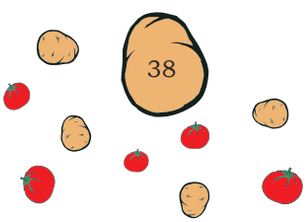
These are used against specific group of weeds and do not prove harmful for other crops. Pendulum, Surflan, Treflan, etc., 2,4–D, etc., kill broad leaved weeds but do not harm the monocots, while Fusilade (fluazifop) controls monocot weeds and not the broad leaved plants.

Non-selective herbicides

These prove lethal to almost all monocot and dicot weeds when they come in its contact, for example diquat.

Table 2.3: Chemical weed control in vegetable crops

S.No.	Crop	Herbicide formulation	Dose (kg/ha)	Time of application
1.	Potato	Fluchloralin	1.0	Pre-plant
		Pendimethalin	2.0	Pre-emergence
		Metribuzin	0.2-0.3	Post-emergence
2.	Cabbage and cauliflower	Fluchloralin	0.75-1.5	Pre-plant
		Pendimethalin	1.0	Pre-emergence
		Alachlor	2.0-3.0	Pre-emergence
		Isoproturon Alachlor	0.75-1.0 1.0-2.0	Post-emergence
3.	Onion and garlic	Fluchloralin	1.0-1.5	Pre-transplant (soil incorporation)
		Alachlor Pendimethalin	1.5-2.0 0.5-1.0	Pre-transplant (surface application)
		Oxyflurofen	0.62	Post-transplant
4.	Carrot	Fluchloralin	0.75-1.5	Pre-plant (soil incorporation)
		Pendimethalin Nitrofen	1.0 1.0	Pre-emergence
		Nitrofen	1.0	Post- emergence
5.	Radish	Benthiocarb Fluchloralin	1.0 0.5	Pre-emergence Pre-emergence
6.	Peas	Linuron Pendimethalin	0.5 1.0	Pre-emergence Pre-emergence
7.	Tomato	Trifluralin	1.0	Pre-plant (soil incorporation)
		Alachlor	1-1.25	Pre-transplant (surface application)
		Fluchloralin	1.25	Pre-transplant (surface application)
		Alachlor	1-2	Pre-emergence
8.	Okra	Fluchloralin Alachlor	0.5-1.0 1-2	Pre-plant (soil incorporation) Pre-emergence
9.	Brinjal	Fluchloralin Pendimethalin	1-1.25 1.0	Pre-plant (soil incorporation) Pre-emergence
10.	Bottle guard and cucumber	Fluchloralin Butachlor	0.5-1.0 1-1.25	Pre-plant (soil incorporation) Pre-emergence
11.	Spinach	Benthiocarb	1.0	Pre-emergence



Application of Herbicide

The success of weed control depends on the method of application of the herbicide. The important factor in the application of herbicide is that it should target the foci accurately and in measured quantity only. Different equipment is used for herbicide as per the formulation and area to be covered. On small holdings or in a greenhouse it can be applied through a backpack handpump sprayer or duster, whereas, in big fields or farms, a tractor unit is more desirable. In large nurseries, over-the-top sprayers are used, which cover full beds will be best. Flat fan nozzles, equally spaced on a boom, are used to get the most uniform distribution of pre-emergence liquid herbicidal formulations.

Hollow or cone nozzles on a boom are used in case of spraying post-emergence herbicides on weeds. Granular herbicides can be applied through common types of spreaders. Herbicide granules can be spread with drop-type or side-throw-type of spreaders.

Equipment used to spray weedicide

Sprayers are of two types – knapsack and foot sprayer. They are used to spray not only herbicides but also insecticides, fungicides, soluble fertilisers etc. in vegetable crops.

Duster is used for dusting fungicides, insecticides, herbicides, etc. in a powder form.

Fig. 2.16: Knapsack sprayer

Precautions to keep in mind while applying weedicides

1. Before application read and follow the directions written on the label.
2. Calibrate your spray equipment and keep it in good working order.
3. Always wear gloves, cap and mask during the spraying of weedicides.
4. Do not apply on a hot sunny day or during strong wind conditions.
5. Do not apply just before and after a rainfall.
6. Stop entry of animals and workers in the spraying area.

7. Post-emergence herbicides should be sprayed when the weeds are at the initial stage.
8. Make a record of major weed species in the vegetable field and use it for planning the spraying schedule for the next season.
9. Competitive crops should be grown in weedy areas and non-competitive crops in the cleaner areas of the field.
10. After spraying weedicides, wash your hands properly with soap in running water.
11. Clean the sprayer or duster by removing the remaining weedicides.
12. Properly oil or grease the sprayer or duster, before and after spraying, to check faulty application.

Practical Exercise

Collect information about herbicides commonly used in your locality

Material required: Writing material.

Procedure

Collect information about commonly used herbicides in your locality either from the farmers or from the agro service centre and prepare the following chart.

S. No.	Name of herbicide	Formulation dry/wet	Concentration	Time of application	Effective against (weed)

- Formulation may be dry or wet.
- Time of application means pre-planting, pre-emergence or post-emergence.

Check Your Progress

A. Fill in the blanks

1. Growing two or more crops next to each other at the same time is called _____.
2. Soil temperatures must reach above _____°C to facilitate solarisation.

3. The different types of crops that grow in the same field in sequenced seasons are known as _____.
4. Pulling out weeds from the field by hand with the help of a *khurpi* is called _____.
5. Diquat is a _____ herbicide.

B. Multiple choice questions

1. Herbicides applied prior to the emergence of the weed seed is known as _____
   (a) pre-plant application.
   (b) pre-emergence application.
   (c) post-emergence application.
   (d) All of the above
2. Pendimethalin can be used in potato as a pre-emergence spray and the dosage is _____.
   (a) 1 kg/ha.
   (b) 2 kg/ha.
   (c) 3 kg/ha.
   (d) None of these
3. Which of the following herbicides can be used as a pre-plant/transplant?
   (a) Alachlor
   (b) Pendimethalin
   (c) Fluchloralin
   (d) All of the above
4. Living organisms, such as fungi, bacteria and insects that are used to control weed population are known as _____.
   (a) myco-herbicides
   (b) persistent herbicides
   (c) bio-herbicides
   (d) herbigation
5. Herbicides applied before planting the main crop are _____.
   (a) pre-plant herbicides
   (b) pre-emergence herbicides
   (c) post-emergence herbicides
   (d) All of the above

C. Subjective questions

1. Explain different methods of weed control in vegetable crops.
2. Classify the various types of herbicides used in weed control.
3. Discuss the chemical method of weed control in solanaceous vegetables.
4. Write various precautions to be followed during the spraying of weedicides.

D. Match the columns

A	B
1. Soil solarisation	(a) Covering exposed surface of soil
2. Mowing	(b) Use of chemicals
3. Mulching	(c) Biological control
4. Herbicide	(d) Superficial trimming
5. Myco-herbicide	(e) Raised soil temperature