Unit 1

Cultivation of Commercial Flower Crops – I

171210CH01

Cultivation of flower crop is an important component of commercial floriculture. There are many flower crops that are grown for cut flowers, loose flowers, *vis-à-vis* for seed production. These crops are used for various purposes. Agro-climatic conditions in a country favour cultivation of a wide range of crops in open field conditions. Now a days, small flower growers are switching to grow crops under protected conditions in their small holdings for earning maximum returns. Quality of flowers grown here is best to meet the international standard, so these flowers are becoming more popular among international community. We have good domestic markets near big cities and up to 70 per cent of the flowers grown in the small holdings are sold there, as there has been a tremendous increase in the income of Indian people, so use of flowers has been a part of their living standard. Thus, only 30 per cent of the grown flowers is left for export. To grow crops for commercial purpose, a cultivator must be aware about the requirements of the crop and

recent techniques developed to obtain better yield with quality product. Knowledge of appropriate agro-climatic conditions is essential to have a quality crop production. Management practices such as selection of improved and suitable varieties according to locality and demand, maintenance of fertility of soil by the application of manures and fertilisers, proper regulation of watering, timely management of weeds, insect-pests and diseases, and proper method of harvesting, grading, sorting and packaging are essential to minimise losses and for obtaining quality products with better yield.

Session 1: Cultivation of China Aster

China Aster *(Callistephus chinensis)*

Family: Asteraceae

China aster, a native of China is one of the most popular annual flowers grown throughout the world. In India, it is grown as traditional flower, though worldwide, it is grown as cut flower, and it is best to be used as bedding and border plant (Fig.1.1).

Fig. 1.1: China aster

Varieties

Kamini, Poornima, Phule Ganesh Pink, Phule Ganesh Purple, Phule Ganesh Violet, Phule Ganesh White, Shashank, and Violet Cushion are Indian bred varieties.

Climate

China aster can be grown year round in areas where night temperature can be maintained around 10–18°C (optimum range being 20–30°C during daytime, and 15–17°C during night) with relative humidity of 50–60 per cent and the site properly exposed to the sun.

Soil

China aster can be grown in a wide range of soils though most suitable ones are well-drained sandy-loam, or loamy soils rich in organic matter and having a pH range of 6.8–7.5.

Propagation

Plants of China asters are commercially propagated through seeds and for one hectare of planting, 2.5–3.0 kg seed is required which is first sown in the nursery and then transplanted. Seeds in the nursery are sown during September–October, and seedlings are transplanted when they attain a height of 10 cm, in about a month.

Land preparation and planting time

To make a fine tilth of soil, field should be ploughed at least thrice to a depth of about 30 cm, followed by planking after every ploughing. Well rotten farmyard manure (FYM) at the rate of 10–15 tonnes per hectare should evenly be mixed in the soil during second ploughing. FYM can be substituted with vermicomposting if available.

In and around the Bengaluru region, the crop can be grown throughout the year, though main seasons are May–June and September–October. In the subtropical regions such as Delhi, its sowing time is September–October, and transplanting is done in October–November, whereas in the temperate regions in the country the seeds in the nursery are sown in September while transplanting is done during October.

NOTES

Spacing

Seedlings of China aster are normally transplanted at a spacing of 30 × 30 or 45 × 45 cm according to soil, growth habit, and season of planting. In light soils, it can be planted at 45 × 20 cm and in medium soil at 60 × 20 cm distance.

Manures and fertilisers

Application of FYM 10–15 tonnes as a basal dose at the time of field preparation and NPK 120:80:120 kg/ha is quite sufficient. Phosphorus and potassium are given only as a basal dose and nitrogen in 2–3 split doses as soil application.

Irrigation

Irrigation requirements depend upon prevailing weather conditions, type of soil, and season of the crop grown. Since it is a winter annual, so in general, irrigation at an interval of 10–12 days is recommended.

Pinching

This is an important practice in some varieties of China aster for getting precocious flowering. Pinching of main shoot at one month after transplanting in variety 'Ostrich Plume Purple' gave a significant increase in the number of nodes, branches, flowers, and flower yield but delayed the flowering by 8–12 days.

Harvesting, yield and postharvest

China aster is harvested in two different ways. Individual flowers are harvested for making garlands and worshipping, while flowers with stalks are harvested for cut flower use. For loose flower use, their harvesting is effected when the flowers are fully open but for cut flowers, these are harvested when the original colour has developed. When flowers are harvested for cut flower, their cut ends are immediately placed in distilled or palatable water, and brought inside the shed for grading and packaging. Life of cut flowers can be extended up to

30 per cent through the use of 60 g sucrose + 250 mg 8-HQS + 70 mg CCC + 50 mg $AgNO_3$ per litre of water in vase solution. About 15–20 t/ha of loose flowers are produced, depending on the varieties used, soil type, cultural operations, and prevailing weather conditions.

Insect-pests

Black blister beetle/aster beetle (*Epicauta pennsylvanica*), a serious pest, feeds on foliage and flowers and mostly destroys the plants completely. Asiatic beetles (*Autoserica castanea*) mostly feed on the leaves during nights and hide themselves in the soil near the base of the plant during daytime. Tarnished plant bugs (*Lygus lineolaris*) are light brown, variously spotted and highly devastating pests as they puncture the terminal shoots below the flower buds which causes the flowers to droop and die. Leafhopper (*Macrosteles fascifrons*) is the most common pest of asters which also acts as virus vector. Leaf miners mine the leaves, remain inside and feed on them. Semilooper caterpillars feed on leaves and flowers and hang themselves through a thread that they emit themselves when alarmed.

Root-knot nematode (*Meloidogyne incognita*) infests China aster roots by galling them, which causes stunting of the plants. Foliage nematode (*Aphelenchoides ritzema-bosi*) feeds on China aster leaves and become very active at 20°C temperature. Nematodes can be controlled by the use of Furadan at 1g/m^2 in the soil, followed by hoeing and watering.

Diseases

Wilt caused by *Fusarium oxysporum f. sp. callistephi* and *Botrytis cinerea* has been found occurring in China aster, showing various symptoms with ultimate wilting of plants. Collar or root rot (*Phytophthora cryptogea*) causes symptoms of water soaking, and blackening of China aster stems and roots with ultimate plant collapse. Stem rot (*Pellicularia filamentosa*) causes rotting of the stem in China aster.

NOTES

Gray mould (*Botrytis cinerea*) occurs when weather is cool and humid. Its infection causes burnt appearance on the infected plants in humid weather.

Leaf spot (*Ascochyta asteris, Septoria callistephi* and *Stemphylium callistephi*) occurs on China aster plants. Symptoms of their attack appear as yellowing of leaves, starting from the lower leaves, turning them brown and then black, which through coalescing become larger in size.

All these are controlled through spraying of 0.2% zineb or maneb twice in a week. Canker (*Phomopsis callistephi*) causes China aster canker on the lower part of the stem, completely damaging the distal portion though the root is untouched. Rust (*Coleosporium solidaginis*) is a serious problem in China aster causing bright yellowish-orange spots on lower surface of leaves, especially in young plants, and this is controlled through use of wettable sulphur. All these pathogens can be controlled by spraying the infected plants with 0.2% captan, mancozeb, zineb, or carbendazim, or through 0.1% spraying of calixin.

Virus

Chrysanthemum mosaic virus (that is a seed-borne disease), California strain of aster yellows, spotted wilt, and curly top are the major viruses infecting China aster. Controlling of insect vectors will check the spread of various viruses. Infected plants should be uprooted and burnt.

Practical Exercise

Activity 1

Demonstrate the harvesting of China aster as a cut flower.

Material required

Scissor or secateur, a bucket with water. China aster flowers are harvested as loose (without stalk, for making garlands, and worshipping purposes), and with stalks as cut flower use.

Procedure

- Select long stalked fully colour developed flowers.
- With the help of scissor or secateur, cut the stalk of the flower as long as possible.

- After cutting, immediately place their cut ends in distilled or palatable water.
- Then bring the flowers inside the shed for grading and packaging.
- The life of the cut flowers can be extended by the use of holding solution.

Check Your Progress

A. Fill in the Blanks

1. For China aster cultivation, _____ soil is best with a pH range of _____.
2. In China aster application of FYM, _____ tonnes and _____ NPK kg/ha are found beneficial.
3. Individual flowers are harvested for making _____ and _____.
4. China aster is commonly propagated by _____.
5. For commercial cultivation of China aster, the seed rate requirement is _____ kg/ha.

B. Multiple Choice Questions

1. Optimum temperature range required for China aster during the day and night is —
   (a) 20–30°C and 15–17°C
   (b) 30–35°C and 17–19°C
   (c) 25–35°C and 13–15°C
   (d) 35–40°C and 19–21°C
2. China aster can be planted at _____ cm spacing.
   (a) 20 × 20 or 35 × 35
   (b) 25 × 25 or 40 × 40
   (c) 35 × 35 or 50 × 50
   (d) 30 × 30 or 45 × 45
3. Normal growing season of China aster is _____.
   (a) June–July and October–November
   (b) February–March and July–August
   (c) May–June and September–October
   (d) November–December and April–May
4. Yields of China aster is about _____ tonnes/ha loose flowers.
   (a) 14–16
   (b) 18–20
   (c) 20-22
   (d) 22–25
5. A serious insect pest of China aster is —
   (a) Aster beetle (Epicauta pennsylvanica)
   (b) Leafhopper (Macrosteles fascifrons)
   (c) Tarnished plant bugs (Lygus lineolaris)
   (d) Root aphid (Anuraphis maidi-radicis)

NOTES

C. Subjective Questions

1. Define pinching in aster.

_____

_____

_____

2. Name any five varieties of China aster.

_____

_____

_____

3. Describe propagation of China aster.

_____

_____

_____

4. Write about planting and transplanting of China aster.

_____

_____

_____

D. Match the Columns

A	B
1. Stunting of the plants	(a) Pellicularia filamentosa
2. Gray mould	(b) Very active at 20°C temperature
3. Stem rot	(c) Nematodes control
4. Foliage nematode	(d) Root-knot nematode
5. Furadan at 1g/m^2	(e) Botrytis cinerea

Fig. 1.2: Chrysanthemum

Session 2: Cultivation of Chrysanthemum

Chrysanthemum (*Dendranthema grandiflora*, formerly called *Chrysanthemum morifolium*)

Family: Asteraceae

Chrysanthemum (Queen of East/Autumn Queen, *Guldaudi*), widely grown worldwide is the oldest flowering plant. It is used as

potted plant (pot mums), as well as, cut flower, and in Asia, even as loose flower.

Types and varieties

Broadly, these are classified into seven groups:

Single

These have up to five radiating whorls with strap-like ray florets and conspicuous disc.

Fig. 1.3: Single

Anemone

These are well-developed disc florets. So the disc is raised and the ray florets are either tubular or ligulate.

Fig. 1.4: Anemone

Fig. 1.5: Pompon

Pompon

This type has invisible disc, small, but quite compact with hemispherical shape, where ray florets are short, broad, and regularly arranged.

Decorative

This type has an invisible disc due to ray florets being present over the entire capitulum; and is large or pompon-type small-flowered.

Fig. 1.6: Decorative

Fig. 1.7: Incurved

Fig. 1.8: Reflexed

Fig. 1.9: Intermediate

Incurved

Flowerhead is fully double, and perfectly globular where petals are incurving and closed tightly over the crown.

Reflexed

Flowerheads are rounded and fully double with petals falling (curving) outwards and downwards touching the stem, often with curl or sideways twist and overlapping as bird's feathers. These maybe fully reflexed, partly reflexed, or reflexed having spiky outline.

Intermediate (formerly incurving)

Here, flowerheads are double and globular, but halfway between the incurved and reflexed. Where petals are loosely incurving with regular shape, it is named as *formal intermediate*, and where these are irregularly incurving, it is known as *informal intermediate*.

Chrysanthemum varieties can be classified as:

Standard varieties (large flowered varieties)

Basanti, Bronze Princess Anne, Gay Anne, Giant Indianapolis White, Indira, Jaya, Mahatma Gandhi, Pink Champagne, Purnima, Purple Anne, Rakhi, Red Gold, Red Resilient, Shanti, Sharad Mala, Snowball, Sonar Bangla, Tata Century, Thai Chung Queen, Vaatika, White Star, Yellow Fred Shoesmith, Yellow Star, etc.

Spray varieties (small flowered varieties)

Ajay, Apsara, Arctic, Baggi, Birbal Sahni, Cameo, Charlia, Flirt, Jayanti, Jubilee, Kundan, Lal Pari, Nanako, Pusa Anmol, Pusa Aditya, Riot, Surf, White Bouquets, etc.

Climate

Chrysanthemums are short day plants, as for profuse flowering these require short days though for better vegetative growth, these require long days. The critical

day length is 14–15 hours for vegetative growth and less than 12 hours for flower initiation. For optimum flowering, it requires 20–28°C temperature in the day time and 5–20°C temperature in the night time.

Soil

Chrysanthemum can be grown on various types of soils; however, sandy-loam to loamy soils rich in organic matters are more suitable having around pH of 6.5, but the soil should not be waterlogged.

Propagation

Commercially, chrysanthemum is propagated through suckers and terminal cuttings, but it is done even through seeds for evolution of new varieties though many of the improved varieties do not set seeds except the certain small-flowered spray and pompon types. Only a few types among the large-flowered ones set seeds.

Seeds

Plants raised through seeds exhibit a large range of variations including colour, shape, and size. These germinate within 10 days and become ready for transplanting in about 40 days.

Suckers

When flowering is over, the stem of chrysanthemum is cut off just above the ground to induce suckering. After sufficient growth, the suckers are separated and planted in sandy soil, and those having well-formed roots are directly transplanted in the field. Suckering is a natural phenomenon which is further encouraged by removal of main shoot after flowering, and as these suckers already have roots so their establishment is almost certain with early take off, although there is no uniformity in growth and flowering, and there are greater chances for carrying diseases the mother plant had.

Cuttings

Terminal or tip cuttings, 5–8 cm long, are taken from a healthy stalk. Cuttings dipped in Seradix or 500 ppm IBA are inserted 3–5 cm apart, in sand beds, made under filtered light, followed with irrigation immediately

and daily until 3–4 weeks when these become ready for transplanting. Though these start slowly with a high mortality rate as compared to suckers but by and large remain healthy and come up uniformly.

Land preparation

For chrysanthemum growing, there should be three deep ploughings, each followed by planking, where at second ploughing some 300–500 quintals/ha well rotten compost or farmyard manure should evenly be mixed, and after the third ploughing, the soil should make a fine tilth. All the foreign materials including the rootstocks of perennial weeds, stones, grits, chips, wood pieces, polythene shreds, etc., are to be taken out, soil is to be properly levelled, and then beds of convenient sizes are to be made by having provision of bunds and irrigation channels.

Planting

Cuttings are planted immediately after these have been rooted. Ideal planting time is May–June. In North India, planting should be carried out after the second week of June. It would be better to plant first in the nursery beds, and then finally transplanting in the permanent beds after one month, followed by immediate irrigation. It should be ensured that wherever the chrysanthemums are to be transplanted, the soil should be free of waterlogging so it would be better to transplant the rooted cuttings on ridges.

Planting density influences plant vigour and flower quality. Density may differ due to agroclimatic conditions prevailing at a location, and from variety to variety. In case of cut flower varieties, the plant density may go up to 64/m^2; however, for economic returns the plant density may be maintained at 25–32/m^2. Usual spacing being kept in India is 20 × 30 cm, 30 × 30 cm, or 40 × 40 cm/m^2, however, the spacing of 20 × 30 cm gives best economic yield.

Irrigation

Watering the plants solely depends on the stage of plant growth, the soil type, soil moisture level, prevailing weather condition, and relative atmospheric humidity.

Immediately after transplanting, the chrysanthemums are at once watered to recover from the lifting shock and for proper settling of roots, and thereafter, these are watered at an interval of every four days in the summer season, however in winters, these maybe watered at an interval of 7–10 days. Until these are properly established, the soil should remain continuously moist, but thereafter the scarcity should alternate with the sufficiency of water so that the growth of plants is proper. Proper drainage system must be maintained throughout the crop duration.

Manure and fertilisers

If sufficient quantity of farmyard manure has been incorporated in the soil at the time of bed preparation, it does not require any further feeding except the specific ones. In case sufficient FYM is not available, and as this is heavy feeder for nitrogen and potassium, so 50:160:80 kg NPK/ha fertiliser may be applied afterwards for good results. Phosphorus, a slow-release fertiliser, is applied as the basal dose before planting along with some 20 kg of nitrogen. The other two split doses of nitrogen should be applied after every two months of planting but not at the stage when the buds are likely to be formed. It would be better if the first nitrogen application matches with first pinching. Entire potassium fertiliser should also be applied as basal dose.

Staking

Stakes in chrysanthemum are very necessary to keep the plants straight, in proper shape, and to support the plants from lodging when in bloom, especially in case of taller varieties. Normally used stakes are prepared from willows and bamboos. For a single bloom production, only one stake is required but for heavy bloomers, three to five stakes are used to control outside growth of the plants in pots. The stakes should always be slightly smaller than the level of blooms for a perfect and spectacular viewing.

De-suckering

Removeal of suckers is necessary so that energy is saved for the growth of main shoot, otherwise flower quality will be hampered drastically.

NOTES

Pinching or stopping

Pinching in chrysanthemum is carried out usually by hand. It refers to the removal of growing tips at the 10–15 cm stage, so that many lateral shoots are formed for precocious flowering. In certain varieties, the practice is repeated after 30–45 days of first pinching for multifold increase of floral buds so that at the flowering stage, the plant is full of blooms.

Disbudding and de-shooting

These operations are carried out mostly in the large-flowered and decorative varieties. Disbudding is the removal of side buds to control the number and size of flowers. In large flower type cultivars, immature flower buds are removed to get large size flowers or a large number in small flower type cultivars. In standard types and others where only one largest bud is desired, other axillary buds around the centre are removed. In spray varieties, the large central bud is removed and the lateral ones are allowed to develop depending upon the type of spray to be produced.

Weed control

For maintaining uniform warmth in the soil, to conserve moisture, and to hinder the emergence of weeds in the crop, 5–7 cm thick mulches made of sawdust, straw, etc., are spread on the ground. In small holdings, the weeding should be carried out manually, while in the large scale plantings, herbicides such as trifluralin at 4 kg/ha as pre-emergence should be applied.

Use of growth regulators

Ascorbic acid spraying at 1000 ppm (1 g/l) after 30 or 70 days of transplanting increases the overall growth of plants. Spraying of B-nine at 5000 ppm provides highest number of flowers per plant. GA_3 at 500 ppm should be sprayed at 30, 45, and 60 days after planting for increasing flower yield manifold. Number of quality flowers is increased when plants are sprayed with 0.1% tricontanol.

Harvesting

Standard chrysanthemum is harvested when fully open, but before central disc starts elongating. Spray cultivars are harvested when fully open but before the shedding of pollen, and pompons are harvested when the centre of oldest flower is fully open. Harvesting should be done early in the morning. The average yield of good quality flower ranges from 10–15 tonnes/ha.

Insect-pests

Aphids

Small greenish to black-dotted tiny insects, where nymphs and adults both cluster on the tender plant parts (flower buds, young leaves, and branch tips). Apart from sucking the sap, they also excrete honeydew which attracts ants and sooty mould, *vis-à-vis* act as a carrier of various viruses.

Thrips

Nymphs and adults of the thrips are also tiny insects which damage the plants similar to aphids but these don't secrete honeydew or attract ants or act as a virus vector.

Leafminers

Larvae mine the leaves and keep on feeding the tissues under the epidermis so the leaves are disfigured with irregular white linings.

These insects can be controlled effectively through spraying the plants with dimethoate (0.3%), thiodan 1.25 ml/l or dicofol (0.05%). Use of predatory midge (*Aphidoletes aphidimyza*) and lacewigs (*Chrysopa sp.*) as well as fungi *Beauveria bassiana* and *Verticillium lecanii* can effectively be used for control of aphids. Predatory insects such as *Neoseiulus cucumeris* and *N. barkeri* are used against thrips, *Orius insidiosus* and *O. tristicolor* against Western flower thrips as well as onion thrips, and the entomopathogenic fungus have been found effective against thrips. For controlling leaf miners, *Diglyphus begini* and *Dacnusa* wasps have been found quite effective.

NOTES

Whiteflies

These are havoc in a chrysanthemum field, especially in the greenhouses. Their attack causes leaf yellowing-cum-drying, and in severe infestation, the plants are even killed. These also transmit the viruses. In abundance, these start flying over the crop when the plants are slightly shaken.

There is no effective chemical control for this pest but placing of at least one yellow sticky trap/10 m^2 is quite effective. Parasitic wasp such as *Encarsia formosa*, predatory coccinellid beetle (*Delphastus pusillus*) and entomopathogenic fungus (*Paecilomyces fumosoroseus*) are effective for controlling whiteflies.

Mealybugs

Nymphs and adults are utterly slow-moving insects having shining white to gray covering on their entire bodies. They are found clustered especially on the shoot tips sucking plant sap. Their severe attack causes the plants to be infected by various pathogens, so the plants are likely to die. For pest control, preventive spray of NSKE or azadirachtin 0.5 ml/l is the first step, pesticides such as acephate, azadirachtin, bendiocarb, chlorpyriphos or diazinon control mealybugs effectively when sprayed fortnightly 3–4 times. Parasitic insects such as *Lindorus lophanthae* and *Metaphycus helvolus* parasitoid the mealybugs, but their availability for field application is generally different. Ladybird beetle is often a good parasite for mealybugs.

Bihar or Hairy caterpillar

The chrysanthemum plants are attacked during rainy season and attack continues until winter by the greenish-brown caterpillar having dark markings. These can be hand-picked and killed. White grubs also feed on the underground parts of the plants during hot weather.

Monocrotophos at 1 ml/l or carbaryl at 2 g/l is effective in killing the caterpillars. Against white grubs, the pathogenic nematode *Steinernema carpocapsae* should be introduced in moist soil through water at 14–20°C temperature. These enter the body of the grub and release bacteria that cause a fatal infection.

Red spider mites

These are quite tiny dot-like red insects which can be found sticking to the underside of leaves, and sometimes even on open flower buds of the plant sucking their sap, especially during summer.

Two to three weekly sprayings with methyl demeton at 1 ml/l or dicofol at 2 g/l is effective in controlling these mites. Parasitic mites such as *Neoseiulus californicus, Mesoseiulus longipes, Phytoseiulus persimilis,* etc., are effective in controlling these mites.

Root-knot nematodes

Nematodes feed the chrysanthemum roots by making galls and their infestation causes cupping of leaves, *vis-à-vis* plant distortion and stunting. Root knots can be observed by uprooting such plants.

The soil should be sterilised before planting. Oxamyl 10G either as a soil drench, as granules, or as sprays will control the nematodes.

Diseases

Root rot and damping off *(Pythium sp., Phytophthora sp.)*

These are serious soil-borne diseases during warm and moist conditions due to which the rotting of stem cutting occurs. These fungi also enter the plants through the wounds inflicted through pinching. Its infection causes sudden wilting of roots, thereby causing drooping of leaves and stems. Infected cuttings should be destroyed and soil should be drenched with orthocide or etridiazole + thiophanate-M or metalaxyl.

Sclerotinia rot *(Sclerotinia sclerotiorum)*

It is symptomised as light brown lesions on the stems. This develops rapidly girdling the stem by which the plants ultimately wilt. During wet weather, a dense white fluffy fungal growth appears. Before planting, the soil should be sterilised with chloropicrin/formaldehyde/ methyl bromide and on the plants 1.5 g/l carbendazim or 2 g/l benomyl should be sprayed.

Verticillium and Fusarium wilts *(Verticillium albo-atrum, Fusarium oxysporum var. tracheiphilum)*

These are highly devastating diseases to chrysanthemums. These fungi being soil-borne enter the plants through roots. At initial infection, conspicuous leaf yellowing and browning appears but later on progress upwards so the plants become weak and stunted and mostly fail to produce flowers. This is most prevalent in glasshouse grown chrysanthemums. Soil drenching with dexon or carbendazim is effective against these diseases.

Rayblight *(Didymella chrysanthemi, Mycosphaerella ligulicola)*

It is symptomised by flowers becoming one-sided due to deformed ray florets at one side. Their early infection causes even bud blasting. Due to rotting, the inner florets become dark brown. To control these maladies the field humidity should be proper, infected plants should be removed and sprayed with benomyl and mancozeb at 2 g/l, and resistant varieties such as 'Iceberg', 'Irene', 'Minong', and 'Red Daisy' should be used.

Leaf spots *(Septoria chrysanthemi)*

These initially appear late in the season on older leaves as grey-brown circular spots which afterwards turn dark brown to black covering the entire plant. There are certain other pathogens also causing leaf spots, and in such cases, dark brown spots with yellowish margins are produced which expand in size afterwards covering the entire leaf. Leaf spots can be prevented by fortnightly spraying of bordeaux mixture or mancozeb at 0.2% along with sticker (0.1%).

White rusts *(Puccinia horiana, P. chrysanthemi)*

This is the most common problem in chrysanthemum. Symptoms appear as small blisters on the undersurface of leaves, which on eruption release light brown spores. At early stages, the infected leaves should be collected and destroyed; leaves at no time, should remain wet so overhead watering should be avoided, and zineb, or captan (0.15%) should be sprayed for effective control.

Bacterial leafspot (Pseudomonas cichorii)

It appears as dark brown to black sunken spots with concentric areas. To prevent this problem, streptomycin or cupric hydroxide or copper pentahydrate can be used to treat the infected plants.

Viral and phytoplasma diseases

Tomato spotted wilt virus (TSWV), turnip mosaic virus (TuMV), tomato aspermy virus (TAV), chrysanthemum virus B (CVB) and aster yellows have been found attacking chrysanthemums. TSWV produces ring and line patterns, paled areas, mottling and necrotic spots on the leaves so cuttings taken from such plants become the source of further infection. TuMV causes mottling in the infected plants. TAV is transmitted by *Acyrthosiphon solani, Macrosiphoniella, Myzus persicae,* etc., aphids and causes distortion and irregular flower colouration. CVB has also been recorded on chrysanthemum plants. Aster yellows mycoplasma infection causes greening of flowers, precocious branching, rosetting and stunting in plants, and sometimes the upper portion of flowering stem even becoming thin, more upright and yellowish, followed by death in a few months. Since no effective control measures are available for viruses, viroids and mycoplasma, the infected plants should be uprooted and burnt. Regular spraying of the crop with malathion to control the insects which suck the cell sap and transmit these diseases will control these diseases.

Practical Exercise

Activity 1

Propagation of chrysanthemum by cutting.

Material required

Healthy chrysanthemum plant, secateur, IBA, water can, etc.

Procedure

- Select the terminal branches of a healthy plant for cutting.
- Terminal tip cuttings of 5–8 cm long are cut with the help of secateur.
- Remove basal leaves and half of the other open leaves.
- Base of the cutting is dipped in IBA 500 ppm or Seradix.
- Plant the cutting by inserting them 3–5 cm apart in sand beds.
- Immediately after planting, light watering with fine rose can should be given.
- Irrigate it regularly daily until 3–4 weeks.

Check Your Progress

A. Fill in the Blanks

1. Pinching in chrysanthemum is done by _____ of the growing tips of the plants at _____ stage.
2. Standard chrysanthemum is harvested when _____ but before _____ begins to elongate.
3. Chrysanthemum is commonly known as _____ or _____.
4. Chrysanthemum flowers, which have invisible disc, are _____ and _____.
5. Chrysanthemum can be commercially propagated by _____ and _____ cuttings.

B. Multiple Choice Questions

1. The critical day length required for flower initiation and flower development of chrysanthemum is —
   (a) 14–15 hours and 13–14 hours
   (b) 11–12 hours and 12–13 hours
   (c) 10–11 hours and 9–10 hours
   (d) 16–17 hours and 15–16 hours
2. Chrysanthemum can be grown on the soil pH of about —
   (a) 7.5
   (b) 6.5
   (c) 5.5
   (d) 4.5
3. Terminal or tip cuttings of _____ for chrysanthemum should be taken from a healthy stalk.
   (a) 7–10 cm
   (b) 10–15 cm
   (c) 5–8 cm
   (d) 15–20 cm
4. _____ are used to control the outside growth of heavy bloomers pots plants of chrysanthemum.
   (a) 7–10 stakes
   (b) 10–12 stakes
   (c) 1–2 stakes
   (d) 3–5 stakes
5. Removal of suckers from the base of chrysanthemum is known as _____ .
   (a) de-suckering
   (b) pinching
   (c) stopping
   (d) disbudding and de-shooting
6. _____ is the removal of the growing tips of plants at 10–15 cm stage which results in the production of several lateral shoots.

(a) De-suckering
(b) Pinching or stopping
(c) Disbudding
(d) Topping

C. Subjective Questions

1. How the varieties of chrysanthemum are classified?

   _____

   _____

2. Write about the vegetative propagation of chrysanthemum.

   _____

   _____

3. What is disbudding in chrysanthemum?

   _____

   _____

4. Write about staking in chrysanthemum and give its advantages.

   _____

   _____

D. Match the Columns

A	B
1. Cuttings	(a) Invisible disc
2. Pompon type chrysanthemum	(b) Terminal 5–8 cm long healthy stalk
3. Standard variety	(c) Mahatma Gandhi
4. Single type chrysanthemum	(d) Strap-like ray florets

Session 3: Cultivation of Tuberose

Tuberose: *Polianthes tuberosa*

Family: Agavaceae (formerly called Amaryllidaceae)

Tuberose is an important bulbous ornamental plant with true bulbs as the propagating material. It occupies a very prominent position due to its fragrant white flowers and for its use as loose or cut flowers, for making garlands and in various floral designs as well as in perfume industry. This is an ornamental plant, which can be grown in temperate areas of the country during summer by planting in March–April. It can also be grown in tropical areas of the country by planting

Fig. 1.10: Tuberose

in September–October, and in the sub-tropical areas of the country by planting during February (Fig. 1.10).

Cultivars

On the basis of the number of rows of petals in a flower, tuberose varieties are classified into three types:
Single : Bearing single row of petals
Semi-double: Bearing 2–3 rows of petals
Double: Having fully double flowers
Single and semi-double ones last longer with strong fragrance than the doubles, as opening in the singles is comparatively much better while in doubles, it is poor. In tuberose, yet there are only ten single varieties in existence such as *Arka Nirantara*, *Bidhan Snigdha*, *Snigdha Ujjwal*, Hyderabad Single, Mexican Single (Calcutta Single), *Phule Rajani*, *Prajwal*, *Rajat Rekha*, *Shringar*, and Sikkim Selection (semi-double); while the doubles are only four, and these are Mexican Double (The Pearl or Calcutta Double), *Suvasini*, *Swarna Rekha*, and *Vaibhav*.

Climate

Tuberose grows well in the tropics throughout the year, in subtropics it is planted in February for best results, and in the temperate regions of the country it is planted during March–April. The commercial cultivation is mainly confined to warm and humid areas with temperature range of 20 to 35°C where plenty of sunlight is available. A high temperature of 40°C, as well as, low temperature of 10°C is reported to reduce spike length, weight, and quality of flowers. A temperature range of 20–30°C is found to be optimum for maximum bulb production.

Soil

Tuberose can be grown in a variety of soils at a fully exposed site, rich in organic matter, well aerated, water-retentive but not waterlogged and whose pH is 6.5–7.5, though performance is excellent in sandy loam to loamy soils. Under filtered situation, the plants become lanky with shy blooming habit, though under complete shade, there is no flowering at all.

Propagation

A few of the single varieties set seeds. Seed propagation is a very slow process and is meant only for the evolution of new varieties. From flowering to seed maturity, it takes about two months, and the shining black seeds are collected after maturity from the capsules, dried, and then sown in sandy-loam soil, which normally takes three seasons to attain the flowering size.

Commercially it is multiplied only through healthy bulbs and bulblets formed around the main bulb. A fully developed bulb forms 15–30 bulblets in one season by which, if properly cared, attain flowering size further in one growing season; though if retained with the mother bulbs, these may require 3–4 seasons for full development. The bulbs are spindle-shaped, and if attained 2–3 cm diameter, these are quite suitable for taking the flower crops. It is better to avoid fresh bulbs, as it will result in more vegetative growth. Bulbs stored for 4–6 weeks after harvest are ideal for planting.

The size of the bulbs plays an important role in growth and production. Although, larger bulbs result into slightly delayed sprouting but flowering is not delayed, and instead higher spike yield *vis-à-vis* loose flowers, is obtained.

Preparation of land

The land should be free from weeds and has to be thoroughly ploughed three times, followed by planking each time; all the hard materials and the rootstocks of all the perennial weeds, especially the *doob* grass and the rhizomes of nutsedge, along with polythene shreds, wood, brick and stone pieces should be taken out, and soil has to be brought to a fine tilth, properly levelled, and partitioned into various beds of convenient size keeping the provision for water channels and bunds. Since the cropping is perennial at least for three years, so every year this will have to pass through the rainy season, so proper slope will have to be given for draining out the rain water.

Notes

Planting

The planting time varies from place to place depending on climatic conditions. It is planted during February–March in the plains of subtropical regions, such as Delhi during March–April on hills having temperate climatic conditions, during July–August in parts of South India, and during April–May under Bengaluru conditions. These are generally planted on flat beds having a slope to one side to drain out the excess water during rains to avoid waterlogging. Since this is planted for a perennial cropping, so ridge planting becomes redundant.

For harvesting the flowers, it is preferable to have 30 × 30 cm, or better if the distance is kept 40 × 40 cm for perennial cropping so that afterwards there may not be any problem of space. However, for bulbs the spacing may be kept at 20 × 10 cm, 20 × 15 cm, 20 × 20 cm and 20 × 30 cm; looking at the size of bulbs, smaller ones require a high density while larger ones, poor. For one hectare of planting, some 5 lakhs of small bulblets are required, though for flowering it is 60,000 for perennial cropping, and one lakh bulbs when the crop is for 1–2 years.

Planting depth is normally 4–8 cm, it is utterly deep in sandy-loam soils while quite shallow in clayey soils, though size of the bulbs also plays an important role for depth of planting because smaller bulbs require shallow planting as compared to larger bulbs.

Manures and Fertilisers

At second ploughing, 20–30 tonnes of well-rotten compost should thoroughly be mixed in the soil. Nitrogen at 200 kg/ha and phosphorus fertilisation at 60 kg/ha is most necessary in case of tuberose as these help in vegetative growth, leaf development, bulb production, and flowering, though potassium is not as important, if the soil is not deficient, however, soils having low potassium should be supplied with 50 kg/ha. Excessive use of any element is harmful, as excess of N causes taller and soft spikes, which can break during light winds and become more vulnerable to insect-pests and pathogen attack, *vis-à-vis* flower quality also becomes poor. Nitrogen deficiency is expressed as a typical

paling of foliage, less number of florets per spike, and less number of spikes per plant. Phosphorus deficiency causes reduction in growth and flowering, upper leaves become dark green but lower ones turn purple. Calcium deficiency causes cracking of spike and bud rot. Magnesium deficiency exhibits interveinal chlorosis on older leaves and iron deficiency on the new leaves. Boron deficiency causes stunting in the inflorescence, leaf deformity, and cracking of leaf margins. Manganese deficiency is expressed as yellowing of leaves between the veins. To avoid these problems, a mixed micronutrient fertiliser should be applied to soil before planting.

Irrigation

The available soil moisture markedly influences growth and flowering. The soil type, weather condition, and stage of growth, all influence irrigation frequency. At the time of bulb planting there should be sufficient moisture in the soil up to the sprouting of the bulbs, and when these have sprouted, first irrigation is given. Subsequently, in light soils it should be given weekly, and in heavy soils at an interval of 10–12 days. During summer, the frequency of irrigation is more as compared to winter. However, when the crop is over, the watering is almost withheld so that the bulbs are forced to go into dormancy and these may be quite fresh in the next cropping season. After the use of every fertiliser, watering is must.

Weed control

In any crop, weed is a menace as it robs the crop of its nutrients, moisture, sunlight, *vis-à-vis* aeration, and lack of aeration encourages the development of diseases and pests in the crop. Generally, in India only hand weeding is done through our antiquated handy tool *khurpi*, however, in large plantings 1.5 l/ha of pendimethalin or 3 kg/ha of kraft atrazine is quite effective, pendimethalin as pre-emergence spraying (diluted in water to wet one hectare of land) in the field while Atrazine is used as a pre-plant herbicide. Their use increases the quality spikes, as well as the bulbs and bulblets. Covering the field with 5–8 cm top layer

with mulches such as chopped bagasse, dry leaves, straw, rice husk, sawdust, various types of oil cakes, and groundnut husks not only checks the growing of weeds, but after decomposition also provides organic manure to the field in a course of time. Black polythene mulch is very effective in checking weed germination, but it does not decompose.

Harvesting of flowers and yield

Flowering starts three to four months after planting. Loose flowers are harvested one by one as these are used for making garlands and other floral ornaments while for bouquets and vase arrangement the spikes are cut from the base. The ideal stage for cutting spikes is when the first pair of flowers is fully open. Immediately after harvest the spikes are kept in distilled water. Picking of flowers is to be done during cool hours of the morning or evening. About five people are required to harvest 60 kg of flowers in two to three hours. Once planted, the crops can be harvested successfully for three years especially for loose flowers. An average of 12–15 tonnes of loose flowers per hectare can be obtained while 100,000–125,000 spikes can be obtained from per hectare of area.

Harvesting of bulbs and storage

At the end of every third cropping, the bulbs should be lifted. When the flowering is over and the plants have started yellowing, it is the time to start the bulb harvesting. The watering should be adjusted in such a manner that there is sufficient moisture for lifting of bulbs. The soil around the plant is loosened with the help of a spade or digger, the whole clump is taken out, the aerial part of the plant is twisted off, the bulbs are cleaned and shade-dried, and then stored in a well-ventilated place under room condition for three months. The yield of bulb is dependent on the cultivar used, the soil type, the environmental conditions, and size of the bulbs planted. Normally, 40 × 40 cm planting of 2.5–3.0 cm diameter of bulb produces about 25 tonnes of bulbs in three year cropping. The bulb yield in one year of cropping is usually 10–12 tonnes.

Insect-pests

Grasshoppers *(Hieroglyphus spp.)*

These pests are highly devastating on young leaves and emerging flower buds, especially during the rainy season. For their control, 0.2% methyl parathion or dimethoate spraying is quite effective.

Weevils

The adult feed in the darkness on the leaves making notches on the edges which may be trapped and killed as they are less in number. Their larvae feed on the roots and tunnel into the bulbs whose attack may be prevented by applying furadan granules at 3–4 kg/ha at the time of bed making. Dimethoate spraying at 0.2% will control the weevils effectively.

Aphids *(Aphis spp., Myzus persicae)*

These are very small in size and multiply rapidly. They feed on the growing points and floral buds which maybe controlled by spraying nicotine solution. Dimethoate spraying at 0.2% is quite effective against aphids.

Thrips *(Taeniothrips spp.)*

These are minute insects which suck the sap of the leaves, buds, and flowers, and act as carrier agent in causing 'bunchy top' disease where the inflorescence is malformed. While controlling the grasshopper, this will also be controlled. Dimethoate foliar spraying at 0.2% will control the thrips.

Red spider mites *(Tetranychus telarius)*

These suck the sap on foliage causing yellow stripes and streaks, and in severe cases leaves turn yellow, silvery, or bronze and finally get deformed. Kelthane spraying will prevent its infestation.

Nematodes

Aphelenchoides besseyi causes greasy streak on foliage and *Meloidogyne* spp. (*M. incognita, M. javanica, M. arenaria, M. acrita*) causes root galling, poor growth of plants with the leaf tip burn and yellowing, and suppressing spike emergence in their severe infestation. Bed fumigation and post-planting drenches with methyl bromide will rid the plant of these pests.

NOTES

Diseases

Stem rot (*Sclerotium rolfsii*)

It is caused at the soil level. Leaves lose their greenness, the whole leaf rots and gets detached from the plant. Due to its infection, round and brown sclerotia are formed on and around the infected leaves. Ultimately, the plants become too weak to produce flowers. Mercuric chloride 0.1% and commercial formalin 0.2% have excellent control of the disease. Dusting 20% brassicol has been found quite effective. Drenching soil with zineb (0.3%) or thiram (0.2%) thrice at 20 days interval has been found quite effective for controlling stem rot.

Botrytis spots and leaf blight *(Botrytis elliptica)*

It is a problem under cool-cum-moist growing conditions. Initially when it is noticed, 0.2% weekly maneb spraying should be followed and the field humidity should be kept under check. Before planting, the bulbs should also be treated by dipping them for one hour in 0.2% captan. Ammonical copper at 0.2% spraying fortnightly is quite effective in controlling leaf blight.

Alternaria leaf spot *(Alternaria polyanthi)*

It is also seen on tuberose leaves. It is controlled through spraying of 0.2% mancozeb at 10 days' interval.

Flower bud rot *(Erwinia carotovora)*

It is sometimes observed on the floral buds which may be controlled by spraying mercuric chloride or streptocyclin at 0.01%.

Leaf mottling

It is caused due to a virus. Such plants should be destroyed to check further spread.

Practical Exercise

Activity 1

Identification of different types of tuberose with their characteristics and varieties.

Material required

Pen, pencil, notebook, tuberose, etc.

Procedure

Note down the observations in the table given below.

Type	Characteristic	Varieties
Single		
Semi-double		
Double		

Check Your Progress

A. Fill in the Blanks

1. Commercially, tuberose is propagated by _____.
2. Semi-double flowers of tuberose bears _____rows of petals.
3. A fully developed bulb of tuberose forms _____ bulblets in one season.
4. Tuberose flowering starts after _____ months of planting.
5. The bulb of tuberose is _____ shaped.

B. Multiple Choice Questions

1. Long flower spike tuberoses are mostly used as —
   (a) cut flowers
   (b) table decoration
   (c) bouquet preparation
   (d) All of these
2. Planting time of tuberose in tropical areas of the country is _____.
   (a) September–October
   (b) December–January
   (c) March–April
   (d) June–July
3. Temperature range for commercial cultivation of tuberose is _____.
   (a) 20–35°C
   (b) 35–45°C
   (c) 15–20°C
   (d) 10–15°C
4. Tuberose bulbs should be stored for _____ weeks after harvest.
   (a) 2–3
   (b) 4–6
   (c) 6–8
   (d) 8–10

5. The yield of tuberose bulbs in one year of cropping is usually —
   (a) 6–8 tonnes
   (b) 8–10 tonnes
   (c) 10–12 tonnes
   (d) 12–14 tonnes

C. Subjective Questions

1. What are the different types of tuberose flowers?

   _____

   _____

   _____

2. Explain the planting of tuberose.

   _____

   _____

   _____

3. How and when tuberose can be harvested?

   _____

   _____

   _____

4. Explain the insect pests and disease management in tuberose.

   _____

   _____

   _____

5. Explain Stem rot disease of tuberose.

   _____

   _____

   _____

D. Match the Columns

A	B
1. Typical paling of foliage	(a) Yellowing of leaves in between the veins
2. Phosphorus	(b) Boron
3. Calcium	(c) Interveinal chlorosis on the new leaves
4. Cracking of spike and bud rot	(d) Magnesium
5. Iron	(e) Interveinal chlorosis on older leaves
6. Stunting in the inflorescence	(f) Upper leaves become dark green and lower ones purple
7. Manganese	(g) Nitrogen

Session 4: Cultivation Technique of Gladiolus

Gladiolus: *(Gladiolus hortulanus/ G. hybridus)*

Family: Iridaceae

Gladiolus is one of the leading geophytes grown worldwide for cut flower trade and garden displays. It attracts viewers by its magnificent inflorescence, and wide array of colours, shapes, and sizes of its flowers. Its florets open from bottom to upward one by one and a good spike lasts for more than 10 days in ordinary water during winter (Fig.1.11).

Fig. 1.11: Gladiolus

Varieties

American Beauty (reddish-pink), Anglia (yellow), Applause (deep pink, throat red), *Archana* (orange), *Bindiya* (pink), Blue Sky (violet-blue), *Chirag* (yellow), *Dhanvantari* (light yellow), Eurovision (deep red), Friendship (carmine-rose), Gunjan (light pink), Her Majesty (deep violet), Hunting Song (scarlet-red), Jacksonville Gold (light yellow), Jester (deep yellow), Lohit (coppery), Mascagni (bright red), Novalux (yellow), Oscar (signal-red), Peter Pears (orange-red), Priscilla (pinkish-mauve), Ratna's Butterfly (orange), Rose Spire (light pinkish-mauve), Rose Supreme (light pink), Sancerre (white), *Suchitra* (light pink), Sylvia (red), True Yellow (yellow), Urmil (violet), White Prosperity (white), Wind Song (purplish-mauve), Yellow Stone (sulphur-yellow), etc.

Propagation

Gladiolus is propagated through corms and cormlets, though for evolution of new varieties, seed are used. In normal course, seed propagation is not advised as it provides varying colours in the progeny, and takes about three years to reach the flowering size. Cormlets (cormels) are the potent source for its multiplication as a plant and may produce from a few to 1000 cormlets, which when planted after removing the tunic, sprout along the corms and grow well, provide healthy stock and well-crowned corms. The corms are generally used for production of flowers so in the end of the season, one to eight corms may be formed underground depending upon the cultural practices followed, the climatic conditions prevailing, and the type of variety used. Though planting of injured corms in the plains is a high risk, so fractionated corms cannot be used as planting stocks here but in temperate areas these can be used after treatment with some effective bactericide and fungicide. Nowadays, micro-propagation is getting popularity to get disease-free corm and cormlets, which are used as propagating material at commercial level.

Climate

In India, it is grown during summer in temperate areas and in the subtropical areas during winter. Though winter temperature in the plains is not so congenial therefore spike size is smaller in the plains than those grown in the hills. Gladiolus prefers a fully sunny condition as it is a long day plant. If atmospheric humidity is high, its flowers grow well up to 50°C, however, usually it grows well in 16–35°C temperatures.

Soil

Though it tolerates a large variety of soils but well-drained sandy-loam soil rich in organic matter is the best for gladiolus cultivation. Heavy soil is not quite preferable. It grows better on fairly acidic soil having a pH of 5.5–6.5, though these can be grown successfully in soil having pH up to 7.5. Waterlogged soil should be

avoided for its cultivation. Rain is not favourable during flowering as flowers get damaged, therefore if cultivation is done during rains, its spikes require to be protected.

Land preparation

Gladiolus should be grown in a levelled field in a sunny condition which is devoid of perennial weeds because such weeds make compaction of the soils and their rootstocks hinder the cultivation practices. Green manuring with *sunhemp*, *dhiancha*, moong, lupins or other leguminous crops can be used before planting. First ploughing is done to a depth of 30 cm, and if need be it may be sown with the seeds of some green manuring crop, followed by planking, and then the field is left as such for one month for proper growth of the cover crop, however, the green manure crop is to be irrigated regularly. The second ploughing is done when the green manure crop has attained up to 60 cm height, that is, 30–45 days of growth and 3–4 weeks before planting and then it is knocked down followed by incorporation of 20–30 tonnes of farmyard manure or compost and flooding so that green manure crop is fully decomposed, and FYM is also fully mixed up with the soil. At planting, there should be sufficient moisture, so that, until sprouting of the corms, there may not be any necessity for watering, otherwise, soil-borne pathogens enter the corms. One should ensure that at third (final) ploughing, all the stubbles, rootstocks of perennial weeds, such as, *nutsedge* and *doob* grass are taken out along with other hard foreign materials and polythene shreds so that the soil becomes fully pulverised. At this time, 6.25 q/ha of single superphosphate and 1.7 q/ha muriate of potash should evenly and thoroughly be mixed in the soil. Now the soil is properly levelled, and then after the beds of convenient sizes are prepared along the bunds, channels, and sub-channels for convenience of field operations and watering.

Planting

It is an open field cultivated crop, being grown during winter in the subtropical and tropical conditions, and

during summer, in the temperate regions, however at places, such as Bengaluru, it can be grown throughout the year. Corms are planted for the purpose of flowers, and cormlets for further multiplication to have healthy stock for the next planting season, therefore, both should be planted separately. It would be better if one week prior to planting, the corms and cormlets are dipped in 0.2% solution of captan, followed by shade-drying to avoid penetration of any germ in the corm, whether present on the corm or in the soil. Diseased or infested corms or cormlets should be discarded and only healthy stocks should be planted. On the basis of the spherical diameter, the corms are classified into large (>5.1 cm), medium-large (3.8–5.0 cm), medium (2.5–3.8 cm) and small (<2.5 cm) groups and various sub-groups. These groups produce varying spike length, floret number per spike, flowering duration, and number and weight of corms and cormels, etc., so they require varying planting distances. Different cultivars require different size of corms for best performance. However, in general, a corm with 4.5–5.0 cm diameter and more than 40 g weight has been ascertained to be moderate for producing best quality blooms, corms and cormels. Larger corms take a shorter period to bloom as compared to smaller ones. The late-flowering varieties produce more corms with larger cormlets while early-flowering ones produce corms with smaller cormlets.

Time and depth of planting and spacing

September–October in the plains and March–April in the hills is the optimum time for planting of gladiolus, whereas in Bengaluru climate, planting can be done round the year.

Generally, a planting depth of 7–15 cm is suggested. Larger corms as well as lighter soil require deeper planting depth as compared to smaller ones and heavier soil condition. While planting, care should be taken that soil has sufficient moisture and the corms are planted with the right side placed upwards. In normal soil, the corms are planted at a depth that is double of their polar diameter. Deeper planting causes poor contractile root formation, and the plants remain stronger and taller

but corm and cormel formation is poor, while shallow planting causes precocious contractile root formation with a good multiplication of daughter corms and cormlets though spike size is smaller.

Planting density is basically dependent upon the size of the planting material, season of growing, and soil type. It is advisable to plant gladioli in double-row system, where two rows of corm planting will have to be done in each line, distance being 15 cm from one row to another in a line, and the corms are put alternatively in each row, though distance from one 2-row line to another 2-row line in the bed is kept 40 cm for the convenience of cultural operations. Corm to corm distance in a row is maintained at 10–15 cm (larger corms requiring larger space than the smaller ones), thus some 40 corms will be accommodated per square metre of the bed-area, and in one hectare some 1,68,000–2,68,000 corms will be accommodated after excluding one-third of area for bund cum furrow making. In temperate areas, only high density should be maintained as it is grown there during summer when climate is highly congenial, the soil is sandy loam, highly porous, and slightly acidic, so all these factors collectively contribute to the harvesting of a good crop with respect to spike size as well as for corm and cormel production.

The method of planting is quite simple. The lines in the beds are marked at 55 cm distance, and while planting, the corms are swiftly kept at specified distances at both the sides of each line (distance from one side to the other of the line being 15 cm) in each bed. Then, from in between the lines, the soil is taken through a spade to cover the corms which will form the automatic ridges and furrows. No direct watering to the plants is to be given but water is released only in the furrows, from where required amount of water is absorbed by the individual plants and this way there would not be any waterlogging problem also, *vis-a-vis* which will enable the grower for easy cultural operations.

Manures and fertilisers

Gladiolus requires both macro and micronutrients for its growth. In light soils, nitrogen is applied in three

split doses, that is, — (i) at planting, (ii) side-dressed after the development of 2–3 leaves, and (iii) at the time of spike emergence. In heavy soils, it requires two split applications, viz. at the time of planting and after 45 days. Full doses of P_2O_5 and K_2O are applied at the time of planting. If spikes are found to be smaller, it will not give proper remuneration in the market, at the time of spike swelling stage, 70 g/m^2 of urea should be applied immediately followed by watering. However, urea dose should never be repeated otherwise corm size will become very poor. Fertiliser dose also varies with different regions and it is essential to conduct soil nutrient analysis before the fertiliser application. To obtain higher yield of corms, the cormels are supplied with 500 kg/ha of nitrogen and phosphorus each. Full dose of phosphorus should be applied at the planting time of cormels, whereas nitrogen has to be given in three equal splits, that is one-third at planting time, one-third at 60 days after planting, and remaining one-third at 90 days after planting.

Irrigation

To avoid irrigation before sprouting, it would be better to irrigate the field lightly at third ploughing so that at planting time there is sufficient moisture in the field. This minimises disease occurrence. Lack of moisture in the soil will delay sprouting so one should ensure that soil contains sufficient moisture at planting. First watering is provided once all the corms have sprouted. The frequency of irrigation depends on the weather condition, soil type, and rainfall. During warm weather, watering should be done superficially after every five days, whereas in cold weather once in 10–12 days. When the plants attain a height of 20 cm, they should be hilled up to the height of 10–15 cm. This enables the plants to grow erect even during high winds and severe rains.

Weed control

Gladiolus requires weeding twice in a month, and as it is a roughly six month crop so before three months of flowering, initial four months require routine weedings.

Though in India, only manual weeding is practised but it is quite expensive, and there are chances of damage to the plants which gives an opportunity for entry of the pathogens through wounds inflicted, if any. No system in India is developed for mechanical weeding in gladiolus field, hence an efficient system of chemical weeding is the only option. First, weeding is carried out within four weeks of planting, second weeding during top dressing, and rest as per the requirement. Pendimethalin (Stomp) at 1.25 kg a.i./ha can be used as a pre-emergence weedicide to control weeds in the field up to 75–80 days after planting. After planting of the corms, pendimethalin is diluted in water and sprayed over the whole planting at one stretch sufficiently to wet upper layer of the soil.

Staking

Varieties producing taller spikes require staking with bamboo or willow sticks to save them from breakage due to lodging or winds. One stick is inserted some 10–15 cm away from plant base so that forming corm is not damaged. The stakes should be inserted when swelling of spike has started, and then the plant should be loosely tied with the stake to a height of about 30–40 cm. Second tying should be carried out at 50–60 cm height when the flowers in the spike have started swelling. Alternatively, the beds should be pegged at each corner and 3-tier strings should be stretched all around the bed and in between the plants, so the plants could be saved from wind damage or lodging.

Growth regulators

Application of growth regulators like GA_3, IAA, NAA, CCC, B-Nine, etc., as soil drench or foliar application improves the growth and flowering of plants and induces earliness. Soaking of corms in GA_3 at 250 ppm increases sprouting, improves subsequent growth, and production of flowers. Prolonging the storage life or delaying the sprouting of the corms with the application of higher doses of ethrel (ethephon) is a common practice provided the temperature is not a limiting factor. Growth promoters like GA_3, NAA, kinetin, etc., at a concentration of 10–50 ppm enhance sprouting.

Harvesting and yield

In gladiolus, florets are borne alternatively on long slender spikes. These spikes are harvested for cut flowers. The quality of spikes is judged by the length of spike, the number of florets per spike, number of florets opening at a time, number of florets remaining open at a time, the arrangement of florets on the spike, floret colour, size, and texture (simple and thin, leathery and folded, frilled or ruffled, etc.). An ideal spike should be in tight bud stage with three to four buds showing colour so that these may easily open one by one in the vase. While harvesting, there must be four to five leaves left on the plant which will help further the corm development in the subsequent period as still the corm and cormel development takes place.

Generally, one plant produces single marketable spike and 1–3 plantable corms and a few-to-many cormlets. Roughly the production of spike is double the number of the planted corm provided the planted corm is of a large size.

Post harvest

For local markets, the spikes are removed when the first batch of florets have started opening, however, for distant markets the proper stage for cutting is when the first batch of florets has started showing colour. The spikes are harvested mostly early in the morning, leaving atleast four leaves intact on the mother plant, and the cut ends are immediately placed in a bucket containing palatable water. For transportation, these survive dry for up to two days. The cut spikes are taken to the packing shed where these are pulsed with 20% sugar + 200 ppm 8-HQC for 24 hours. If needed, these can be stored dry for up to two weeks at 1°–2°C. For local markets these are packed in a bundle with 12 spikes each, and then wrapped in newspaper, and then finally some such 25 bundles are packed with hessian cloth for transportation to the nearest market. For distant markets, the spikes are packed in 100 × 25 × 10 cm perforated cardboard boxes. However, the packing should be done when no part of spike surface is wet to avoid botrytis infection during transportation.

Harvesting or lifting of corms, curing and storage

The corms and cormlets are lifted after 45 days of flower cutting as by this time all the corms and cormels have matured. When 25% cormlets have changed to brown colour, it is a sign of maturity. At lifting, there should be sufficient moisture in the soil to facilitate proper lifting, though in no case the soil should be wet. The adjoining soil to the plants is loosened by spade, shovel, or *khurpi*, the plants are gently pulled out of the soil one by one, the adhering soil is knocked down so the corms and cormlets are completely clear of the soil, all the cormlets at this time are attached with the corms with their stolons so these should also be taken out one by one, the aerial plant is twisted off without injuring the corms, and then finally, the mummified remnant of the planted mother corm is also twisted off through thumb and fingers. All the daughter corms of one variety are placed in small cloth or perforated nylon bags, labelled, and then kept in an aerated room for curing. All the cormels of one variety are also placed in the cloth bags, labelled, and kept separately for curing. After a fortnight, the corms and cormlets are treated by dipping for one hour in 0.2% captan solution, and then again dried in the same room at least for one month. All these varieties, after perfect curing, are either placed in crates or in gunny bags and put in cold storage at 3°–7°C temperature and 68–75% RH at least for two months. By September end these should be taken out from cold storage and thinly spread in a room for acclimatisation, and then again dipped in 0.2% captan for one hour, and then again dried, and by this time (mid-October) the field should be ready for transplanting in the plains. In the hills, cold storage treatment is not necessary as the corms and cormels can be stored at room temperature effectively.

Pests

Aphids *(Aphis gossypii, Macrosiphum euphorbiae, Myzus persicae)*

These are very harmful pests of gladioli, especially during hot and cloudy weathers, and these continue sucking the sap from tender plant parts and flowers by

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clustering there. These also act as vectors for the dispersal of viral diseases so viral infection can be brought to the minimum by controlling these pests. Spraying the crop with imidacloprid 17.8% SL at 250ml in 500 litres of water per hectare or 100ml ranxypyrex in 500 litres of water/ha will kill these pests.

Thrips *(Taeniothrips simplex, Frankliniella occidentalis)*

With their light yellow nymphs and adults, these can be found moving on gladiolus plants everywhere, especially on the buds and flowers and rasping the sap of the tender parts. Spraying with sevin 0.2% or methyl parathion 0.1% will kill these pests.

Borer *(Helicoverpa armigera)*

It is a polyphagus insect which feeds on every part of the plant. Spodoptera litura and Trichoplusia semilooper also have been found feeding on gladiolus leaves and flowers, and when disturbed, the semilooper hangs itself through a thread on the plant. Thiodan 35 EC at 0.5 % spraying will kill the larvae of these insects.

Cutworms *(Agrotis ipsilon),* ***and whitegrubs*** *(Phyllophaga spp.* and *Poppillia spp.)*

These feed on underground gladiolus corms and roots. Underground pests can be controlled through the use of furadan granules mixed in the soil at the time of field preparation.

Mites *(Rhizoglyphus echinopus, Tetranychus urticae)*

These are yellowish-white with a pink tinge which feed generally on the undersurface of leaves but in their severe infestation, these are observed everywhere on the plants. Their infestation is favoured by warm and shady conditions. Dichlorvos smoking in the greenhouse is very effective in controlling these pests. Kelthane 25 WP at 2 g/l also controls the mites.

Mealybugs *(Pseudococcus maritimus)*

These feed on the base of the corms in the field and suck their sap. In the storage when temperature is above 15°C, these multiply rapidly, feeding on

the corms which cause the corms to shrink. Lysol soaking of corms for three hours will control the mealybugs. Azadirachtin, chlorpyrifos, bendiocarb, or acephate spraying on the corms is also effective.

Nematodes *(Meloidogyne incognita and Trichodorus species)*

These have been found infesting on gladiolus roots by galling them which causes the plants to become stunted with poor growth. Soil fumigation and hot-water treatment of dormant corms at 53°C for half an hour will kill these pests. These are also controlled by application of aldicarb, furadan or nemagon.

Diseases

Storage rot *(Penicillium gladioli, Rhizopus arrhizus)*

It occurs due to excessive humidity or more than 5°C temperature in the storage, and storage of improperly cured or injured corms. Corms and plants treated as suggested under fusarium infection will rid of this problem also, however, the storage condition should be proper.

Fusarium wilt

Fusarium oxysporum f. sp. *gladioli* and *F. orthoceras* var. *gladioli* are responsible for this disease. In the field, these show plant yellowing, and bending to one side as the disease attacks the vascular system and from such infections corms cannot be saved if once infected. Use of benomyl at 0.1% alternately with captan at 0.2% fortnightly to the standing crop, and corm dipping for one hour in 0.2% captan after lifting and before planting will give an assurance for a healthy crop.

Botrytis blight and floral rot *(Botrytis gladioli, B. cinerea)*

It occurs when the weather is very cold, windy and cloudy. If immediately after its appearance, weather becomes dry, the tip of the flower bud also dries up so flowers do not open but when the weather is humid, the flowers become watery, and the whole crop is destroyed as if burnt. Regular spraying with maneb or benlate at 0.2% during inclement weather conditions, at weekly interval will keep this problem under check.

Leaf spots *(Alternaria alternata, Curvularia lunata, C. trifolii and Septoria gladioli)*

These occur on gladioli in various forms such as tip and side burning due to *Alternaria*, sides towards the tip start drying with a frog-eye like appearance due to the infection of *Curvularia*, and there are brown circular spots on older leaves, late in the season, which later on may coalesce and exhibit shot-holes due to infection of *Septoria*. All these problems can be solved by applying 0.2% maneb sprays.

Bacterial scab, neck, or stem rot *(Pseudomonas marginata, P. gladioli* pv. *gladioli)*

It appears in the form of raised reddish specks at the base of the plant initially but afterwards fleshy basal parts rot with falling of the leaves. Corms show water-soaked pale-yellow circular lesions which afterwards turn brown to black and exude a gummy substance. Such plants should be destroyed. To avoid the plants being infected with this disease, the corms should be dipped in $HgCl_2$ solution after lifting and before planting.

Bacterial blight *(Xanthomonas gummisudans)*

It is a serious problem on gladiolus on poorly drained soils, *vis-à-vis* wet climatic conditions, and initially its infection causes irregular water-soaked lesions on the corms which later on turn brown and dry up where leaves also become affected afterwards. Infected parts release a slimy exudate, so these plants should be removed from the field. Before planting and after harvesting, the corms should be dipped in $HgCl_2$ solution, and care should be taken to avoid waterlogging.

Cucumber mosaic virus (CMV)

On gladiolus plants, it appears as the discrete lighter streaks on the leaves. Its infection does not have any adverse effect on gladiolus plants as it is not visible on plant or flowers, and no obvious adverse effect is visible on further vegetative generations.

Aster yellows

It is a serious problem in gladioli where straw-yellowing of the upper part of plant occurs, and the spikes show

twisting cum bending. Any plant observed in the field with these symptoms, should immediately be uprooted and destroyed to check its further dispersal.

Physiological disorders

Flower abortion (blasting) and blindness are the most common physiological disorders in gladiolus. These are primarily due to poor light conditions, especially in the winter crops. Sometimes, etiolated plants are observed in greenhouses. This may be due to the imbalanced relationship between light and temperature.

Fluoride injury is a very common phenomenon in gladiolus plantings and even at 1 ppb level, it expresses the effect of fluorine. The effect is expressed in the form of tip burn on leaves. Fluoride toxicity can be reduced by spraying 5% lime or magnesium sulphate.

Crooked stem

Though it is not a common problem but sometimes when the temperature is too high or the fluctuation is too frequent, the stems get crooked.

Practical Exercise

Activity 1

Demonstrate the planting of gladiolus.

Material Required

Corms are planted for harvesting flowers, and cormlets for further multiplication, to have a healthy stock for the next planting season.

Procedure

- Select a corm of 4.5–5.0 cm in diameter.
- Weight of the corm should be 40 g or above.
- It should be healthy and without injury.
- Dip the corms in 0.2% solution of captan for one day prior to planting.
- The lines in the beds are marked at a distance of 55 cm.
- The corms are kept at specified distances on both sides of each line (distance from one side to the other of the line being 15 cm).
- The soil in between the lines is taken through a spade to cover the corms (a planting depth of 7–15 cm is suggested) which will form ridges and furrows.
- Space between two rows should be 40 cm, and within the row it should be 15 cm.

Check Your Progress

A. Fill in the Blanks

1. One of the leading geophytes grown for cut flower trade and garden displays is _____.
2. Gladiolus is propagated through _____ or _____.
3. Gladiolus plant may produce up to _____ cormlets.
4. Corms or cormlets of gladiolus can be planted up to the depth of _____ cm.
5. Single plant of gladiolus produces _____ marketable spike and _____ plantable corms.
6. In gladiolus, the qualities of spikes are judged by the _____ of spike.

B. Multiple Choice Questions

1. Gladiolus prefers _____.
   (a) fully shade weather
   (b) fully rainy weather
   (c) fully moist weather
   (d) fully sunny weather
2. A planting depth of _____ is suggested for gladiolus.
   (a) 7–15 cm
   (b) 15–20 cm
   (c) 20–25 cm
   (d) 25–30 cm
3. GA_3 is used for soaking of corms at a concentration of _____ to increase sprouting.
   (a) 250 ppm
   (b) 300 ppm
   (c) 200 ppm
   (d) 150 ppm
4. Growth promoters like GA_3, NAA, kinetin, etc., at a concentration of _____ ppm to enhance sprouting.
   (a) 5–10
   (b) 10–50
   (c) 50–100
   (d) 100–150
5. The most common physiological disorder in gladiolus is _____
   (a) flower abortion
   (b) fluoride injury
   (c) crooked stem
   (d) None of these

C. Subjective Questions

1. Describe the staking of gladiolus.

   _____

   _____

   _____

2. Explain the harvesting of gladiolus.

   _____

   _____

   _____

3. Explain the physiological disorders in gladiolus.

   _____

   _____

   _____

D. Match the Columns

A	B
1. Flower abortion	(a) High temperature or frequent fluctuation
2. Fluoride injury	(b) Deficiency of calcium
3. Topple	(c) Tip burn on leaves
4. Crooked stem	(d) Poor light condition

SESSION 5: CULTIVATION TECHNIQUE OF CARNATION

Carnation: *(Dianthus caryophyllus)*

Family: Caryophyllaceae

Carnation is the leading global cut flower grown under greenhouses in the lower hills or at places having mild climate in India. A highly pleasing clove-like fragrance emitted by its flowers, being light weight, having various colours, forms and sizes, having excellent keeping quality with the ability to easy rehydration and withstanding long distance transportation have made it the most favourite flower globally. It is a native of the Mediterranean region, and is being produced commercially in different countries, especially Columbia, Kenya, Israel, Holland, Poland, USA, France, Italy, Spain and Japan. India has

the potential for growing good quality carnation under protected cultivation, especially in the lower hills of Solan, Ooty, Kodaikanal; in higher hills such as Shimla, Srinagar, and Kullu under hi-tech polyhouses; and in areas having mild climate such as Pune, Bangalore, etc. Broadly these are of three types, viz. standard, spray, and miniature (Fig. 1.12).

Fig. 1.12: Types of Carnations

Commercial varieties

Standard types

Altetico (bicolour), Arthur Sim (fancy), Candy (yellow), Corso (pink), Cream Valencia (cream), Desio (red), Espona (red), Europa (orange), Exotica (yellow), Golden Cabaret (yellow), Hellas (yellow), Light Pink (pink), Master (red), Nikita (yellow), Orange Isac (orange), Orange Triumph (orange), Parade (white), Pink Corso (pink), Red Corso (red), Safari (bicolour), Scania (scarlet), Sonsara (white), Tanga (red), Venus (pink),White Candy (white), etc.

Sprays

Alister (red), Bagatel-Wesbag (white), Boreal (pink), Cotillon (bicolour), Darling Red (red), Durango (pink), Elsy (red), Etna (red), Excel (white), Fantasia (pink), Flash (pink), Furlana (orange), Galina (pink), 'Garfield (bicolour), Gaucho (bicolour), Hermon (white), Koreno (pink), Kortina (red), Sintonia (orange), White Lilia (white), etc.

Climate

Carnations like mild climate. Cultivation at 30° North and South latitude of equator is the ideal climate. For successful commercial cultivation, it should be grown only under cover but with ample sunshine, approximately 21.5 klux for at least 8 h/day as it is a quantitative long day plant. The locations having day temperature of 25°C and night temperature of 10°–18°C are quite suitable for growing it. It requires 50–60 per cent relative humidity and good air circulation. Carbon dioxide concentration in the greenhouses should be 300–700 ppm during cloudy days and 700–1,000 ppm on sunny days.

Soil

Waterlogged conditions are not suitable for carnation growing. A rich but light sandy-loam soil with a pH range of 6.0–7.5 is quite suitable for its successful cultivation. Clayey and silty soil can be amended by the incorporation of farmyard manure. Prior to carnation planting, the soil should be sterilised through solarisation or through the use of 5% formalin.

Propagation

Terminal cuttings are a potent source for its multiplication, therefore, healthy mother plants having good vegetative growth should be selected for taking cuttings. Such plants should be covered from November to February to protect them from winter damage. Once started, these continue to provide cuttings for a period of four months. The cuttings of 10–15 cm long, having at least three nodes, better if there are four to five pairs of leaves, are taken from the mother plant, their lower one to two pair leaves are removed and planted in sand bed or in cocopeat in mist chamber. Over-watering of cuttings should be avoided otherwise these will rot. Cuttings should be treated for up to 12 seconds with NAA 500 ppm, and then planted at 3 × 3 cm distance in trays, sand-beds, or propagating beds for better rooting. To avoid infection of various soil-borne pathogens, the rooting nursery beds should be treated with 0.2%

captan solution. For rooting, it would be better if the cuttings are raised in a polythene chamber where daily misting of cuttings will root them within 30 days in the temperature range of 20°–26°C. After rooting, the cuttings are shifted in a hardening chamber, that is, mini portable tunnel measuring 3×1.5 m, covered with hessian cloth or any other material for 50% shading, and the mixture should contain sand, FYM, rice hulls and ash. This chamber should have a fogging provision which should emit fog for 10 seconds after every 15 minutes, if it has a bright sunlight. Here it takes about three weeks, for the cuttings, to become ready for transplanting.

Exporting units have a provision of tissue culture to multiply elite carnation varieties in large number. For this, only apical shoot tips are taken though it can be micro-propagated even through stem nodes, leaves, petals, and anthers. It is a modified Murashige and Skoog (MS) medium which has been found suitable for its propagation. These are propagated through callus or by direct regeneration process by placing them at 25°C temperature.

Cultural practices

Commercially, perpetual (Sim) carnations are grown under protected structures with sufficient light (long days with over 16 hour lighting and 100 W bulb fitted 1.5 m high and spaced at 10.5 m), 10°–16°C night and 18°–23°C day temperatures, sufficient ventilation, 50–60% relative humidity, and from 700 to 1000 ppm CO_2 when there is bright light. Looking into these, polyhouse will have to be created where temperatures may be lowered during summers and temperatures and lighting may be raised during winters, fitted with fan and pad cooling system, vis-à-vis top and side vents for providing fresh air, with the provision of 1.2 m wide beds, and some 60 cm space for cultural operations in between beds. Portable tunnels of the dimension 3 m × 1.5 m × 1.5 m may also be used to protect open-cultivated crops during rainy season. Tunnels protect the crops against rain and increase the growing temperature during winter.

Bed preparation

Ground beds, raised benches, or pots with perfect drainage provision may be used for its cultivation. The soil should be incorporated with 30 tonnes/ha of farmyard manure or any other organic manure at the time of bed preparation and ploughed, followed by planking after taking out all the stones, brick pieces, wood pieces, polythene shreds, and rootstocks of all the perennial weeds, especially sedge and Cynodon grass. Then the ground is treated with 5% formalin and covered with black polythene for about one week, then exposed for about one week and then again the field is ploughed, after mixing thoroughly 6 quintals of calcium ammonium nitrate, 12 quintals of single superphosphate and 1.7 quintals of muriate of potash in the soil, and the soil is brought to a fine tilth. 15–20 cm raised beds having a width of 1.2 cm are now prepared with a 60 cm path in between for working. The field is now ready for transplanting.

Transplanting

For flowering regulation, one will have to make a schedule for continuous harvesting of flowers throughout the year as carnations usually flower in five to six months of transplanting under open conditions but under protected conditions these start flowering within four months. Carnations planted under North Indian weather during mid-September–November (the optimum planting time) start producing flowers from February to April, whereas in the hills as the ideal planting time is October to February, these start giving flowers from mid-April to mid-July, and in the areas encountering snowfall, the transplanting is carried out during March–April to obtain flowers from August to October. However, in controlled greenhouses, there is no problem as to when the carnations should be transplanted.

Spacing

Depending upon the type of pinching and cultivar, different densities are adopted. It would be better to

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adopt 20 × 15 cm (33 plants/m^2) spacing for standards and 20 × 20 cm (25 plants/m^2) for sprays. For better aeration and convenience, the latter spacing is more practical where some 1,87,000 plants are accommodated per hectare. However, 30 × 30 cm spacing is considered the best because of proper air circulation where some 83,110 plants/ha can be accommodated.

Staking or support

With the help of fixed frames on either end of the beds, nylon nets of 10 × 10 cm, 12.5 × 12.5 cm or 15 × 15 cm square are placed on beds before taking up planting. To support the stems, the nets are raised upto 15 cm height of plants after the plants have attained 20 cm height.

Manure and fertilisers

A sizeable description about the application of fertilisers is given under 'Bed preparation', however in addition to that, six quintals of calcium ammonium nitrate should be given one month after transplanting by mixing thoroughly in the field. Leaf sampling and testing for further use of fertilisers and other elements such as Fe, Zn, Cu, Mn, Mo, and B can be worked out so that these are applied as per requirement as foliar sprays. A basal dose of NPK at the rate of 20:20:10 g/m^2 is applied three weeks after planting. Fertigation is done with N at 100 ppm and K at 140 ppm twice in a week along with other nutrients such as Ca, Mg, Fe, B, Mn, Cu, and Zn. Excess of potassium causes magnesium and boron deficiency. It may cause excessive calyx splitting and abnormal opening of flower buds.

Irrigation

Watering is carried out once immediately after planting and then through drip system, because the use of sprinkler is prohibited in carnation planting for the fear of spread of disease. Drip irrigation is the best option for maximum saving and need-based application. After the establishment of plants, they must be regularly watered during warm sunny days.

Weed control

Whether it is a greenhouse or an open field cultivation, the weeding in carnation is carried out only manually through the antiquated tool khurpi or khilni. No weed should be allowed to grow and flourish as it will deteriorate the crop production.

Pinching or stopping

Pinching is a practice for quality carnation production. First pinching in carnation, preferably below the sixth node, is carried out about one month after planting, wherein, leaving five to six nodes on the plant, the tips of apical shoots are removed, and this is technically known as first or single pinch. In this case, flowering occurs earlier and at one time. Plants pinched above the sixth node produce flowers on smaller axillary shoots, therefore, pinching below the sixth node is recommended. However, pinching above the sixth node has another advantage as the plants produce six well-developed lateral shoots. This is particularly applicable in standard carnations for harvesting higher percentage of quality flowers. Pinch and a half (second pinch) is a usual single pinching in carnation and then after 30–45 days when the laterals have attained about 10 cm length, half of the longer laterals leaving about two to four pairs of leaves (one to two nodes) are again pinched so that two–four shoots come out again. This way, two to three flowers are obtained early in the first flush and six to eight in the later flush. This type of pinching does not have any peak time for flowering and the time is drastically reduced in obtaining the first blooms. In double pinch, first the single pinching of the main shoot is done as in single pinch, then after about five to six weeks of first pinching, second pinching of all the laterals at two to three nodes is done. This way generally 8–10 shoots are retained and the operation is carried out to delay the flowering period.

De-shooting

After pinching, many side shoots (offsets) start appearing and when these attain some 3–5 cm length, these are

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removed in standard carnations leaving 3–5 shoots per plant, but in case of spray cultivars 6–10 such shoots are retained.

Disbudding

This operation is usually carried out in standard carnations where all the lateral buds below the terminal one are removed when they are 5–10 mm in diameter. The lateral buds down to about six nodes from the terminal floral bud are removed to divert the entire energy towards development of the main terminal bud. In case of spray cultivars, number of lateral buds can be increased by removing main terminal bud from the plants.

Use of growth regulators

Spray of 50 ppm benzyladenine (BA) at monthly intervals increases the yield of cuttings. Long-stemmed blooms with early flowering can be obtained by spraying 100 ppm GA_3 twice — once at first pinch, and second, when axillary shoots are about 10 cm long. Spray of 300 ppm mepiquat chloride — first, when axillary shoots are about 10 cm and the second, at floral bud initiation, produces healthy stems, and reduces calyx splitting.

Harvesting, yield and post harvest

In standard carnations, the flowers are harvested at paint-brush stage, the stage when elongation outside the calyx starts or when bud diameter is 1.5–2.0 cm; while in sprays when each stem has two opened flowers and other buds showing colour. The harvesting of flowers is carried out early in the morning and the cut ends are placed in a bucket containing palatable water. While harvesting the flower stems, some 3–4 nodes should be left below the stem on the mother plant for growth of the next season's crop. Crop is retained at least for two years for a good harvest.

Grading

The harvested flowers are graded on the basis of flower quality and stem lengths:
Blue/Fancy (A grade): with 60–70 cm stem length
Red/Standard (B grade): with 50–60 cm stem length
Green/Short (C grade): with 40–50 cm stem length

The cut flower yield is 150–400 per square metre area. Yield in the open field varies from 150 to 200 stems and in the greenhouse it is 300 to 400 stems/m^2, however, in the second year the yield jumps to its one and half times.

Post harvest

Carnation flowers are very sensitive to ethylene, that's why just after harvesting, these should be kept or pulsed in a solution containing 10% sucrose + 1 mm STS (silver thiosulphate) for up to 10 hours before transportation to sustain their proper life. After pulsing, the flowers can be stored in water with a nutritive solution at 2°–4°C and 95% RH so that sleepiness can be avoided to occur. Ordinarily the cut flower life of carnation is six days which can be extended up to 22 days by the addition of silver ions in the water electrolytically.

Bunches of 25 flowers each are packed in the insulated corrugated cardboard box of the dimension 122 × 50 × 30 cm, which accommodates some 800 flower stems putting cut ends in the centre and the flowers at both the ends of the boxes and in between the bundles, the newspapers are layered all around the flowers. These are transported at 2°–4°C temperature in refrigerated van.

Pests

Gram pod borer/cotton budworm *(Helicoverpa armigera)*

Its larvae are highly destructive to every part of the plant as these feed voraciously and damage the whole plant. Methyl parathion spraying at 0.2% twice fortnightly is very effective for controlling this pest.

Carnation tortrix moth *(Tortrix pronubana)*

Its larvae fasten some of the leaves together with silken threads and feed voraciously beneath this shelter, on leaves, stems, growing points and bore the floral buds, especially during summer months. Fortnightly spraying of the plants with sevin at 0.15% + kelthane at 0.2% from July to September will keep this pest at bay.

Armyworm *(Spodoptera exigua)*

Its larvae are highly destructive to the basal part of the stem. These are controlled by mixing furadan granules in the soil at the time of soil preparation.

Aphids *(Myzus persicae)*

The nymphs and adults cluster towards the tip of the shoots and other tender parts, and remain there sucking the sap. Apart from transmitting viral infections to other plants, their infestation invites ants and sooty mould. Malathion at 0.2% or demeton methyl at 0.25% spraying will control this pest.

Thrips *(Frankliniella tritici, F. occidentalis, Thrips tabaci)*

The nymphs and adults feed voraciously on leaves and flowers by rasping their sap. Their infestation causes patches with black specks, crinkling and yellowing of leaves and streaking of flowers. These continue feeding on the undersurface of leaves during daytime, especially in clear weather. Controlling aphids will control these pests also.

Carnation fly *(Delia brunnescens, Hylemya brunnescens)*

Its maggots tunnel into the leaves and stems of carnation which results into wilting and death of the plant. Leaf beetle (*Aulacophora nigripennis*) has also been found infesting carnation leaves. At initial stage of infestation, these may be controlled through fortnightly spraying with 0.2% rogor thrice.

Red spider mite *(Tetranychus urticae)*

It is the most serious pest of carnation where nymphs and adults both stick to the underside of the leaves, and continue sucking the plant sap so the leaves become pale-yellow with dusty coating cum fine webbing. Their infestation causes the plants to stunt and the flower quality becomes very poor. Spraying dicofol (0.2%) fortnightly is effective in controlling this pest.

Nematodes *(Pratylenchus curvitatus, Helicotylenchus varicaudatus, Meloidogyne incognita)*

These have been found infesting carnation roots causing root galling, root injury, plant stunting, and reduction

in the number of flowers. Before planting, the soil should be sterilised and at the time of soil preparation, Furadan 3G at 25–40 kg/ha should be mixed in the soil just before planting and watered just after planting. This will kill the whole nematode population present in the field. The cuttings should be taken from a healthy stock.

Diseases

Fusarium wilt *(Fusarium oxysporum f. sp. dianthi, F. roseum var. cerealis)*

This is the most serious problem of carnation during warm and humid weather conditions where the leaves of the affected plants become yellow and drop, the stems become soft and collapse with ultimate death of the plants. *F. roseum var. cerealis* causes rotting of all the stem parts. Fusarium culmorum infects the stems at the soil line and a little above, and the rotting starts from the surface tissues and extends to the inner side, ultimately causing the death of the entire plant. *Fusarium tricinctum f. poae* is carried onto the carnation from grasses through a mite *Siteroptes graminum* which carries it deeper into the flower centre so it is controlled by controlling the vector through kelthane at 0.2% concentration. Before planting, the soil should be sterilised through solarization. Drenching of soil around the plant's base with bavistin (0.15%) is quite effective. Spraying the plants with mancozeb (0.1%) + bavistin (0.1%) also proves very effective in keeping these diseases under control.

Rhizoctonia stem rot *(Rhizoctonia solani)*

It is a soil-borne disease, therefore it is transmitted through infected soil. This affects the plants at the soil level and within a week of its infection, the plants die. Drenching the infected plants either with bavistin (0.2%) or thiram (0.2%) can be effective in controlling this disease.

Alternaria leaf spot and blight *(Alternaria dianthi)*

It appears as spots on stems and leaves so the leaves die prematurely. Bud rot is caused due to the infection of A. *dianthicola* during cool and humid weathers. Leafspot

is caused by *Septoria dianthi* whose infection on leaves causes light brown circular spots with a purplish-brown border on the leaves, and sometimes even on the stems. Here, the centre of the spots bear minute black specks. These spots expand and coalesce to form larger blots, sometimes with shot holes. To prevent the spread of *Septoria* to other leaves and plants, wetting of the plants should be avoided, and infected leaves should be removed. Chemical controls are similar to that of *Alternaria*. To prevent *Alternaria* infection, the soil should be sterilised, the cuttings used should be collected from a healthy stock, dipped in 0.2% mancozeb for 30 minutes and sprayed fortnightly with 0.2% mancozeb or 0.3% Blitox.

Rust *(Uromyces caryophyllinus)*

It appears on carnation leaves and stems as chocolate-brown patches, causing early defoliation and poorly grown plants with stunting and curled leaves. The disease is favoured by highly humid condition. It is controlled through spraying with 0.15 Plantvax (oxycarboxin) + 0.2% mancozeb.

Flower bud diseases

These are caused due to the infection of *Alternaria dianthicola, Fusarium tricinctum f. poae, Botrytis cinerea*, and *Pleospora herbarum* (the former two have been described earlier). *Pleospora herbarum* causes calyx rot in carnation but its control in the open is very difficult, however, in the greenhouse, spraying zineb and maneb at 0.2% may control this pathogen. *Botrytis cinerea* causes graymould (*Botrytis blight*) in carnation. This is a very serious problem when the weather is humid and cool. This pathogen causes rotting of stored cuttings and water-soaked lesions on the flowers in the field during the rains, and in storage where temperature is quite low and humidity is very high. The disease intensity can be reduced by reduction of humidity levels both in the greenhouse and storage. Captan, zineb, chlorothalonil, or iprodione at 0.2% spraying will control this problem.

Bacterial leaf spot *(Pseudomonas woodsii)*

It is observed on the carnation leaves in the form of elongated brown spots, where in severe cases the plants get killed. However, the infected leaves should be removed

and burnt and the plants should be sprayed with Bordeaux mixture or copper oxychloride in the end of summer (by the start of autumn) and again in mid-autumn.

Viruses

Carnations are attacked by streak, mosaic, mottle, vein mottle, ring spot, and etched ring viruses by which flower quality and yield get reduced drastically. Vein mottle, mottle, carnation yellow necrotic fleck virus, carnation etched ring virus and carnation latent virus are carried by aphids while the ring spot and mottle spread through harvesting tools and handling. The vector for streak virus is not known. Mottle virus causes leaf mottling and colour breaking. Through shoot culture, the virus may be avoided. To get rid of viruses, the best way is to uproot and destroy such plants along with timely control of insects.

Physiological disorder

Calyx splitting

It is due to nutritional imbalance, erratic irrigation, genetic and environmental factors, and cultural practices. It occurs mostly because of the excessive number of petals in the buds coupled with temperature being lower than 10°C at the time of bud formation and development. Low nitrogen, high ammonical nitrogen or low boron levels also contribute towards calyx splitting. When calyx is unable to bear the pressure being generated due to sequential growth of the petals, calyx ruptures completely or into two halves, and such flowers are not acceptable in the market. It is suggested that a rubber band be placed on the bud at the time of maximum growth when mouth just starts opening and at the portion having maximum diameter. Sometimes calyx splitting occurs at the bud formation stage, when there is water scarcity in the soil, followed by sudden irrigation. Application of nitrogen to a certain limit controls the splitting, however, over-fertilising with nitrogen may also cause splitting. High day-temperature and low night-temperature may help checking the splitting.

Curly tip

It is distortion and curling of the growing tips, young shoots failing to separate and continuation of growth occurs in a characteristic curvature which is probably due to low light and low temperature conditions prevailing for long, and this may further aggravate due to nitrogen deficiency.

Practical Exercise

Activity 1

Demonstrate the cutting of carnation.

Procedure

- Carnation is multiplied through terminal cuttings.
- The mother plants from which cuttings are to be taken should be covered from November to February.
- Prepare 10–15 cm long cuttings with 4–5 pairs of leaves and at least three nodes.
- Remove 1–2 pair of lower leaves.
- Prepared cuttings should be treated for 12 seconds with NAA 500 ppm.
- Drench the rooting medium with 0.2% solution of Bavistin or captan.
- Plant the prepared cutting in a sand bed or in cocopeat in mist chamber.

Check Your Progress

A. Fill in the Blanks

1. All the lateral buds below the terminal one are removed when they are 5–10 mm in diameter in _____ method.
2. A practice for quality carnation production is _____.
3. Carnation is propagated by _____.
4. Carnation can be planted at _____.
5. Terminal cuttings of _____ length with at least three nodes are used for propagation.

B. Multiple Choice Questions

1. Carnation yields _____.
   (a) 150–400 cut flowers/m^2
   (b) 300–500 cut flowers/m^2
   (c) 500–600 cut flowers/m^2
   (d) 600–700 cut flowers/m^2

2. Carnation blue or Fancy (A) grade has _____ stem length.
   (a) 90–100 cm
   (b) 60–70 cm
   (c) 100–120 cm
   (d) 120–150 cm
3. Red or Standard (B) grade carnation flowers have _____ stem length.
   (a) 30–40 cm
   (b) 40–50 cm
   (c) 50–60 cm
   (d) 60–70 cm
4. The Green or Short (C) grade flowers of carnation have _____ stem length.
   (a) 30–40 cm
   (b) 40–50 cm
   (c) 50–60 cm
   (d) 60–70 cm

C. Subjective Questions

1. How can carnation be propagated by cutting?

   _____
   _____
   _____

2. What is pinching in carnation?

   _____
   _____
   _____

3. Give the causes and remedy for calyx splitting in carnation.

   _____
   _____
   _____

4. Describe the methods of harvesting in carnation.

   _____
   _____
   _____

5. What are the physiological disorders of carnation?

   _____
   _____
   _____

6. How is post harvest care taken with harvested flowers?

   _____
   _____
   _____

NOTES

7. Write about the grading of carnation flowers.

_____

_____

_____

C. Match the Columns

A	B
1. Calyx splitting	(a) *Pseudomonas woodsii*
2. Curly tip	(b) *Alternaria dianthicola*
3. Bacterial leaf spot	(c) Nutritional imbalance
4. Flower bud diseases	(d) *Tortrix pronubata*
5. Carnation tortrix moth	(e) Low light and low temperature

Session 6: Cultivation Technique of Gerbera

Gerbera: *(Gerbera jamesonii)*

Family: Asteraceae

Gerbera (Barberton daisy, Transvaal daisy, African daisy and Hilton daisy) is an important cut flower crop, even used for bedding and border planting, and is grown throughout the world. It is native to the Republic of South Africa (Fig. 1.13).

Fig. 1.13: Gerbera

Varieties

Aalsmeera (orange), Aida (orange), Alp (white), Ansofie (off-white), Appelbloesem (pink), Aruba (yellow), Baron

(red), Blush (red), Calcutta Pink (pink), Calcutta Red (red), Calcutta White (white), Calcutta Yellow (yellow), Casava (red), Cornice (orangish-yellow, disc orange, centre black), Cream Clementine (cream), Crossroad (yellow, centre red), Davis Memory (light mauve), Delphi (white), Dino (semi-double, yellow), Dusty (red), Faith (orange), Fiona (light pink), Flamingo (pale-rose), Foske (orangish-yellow, disc small and orange), Fredaisy (pink), Fredeking (yellow), Fredorella (red), Fuego (red), General Kaiser (mauvish-orange), Goldspot (orangish-yellow), Goliath (orange, centre yellow), Gracia (large, violet-red), Greenish Yellow, Gucci (pure yellow), Kalimpong Red, Kalimpong Yellow, Labalgo (lilac), Laurentius (yellow), Lilabella (purple-red), Magnum (pink), Maron Clementine (orange), Nevada (light yellow), Ornella (red), Pink Elegance (deep pink), President (red), Princess (yellow), Rosabella (pinkish-mauve), Rosalin (soft mauve), Ruby Red (red), Sangria (red), Sundance (yellow, margins intense), Sunset (red), Symphonie (white), Terramor (light red), Terraqueen (pink), Tropic Blend (yellow), Uranus (yellow), Valentine (pink), Venturi (red), Vesta (red), Vino (red), Whitsun (white), etc.

Climate

In gerbera, the optimum temperature should be 8°–23°C and light 450–600 foot-candle (fc) for vigorous growth and quality cum quantity flower production. Short days along with high light intensity is excellent for flower production, however, the influence of cultivar dominates it. Warmer temperature encourages growth while the cold temperature slows it down. Gerbera plants are slightly photoperiodic but highly responsive to high light intensity and its duration. Short days speed up flowering while long days delay it. Optimum relative humidity for growing it should be 70%.

Soil

Gerbera is not very particular about the soil types, though the soil and irrigation water EC should be below 1, however, the soil should be quite deep (>50 cm), porous, well-drained, rich in organic matter including nitrate with a soil pH of 5.5–7.2, and have good water-

holding capacity. Higher acidity in soil hampers the absorption of Mn and Fe while lower acidity causes the worst soil structure. Slightly calcareous soil with proper soil characteristics is excellent for gerbera cultivation, however, the excess of lime or excess moisture at the roots causes chlorosis where leaves show yellowing. Peat soils are quite unsatisfactory, especially where the water table is high. An ideal soil mixture for gerbera cultivation would be 1 part coarse sand + 1 part fibrous loam + ½ part peat + ½ part well-decomposed leafsoil + ¼ part well-rotten manure. Before planting gerbera, the soil is either solarized or sterilised with 2% formalin as a precautionary measure against the infection of soil-borne pathogens such as *Fusarium, Phytophthora, Pythium, Rhizoctonia*, etc.

Propagation

Seed propagation is meant only to evolve new varieties as normally through seeds the plants are not true to the type, and in most cases, the improved varieties do not set seeds.

Gerbera is propagated vegetatively through the division of clumps and cuttings, *vis-à-vis* micropropagation. It is planted in early September on the hills and subtropical weather or climate in June – July in the plains. The clumps are lifted and divided into smallest units, having central growing point intact, the leaves are trimmed and the whole clump is treated with 0.2% captan. Divisions of clump are then planted at a filtered place having 18°–20°C temperature and more than 80% RH, in the sterilised medium by having the central growing point perfectly exposed, followed by watering. These take 2–3 weeks for establishment and when flowers start appearing the first flowers should be nipped. In suckers planted in September, flowering starts from February.

Growing of plants at 25–30°C temperature with more than 80% RH in a nutrient-rich soil encourages the formation of more side shoots in the axils of leaves which are detached similar to that of clump-division and planted in rooting media where these become ready for transplanting in 2–3 months.

It is now a common trend in the country to multiply the planting stalk of the elite cultivars through tissue culture for obtaining uniform and disease-free material. Generally, MS medium supplemented with various growth substances is used with gerbera explants such as shoot tips, floral buds, capitulum, leaves, midribs, petioles, etc.

Bed preparation

For planting, soil should be made fully pulverised through deep ploughing, rootstocks of the perennial weeds along with other hard foreign materials such as pieces of wood, stones, bricks, and plastic shreds taken out and then properly levelled. It would be wise to disinfect the soil before planting, to avoid the menace of Phytophthora and other root rot fungi. Soil may be solarised by covering it with black polythene film for 6–8 weeks so that solar heat is generated, and all the spores of harmful fungi are killed.

Usually, gerberas are grown on 15–20 cm raised beds for better drainage. Bed width may be adjusted at 1.2–1.6 m at any length as per the convenience. Between two beds, there should be clearance of 40 cm to facilitate walking, irrigation, and cultural operations in the field.

Planting

In seedlings, the vegetative shoot is formed terminating into a flower, followed by a second flower, then a third, and so on. Before the first flower appearance, some 2–8 leaves are formed on the plant. Subsequently, for production of flowers, every time new lateral vegetative shoots emerge with almost the same number of leaves, and these vegetative buds are known as crown, and so in a course of time, the plant becomes quite leafy due to primary rootstock, secondary, and so on. The crown should be well above the surface of the soil. In case of annual cropping, the spacing should be close while for perennial cropping, it should be wide. Spacing in the beds or in the large pots for the plants being grown for cut flower production is recommended as 33 × 33 cm to 38 × 38 cm.

Planting time

In India, the proper planting time for most of the tropical and sub-tropical regions should be October (open or in greenhouse), while in Kerala, it is June. Plant density of 7.5 plants/m^2 is thought to be standard. Planting on the hills can be carried out in February–March. In case of gerbera, no pinching is required, however, the very first flower may be nipped to promote vegetative growth and uniformity in flowering.

Manures and Fertilisers

Gerbera is heavy feeder, so frequent application of nutrients at regular intervals is useful for optimum growth and flowering. Farmyard manure at 750 quintals per hectare in fairly light sandy soil at the time of preparation should be incorporated and thoroughly mixed, and in the second year, it should be incorporated with peat as a substitute for manure, provided the pH through liming is adjusted at 6.0–7.5. Growing in peat with ammonium nitrate plus superphosphate plus potassium sulphate at 4 g/l is quite beneficial in producing quality blooms. Excess of nitrogen reduces yield and vase life, and deficiency causes yellowing of old leaves as this translocates in the new leaves upward. Underside of the veins in older leaves show brown discolouration due to phosphorus deficiency, marginal necrosis of old leaves occurs due to potassium deficiency, and intense yellowing of new leaves occurs in case of Ca deficiency, Mg and Fe requirement is more in this crop and Mg deficiency is characterised as thick and crispy interveinal chlorosis on older leaves.

Irrigation

Over-watering in gerberas at any stage of their growth and development is not advisable. The plants should be allowed to get dried slightly between two irrigations which will cause plants to retard naturally without any use of growth retardant on potted plants. When watering, these should be sufficiently watered, at least 5 cm flooding throughout so that soil becomes moderately moist to a depth of at least 10 cm. Water requirement of

the full-grown gerbera plant is from 500–700 ml per day depending upon the prevailing weather conditions and growth stage of the crop. Sub-surface drip irrigation is the best for maximising flower production. The irrigation should be based on the soil type, the weather condition, and the crop stage. First, water is given immediately after transplanting. Irrigation water should be of good quality having proper EC and pH.

Harvesting and yield

First flowers appear after 50–70 days of planting. While the outer two whorls of disc florets are falling straight on the flowerhead showing pollen grains in case of singles, and the disc flowers being fully developed in doubles, these are harvested during cool hours of the day by pulling (not cutting) near the base of stalk. About 150–250 flowers are harvested per square metre annually. Though there is a great difference in the vase life of various cultivars but normally freshly harvested gerbera stems last 2–3 weeks.

The cut flowers are pulsed with 1000 ppm silver nitrate, 600 ppm sodium hypochlorite, 6% sucrose, and 0.1% Tween-20 surfactant for 10 minutes for reducing bacterial stem blockage and to prolong vase life. Immersing the gerbera cut ends for 24 hours in a 200 mg 8-HQS, 50 mg $AgNO_3$, and 5% sucrose in one litre of water prolongs the life by 4–5 days.

The flowers are packed in insulated boxes for transportation from one place to another, but in Holland, plastic-coated metal grids of 50 × 75 cm with mesh size of 2 × 2 cm are commonly used by the seller for packing gerbera flowers. The flower heads are supported by the grids or mini sleeves which are suspended above a plastic tray measuring 48 × 70 × 30 cm, at a height which can be adjusted as per the length of the floral stalk so that cut ends are immersed in water to a 15 cm depth in the tray. Individual flowers are now a days packed in specially prepared transparent polythene bags but with cut ends inserted into air-tight plastic tube filled with water or vase-solution. Locally, these are packed in bunches of 10–12 with their cut ends placed in water or vase solution. The stem length of gerbera should not be

less than 40 cm, should be straight, firm and the flower diameter not less than 7 cm.

After receiving the consignments, the cut stems require to be rehydrated immediately with 43°C warm water. Solution of 25 ppm silver nitrate at 3.5 pH should be used as a holding solution and dipping the flower heads in 0.1 mM benzyladenine (BA) delays the senescence and maintains the flower weight. Gerbera cut flowers respond well to re-cutting of cut ends before placing in preservative solution or until marketing. Shortage of water as a result of vessel blockage or microbial growth may cause flower drooping. Its stalk being hollow, sometimes due to filling of air inside, water absorption is held up so pricking of the stalk 10 cm below the flowerhead will facilitate escape of the air, *vis-a-vis* help in the absorption of water.

Insect-pests

White flies *(Trialeurodes vaporariorum)*

When greenhouse weather is hot and dry, gerbera may be attacked with tiny white flies (1.5 mm long). After hatching from the eggs, the new crawlers start moving from leaf to leaf and then start sucking the sap from the young leaves from where these do not move until their maturity, then moulting into nymphs of yellow colour with red eyes and then into pupae, and finally, becoming whitish-yellow adults. Its infection causes chlorosis, yellowing of leaves, premature leaf defoliation cum bud shedding, and gradual drying of the plants, and overall infested plants become aesthetically unappealing. Spraying the insecticides such as Confidor (Imidacloprid) at 0.005%; Astra, Lanate (Methomyl) or Pride (Acetamiprid) at 0.004%; and Neemazol, Rogor (Dimethoate) or Malathion at 0.02% continuously thrice at 5–7 days will control all the stages of this pest.

Leaf miners *(Liriomyza trifolii, L. huidobrensis)*

The yellowish-brown larvae feed on the plants by irregularly tunneling the young leaves, and their severe infestation causes drying and drooping of the leaves. Neem cake extract is highly effective which may be used

regularly. Twice spraying of Imidacloprid, pyrazophos, or Esfenvalerate at fortnight intervals will control this pest. Vertimec (Abamectin) at 0.005%; Chlorpyriphos or Dichlorovos at 0.01%; Acephate or Methomyl at 0.015%; or Dimethoate at 0.1% spraying will control this pest.

Aphids *(bean aphid, Aphis fabae;* green peach aphid, *Myzus persicae)*

The nymphs and adults of aphids cluster on new growth and around tender plant parts rasping their sap and distorting them. These can be controlled through fumigation with Sulfotep smoke cartridges at 200 m^3 or Primicarb smoke candles at 700 m^3, and chemical control through spraying with 0.01% Ambush, 0.02% Malathion, 0.1% Dichlorvos, Methomyl or Oxamyl, 0.04% Decamethrin or Cypermethrin. Spraying water with jet nozzle or spraying of the tobacco decoction will also control these pests.

Mites *(Hemitarsonemus latus, Steneotarsonemus pallidus)*

Former mite feeds even on gerbera roots and the next one on the leaves and flowers, spin the webs and cause crooked and deformed flowers. Sulphur dusting of plants before flowering and Mitac, Torque, and Rospin application to the flowering plants will control these mites.

Caterpillars *(Helicoverpa armigera)*

These being polyphagus, feed on every part of the plant. *Bacillus thuringiensis* based parasites are very effective in keeping such insects under check.

Root-knot nematode *(Meloidogyne incognita)*

It causes root-galling so root and shoot growth is restricted and foliage becomes yellow. Organophosphate chemicals mixed in the soil will control this pest. Neem cake 30–50 g/plant, Carbofuran (Furadan) 10 g/plant or Diazinon (Suzon) 0.015% drenching will kill the nematodes to a great extent.

Slugs and snails

These occur in high humid areas having diffused or no light and where temperature is below 21°C. During

daytime, these hide themselves below the debris but become active during the night hours when these feed on foliage, new shoots, and flowers. Proper sanitation will destroy their hiding places. These can be trapped by spreading vegetable refuse. Introducing finely ground lime in dry soil and during dry period, and copper sulphate barriers will kill these pests while crossing the line.

Diseases

Crown/foot/rootrot or wilt *(Phytophthora cryptogea)*

It is a soil borne disease. Due to its infection, the plant roots and stalk bases become black-brown, followed by rotting. Its infection causes crown rotting and ultimate death of the infected plant. *Fusarium oxysporum* also causes foot rot with almost the same symptoms as that of *Phytophthora* but on cutting, vascular system of such plants shows blackening. Top-dressing of nutrients such as ferrous sulphate, Zn-EDTA, or zinc sulphate and calcium nitrate suppress the incidence of *Phytophthora* foot rot. Soil sterilisation with Vapam at 100 ml/m^2 keeps this problem under check, and warming of the soil at 26°C also reduces incidence of this disease. Soil sterilisation together with regular application of fungicides such as copper oxychloride in the soil will control even the root rot caused by soil-borne pathogens such as *Pythium irregulare, P. ultimum, Sclerotium rolfsii, S. sclerotiorum,* and *Rhizoctonia solani.*

Pythium

Infection stunts the plants together with peeling of the root skins while *Sclerotium* causes aerial rotting, and these become very serious at 30–34°C temperature range. *Sclerotium* infection appears first as water-soaked lesions on collar and other parts touching the soil, and then afterwards, the plants turn yellow, then brown to black and then die. Methyl bromide or Metam at half doses under plastic is very effective though its full dose causes phytotoxicity. Prothiocarb at 0.15% on young infected plants or Furadaxyl at 2 g/l is quite effective in controlling these pathogens.

Rhizoctonia solani

This causes plant stunting and ultimate death of the plant. Soil sterilisation and drenching with 0.4% copper oxychloride or 0.2% Dithane M-45 controls this disease.

Powdery mildew

It is caused by *Erysiphe cichoracearum, E. sclerotiorum,* and *Oidium erysiphoides f. sp. gerberae*. Due to their infection, white powdery coating on gerbera foliage and floral stalks occurs. Spraying of karathane or wettable sulphur is found effective against *E. cichoracearum,* while *Oidium erysiphoides* f. sp. *gerberae* is brought under control by removing the old leaves, allowing proper ventilation, by reducing relative humidity and spraying 0.1% benomyl in the greenhouse. Spraying of dinitro capryl phenyl crotonate (Mildex) at 0.25% + a wetting agent controls the disease without any plant injury.

Blight (Grey mould)

This occurs as plants are infected with *Botrytis cinerea* due to deep planting, poor aeration cum ventilation and poor drainage in the greenhouses by which small black spots on ray florets appear. In the morning, when atmospheric humidity is more than 90% for more than two hours, grey spots on the flower petals start developing. It also kills the young growing tissues, and its infection also causes damping off in seedlings. Benlate at 0.1%, Dithane M-45 or Z-78 at 0.2%, or Thiram at 0.1% weekly spraying may control this problem. Sprinkler or overhead irrigation should be avoided.

Leaf spot *(Alternaria brassiciola, Phyllosticta gerbericola* and *Cercospora gerberae)*

These pathogens cause various kinds of leaf spot symptoms on gerbera leaves. Such problems may be controlled through spraying with 0.2% Dithane M-45 or Z-78. Sometimes, *Verticillium dahliae* causes severe stunting and slow wilting of plants, and this should be controlled through soil sterilisation.

Viruses

So far recorded, viruses on gerbera crop are CMV, 'gerbera ilar virus' (GIV), 'gerbera mosaic virus' (GMV), TRV, and TSWV which spread through aphids, thrips, and nematodes. CMV causes leaf mottling and distortion of colour with broken streaks on flowers, stalks, and leaves. GIV retards the growth with chlorosis. GMV is transmitted through grafting and causes mottling in the plants. TRV transmitted through Trichodorus nematodes expresses yellow or black annulated ring spots on the leaves. The nematodes are controlled through soil steaming before crop planting. TSWV reduces plant vigour so the flower quality becomes poor. One can get rid of viruses through sanitation, immediate destroying of the infected plants, use of virus-free material, soil steaming to kill nematode vectors, and management of virus vectors.

Practical Exercise

Activity 1

Collection of various disease samples of gerbera plant

Material required

Herbarium, sticking tape, coloured pencil, pen, etc.

Procedure

- Visit a nearby greenhouse or field planted with the gerbera plant.
- Observe the plants for symptoms of various diseases.
- Pluck the leaves showing clear symptoms.
- Paste the dry leaves on the herbarium sheet.
- Write down the information of the disease symptoms shown.
- Information to be written includes —
  - Name of the disease
  - Causal organism
  - Control measures
  - Place of collection
  - Date of collection

Check Your Progress

A. Fill in the Blanks

1. Gerbera is a native of _____.
2. Gerbera can be propagated vegetatively through _____ and _____.
3. Planting time of gerbera in most of the tropical and sub-tropical regions is _____.
4. In gerbera first flower appears after _____ days of planting.
5. About _____ flowers of gerbera are harvested per square metre annually.

B. Multiple Choice Questions

1. Farmyard manure at _____ per hectare in fairly light sandy soil at the time of preparation should be incorporated.
   (a) 750 quintals
   (b) 1000 quintals
   (c) 1500 quintals
   (d) 2000 quintals
2. Water requirement of the full-grown gerbera plant is from _____ per day.
   (a) 400–500 ml
   (b) 450–600 ml
   (c) 550–760 ml
   (d) 500–700 ml
3. Gerberas are grown on _____ cm raised beds for better drainage.
   (a) 10 to 15
   (b) 12 to 22
   (c) 15 to 20
   (d) 15 to 25

C. Subjective Questions

1. Write the procedure of commercial propagation of Gerbera.

   _____

   _____

   _____

2. How is the bed prepared for Gerbera planting?

   _____

   _____

   _____

NOTES

3. What is the bent neck in Gerbera?

_____

_____

_____

D. Match the Columns

A	B
1. GIV	(a) 500–700ml/day
2. Gerbera planting	(b) Stunted plants and peeling of root skin
3. Pythium	(c) October
4. Water requirement	(d) Gerberailar virus