Unit 2

Protected Cultivation of Rose, Gerbera, Carnation, Lilium and Orchids

Open field flower cultivation is mostly dependent on natural climatic conditions, where the crops are often damaged due to high winds, untimely as well as excess rainfall, flood, high or low temperature, less or more humidity, pests, diseases and soil-borne problems, etc. To manage these challenges, protected cultivation techniques are gaining momentum. Under protected cultivation technologies, the crop canopy is covered with different materials (insect-proof net, shade net, polyethylene film, etc.). Under protected conditions, the crops are grown inside different protected structures such as a greenhouse having controlled condition parameters like light, temperature, humidity, irrigation, soil, which are managed and maintained with the help of different control systems. With the rise in demand for quality cut flowers, cultivation under greenhouse conditions will increase steadily. The common flowers cultivated under polyhouse conditions are — roses, gerbera, carnation, lilium, anthurium, orchids, etc.

Session 1: Protected Cultivation and Package of Practices for Roses

Rose is popularly known as the queen of flowers. It is a leading cut flower, grown commercially all over the world. Rose stands first in the global cut flower trade. Rose is cultivated for cut flower, oil-extraction, rose water, and flavouring agents. Some rose species are rich in Vitamin C. Rose petals are used for preparing *gulkand* and *pankhuri*. Earlier, commercial rose cultivation in India was mainly in open-field conditions. Later, improved cultivation practices like mulching, drip irrigation, fertigation, better canopy management practices, and use of improved varieties or hybrids boosted the rose cultivation. With the introduction of greenhouse technology in India during the late 1990s, export quality cut rose cultivation began in entrepreneurial mode.

Classification

Roses can be classified mainly into the following types.

- Hybrid tea: They are most popular in modern days and bear large flowers.
- Floribunda: They are also known as hybrid polyanthas.
- Polyanthas: They produce enormous clusters of small flowers, which bloom for several months.
- Climbers and ramblers: Climbers grow upward with the help of modified organs. Ramblers are climbers with large clusters of small, single or double flowers.
- Miniatures: They are popular baby roses with small leaves and flowers. They are hardy and ideal for growing in pots.
- China roses: They are the ancestors of the present day popular roses. They show variation in colour from deep red and maroon to pink or white. They are bushy and often with an irregular outline.

(a) Hybrid tea rose

(b) Floribunda rose

(c) Polyanthas

(d) Climbers and ramblers

(e) Miniature roses

(f) China rose

Fig. 2.1: Classification of different roses

Table 2.1: Varieties used for cut flower purpose

Flower colour	Varieties
Red	Jaguar, Gabriella, Sasha, Grand Gala, First Red, Dallas, E.G. Hill, Happiness, Taj Mahal
Pink	Kiss, Europe, Prophyta, Royal, Nobles, Pink, Aristocrat, Better Times
Bi-colour	Amour, Rodeo, Confetti, Ambience, Leonidas, Yellow Gloria
Orange	Indian Puma, Candid, Mercedes, Jazz, Orange Delight, President Herbert
Yellow	Golden Time, Golden Gate, Frisco, Golden Rapture, Golden Sceptor
Cream	Prestige, Vivaldi, Versilia, Florence
Purple	Jacaranda, Souvenir
White	Eskimo, Double White Killarney, White Pearl

Temperature and Humidity

Rose requires good light throughout the year. Temperature range of 15°C to 28°C and relative humidity around 75 per cent is ideal for quality rose cultivation.

Soil

Soil should be well prepared to a good depth and well-drained, rich in organic matter with a pH range of 5.5 to 6.5. For cultivation of rose, sandy loam soils are preferable.

Propagation

- Cuttings: Fresh and mature shoots should be selected for propagation by the cutting method. The cut ends of the shoots should be dipped in Indole Butyric Acid (IBA) (rooting hormone) and planted in beds. This method is practised only for multiplication of rootstock and a few classes of rose, for example, miniatures and climbers.

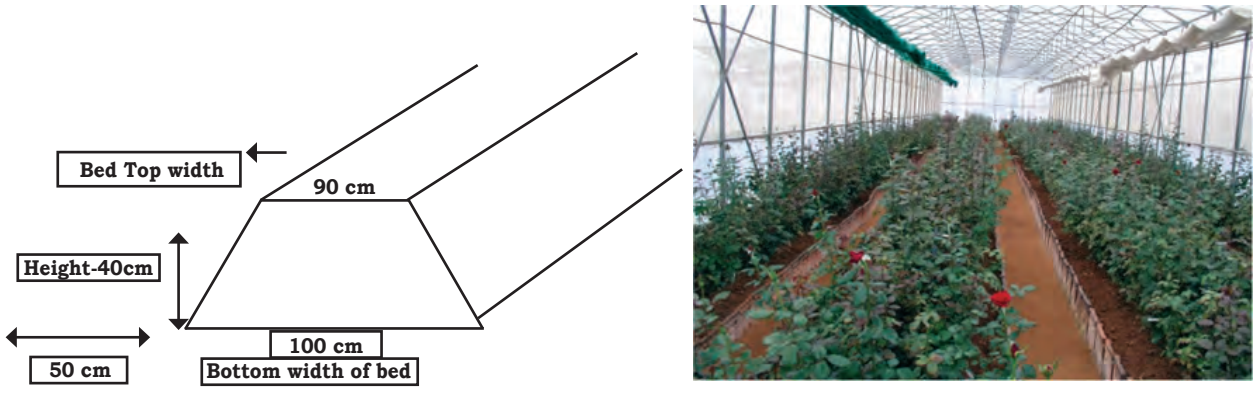
- Budding: This is the most common method of propagation, although tedious and time consuming. Budding is done in February–March, when dormant eyes on a scion of chosen variety are budded either by the T-budding method or inverted 'T' method on a native rootstock.

Fig. 2.2: Budding in rose

Bed Preparation

Cut rose cultivation should be done on raised beds. Soil should be prepared thoroughly and mixed well with organic matter at 50 t/ha FYM. FYM should also be preferably enriched with bio-agents like *Trichoderma harzianum* and/or *Pseudomonas fluorescens,* which are mixed well separately in different heaps of FYM and kept for about a month. They should be mixed just before applying FYM in the planting beds. A little sand and rice husk may be added to the soil for better drainage and non-compaction. The soil should be fumigated if possible or soil solarisation should be done thoroughly before bed preparation. Then the raised beds of the following dimensions should be prepared.

- Bottom width — 100 cm
- Top width — 90 cm
- Path width — 50 cm
- Height — 40 cm



(a) (b)

Fig. 2.3 (a and b): Bed preparation

Planting

Planting is done on the bed with paired row system in a zigzag fashion. Plant to plant distance should be maintained at 20cm and row to row spacing at 40 cm. While planting, care should be taken that the budded portion is above the ground level. About 48,000 plants can be accommodated in a one acre greenhouse.

Common Cultural Operations Involved in Rose Cultivation Under Greenhouse Conditions

Pruning

It should be done between October and November. At the time of harvesting, a cut is given on the second pair of leaves in the first year plant. In subsequent years, pruning is done on the wood that has grown after the previous pruning.

(a) (b) (c)

Fig. 2.4 (a, b and c): Pruning in rose

Pinching

In this process, a part of the terminal growing portion of the stem is removed to promote auxiliary branching and delay maturity of the buds.

Stem bending

In this process, the stems are bent in such a manner that the angle between the original and the bent shoot is less than 45°. This is generally carried out five months after planting for breaking the apical dominance of the plant. This helps in breaking apical dominance and simultaneously provides active foliage for photosynthesis resulting in the development of reproductive flower stems.

Fig. 2.5: Stem bending in rose

Fig. 2.6: Rose plant after bending

Manures and Fertilisers

Rose plants require 200–300 kg of nitrogen, 150–200 kg/ha each of phosphorous and 200–300 kg/ha potassium depending upon the fertility status of the soil. Nitrogen is applied in split doses. The first dose is applied at the time of pruning and the second dose 25–30 days after pruning. The basal dose of fertilisers may also be supplemented with foliar feeding, consisting two parts urea, one part di-hydrogen ammonium phosphate, one part potassium phosphate and one part potassium nitrate, and using 3 g of this mixture/L of water after one week or 10 days till flowering.

Fertigation with drip irrigation is given in roses at the rate of 80–100 ppm of N, 50–60 ppm of P and 60–80 ppm of K two to three times per week, while micronutrients at the rate of 25–50 ppm once in two weeks or weekly. The following fertigation schedule should be followed, preferably.

Table 2.2: Month-wise fertigation schedule for rose under protected cultivation (1000m²)

Particulars	Month-wise application of water soluble fertilisers (kg/1000m²)												
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Irrigation nos.	4	6	7	8	8	8	6	6	8	8	6	4	79
Urea phosphate	1.5	2.1	3.7	4.5	5.1	5.3	3.4	2.9	2.9	2.9	2.7	1.7	38.7
Urea	1.9	2.6	4.5	5.2	6.0	6.2	4.0	3.3	3.4	3.4	3.2	2.1	45.8
SOP	1.8	2.5	4.3	6.4	7.2	7.5	4.8	4.1	3.1	3.1	3.1	2.0	49.9

Source: Hasan et al. 2010. *Fertigation Scheduling for Horticultural Crops*. Technical Bulletin. TB-ICN: 80/2010, p. 44, I.A.R.I., New Delhi.

Common Pests and Diseases

The key pests and diseases in rose plants are mites, aphids, thrips, leaf miner, die-back, black spot, powdery mildew, collar rot, root rot, etc. The management of pests and diseases has been discussed in Unit 4, Session 2.

Harvesting

- **For local market**: When the outer one or two petals start unfurling.
- **For distant market**: A tight bud showing complete colour stage should be harvested.
- **Loose flower**: Fully opened flowers.
- The red flowers may not open if harvested at the tight bud stage but white, pink and yellow cultivars are harvested earlier than red.

Post-harvest Management

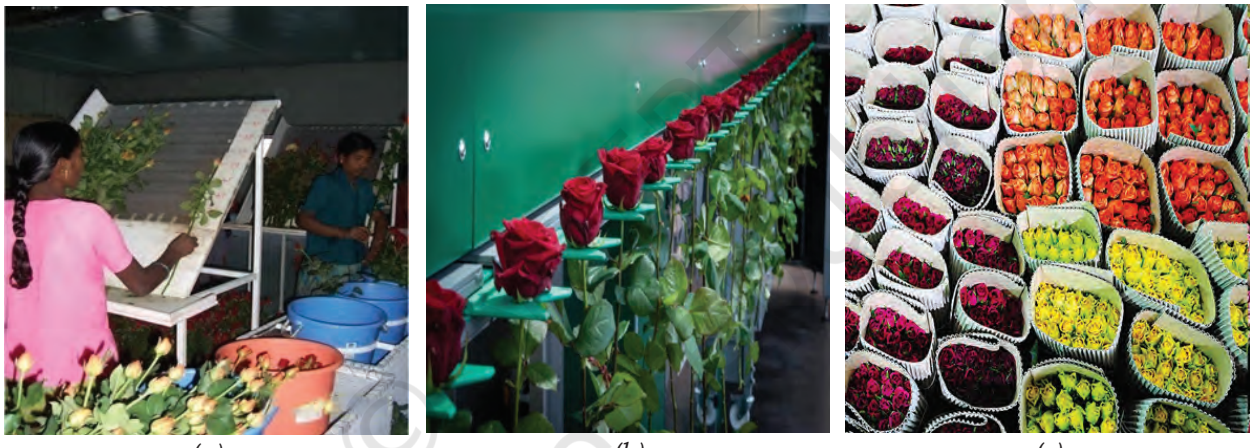
After harvesting, the flower stems should be kept in buckets containing water in a vertical position for a few hours, to remove the field heat and retain the moisture and then shifted to cold rooms (3–5°C) for

better shelf life. During cooling, the stems should be put in aluminium sulphate or citric acid (300 ppm) or bleach solution (50 ppm chlorine for disinfestations).

Grading and Packaging

Stems should be graded in an air conditioned room after pre-cooling. Healthy stems should be sorted out as per the grade depending upon the stem length, cultivar and quality of the flower. The bud size should be representative of the variety and the length of the neck should not be much. Grading can be classified into:

Long stemmed (70–120 cm): with 10 cm difference,
Medium stemmed (50–70 cm): with 5 cm difference, and
Small stemmed (30–50 cm): with 3–5 cm difference.



(a) (b) (c)

Fig. 2.7 (a, b and c): Grading and packaging

The graded stems are sorted into bundles of 20 each, tied loosely with a rubber band and wrapped with a 2-ply soft corrugated paper. The bunches are packed in pre-cooled 5-ply tele boxes of fibre board in such a way that the flower heads face the opposite direction.

Yield

A yield of 150–250 quality flower stems per m^2 per year can be expected under protected conditions for six to eight years.

Practical Exercise

Activity 1

Visit a greenhouse rose field and observe different horticultural operations practiced in the greenhouse cultivation of rose.

Material required: Writing material

Procedure

- Visit a field and note down the varieties.
- Note down the observations on common cultural operations carried out by the farmers.
- Note down the importance of each operation.

Check Your Progress

A. Fill in the blanks

1. Most preferable soil for the cultivation of rose is_____.
2. Pruning of roses should be done in the month of _____.
3. The ideal relative humidity for quality rose cultivation is _____ per cent.
4. The optimum temperature for growing of roses is _____.
5. Commercially roses are propagated by _____ method.

B. Multiple choice questions

1. Which one of the following is not a type of rose?
   (a) Floribunda
   (b) Designer
   (c) Miniature
   (d) Rambler
2. Which of the following activities is not done in rose production?
   (a) Pinching
   (b) Stem bending
   (c) Pruning
   (d) Pulsing
3. How many plants can be accommodated in a one acre greenhouse?
   (a) 30,000–35,000
   (b) 35,000–38,000
   (c) 40,0000–42,000
   (d) 45,000–48,000

4. Rose petals are used to prepare _____.
   (a) *gulkand*
   (b) *pankhuri*
   (c) both (a) and (b)
   (d) none
5. The ideal pH range for rose cultivation is _____.
   (a) 4.5–5.5
   (b) 5.5–6.5
   (c) 6.5–7.5
   (d) 7.5–8.5

C. Subjective questions

1. Write the names of three varieties of bi-colour rose.

   _____

   _____

   _____

2. Explain the two major diseases of rose.

   _____

   _____

   _____

3. What is stem bending?

   _____

   _____

   _____

4. List out common pests and diseases of rose.

   _____

   _____

   _____

D. Match the columns

A	B
1. Thrips	(a) Rose variety
2. Tight bud	(b) Disease of rose
3. First red	(c) Pests of rose
4. Black spot	(d) Harvesting stage

NOTES

Session 2: Protected Cultivation and Package of Practices for Gerbera

Gerbera flower is a native of South Africa and currently one of the most favoured and liked cut flowers across the world, and is very popular among greenhouse growers. Its beauty, variety of colours, and shape is most likeable for different purposes, be it some occasion or decoration, bouquet preparation or beautification. It is available both in single and double florets with black centred varieties being in high demand in national and international markets. Commercially, the single and semi-double types of gerbera are grown mainly for garden decoration whereas the double type varieties are grown for cut flower trade.

(a) (b)

Fig. 2.8 (a and b): Gerbera cultivation in a polyhouse

Climatic Requirement

Day temperature range between 22–25°C and night temperature range between 12–16°C is favourable for a good crop of gerbera. Poor light during winter adversely affects the flower production, hence, measures such as opening of silver shade net during the day should be taken.

Soil

Light sandy loams, slightly acidic or neutral soils are good for gerbera cultivation. A good amount of organic matter along with rice husk provides good aeration and growth of the plants. Gerbera is a long duration crop of four to five years, therefore, healthy soil management

is very crucial to the crop. Even slight degradation in the health of soil and pathogenic infestation can lead to early mortality of the crop. Besides, it is generally grown on raised beds, which cannot be disturbed during crop life. Therefore, the soil has to be properly treated, thoroughly prepared, and well-mixed with farmyard manure and rice husk for efficient drainage. Farmyard manure mixed in the bed must be enriched with beneficial microbes like *Trichoderma harzianum*, *T. viride* or *T. virens* and *Pseudomonas fluorescens*.

Varieties

A large number of commercially important varieties are grown in different parts of the world. Among them, Anneke, Alsmeera, Alexias Ginna, Ibiza, Lyonella, Monique, Ornella, Parade, Gold Spot, Regina, Sunset, Tara, Rosetta, Gloria, etc., are grown in India under protected cultivation for local and export purpose.

Fig. 2.9: Different colour varieties of gerbera

Fig. 2.10: Tissue-cultured planting material of gerbera

Fig. 2.11: Prepared beds of gerbera

Fig. 2.12: Transplanting of gerbera under a raised bed

Fig. 2.13: Transplanted field of gerbera

Propagation

Gerbera may be propagated through seeds, tissue culture or through division of clumps. However, the propagation of gerbera through division and tissue culture is the norm. It is advisable to buy plant materials from recognised commercial suppliers only, as the yield and quality depends on the quality of planting material.

Time of Planting

Planting is generally done during January–March and also during June–August. It is important that they are not planted too deeply, that is, the crown of the plants should be at soil level or a little above it.

Planting and Spacing

Gerberas are mainly planted on a raised bed of 1 m width and 50 cm height with a 30 cm passage between the beds. Row to row distance is to be 30 cm and plant to plant distance has to be 20 cm. By following this spacing, it is possible to accommodate about 60,000 plants per acre inside a greenhouse.

Nutrient Management

Gerbera is a heavy feeder. It requires an application of 10:15:20 g NPK/m^2/month during the first three months

of planting, starting from the third week and 15:10:30 g NPK/m^2/month from the fourth month (when flowering starts). Spraying of micronutrients like boron, calcium, magnesium, and copper @ 0.15 per cent (1.5 ml/L) once in a month is also recommended to get better quality bloom. Now, for commercial purposes, nutrition is given through fertigation. Mixed micronutrient formulations (25–50 ppm) may also be given fortnightly. The following fertigation schedule is to be adopted for gerbera cultivation in greenhouses.

Table 2.3: Month-wise fertigation schedule for gerbera under protected cultivation (1000m^2)

Particulars	Month-wise application of water soluble fertilisers (kg/1000m^2)												
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Irrigation nos.	4	6	7	8	8	8	8	8	8	8	6	4	79
Urea phosphate	1.5	2.1	3.2	4.6	2.1	2.1	1.4	1.4	2.5	2.6	2.7	1.7	27.6
Urea	1.4	1.9	2.9	4.2	2.5	2.6	1.7	1.5	2.4	2.5	2.4	1.5	27.5
SOP	1.8	2.5	3.7	5.4	3.0	3.1	2.0	1.7	2.6	2.7	3.1	2.0	33.8

Source: Hasan et al. 2010. *Fertigation Scheduling for Horticultural Crops.* Technical Bulletin. TB-ICN: 80/2010, p. 44, I.A.R.I., New Delhi.

Irrigation and Water Management

After planting, initially up to four weeks, the crop should be irrigated with water cans, and later drip irrigation should be used. The crop has a water requirement of 2–4 L/m^2/day.

Fig. 2.14: Drip irrigation

Weed Management

Uproot the weeds if any, when they are small. Two to three manual weedings may be required. The first weeding should be done one month after planting.

Harvesting

Gerbera starts flowering 8–12 weeks after planting. Harvest the fully opened flowers two to three times in a week. The stems should be pulled, not cut and the 'heel' (base of the stem) should then be cut by secateurs to allow hydration. Freshly harvested cut gerbera stems can last from seven to 10 days depending upon the varieties. Gerbera flowers are preferred only when the diameter of the flower is more than 12 cm. Therefore, grading is done based on the size, colour, and stalk length of the flowers.

Post-harvest Management of Gerbera

Gerbera stem is highly prone to bending. A bent stem is not accepted well in the trade. The stem should not be less than 40 cm and should be firm and straight. The flower should be uniform in size and should not be less than 7 cm in diameter. Gerbera flowers are packed in flat boxes containing paper inserted with holes for individual stems. Support is necessary to hold the stems immobile. For domestic purpose, individual flowers can be inserted in polyethylene sleeves before packing, to protect them from damage caused by bruising.

(a) (b) (c)

Fig. 2.15 (a, b and c): Packaging of gerbera

Yield

The average yield in a greenhouse is around 200 cut flowers/m^2 per year, of which, around 85 per cent is of first grade quality.

Success Story of a Gerbera Grower

Smt. Mamata Varshney, M.A. from village Tarasevaniya in Bhopal district, underwent a training programme on protected cultivation technologies in 2015 at Precision Farming Development Centre (PFDC). After availing a subsidy from the State Horticulture Mission, she established a Naturally Ventilated Polyhouse of 2000 sq.m and started cultivating gerbera.

Courtesy: CIAE, Bhopal
Figure: A successful gerbera grower in Bhopal

PFDC staff provided her technical guidance for the layout of the polyhouse as well as in crop management from time to time. She invested ₹ 10 lakh for the installation of the polyhouse. She has employed two agricultural labourers. By adopting this technology, she not only produced quality flowers but also got a high market price. At present, her annual income from gerbera cultivation in a polyhouse is about ₹ 6 lakh. Having found the techno-economic advantage of polyhouse cultivation, she is planning to extend the polyhouse area by one more acre.

Practical Exercise

Activity 1

Visit a nearby gerbera growing field and observe different cultural operations practised in greenhouse cultivation.

Material required: Writing material

Procedure

- Note down the observations on common cultural operations carried out by farmers such as the number of plants per sq. m, name of variety, colour of flower, plant spacing, etc.
- Note down the method of harvesting of flowers.
- Note down the expected yield per m^2.

Check Your Progress

A. Fill in the blanks

1. The average yield of gerbera in a greenhouse is around _____ per m^2 per year.
2. In one acre greenhouse, we can accommodate about _____ plants of gerbera.
3. The water requirement of gerbera is _____ litre per day per m^2.
4. Gerbera is a native of _____.
5. Day temperature range between _____ and night temperature range between _____ is favourable for a good crop of gerbera.

B. Multiple choice questions

1. Gerbera starts flowering _____ weeks after planting.
   (a) 2–3
   (b) 4–6
   (c) 8–12
   (d) 15–20
2. The average gerbera flower yield in a greenhouse is around _____.
   (a) 50 flowers/m^2/year
   (b) 100 flowers/m^2/year
   (c) 200 flowers/m^2/year
   (d) 400 flowers/m^2/year
3. Which of the following is/are gerbera variety(ies)?
   (a) Anneke
   (b) Alsmeera
   (c) Alexias Ginna
   (d) All of the above

4. Farmyard manure mixed in the bed must be enriched with beneficial microbes such as _____.
   (a) *Trichoderma harzianum*
   (b) *T. viride*
   (c) *Pseudomonas fluorescens*
   (d) All of the above

C. Subjective questions

1. Write about the bed preparation and method of planting of gerbera.

   _____

   _____

   _____

2. Write a short note on grading and packing of gerbera flowers.

   _____

   _____

   _____

3. Describe the nutrient management in gerbera.

   _____

   _____

   _____

D. Match the columns

	A	B
1.	Propagation	(a) Packing
2.	Polyethylene sleeve	(b) Micronutrient
3.	Boron	(c) Division
4.	Bent neck	(d) Disorder

Session 3: Protected Cultivation and Package of Practices for Carnation

Carnation (*Dianthus caryophyllus* L.) is one of the most popular commercial cut flowers of the world, ranking second in commercial importance after rose. Several exporting countries prefer carnations over roses and chrysanthemums because of its excellent keeping

Notes

quality, wide range of forms and colours and its ability to withstand long distance transportation. Cut carnations, roses and chrysanthemums contribute close to 50 per cent of the world's cut flower trade.

Fig. 2.16: Carnation crop

Climatic Requirement

Carnation is one of the most delicate crops and hence requires a very congenial environment, which is stress free and ideal for proper and healthy growth of the plants. The general environmental requirements of the crop are as follows:

- Light: Carnation is a quantitative long day crop (long days of more than 13 hours), so it prefers plenty of sunshine. 100 watt bulbs spaced at 10.5 m and of 1.5 m height can be installed above the foggers if the light intensity is less.
- Day Temperature— 15°C to 18.3°C (up to 25°C) and night temperature— 10°C–15°C.
- Ventilation: Free circulation of air in a naturally ventilated greenhouse or else forced ventilation with gentle flow of air is favourable.
- Relative humidity: 50–60 per cent
- CO_2: 500–1500 ppm

Soil

- Light textured loamy soil or sandy loam soil is ideal for its cultivation.
- Soil pH: 6–7

- Soil has to be treated properly, thoroughly prepared, and should be crisp, well-mixed with properly decomposed farmyard manure and rice husk for efficient drainage. Farmyard manure mixed in the bed must be cured and enriched with beneficial microbes like *Trichoderma harzianum, T. viride* or *T. virens* and *Pseudomonas fluorescens.*

Varieties

Popular cultivars of carnation are Dona, Pink Dona, Dakar, Disney, Dark Tempo, Empire, Eilat, Elvis, Fancy Fuego, Liberty, Malaga, White Dona, Rony, Rhodos, Lipstick, Mila, Milky Way, Romana, White Tendra, Corleone, Design, Natila, Bagatel, Silvery Pink, Solar, Cobra, Pendy, Lorella, Cabaret, Tanga, Sonsara, Green Lady, Tempo, Varna, Charment, Red Eye, Red Fuego, Red Vital, Aveiro, White Prestige, T-587, Rosa Bebe, Spur, Suprema, D-925, Celebration, Osiris, Stella, Prestige, Sonia, Abril, Autumn, Sunshine, Berry, Orbit Plus, Nadeja, Picaro, etc.

Propagation

Rooted terminal stem cuttings

- Carnation is commercially propagated through stem cuttings. Terminal stem cuttings from well maintained mother plants, measuring 10–15 cm and 7–10 cm long with four to five leaves are selected for multiplication.
- These cuttings are treated with carbendazim (0.1 per cent) for reducing the spread of fungal diseases during rooting. The lower ends of cuttings are treated with NAA 500 ppm for five seconds to encourage rooting. Carnation cuttings can also be rooted in a mist chamber for better success. Treated cuttings are planted in sand/vermiculite/perlite/cocopeat, etc., media for propagation. Carnation cuttings start rooting within a month after planting in a mist chamber. After complete rooting, the cuttings are transferred into a hardening chamber containing sterilised mixture of sand:soil:FYM (1:1:1).

Fig. 2.17: Terminal cuttings of carnation

Fig. 2.18: Bed preparation for carnation

Fig. 2.19: Sterilisation of the bed by formaldehyde

Fig. 2.20: Bed preparation

Micro-propagation (Tissue culture)

Large scale multiplication of disease free carnation plantlets is done through tissue culture method.

Bed Preparation

Raised beds should be prepared with application of 5 kg coir pith with 15 g N, 20 g P_2O_5 and 10 g K_2O, per square meter area. Planting in carnation is done on raised beds of 25–30 cm height, 1 m width and of convenient length. Before planting, chemical soil sterilisation with 4 per cent formaldehyde (160 ml of formaldehyde in four litres of water) is the norm. After formalin application, the beds should be covered with plastic sheets for 2–3 days. Irrigate the beds after removing these sheets, in such a way that all the chemicals drain out from the beds before planting. However, formaldehyde is being phased out and hence should be avoided. Hydrogen peroxide (silver nano formulations) can also be used for bed treatment.

Time of Planting

- North Indian plains: September–October
- Low hills: September–November
- Mid hills: January–February
- High hills: March–April

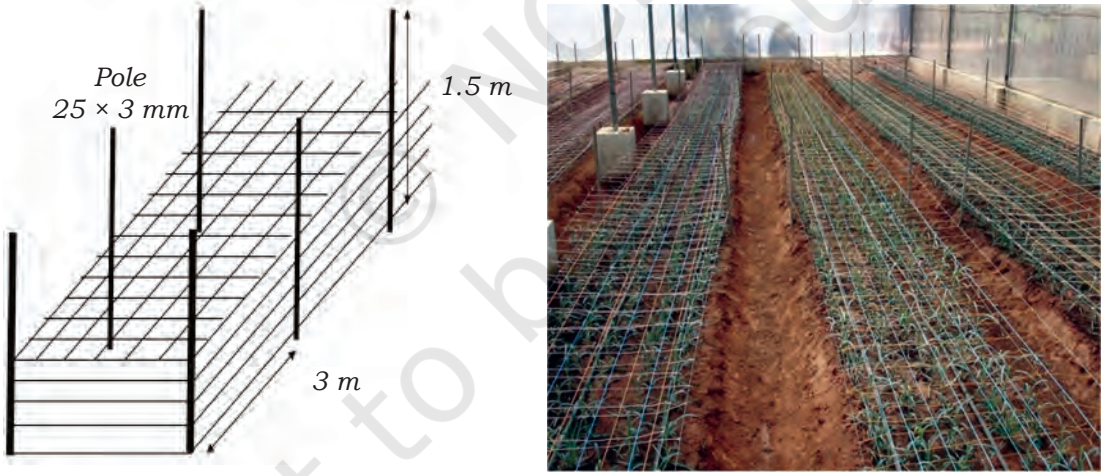
Fig. 2.21: Prepared bed

Planting Method, Density and Spacing

Rooted cuttings plugged in soil or cocopeat should be planted at a distance of 15 cm between rows and 15 cm between plants, keeping one-third portion in soil and two-third portion outside for good establishment. The soil should be pressed with the thumb, placing the plug in the depression before covering it with soil from the sides and pressing gently. Usually, 32 plants/m^2 net area (per m^2 of bed) and about 20 plants per gross m^2 (per m^2 of greenhouse) are planted.

Support System (netting)

As carnation is vulnerable to bending, it should be supported with four to five successive layers of criss-cross support net of variable size of mesh, further supported well on the sides with GI pipe and GI wire lines to take the maximum weight. The supporting net should be 7.5 × 7.5 cm mesh. Four to five such layers of mesh should be tied as the plants gain in height. Also the mesh size of the net may be increased to 12–15 cm at the top.



(a) (b)

Fig. 2.22 (a and b): Support system (netting)

Pinching

Pinching should be done based on market demand. Pinching methods are single, one and a half or double pinch. Pinching can be done when the plants attain the six-node stage. The pinch is given three to four weeks

after planting. This is called single pinching. This gives rise to four to six lateral shoots. Two to three of these lateral shoots are pinched again for a 'one and half pinch'. For the 'double pinch', all the lateral shoots are pinched off.

Fig. 2.23: Pinching in carnation

Nutrient Management

- Standards— FYM: 5 kg, N: 30g, P: 20g, K: 10g/m^2
- Spray— FYM: 5 kg, N: 40g, P: 20g, K: 10g/m^2

Table 2.4: Month-wise fertigation schedule for carnation under protected cultivation (1000m^2)

Particulars	Month wise application of water soluble fertilisers (kg/1000m^2)												
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Irrigation nos.	4	6	8	6	8	8	6	6	6	8	6	4	76
Urea phosphate	1.0	1.4	2.1	1.5	1.7	1.8	1.1	1.0	1.5	1.8	1.8	1.1	17.9
Urea	1.1	1.5	2.3	2.4	2.6	2.7	1.8	1.5	1.8	2.2	1.9	1.2	23.0
SOP	1.3	1.8	2.8	2.7	3.0	3.1	2.0	1.7	1.8	2.1	2.3	1.5	26.3

Source: Hasan et al. 2010. *Fertigation Scheduling for Horticultural Crops*. Technical Bulletin. TB-ICN: 80/2010, p. 44, I.A.R.I., New Delhi.

These days nutrition is commercially given through fertigation. Mixed micronutrient formulations (25–50 ppm) may also be given fortnightly.

Irrigation and Water Management

- Lateral pipes for drip irrigation are laid over the planting beds at about 30 cm distance each. Thus, if there are five rows of plants on one bed width, three drip lateral lines may be laid.
- Normally, 2–3 litres of water/m^2/day is required for the planting bed, depending upon the agro-climatic conditions and location of the greenhouse.
- During the vegetative phase, overhead irrigation is beneficial.

Weed Management

- Since the plants are very delicate, the presence of weeds further weakens the stems leading to more bending, therefore, three to four hand weedings are done carefully.
- Chemical weedicides for annual grasses and broad-leaved weeds *viz.*, oxadiazon (pre-emergent) @ 500 g a.i./acre and napropamide (post-emergent) @ 1 kg a.i./acre can be used in a greenhouse.

a.i. — active ingredient

Harvesting

- Harvesting of the standard carnation flower should be done when the petals have started to elongate outside the calyx (paint brush or cross bud stage). The spray varieties are harvested with two open flowers on each stem. It takes 12–15 weeks for the single pinched plant to yield cut blooms. The best time for harvesting is in the morning. Flowers are harvested with a sharp knife or pruning secateurs leaving 2–3 leaves above the ground level. Immediately after harvesting, the flowers are placed in a bucket containing clean water or with 1 ml of sodium hypochlorite solution (15 per cent a.i.) in 10 litres of water.
- The common grades are: (A) over 45 cm, (B) 30–45 cm and (C) Less than 30 cm.

Fig. 2.24: Disbudding in carnation

Packaging

- In bundles of 10, 12, 20 or 25.
- One can accommodate about 800–1000 cut carnation flowers in corrugated cardboard boxes of 120 × 60 × 30 cm (L × W × H) each.
- Wrap flower bunches in CFB sleeves.

(a) (b) (c)

Fig. 2.25: Packaging of carnation

Yield

The expected yield is about 10–12 stems per plant per year (300 flowers/m^2).

Practical Exercise

Activity 1

Visit a greenhouse that grows carnation flowers and draw how carnations are supported.

Material required: Writing material

Procedure

- Note down the observations on common horticultural operations carried out by farmers for carnation cultivation viz., supporting, pinching, disbudding, nutrition, etc.
- Note down how they harvest and pack the flower stems.

Check Your Progress

A. Fill in the blanks

1. The most suitable soil for carnation cultivation is _____.
2. Carnation harvesting starts within _____ to _____ days after planting.
3. The commonly used propagation materials in carnation are _____ stem cuttings.

B. Multiple choice questions

1. The optimum CO_2 for carnation in greenhouses is _____.
   (a) 200–300 ppm
   (b) 300–500 ppm
   (c) 500–1500 ppm
   (d) 3000–3500 ppm
2. The optimum soil/media pH for carnation is _____.
   (a) 3–5
   (b) 5–6
   (c) 6–7
   (d) 8–9
3. Corrugated cardboard boxes of 120 × 60 × 30 cm (L × W × H), each can accommodate about _____ cut flowers carnation.
   (a) 100–200
   (b) 200–300
   (c) 300–500
   (d) 800–1000

C. Subjective questions

1. Explain the method of planting in carnation.

   _____

   _____

   _____

2. What should be the greenhouse climate for growing carnation?

   _____

   _____

   _____

3. Explain how carnations are supported.

   _____

   _____

   _____

D. Match the columns

A	B
1. Paint brush	(a) Support system
2. Netting	(b) Packaging
3. CFB sleeves	(c) Tissue culture
4. Micro-propagation	(d) Harvesting stage

Session 4: Protected Cultivation and Package of Practices for Orchids

Orchidaceae is a large family comprising 800 genera and 2,500 spp. of monocotyledons in the world. Orchids are the most accepted and fascinating flowers in the world. They are a high value commodity, sold at premium prices both in the international and domestic markets. Apart from this, they are also in high demand as potted plants. The orchid culture has become a highly developed and remunerative business venture all over the world.

Importance and Uses

Miniature orchids are grown in pots, baskets, etc., as potted plants for indoor gardening. Large flower producing types are commercially grown under protected structures (polyhouses/shade net houses) for cut flower production. Such flowers have good shelf life and have a higher value as cut flowers. Apart from their use as ornamentals, some of them are found to be edible and some others have medicinal value also.

Fig. 2.26: Orchid plants

Environment for Orchids

Temperature, light, humidity, aeration, CO_2 concentration, etc., are important environmental factors, which regulate the growth and flowering of orchids. Hence, they are commercially grown under protected structures.

Temperature

The optimum temperature required for most of the orchids is between 15°C and 26°C. Orchids can be grouped into three categories based on temperature requirements.

Warm orchids

These orchids require day temperature between 21°C and 29°C and night temperature between 18°C and 21°C for better growth and flowering.

For example, *Arachnis*, *Dendrobium*, *Vanda*, *Phalaenopsis*, *Aranda*, *Mokara,* etc.

Cool orchids

An optimum temperature between 15°C to 21°C during the day and between 10°C to12°C at night is suitable for cool orchids like *Cymbidium*, *Paphiopedilum*, *Calanthe*, *Miltonia*, *Pleione* and *Odontoglossum* for proper growth and flowering.

Intermediate orchids

Orchids like *Cattleya*, *Laelia*, *Oncidium*, Brassavola, and some species of *Dendrobium*, *Coelogyne*, etc., belong to this group. The temperature requirement is between 18°C to 21°C during the day and 15°C to 18°C during the night.

Light

The optimum light intensity for most orchids is generally between 3000–6000 foot candles. However, orchids like *Cypripedium* and *Phalenopsis* need light intensity of about 200–300 foot candles, and hence should be kept in comparatively shaded portions of the orchid house, while *Cymbidium* grows under a full sun. Therefore, depending on the type of orchids and climatic conditions of the region, one has to use a specific type of shade net for proper growth and flowering. Generally 50–75 per cent shade net is used.

Humidity

Humidity is very important for the good growth of the plants. Orchids prefer high humidity, about 70 per cent during the day. However, the requirement

varies according to the genera. Under high temperature conditions, humidity is required. The requirement is high for young plants also. The humidity inside the orchidarium can be maintained by mist irrigation or by fitting humidifiers. Excessive high relative humidity (above 70 per cent) contributes to the succulent growth of the plants, and takes care of diseases.

Aeration

A majority of orchids are epiphytic, for which free air circulation is essential. Air impurities like dust particles and gases like ethylene can damage the flowers. Most of the commonly grown orchids have aerial roots, hence fresh moving air around the roots improves the plant growth and the quality of flowers. The circulation of fresh air is also essential to maintain the uniformity of temperature. It also reduces the occurrence of diseases and physiological disorders.

Propagation

Orchids can be propagated both by sexual (seed) and asexual (vegetative) methods. Seed propagation is mainly practised for breeding purposes. Different vegetative propagation methods usually practised include division, cutting, back bulbs, off-shoots and tissue culture. Tissue culture is the most common method of commercial propagation followed under protected cultivation.

Containers

The generally used containers for orchid cultivation are (1) pots, (2) baskets, (3) wooden logs, (4) tree fern blocks, and (5) coconut husk, etc. The containers should have many holes for good drainage and aeration. Pots with both bottom and side holes are a better choice. The pot size may vary from thumb size to 20 inch depending on the type of orchid. Nowadays, plastic pots are also commonly used. Wooden baskets of various sizes and shapes made of high quality wood, which can withstand frequent watering are also chosen by some growers. Generally, square baskets are used.

Potting media

Fig. 2.27: Pots for growing orchids

The media for orchids should have good drainage, aeration and nutrition. In any case there should be no water stagnation. The potting mixture generally used consists of diverse material: brick pieces, charcoal pieces, peat moss, stone pieces or jelly, tree fern fibre, farmyard manure, rock wool plugs, and vermiculite, etc. The compost used is brick pieces, stone pieces, and coke mixed in equal proportions (1:1:1). Different media for epiphytic orchids are osmunda fibre, red wood fibre, perlite, coarse peat moss, gravel, tile pieces, brick pieces, charcoal, coconut husk, etc. Media should be a good supporter for the orchid plants rather than supplying only nutrients.

Whole coconut husk, after removing the coconut, can be utilised for growing orchids. They can be kept hanging from the roof. Terrestrial orchids can be grown on sphagnum moss, tree fern fibre, perlite, charcoal, loamy soil, leaf mould, rice husk, river sand, saw dust, etc. An ideal medium should preferably be inert, resistant to organic decomposition as well as porous to ensure adequate aeration and drainage. It should be less costly and easily available. A mixture of different components mentioned above can also be used.

Fig. 2.28: Potting mixture

Planting and Aftercare

Shallow planting should be done in the containers and support should be given using bamboo sticks or any such pegs.

Watering

The maintenance of adequate humidity is highly essential for successful orchid growing, as the plant absorbs moisture from the atmosphere. Excess water is more damaging than less water. Over watering leads to disease infestation and also affects aeration, hence it should be avoided. If the medium contains coconut husk, tree fern fibre or sphagnum moss, less frequent watering is needed. During the summer months frequent watering is needed. Media should not be too wet or too dry. Mist irrigation or fogger method is ideal to maintain humidity in the atmosphere. The quality of water is also important. High salt content in water adversely affects growth, hence ideal pH level of water should be 5.5–6.5.

Shade regulation

Basically orchids are shade loving plants, hence partial shade should be provided for the plants by installing shade net (50–75 per cent) inside the greenhouse.

Feeding of orchids

Orchids require large quantities of nutrients for their growth and development. Since, the media contains little or negligible quantities of nutrients, their regular application becomes essential. The quality and frequency of application depends on the stage of development, season and type of orchid. Usually, foliar application is more effective. The demand for nitrogen is more during the initial period of growth or vegetative phase. Phosphorus and potassium are required for initiation of flowering and production of a larger number of good-sized flowers. A fertiliser combination containing NPK @ 3:1:1 during the vegetative phase and the same at the proportion of 1:2:2 during the flowering phase is an ideal nutrition for orchids. This can be applied at 0.2 per cent level twice a week. The dose can be changed

according to the plant health, season, stage of growth, etc. Usually, the fertiliser requirement is low during the rainy season.

Apart from the inorganic fertilisers, organic manures like cow dung, neem cake, groundnut cake, etc., are to be applied once in a month. It is better to use fermented cakes (groundnut, sunflower, safflower, etc.) by soaking them in water (1 kg in 10 litres of water) for three to four days and diluting 10–15 times by adding water and applying to the plants. While spraying, care should be taken to avoid the fertilisers from falling on the flowers and inorganic fertiliser application should be stopped three to four days prior to flower harvest. Some essential elements like magnesium, iron, zinc, manganese, etc., also have their roles in the growth and flowering, hence they should be applied once in a month. Growth regulator application, especially BA and GA @ 50–100 ppm also gives good results for enhancing growth and flowering in orchids.

Repotting

Frequent repotting is not required in orchids. When the medium is broken into very small pieces, leading to poor aeration and drainage, then repotting should be done. Also, when the plants are overgrown, then repotting is needed. The original media components can be reused after treating with a fungicide if they are in good condition. Repotted plants should be kept in shade for some days and manuring should be commenced only after some time.

Harvest

In general, orchid flowers do not mature until three to four days after they open. Hence, flower spikes are harvested when 75 per cent of the flowers are open and the remaining buds are still unopened along with a long stem. Harvesting should preferably be done in the evening and the harvesting tools should be sterilised. Immediately after harvesting, the lower 0.75 cm stalk should be cut off. Keep the bases of the flowers in a tube containing fresh water with floral preservative.

Post-harvest Handling

Grading

Grading should be done based on the spike length of the flower, number of flowers per stem and size and arrangement of flowers on the spike.

Floral preservatives

Though long lasting, using floral preservatives on orchids enhances their quality and extends their vase life. Floral preservatives can be applied in two ways.

(1) Pulsing solution
(2) Holding or vase solution

Pulsing solution

Pulsing refers to short duration, pre-shipment or pre-storage treatment of orchids. The effect lasts throughout the entire vase life of the flowers. The main component of pulsing solution is sugar (sucrose). Since pulsing involves short duration treatment, relatively higher level of sucrose is used.

8-Hydroxy quinoline citrate (8-HQC) 500 ppm + sucrose 5% for 12 hrs

Holding or vase solution

The level of sucrose in vase solutions is, therefore, also kept very low (0.5–2 per cent), due to long duration for which flowers are kept in the following solution:

Silver nitrate ($AgNO_3$) 25 ppm + 8-HQC 400 ppm + sucrose 2%

Packaging

Stem bases should be tied in water soaked cotton wads and flowers wrapped in polyethylene wrapper (50 gauge). Then the flowers should be packed in corrugated telescopic boxes. Cymbidium spikes are often packed 100 flowers in a box.

Storage

Tropical and subtropical orchids, for example, Dendrobium can be stored at more than 10°C for two weeks. Temperate orchids such as Cymbidium can be stored at –0.5 to 4°C.

Yield

8–10 spikes/plant/year

Pest and Diseases

Common pests of orchids include aphids, mealy bugs, scales, slugs, snails, spider mites and diseases like black rot, leaf spot, petal blight, virus, etc.

Practical Exercise

Activity 1

Visit a nearby orchid growing greenhouse and make a herbarium of different orchids grown there.

Material required: Writing material and herbarium file

Procedure

- Identify an orchid cultivating farmer.
- Collect leaves, flowers and other parts of plants, press dry and prepare a herbarium.

Activity 2

Note down the observations on common cultural operations carried by a farmer.

Material required: Writing material and practical file

Procedure

Note down the following observations:

- Number of plants per sq.m
- Name of variety
- Colour of flowers
- How they harvest the flowers
- Expected yield

Check Your Progress

A. Fill in the blanks

1. The optimum humidity for most of the orchids is around _____ per cent.
2. Commercial method of orchid propagation is _____.
3. Flower spikes of orchid crops are harvested when _____ of the flowers are open.
4. The temperature requirement for warm orchids is _____ and _____ during the day and night, respectively.

B. Multiple choice questions

1. Containers used for growing orchids are _____.
   (a) pots
   (b) baskets
   (c) coconut husk
   (d) all of these
2. Potting media for orchid should provide _____.
   (a) aeration
   (b) drainage
   (c) nutrition
   (d) all of these
3. Ideal pH level of water should be _____.
   (a) 4.5–5.5
   (b) 5.5–6.5
   (c) 6.5–7.5
   (d) 7.5–8.5
4. Orchids are _____.
   (a) shade loving plants
   (b) shade hating plants
   (c) both
   (d) none

C. Subjective questions

1. Why should we go for shade regulation in orchid cultivation?

   _____

   _____

   _____

2. Which are the common pests and diseases of orchids?

   _____

   _____

   _____

3. What are the important uses of orchids?

   _____

   _____

   _____

D. Match the columns

A	B
1. Sucrose	(a) Propagation
2. Coconut husk	(b) Disease
3. Back bulbs	(c) Pulsing
4. Black rot	(d) Growing media

Session 5: Protected Cultivation and Package of Practices for Lilium

The genus lilium (*Lilium michiganense*) is a herbaceous, bulbous flowering plant belonging to the family Liliaceae. Lilies are one of the most beautiful and precious cut flowers, highly valued for their beauty all over the world.

Fig. 2.29: Greenhouse cultivation of lilium

Different Factors for Lilium Cultivation

Irrigation water quality

Lilium requires good quality irrigation water having EC 0.5–1 dS/m. The maximum acceptable free chlorine level in irrigation water used for greenhouse irrigation should be 2 m mol/L.

EC — Electrical Conductivity

dS/m — decisiemens/m

Temperature

They grow mostly in cold and humid areas, mainly in deep forests naturally. They require low temperature in the range of 12–13°C for the development of roots. During the cultivation stage, the optimum daily temperature requirement is between 15 to 22°C.

Humidity

For optimum growth of lilies, relative humidity inside the greenhouse should be 80–85 per cent.

Light intensity

Lilium plants grow optimally under high light intensity. A dimly lit greenhouse can affect the lilium crop

adversely. Therefore, opening and closing of silver net inside the greenhouse is more important in case of lilium crop, depending on the time of year, the location of production, sunlight in the greenhouse and the variety. At times additional lighting may even be essential because insufficient light results in inadequate growth and bud drop.

CO_2

CO_2 higher than normal in microclimate around the plants ranging from 800–1200 ppm induces their good development. High CO_2 level during early hours of the day is preferred, therefore, closing the side curtains of the greenhouse in the evening and opening early in the morning around sunrise helps in the growth of the plants.

Shading net

Lilium requires a good amount of light for optimum growth and quality of flowers, but intense radiation is best avoided to prevent leaf scorching and poor flower quality and freshness. In such a situation, shade nets of 30–50 per cent capacity come in handy to reduce light intensity depending upon the region and season. It is better to devise a chain and pulley system to spread or roll back the shade net as and when demand and situation arises.

Ventilation

Since greenhouses have a tendency to heat up, especially during intense solar radiation during summer, it is always advisable to devise mechanisms and operations to lower the temperature to prevent the crop from dehydration. It is impossible to get quality lilium flowers under moisture stress. Greenhouses should have proper ventilation at the top and the sides preferably by a forced air ventilation mechanism. The side curtains should be opened by 9–10 am. The height of the greenhouse, top and side ventilation is very crucial. The side and top ventilation depends on the design and size of the greenhouse.

Bedding Media

Soil

Soil should be sterilised and should possess good aeration. For Asiatics and longiflorum varieties, the pH should be 6–7; for Oriental hybrids, a pH of 5.5–6.5 is preferred. Chlorine in the soil should not exceed 1.5 m mol/L.

Bed composition

Soil should be prepared thoroughly because raised beds cannot be shifted, puddled or mixed with inputs as and when desired during planting. A ratio of soil, FYM, sand (6:3:1) with a moderate amount of rice husk and a little river sand should be added for preparing the beds.

Bed preparation

Beds should be approximately 100 cm in width and 25–30 cm in height. There should be a 50 cm path between the two beds.

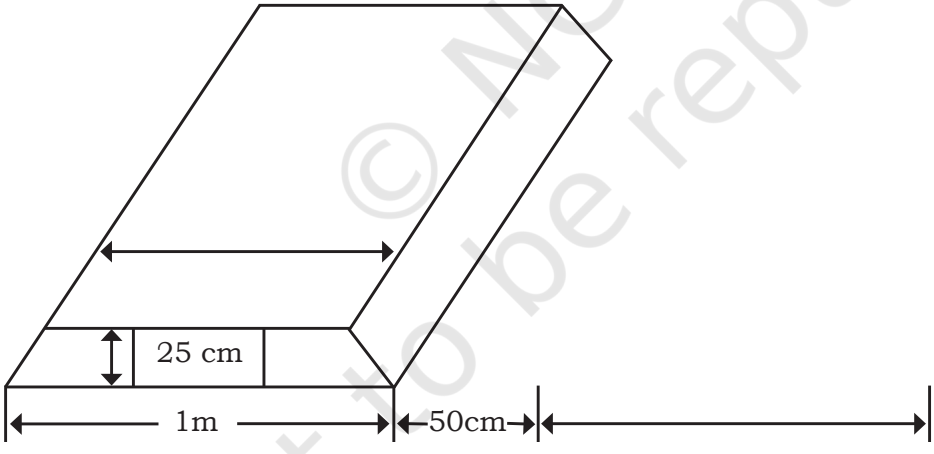


Fig. 2.30: Layout for bed preparation

Mulching

Silver black mulching is ideal for lilium. The silver side on the top repels the sucking pests while the black side helps in discouraging the growth of weeds. Therefore, mulching helps in clean cultivation and avoidance of the use of weedicides.

Pollyanna

Fig. 2.31: Asiatic lilium varieties

Varieties and Commercial Types

Asiatic hybrids *(L. x. elegans)*

Asiatic hybrids are derived from Central and East Asian species. The varieties are Brunello, Elite, Latoya, Tresor, and Navona. Flowers of hybrid varieties are medium in size, upright and outward facing, mostly unscented.

Oriental hybrids

These are hybrids of *L.auratum* and *L.speciosum*. They have fragrance and the flowers tend to be outward facing. The flowers may be quite large and the plants tend to be tall. The varieties are Acapulco, Sorbonne, and Simplon.

LA hybrids

These are a cross between Longiflorum lilies and Asiatic hybrids. Warmer flower colours are found in the Asiatic traits. The upright calyx causes the flower heads to face upward. These have a longer vase life. The varieties are Serrada, Courier, Menorca, and Brindisi.

Plant Spacing and Planting Depth

The bulbs can be planted on a 1 m wide bed in six rows with spacing of 15 × 15 cm for small bulbs of 8–12 cm diameter and 16 × 18 cm for bigger bulbs (12–14 cm diameter). With this spacing, about 25–40 bulbs per m^2 greenhouse area can be accommodated. The planting depth of bulbous

(a) Cv. Detroit

(b) Cv. Brunello

(c) Cv. Pollyanna

(d) Cv. Brindisii (LA) *(e) Cv. Lateya (LA)* *(f) Cv. Elite*

Fig. 2.32 (a, b, c, d, e and f) : Lilium cultivar

flowers is often very crucial and alters the sprouting, uniformity, and the quality of flowers. The ideal planting depth is 6 inches. Planting depth varies according to the size of the bulb. In general, bulbs are planted at a depth of three times more than the diameter of the bulb. After planting of the bulb and irrigation, the soil declines about an inch. The height of the bulb is approximately one inch, which leaves four inches of soil on top of the bulb. This is sufficient soil for the roots to develop.

Fig. 2.33: Asiatic lilium propagation

Irrigation

The soil has to be thoroughly moistened. Planting can be done only when the moisture is ideal because the root initiation has to start from the planted bulbs as soon as possible. Moisten the soil a few days before planting to

enable rooting to start immediately after planting. After about 3–4 weeks of planting, start regular irrigation with about 3 to 4 L/m^2/day. During other seasons, 2 to 3 L/m^2/day is the required quantity of water to be given.

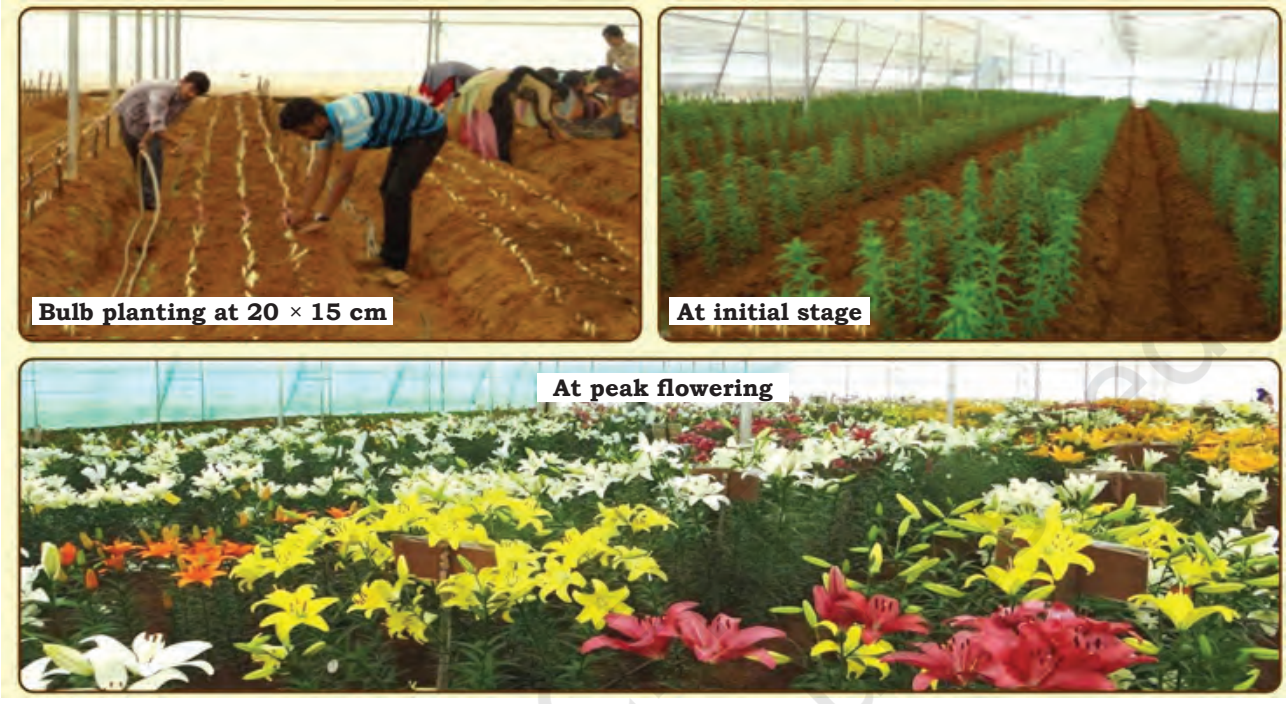


Fig. 2.34: Growing of Asiatic lilium

Fig. 2.35: Drip irrigation in lilium

Fertigation

Bulbous crops harbour most of the nutrients required for plant growth. Lilium is also a bulbous crop, but it is very sensitive to salt, therefore, avoid extra dosage as it can worsen salt deposition. Due to the presence of food

reserves in the bulb, hardly any nutrients are required in the initial one month from an external source. Besides, root development at the initial stages is always more important, so phosphorus supply should be rich for the first three months of the crop. The following schedule of basal dosages or through fertigation should be maintained.

- First three months: 12:61:00 @ 2 kg/100 sqm
- Three weeks after planting: Calcium nitrate @ 1 kg/m^2
- Six weeks after planting: Potassium nitrate @ 1 kg/m^2

The following fertigation scheduling through drip irrigation should be maintained in the lilium growing greenhouses. Mixed micronutrient formulations (25–50 ppm) should also be given fortnightly.

Table 2.5: Month-wise fertigation schedule for lilium under protected cultivation (1000m^2)

Particulars	Month-wise application of water soluble fertilisers (kg/1000m^2)												
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Irrigation nos.	4	6	8	6	8	8	6	6	6	8	6	4	76
Urea phosphate	1.3	1.7	2.7	2.3	2.6	2.7	1.7	1.5	1.8	2.1	2.2	1.4	24.0
Urea	1.5	1.7	2.7	2.3	2.6	2.7	1.7	1.5	1.8	2.1	2.2	1.4	24.0
SOP	1.8	2.5	3.7	3.4	3.8	3.9	2.5	2.2	2.6	3.1	3.1	2.0	34.6

Source: Hasan et al. 2010. *Fertigation Scheduling for Horticultural Crops*. Technical Bulletin. TB-ICN: 80/2010, p. 44, I.A.R.I., New Delhi.

Forcing in Lily Flower Cultivation

Forcing is a way of encouraging a bulb to bloom in an unusual time of the year. Lilium bulbs often require cold treatment of 2–4°C for 1–2 months for Asiatic and Oriental hybrids. This is why 'frozen-in' lily bulbs kept in a refrigerator at 8–10°C for pre-cooling can be used for off season flowering.

Harvesting and Post-harvest Treatment for Flowers

Liliums should be harvested when the buds are fully formed and cutting should be done about 10 cm from the base. The colour of the flower must become apparent from the bud at the time of harvesting. Grading of stems should be done based on the bud size, quality, length,

and firmness of the stem. The basal foliage of the stem is removed and the stem sticks are then sleeved with cellophane or a soft plastic net. After this, the flowers are bunched together and stored at 2–3°C. The base of the stem is provided with a swab of water containing 2 per cent sucrose and 100 ppm GA_3 for preservation. Protection from infestation can be avoided by adding a few drops of preservative. Perforated boxes are used for shipment of flowers through a cold chain, preferably a refrigerated van.

Fig. 2.36: Packaging of lilium

Harvesting of Bulbs and Treatment

Irrigation frequency is reduced before harvesting because too much moisture in the bulbs could lead to their rotting. At the same time, the bulb scales should not dry out. After harvesting the flowers, the bulbs are retained in beds for four to five weeks till the stems have

dried out completely. Then the bulbs are lifted out and dried in the shade. After removing the dried stems carefully, the bulbs are treated with a fungicide, carbendazim @ 2–3 g/L of water and then dried in the shade. Physical damage to the bulbs must be avoided at all costs and should always be treated with fungicide and bactericide. Excessive drying must be avoided. The bulbs are then stored in sterilised cocopeat in crates in a shaded place and stored in cold storage at 2–3°C and then at –1°C for six weeks.

Fig. 2.37: Harvested bulb

Practical Exercise

Activity 1

Make a list of the varieties of lilium grown in your region.

Material required: Writing material

Procedure

- Note down the varieties and the colours available in the market.
- Note down the packing material.

Check Your Progress

A. Fill in the blanks

1. In general, bulbs of lilium are planted at a depth of _____ times more than the diameter of the bulb.
2. The optimum depth of planting a lilium bulb is _____.

3. Lilium (*Lilium michiganense*) belongs to the _____ family.
4. The ideal mulch for lilium is _____.

B. Multiple choice questions

1. Closing the side ventilation at night increases the concentration of _____ in naturally ventilated polyhouses.
   (a) O_2
   (b) CO_2
   (c) Both (a) and (b)
   (d) None of the above
2. Lilium flowers are stored at _____ temperature.
   (a) 8–10°C
   (b) 10–15°C
   (c) 4–6°C
   (d) 2–3°C
3. The fungicide used to treat bulbs is _____.
   (a) Carbendazim
   (b) Sulphur
   (c) Mancozeb
   (d) None of the above
4. For optimum growth of liliums, the relative humidity inside the greenhouse should be _____.
   (a) 65–70 per cent
   (b) 80–85 per cent
   (c) 85–90 per cent
   (d) 90–95 per cent

C. Subjective questions

1. Write about the bed composition and preparation for liliums.

   _____

   _____

   _____

2. Write a short note on fertigation in liliums.

   _____

   _____

   _____

D. Match the columns

A	B
1. Reduce the light intensity	(a) Chlorine
2. Three weeks after planting	(b) Calcium Nitrate
3. Six weeks after planting	(c) Shading net
4. Water treatment	(d) Potassium Nitrate