

Chapter 1

Present Scenario and Scope of Floriculture in Global Market

Objectives

After studying this chapter, students will be able to:

- know the importance of commercial floriculture
- know different components of commercial floriculture
- know opportunities and weaknesses in commercial floriculture for India
- start agribusiness in commercial floriculture

Introduction

Whenever you go to any market, you might have seen several types of fresh cut flowers, loose flowers, floral arrangements and its value added products displayed in florist shops. You must have attended special functions of dignitaries, where flowers are offered to welcome, greet and depart. In this chapter, you will study the commercial aspect of agriculture, which is like industry requiring high investment with high potential for profit per unit area in comparison to other areas of agriculture and farming.

What do you mean by Commercial Floriculture?

Commercial Floriculture is a branch of Horticulture which deals with commercial growing, marketing and arranging flowers and ornamental plants, which includes annuals, biennials and perennials viz., trees, shrubs, climbers and herbaceous perennials.

What is Hi-Tech Floriculture?

Hi-tech Floriculture is the technology, which is ultra modern, less environment dependent and capital intensive having improved productivity with quality produce.

What do you mean by Floriculturist and Florist?

A person involved in growing, improving and teaching ornamental horticulture is known as a Floriculturist, while a person dealing the business of cut flowers, cut greens, loose flowers and floral products is known as a Florist.

What are salient features of Commercial Floriculture?

In the present scenario flower cultivation has become an integral part of human civilization throughout the world. It is a common saying that a child is borne with flowers, grows with flowers and finally departs with flowers. In day to day activities flowers are used for various activities such as worshipping, religious/ social functions like birthday, wedding, anniversary, welcoming and departing dignitaries, etc. Flowers and ornamental plants have become an integral part of interior decoration of homes, offices, clubs, hotels, restaurants, banks, banquets halls, etc. Flowers have also become part of daily self adornment. Perfume extracted from flowers is used in confectionary, soaps and cosmetics. Flower products are used as source of food and also an additive in food, feed and sweets. Thus, arrive at a conclusion that in the present scenario flowers and mankind have become complimentary to one another.

What are main attributes of Commercial Floriculture?

- ❖ Generate ample employment opportunities
- ❖ Higher profit per unit area in comparison to other agricultural crops
- ❖ Wider choice of crops, species and cultivars make it easy to diversify in agriculture through commercial floriculture
- ❖ Higher potential for export of non-traditional items
- ❖ Beautification of indoor and outdoor places
- ❖ Amelioration of the fast deteriorating environment by combating pollution
- ❖ Providing profit, pleasure, passion and thrill to the persons engaged in flower cultivation
- ❖ Overall improvement of quality of life
- ❖ Development of a permanent sustainable agriculture system

Flowers v/s human feelings

- ❖ Departure (sweet pea)
- ❖ Love (rose, tulip, carnation)
- ❖ Luxury (stock)
- ❖ Message (iris)
- ❖ Presumption (snapdragon)
- ❖ Pride (amaryllis)
- ❖ Purity (lily)
- ❖ Regard (daffodil)
- ❖ Self-esteem (narcissus)
- ❖ Sorrow-jealousy (French marigold)

National Flowers:

- ❖ Carnation (Spain)
- ❖ Chrysanthemum (Japan)
- ❖ Corn flower (Germany)
- ❖ Daffodil (Wales)
- ❖ Lily (Italy)
- ❖ Lotus (India, Egypt)
- ❖ Narcissus (China)
- ❖ Rose (UK, USA, Iran, New Zealand)
- ❖ Tulip (the Netherlands)

What are different components of Commercial Floriculture?

- ❖ Bedding plant industry
- ❖ Florist trade
- ❖ Flower perfumery
- ❖ Landscape gardening
- ❖ Plant nursery
- ❖ Plant rental service
- ❖ Seeds and bulbs

What are main components of Florist trade?

- ❖ Dried, dyed, bleached, flowers and foliage
- ❖ Floral arrangements including bouquets and wreaths
- ❖ Fresh cut flowers and cut greens
- ❖ Loose flowers and garlands

Who are the users of Floricultural products?

- ❖ Amateur home gardeners
- ❖ Commercial flower growers
- ❖ Florist traders and exporters
- ❖ For planting in public parks and gardens
- ❖ Landscape architects, consultants and designers
- ❖ Professional gardeners

What are other associated components of Commercial Floriculture?

- ❖ Greenhouse construction material
- ❖ Potting media
- ❖ Pots and containers manufacturers
- ❖ Packaging material
- ❖ Transportation vehicles
- ❖ Cold storage
- ❖ Horticultural inputs
- ❖ Scientific apparatus, equipments and chemicals
- ❖ Flori-clinics
- ❖ Consultancy, extension and publicity

What is the latest status of Global Floriculture Industry?

Globally over 180 countries are involved in trade of Commercial Floriculture and it has developed at around 10 per cent during last decade. Globally, floriculture trade is being done under four main heads viz., cut flowers, live plants, cut foliage and bulbs.

Export of Floricultural commodities in the world

Commodity	Value (million US\$)	
	2010	2011
Cut flowers	7577.28	8591.95
Live plants	7402.72	8896.32
Cut foliage	1178.28	1318.71
Bulbs	1506.92	1853.59
Total	17665.21	20814.05

Source: UNCOMTRADE

Where does the largest flower market of the world is situated and what are its key features?

Largest international flower market is situated at Aalsmeer in the Netherlands. FloraHolland and Bloemenveiling Aalsmeer, two largest companies of the Netherlands have joined hand together w.e.f. 1st

January, 2008 and are working under the name of FloraHolland, the Netherlands. Total area in Aalsmeer is around one million square meters. The company has five auctions at Aalsmeer, Naaldwijk, Rijnsburg, Bleiswijk and Eelde. Over 20,000 varieties of flowers are auctioned daily. FloraHolland has over 5000 owned members. Daily about 8000 growers across the globe sent their flower material to this cooperative. FloraHolland has over 4000 employees. Total turnover of the company is over about 4.3 billion Euros annually. Each day over 32 million cut flowers and 2 million plants are sold through 40 clocks by FloraHolland.



Flora-Holland the largest flower auction at Aalsmeer in the Netherlands

Total turnover (Euro million) of FloraHolland during 2009 to 2012

Commodity	2009	2010	2011	2012
Cut flowers	2143	2330	2353	2420
Indoor plants	1384	1445	1467	1496
Outdoor plants	0334	355	338	365
Total	3861	4130	4158	4281

Source: www.floraholland.com

Top ten cut flowers sold (value wise) based on Dutch flowers auctions during 2011 and 2012

2011		2012	
Flower	Value (m Euro)	Flower	Value (m Euro)
Rose	761	Rose	768
Chrysanthemum (Spray)	267	Chrysanthemum (Spray)	294
Tulip	223	Tulip	227
Lilium	146	Lilium	137
Gerbera	124	Gerbera	134
Chrysanthemum (disbud)	68	Chrysanthemum (disbud)	74
Cymbidium	59	Cymbidium	60
Freesia	47	Freesia	50
Lisianthus/ Eustoma	41	Lisianthus/ Eustoma	47
Amaryllis/ Hippeastrum	36	Hydrangea	35

Top ten live/pot plants sold (value wise) based on Dutch flowers auctions during 2011 and 2012

2011		2012	
Live/ pot plant	Value (m Euros)	Live/ pot plant	Value (m Euros)
Phalaenopsis	415	Phalaenopsis	448
Kalanchoe	54	Kalanchoe	55
Anthurium	52	Anthurium	52
Rose	45	Rose	48
Chrysanthemum	31	Chrysanthemum	33
Dracaena	30	Hyacinth	28
Ficus	28	Ficus	28
Hyacinth	28	Dracaena	28
Hydrangea	27	Hydrangea	28
Spathiphyllum	23	Mixed plants	27

Top ten outdoor plants sold (value wise) based on Dutch flowers auctions during 2011 and 2012

2011		2012	
Outdoor plant	Value (m Euros)	Outdoor plant	Value (m Euros)
Buxus/ Common box	18	Hydrangea	20
Plergonium/ Geranium	18	Buxus/ Common box	19
Viola/ Pansy	17	Viola/ Pansy	18
Hydrangea	14	Plergonium/ Geranium	17
Lavender	11	Lavender	12
Osteospermum/ Cape daisy	11	Osteospermum/Cape daisy	12
Hellebore	8	Hellebore	9
Petunia	7	Petunia	9
Clematis	6	Rose	7
Fuchsia	6	Decoration	7

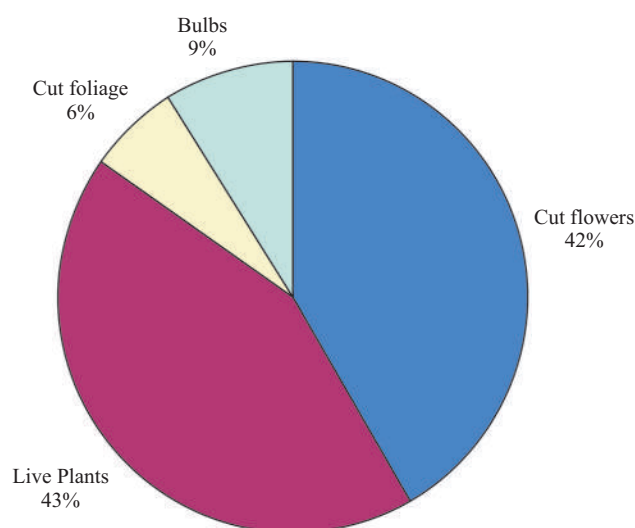
Do you know?

China has maximum acreage under floriculture (over 8.34 lakh ha) followed by India (2.53 lakh ha) in the world. But, contribution of China in global floriculture trade is just 1%, while that of India is below 0.4%.

Floricultural commodities percentage export in the world

Commodity	%age share		
	2009	2010	2011
Cut flowers	42	43	42
Live plants	42	42	43
Cut foliage	7	7	6
Bulbs	9	8	9

Contribution of different components in total export of floricultural products during 2011 in the world



Leading exporters of various floricultural products in the world

Commodity	Year	Leading countries
Total floricultural products	2011	Netherlands (53%) Colombia (6%), Germany (5%), Italy, (4.5%) and Belgium (4.4%)
	2010	Netherlands (48%) Colombia (7%), Belgium (5%), Italy, (5%) and Germany (4%)
Cut flowers	2011	Netherlands (58%), Colombia (15%), Ecuador (8%), Belgium (3%) and Ethiopia (2%)
	2010	Netherlands (50%), Colombia (16%), Ecuador (8%), Kenya (5%) and Belgium (4%)

Live plants	2011	Netherlands (50%), Germany (9%), Italy (8%), Belgium (6%) and Denmark (5%)
	2010	Netherlands (45%), Italy (8%), Germany (8%), Belgium (7%) and Denmark (5%)
Cut foliage	2011	Netherlands (23%), Denmark (14%), USA (9%), Italy (8%) and Belgium (7%)
	2010	Netherlands (19%), Denmark (13%), USA (10%), Italy (9%) and Belgium (4%)
Bulbs	2011	Netherlands (77%), Germany (4%), Chile (2%), Belgium (2%), and New Zealand (1.5%)
	2010	Netherlands (75%), Germany (5%), Belgium (2%), Chile (2%) and USA (2%)

Leading importers of various floricultural products in the world

Commodity	Year	Leading countries
Total floricultural products	2011	Germany (19%) followed by USA (9%), the Netherlands (9%), UK (8.4%) and France (7%)
	2010	Germany (17%) followed by USA (10%), UK (9%), France (9%) and the Netherlands (9%)
Cut flowers	2011	Germany (14%), USA (12.5%), UK (12%), Nigeria (10%), and the Netherlands (9%)
	2010	Germany (15%), USA (14.5%), UK (13%), the Netherlands (9%) and Russia (8%)
Live plants	2011	Germany (23%), France (10%), the Netherlands (9%) UK (6%) and USA (5%)
	2010	Germany (21%), France (12%), the Netherlands (8%) UK (6%) and USA (6%)
Cut foliage	2011	Netherlands (19%), Germany (17%), USA (11%), Japan (7%) and Belgium (6%)
	2010	Netherlands (18%), Germany (14%), USA (11%), Belgium (8%) and France (7%)
Bulbs	2011	USA (11%), Germany (10%), UK (9%), Switzerland (8%) and France (6%)
	2010	USA (12%), Germany (9%), France (8%), Switzerland (7%) and UK (7%)

- Highest per capita consumption of cut flowers are Switzerland (77 Euros), Norway (63), the Netherlands (56), UK (49) and Denmark (48) as reported in “International Statistics of Flowers and Plants 2009”.
- Highest per capita consumption of live plants are Norway (60 Euros), Germany (51), Sweden (47), Denmark (46) and Switzerland (43) as reported in “International Statistics of Flowers and Plants 2009”.

- Germany is the biggest market of floricultural products followed by USA, UK, the Netherlands and France.
- During 2011, total business of dried ornamentals was about 775 million US\$ (dried flowers: 535 million US\$ and dried foliage: 241 million US\$).
- Bulgaria is the largest producer of perfumery- products.
- In United Arab Emirates (UAE) the Dubai Flower Centre has opened in 2005 with the floor of about 3500 square meter for handling about 20 000 ton flowers.
- Distiller and Beverage manufacturer Suntory Ltd. of Japan has developed the world's **first blue roses** in association with Australian firm Florigene Ltd. And it was released on 1- July, 2004 as reported in Japan Online. Suntory officials said researchers extracted the gene that produces blue pigment in pansies and activated it inside the red roses. The gene of the enzyme that produces the blue pigment, delphinidin, is not found in rose petals to begin with. Thanks to biotechnology, the petals of Suntory's blue roses contain nearly 100 percent of the blue pigment. Suntory and Florigene, which is 98.5 percent Suntory-owned, bred a blue carnation using the same basic technology in 1995. The carnations were marketed in Japan, North America and Australia under the brand **Moon-dust**.

Top 10 Flower Auctions around the world in 2012

Name	Country
Flora-Holland	the Netherlands
Landgard	Germany
Ota Floriculture Auction	Japan
The Flower Auction Japan	Japan
Plantion	the Netherlands
Veiling Holambra	Brazil
SICA aux	France
Taipei Flower Auction	Taiwan
UFGCA	Canada
Multiflora	South Africa

- At whole sale level total value of flower seeds in the world is 300-350 million US\$.
- In Dutch market the top five genera of bulbous plants are *Tulipa*, *Lilium*, *Freesia*, *Alstroemeria* and *Iris*.
- Globally around 900 million plants are produced through micro-propagation for which the Netherlands is the largest market.

Do you know?

Lotus is national flower of India as well as Egypt

Indian Floriculture Industry:

Features of Commercial Floriculture in India:

- India is endowed with diverse agro-climatic conditions congenial for growing of a variety of flower crops throughout the year
- Fertile soil
- Abundant water and sunlight
- Readily available low cost labour
- Liberalized Seed and EXIM policy
- Adequate support from financial institutions
- Increase in per capita income specially the disposable income
- Change in rural-urban population ratio
- Higher population growth rate in cities
- Depletion of ozone layer is resulting in climate change and environmental pollution
- Development of hotel and tourism industry
- Use of flowers is being considered as an important parameter for high social values
- National Registration Center for Roses is situated at IARI New Delhi.
- International Registration Authority for Bougainvillea is situated at IARI New Delhi.
- Indian share in international flower trade is below 0.4 per cent and Indian dried ornamentals export has crossed 10, 000 ton's mark. Indian dried ornamentals are mainly exported to USA, UK, Israel, Japan, Hong Kong, Singapore and west European countries. Important dried ornamentals material exported includes lotus pods (10 million/month), camellia, dahlia, bell cups, marigold, jute flowers, wood rose, wild lilies and wild plant material.

Export of different floricultural products from India

Year	Export Value (Rs. Crores)
1999-00	105.2
2000-01	123.1
2001-02	115.4
2002-03	165.9
2003-04	249.6
2004-05	211.0
2005-06	304.7
2006-07	649.8
2007-08	340.3
2008-09	368.8
2009-10	294.5
2010-11	286.4
2011-12*	365.3

*Provisional

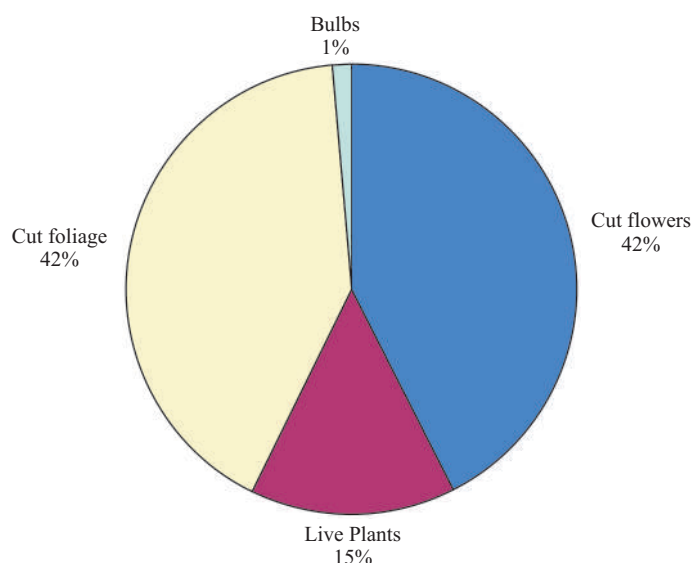
Source: APEDA, New Delhi

Export of various floricultural products from India during 2011-12

Commodity	Value (Rs. Crores)
Dried ornamentals	282.00
Rose cut flowers	21.79
Carnations	0.43
Chrysanthemums	0.01
Other cut flowers	3.08
Rose plants	8.05
Tissue culture plants	37.75
Rhododendrons/ Azaleas	0
Flowering/live plants	1.26
Cut foliage/ mosses	0
Unrooted cuttings	0.50
Bulbs	2.50
Others	4.48
Total	365.3

- For the last over one decade, out of total export about 60 per cent share is from dried flowers and plants.
- Total trade of flowers in India has been estimated around Rs. 1000 crores per annum.
- First All India Coordinated Floriculture Improvement Project was started in 1971 with its head quarter at IARI New Delhi, which has 15 funded, four ICAR institution's and two volunteer centers covering 17 states in India. Under this project research on twelve crops viz., Rose, Gladiolus, Gerbera, Carnation, Chrysanthemum, Orchids, Anthurium, Tuberose, Lilium, Alstroemeria, Tulip and daffodils is being carried out through 64 research projects. During XI five- year plan Rs. 17.22 crores has been sanctioned in addition to Rs. 2.87 crores share from state governments, thus making Rs. 20.09 crores for Floriculture R&D in the country.
- During 11th five-year plan All India Coordinated Floriculture Improvement Project has been elevated to Directorate on Floriculture Project with its Headquarter at IARI, Pusa, New Delhi.
- During the X five-year plan ICAR has proposed a huge project on quality seed production of horticultural crops including flower crops.
- During VIII five-year plan National Research Center for Orchids was established at Gangtok, Sikkim and Eleven Model Floriculture Centers have been set up in the country.
- Total acreage under floriculture in India has reached from 53,000 ha in 1993-94 to 1.06 lakh ha during 2001-02, 1.66 lakh ha during 2007-08, about 1.83 lakh ha during 2009-10, 1.91 lakh ha during 2010-11 and 2.53 lakh ha during 2011-12..
- The total production of loose flowers has reached 16.5 lakh MT and of cut flowers 7.51 billion during 2011-12.

Contribution of different components in total export of floricultural products from India during 2011-12



Area and production of Flower crops in India

Year	Area (lakh ha)	Loose fls**	Cut fls***
2011-12*	2.53	16.5	7.51
2010-11	1.91	10.3	6.90
2009-10	1.83	10.2	6.67
2008-09	1.67	9.87	4.79
2007-08	1.66	8.7	4.36
2006-07	1.45	7.8	3.71
2005-06	1.30	6.6	2.92

*Source- NHB **Loose flowers: lakh Metric Tonnes ***Cut flowers: Billion Numbers

Leading states in Flower acreage (thousand ha) in India

Year	Area (lakh ha)	Loose fls**	Cut fls***
State	2009-10	2010-11	2011-12
Tamil Nadu	32.0 (I)	32.0 (I)	32.3 (II)
Karnataka	27.0(II)	27.0 (II)	29.2 (III)
West Bengal	21.9 (III)	23.1 (III)	23.9 (IV)
Andhra Pradesh	21.4 (IV)	21.8 IV)	64.2 (I)
Maharashtra	17.5 (V)	17.5 (V)	18.9 (V)
Total	182.9	190.9	253.65



Largest flower market in India at Gajipur, Delhi

Area and production of flower crops in India during 2011-12

State	Area '000 ha'	Loose fls '000MT'	Cut flowers 'Lakh no.'
Andhra Pradesh	64.2	389.0	7099.4
Tamil Nadu	32.3	332.8	—
Karnataka	29.2	211.5	10388
West Bengal	23.9	63.9	25042
Maharashtra	18.9	104.0	7914
Total	253.65	1651.6	75066

- Traditional flowers like Marigold, Jasmine, Rose, China aster, Chrysanthemum, Crossandra, Tuberose, etc. are grown in our country in 2/3rd area.
- Modern flowers like Rose, Carnation, Gladiolus, Chrysanthemum, Tuberose and Orchids are grown in 1/3rd area.
- In India total area under modern floriculture is about 700 ha, 70% of which is in greenhouses and 90% of this is under roses.
- The main production centres of modern flowers are at Bangalore, Pune, Nasik, Hyderabad, Chennai, Kalimpong, Delhi, Gurgaon, etc.

Points to Remember

- Floriculture is fast emerging venture and is considered as money spinning industry
- Global trade of all floricultural products has surpassed 20 billion US\$
- Netherlands is the largest exporter of all floricultural products followed by Colombia
- Largest International flower market is at Aalsmeer in the Netherlands having over 1.3 million square meters floor area
- Germany is the biggest market for floricultural products
- Maximum acreage under flower crops is now in China followed by India
- Rose is the leading cut flower and Phalaenopsis is the leading pot plant in the world
- Total area in India has crossed 2.5 lakh ha in 2012 and over 2/3rd is under traditional (loose) flowers
- Rose is being grown in about 90% greenhouses for export
- Over 60% export of total floricultural products is from dried ornamentals
- Directorate of Floriculture Research is at IARI Pusa, New Delhi
- National Registration Center for Roses is situated at IARI New Delhi.
- International Registration Authority for Bougainvillea is situated at IARI New Delhi

Activity

1. Search internet and make inventory of major flower auctions, flower markets, etc.
2. Make list of leading cut flowers, pot plants, and cut foliage plants being marketed in these flower auctions
3. Compare rates of these floricultural items across the globe in flower auctions

Check your progress

A. Multiple Choice Questions.

1. The largest producer of cut flowers in the world is
 - a. USA
 - b. Colombia
 - c. Israel
 - d. the Netherlands
2. Indian share in the global flower market is about
 - a. 5%
 - b. 2%
 - c. 10%
 - d. 0.4%
3. Total floricultural products trade in the world during 2011 was around billion US \$.
 - a. 10
 - b. 20
 - c. 35
 - d. 50
4. Biggest international flower market is located at
 - a. Dubai
 - b. Aalsmeer
 - c. London
 - d. Singapore

5. Colombia is second largest exporter of cut flowers and its share in international flower trade is about.....%
 - a. 5
 - b. 15
 - c. 25
 - d. 40
6. Highest per capita consumption of cut flowers is in
 - a. China
 - b. USA
 - c. Switzerland
 - d. Germany
7. Under flower crops total area in the world is about million hectares.
 - a. 0.25
 - b. 2.5
 - c. 10
 - d. 20
8. Trade of foliage plants in the world is about billion US \$.
 - a. 3
 - b. 9
 - c. 15
 - d. 20
9. Leading exporter of foliage plants in the world is
 - a. Germany
 - b. China
 - c. the Netherlands
 - d. Denmark
10. Biggest market for flower products of about 2 billion US \$ is in
 - a. USA
 - b. Dubai
 - c. Germany
 - d. Japan
11. Which of following is No. one cut flower in international cut flower market?
 - a. Rose
 - b. Gerbera
 - c. Chrysanthemum
 - d. Cymbidium
12. Global Floriculture industry is growing at a rate of per cent per annum.
 - a. 10
 - b. 20
 - c. 30
 - d. 40
13. Which of following is the leading foliage pot plant at the global level?
 - a. Rose
 - b. Dracaena
 - c. Cymbidium
 - d. Geranium
14. In cut foliage trade, which of the following is leading exporter?
 - a. USA
 - b. Italy
 - c. Costa Rica
 - d. the Netherlands
15. In Asia which of the following is largest exporter of flowers?
 - a. India
 - b. China
 - c. Korea
 - d. Japan
16. Maximum consumption of cut roses is during which of the following event?
 - a. Valentines day
 - b. Mother's day
 - c. Easter
 - d. X-mas day

29. Directorate on Floriculture Research in ICAR was started during

- a. 2010 b. 2005
- c. 2000 d. 1998

30. Which of the following person has made significant contribution in Floriculture even being a non-professional?

- a. MS Randhawa b. BPPal
- c. GS Randhawa d. KL Chadha

B. Match the following:

National Flower	Country
a. Rose	i. India
b. Tulip	ii. Spain
c. Lotus	iii. Japan
d. Carnation	iv. USA
e. Chrysanthemum	v. the Netherlands

C. Short answer/ Descriptive questions:

- Q.1 What do you mean by Commercial Floriculture and Hi-tech Floriculture?
- Q.2 Where is largest International flower market situated?
- Q.3 What are the major components of Global floriculture industry?
- Q.4 What are the main attributes of Commercial Floriculture?
- Q.5 What are the main features of Commercial Floriculture in India?
- Q.6 Enlist top five genera of bulbous plants.
- Q.7 What are the top ten cut flowers and live plants in the global flower market at Aalsmeer?

Chapter 2

Employment Avenues in Floriculture Sector

Objectives

After studying this chapter, students will be able to:

- understand the importance of floriculture for employment generation
- enlist & identify different institutions for training in floriculture
- enlist & explore various types of jobs opportunities available for floriculture

Introduction

Floriculture is fast emerging sector of horticulture for money spinning and employment generation. It is evident from the fact that acreage under flower crops has increased from below thirty thousand hectares in 1990 to over two lakh fifty thousand hectares in 2012. Different components of floriculture industry are given below:

A. Directly associated components of commercial floriculture:

- Florist trade:** Different types of cut flowers, cut greens, loose flower crops, dried ornamentals, floral arrangements like bouquets, wreaths, garlands, etc. are daily used in various social and religious functions.



Employment avenues in retailing of loose flowers in India

- ii. **Plant and bedding plant nursery:** This is another component of commercial floriculture and in every small or big town or suburbs, general or specialized plant nurseries are coming up and the demand for plants for interior, exterior decoration/ landscaping is increasing very fast. There are over fifty thousand ornamental plants nurseries in the country and alone in/around Kolkata, there are over three thousand ornamental/ bedding plants nurseries.
- iii. **Planting material production:** There is huge demand for quality and elite planting material of cut flowers, cut greens and loose flowers.
- iv. **Seed production:** In flower crops, in the recent years the demand for hybrids (F_1) has increased very fast in bedding plants, annuals and herbaceous perennials. There is unique demand for F_2 seeds in ornamentals annuals and perennials unlike any other sector of agriculture. Open pollinated formulae mixture seeds are also in demand, in additions to inbred and pure line seed varieties.
- v. **Flower perfumery:** The demand for quality natural perfume is increasing very fast throughout the world.
- vi. **Bonsai production:** In metropolitan cities the demand for dwarfed plants for interior decoration is increasing.
- vii. **Flori-clinics and consultancy services:** There is growing demand for cut flowers, loose flowers, pot plants and other floricultural products, thus flori-clinics and consultancy services are in demand for solution of various related problems.



Employment avenues through e-auctioning of flowers

A. Indirectly associated components of commercial floriculture:

- i. **Manufacturing Pots:** Different types of pots i.e. earthen, plastic, brass, glass or concrete are required to grow various types of ornamental plants. Thus, some person can be involved in producing these pots for earning their livelihood.
- ii. **Greenhouse material:** For quality flower production green houses have become an indispensable part of the floriculture industry. In the recent years the greenhouses have shown greater practical utility with higher returns to the growers and their demand is regularly increasing. Thus, some persons can earn their livelihood by involving in the business of greenhouse material.
- iii. **Packaging material:** For marketing of various floricultural products, good packaging is essential, as ill-packed material become inferior and fetches little or no price. Thus, for packaging good material be used and number of persons can be involved in preparing the packaging material like cartons of corrugated cardboard, wooden or plastic, bamboo baskets, etc.
- iv. **Transporting floricultural products:** For transporting the flower products from their place of production to the actual marketing, some persons can earn their livelihood and for avoiding the cruelty of middlemen the growers should make their own co-operatives and their representatives be involved in this marketing for ensuring higher profit to the growers.
- v. **Cold storage:** Flowers are most perishable commodity, thus these should be stored at the recommended temperature in the cold storage. The cold storage built at the production centres and whole sale markets will be of great utility. The persons can keep the flowers in cold storage on rent basis for earning their livelihood and higher returns to the growers.
- vi. **Flower preservatives:** Treatment of cut flowers and cut foliage before marketing and after taking them to homes by the consumer, different types of flower preservatives can enhance the longevity of flowers and foliage. Thus, some persons can be involved in this trade also.
- vii. **Horticultural inputs:** For growing quality flowers different types of inputs like soil-less growing media, fertilizers, fungicides, insecticides, implements, etc. are required by the growers. Thus, some persons can earn their livelihood by selling such types of horticultural inputs.

Different types of jobs opportunities in commercial floriculture:

- i. **Scientists/ Lecturers/ Teachers:** There is demand for scientists of Floriculture in ICAR, CSIR, BARC, DRDO, DBT and DST departments of the government and R&D establishments of multi-nationals companies. Floriculture is being taught at school level in some states, at graduate level in all state agricultural universities/ general universities having agriculture programmes at graduate, post graduate levels.

Do you know?

Directorate of Floriculture Research (ICAR) is looking after research on flower crops in the country through AICRP in Agricultural Universities.

- ii. **Managers/ Supervisors:** Managers/ Supervisors are employed to manage/ run the commercial cut flowers/ cut foliage/ loose flowers/ planting material production units of government/ public/ multinationals/ private organizations.
- iii. **Horticulture Extension/ Development Officers (HEO/ HDO):** The state governments in Department of Horticulture/ Floriculture are recruiting officers at entry level as HEO/ HDO.
- iv. **Horticulture/ Agriculture Officers:** NABARD, NHB, Ministry of Agriculture, APEDA, Food Corporation of India, National Seed Corporation, Nationalized and Regional Banks recruit officers having basic qualification of B. Sc. (Agriculture)/ B. Sc. (Horticulture).

Do you know?

Like any other Science graduate, B. Sc. (Agriculture)/ B. Sc. (Horticulture) degree students are eligible for competing in civil services (IAS, IPS, IFS, etc.), Indian Forest Services, CDS (Army, Navy, Air Force, ITBP, CRPF, etc.). They can also pursue higher studies in law, journalism, and mass communication.

- v. **Garden superintendents:** For properly managing government/ public/ private gardens superintendents are employed.
- vi. **Technical assistants and technicians:** For assisting scientists/ teachers in government/ public/ multinational/ private organizations in teaching/ R&D programmes technical assistants/ technicians are in demand.
- vii. **Landscape designers/ architects:** There is lot of demand for designing public/ private gardens and landscape designers/ architects are earning respectable livelihood.
- viii. **Gardeners:** For properly maintaining government/ public/ private gardens gardeners are employed.

Do you know?

Total staff of about 150 employees is maintaining Mughal garden at Rashtrapati Bhavan, New Delhi.

- ix. **Florist shops:** There is regular demand for cut flowers/ cut greens/ loose flower crops, dried ornamentals, floral arrangements like bouquets, wreaths, garlands, etc. are daily used in various social and religious functions, thus paved way for self employment.
- x. **Interior decorators:** Several government/ public/ private 3 to 5 star hotels are employing interior decorators.
- xi. **Cold storage owner/ operator:** Flowers are the most perishable horticultural commodity and to enhance their longevity, cold storage units play important role, thus there is potential for employment in this sector for floriculture personnel.
- xii. **Transportation owner/ personnel:** For transporting different types of floricultural products transportation through air, sea, land (bus/ truck/ tempo/ auto rickshaw/ bicycle, etc.) routes to the destination, there are avenues for ample employment.
- xiii. **Marketing manager/ consultant:** Marketing of floricultural products in whole sale/ retail markets manually/ on-line/ e-commerce there are enormous opportunity for employment.

Do you know?

In developing and marketing of various dried floral craft items thousands of workers mainly women are employed by multinational companies engaged in export in Tuticorin district of Tamil Nadu and Ramesh Flowers Limited is the major company exporting dried ornamentals from India.

Institutions for getting specialized training in Floriculture:

- i. **B. Sc. (Agriculture/ Horticulture):** All State/ Central Agricultural Universities/ General Universities with Agriculture Faculty/ Private Agriculture Colleges in the country are offering Floriculture courses at graduate level.

- ii. **M. Sc. And Ph. D (Floriculture and Landscaping/ Horticulture with specialization in Floriculture):** Many State/ Central Agricultural Universities/ Deemed to be University (like IARI, New Delhi), a few general universities with Agriculture Faculty (like BHU, AMLU Aligarh, Agra University, etc.)/ and a few Private Agriculture Universities/ Colleges in the country are offering specialized post graduate courses in Floriculture. PAU Ludhiana was the first State Agricultural University to start specialized M. Sc. (Floriculture and Landscaping) and IARI New Delhi was the first Deemed to be University to start specialized Ph. D (Floriculture) programme in the country.
- iii. **Gardener's specialized training:** State Horticulture/ Floriculture Departments/ CPWD are offering specialized training to gardeners on Floriculture.
- iv. **Certificate courses on Floriculture:** One month to one year certificate courses on different aspects of floriculture, landscaping, gardening, interior decoration, etc. are being offered by many State/ Central Agricultural Universities/ General Universities with Agriculture faculty/ State Horticulture Departments/ Private Agriculture Universities/Colleges in the country through regular class room or distance education programmes.

Table 1: List of Agricultural Universities offering Floriculture courses in India

S. No.	Name and address of the University
1*	Acharya NG Ranga Agricultural University, Rajindra Nagar, Hyderabad-500030 (Andhra Pradesh)
2	Anand Agricultural University, Anand- 388 110 (Gujarat)
3*	Assam Agricultural University, Jorhat- 785 013 (Assam)
4*	Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia- 741 252 (West Bengal)
5*	Bihar Agricultural University, Sabour, Bhagalpur-813 210 (Bihar)
6*	Birsa Agricultural University, Kanke, Ranchi- 834 006 (Jharkhand)
7*	Central Agricultural University, Imphal- 795 004 (Manipur)
8*	Chandra Shekhar Azad University of Agriculture and Technology, Kanpur- 208 002 (Uttar Pradesh)
9*	Chaudhary Charan Singh Haryana Agricultural University, Hisar- 125 004 (Haryana)
10	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur-176 062 (Himachal Pradesh)
11*	Dr YSR Horticulture University, Venkataramanna Gudem, PO Box 7, Tadepalli Gudem, West Godavari District- 534 101 (Andhra Pradesh)
12	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri-415 712 (Maharashtra)
13*	Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Krishinagar, Akola- 444 104 (Maharashtra)
14*	Dr. Yaswant Singh Parmar University of Horticulture and Forestry, Nauni, Solan-173 230 (Himachal Pradesh)
15*	Govind Ballabh Pant University of Agriculture and Technology, Pantnagar- 263 145 (Uttarakhand)
16*	Indira Gandhi Krishi Vishwavidyalaya, Krishak Nagar, Raipur-492 012 (Chhatisgarh)
17*	Jawahar Lal Nehru Krishi Vishwavidyalaya, Jabalpur- 482 004 (Madhya Pradesh)

18	Junagarh Agricultural University, Junagarh- 362 001 (Gujarat)
19*	Kerala Agricultural University, Vellanikara, Trichur- 680 656 (Kerala)
20*	Maharana Partap University of Agriculture and Technology, Udaipur- 313 001 (Rajasthan)
21*	Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722 (Maharashtra)
22	Manayawar Shri Kanshi Ram Ji University of Agriculture and Technology, Banda- 210 001 (Uttar Pradesh)
23*	Marathwada Agricultural University, Parbhani-431 402 (Maharashtra)
24	Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad 224 229 (Uttar Pradesh)
25*	Navsari Agricultural University, Navsari- 396 450 (Gujarat)
26*	Orissa University of Agriculture and Technology, Bhubaneswar-751 003 (Orissa)
27*	Punjab Agricultural University, Ludhiana- 141 004 (Punjab)
28*	Rajendra Agricultural University, Pusa, Samastipur- 848 125 (Bihar)
29*	Rajmata Vijayaraje Scindhia Krishi Vishwa Vidyalaya, Gwalior- 474 002 (Madhya Pradesh)
30	Sardar Kishinagar- Dantiwada Agricultural University, Sardar Kishinagar, Banaskantha- 385 006 (Gujarat)
31*	Sardar Vallabh Bhai Patel University of Agriculture and Technology, Modipuram, Meerut- 250 150 (Uttar Pradesh)
32*	Sher-E-Kashmir University of Agriculture Sciences and Technology, Railway Road Jammu- 180 012 (J&K)
33*	Sher-E-Kashmir University of Agriculture Sciences and Technology, Shalimar, Srinagar- 191 121 (J&K)
34	Swami Keshwanand Rajasthan Agricultural University, Bikaner- 334 006 (Rajasthan)
35*	Tamil Nadu Agricultural University, Coimbatore- 641 003 (Tamil Nadu)
36*	University of Agricultural Sciences, Dharwad- 580 005 (Karnataka)
37*	University of Agricultural Sciences, GKVK, Bangalore- 560 065 (Karnataka)
38	University of Agricultural Sciences, Raichur-584 101 (Karnataka)
39	University of Agricultural Sciences, Shimoga (Karnataka)
40*	University of Horticultural Sciences, Navanagar, Bagalakot- 587 102 (Karnataka)
41*	Uttar Banga Krishi Vishwavidyalaya, Pundibari, Cooch Bihar-736 165 (West Bengal)
42*	Uttarakhand University of Horticulture and Forestry, Pauri Garhwal (Uttarakhand)

* M. Sc./ Ph. D (Floriculture or Horticulture with Floriculture)

Do you know?

Dr. Yaswant Singh Parmar University of Horticulture and Forestry, Nauni, Solan-173 230 (Himachal Pradesh) was the **first** Horticulture university not only in India but in Asia, established during 1985.

Central General Universities with Agricultural Faculty

S. No.	Name and address of the University
1	Aligarh Muslim University, Aligarh- 202 002 (Uttar Pradesh)
2*	Banaras Hindu University, Varanasi- 221 005 (Uttar Pradesh)
3	Visva Bharati, Sriniketan- 731 236 (West Bengal)
4	School of Agriculture Sciences and Rural Development, Nagaland University, Medziphema- 797 106 (Nagaland)

* M. Sc./ Ph. D (Floriculture or Horticulture with Floriculture)

Deemed-to-be Agricultural Universities

S. No.	Name and address of the University
1*	Indian Agricultural Research Institute, Pusa, New Delhi- 110 012
2*	Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad- 211 007 (Uttar Pradesh)

* M. Sc./ Ph. D (Floriculture or Horticulture with Floriculture)

Points to Remember

- Floriculture is fast emerging money spinning and employment generating industry.
- There are several employment avenues in production of cut flowers, loose flowers, dried ornamentals, cut greens, planting material, seed production, landscape gardening/ designing, ornamental plants nurseries, post harvesting handling, marketing, interior decoration etc. in government, public, multinational and private organizations.
- Several State Agricultural Universities, Central Universities with Agriculture faculty and Indian Agricultural Research Institute, New Delhi are engaged in producing trained graduates/ post graduates for handling floriculture related jobs.

Activity

1. Visit different ornamental plants nurseries, commercial flower production units and make list of jobs which are done related to floriculture.
2. Make list after web sites searching for qualification and type of jobs available in Floriculture post graduates.

Check your progress

A. Multiple Choice Questions.

1. Total area under flower crops in India is about lakh hectares
 - a. 1.0
 - b. 1.5
 - c. 2.5
 - d. 5.0
2. Indian Agricultural Research Institute is situated at
 - a. Shimla
 - b. Patna
 - c. New Delhi
 - d. Bangalore

3. Dr. Yaswant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh was the Horticulture university not only in India but in Asia.
 - a. First
 - b. Second
 - c. Third
 - d. Fourth
4. How many Horticulture Universities have been established in India till 2012?
 - a. One
 - b. Two
 - c. Three
 - d. Four
5. Dried ornamentals exporting units are mainly situated at
 - a. Delhi
 - b. Mumbai
 - c. Bhopal
 - d. Tuticorin

B. Match the following:

University name	Place
a. Uttarakhand University of Horticulture and Forestry	i. Nauni, Solan
b. Punjab Agricultural University	ii. Navanagar, Baglaket
c. Dr YSR Horticulture University	iii. Ludhiana
d. University of Horticultural Sciences	iv. Venkataramanna Gudem
e. Dr. Yaswant Singh Parmar University of Horticulture and Forestry	v. Pauri Garhwal

C. Short answer/ Descriptive questions:

- Q.1 What are the main components of Floriculture for employment generation?
- Q.2 Enlist Horticulture Universities teaching Floriculture in the country.
- Q.3 What types of jobs are offered to persons trained in Floriculture?
- Q.4 What are indirectly associated components of industry offering job avenues to floriculture trained persons?

Chapter 3

Outdoor Room Concept: Public Area, Private Area and Family Area

Objectives

After studying this chapter, students will be able to:

- understand the general concepts of home landscaping
- discuss the concepts of outdoor room
- elaborate the importance of need analysis and site analysis
- identify the areas for home landscaping viz., public area, private area and service area

Introduction:

The general assumption of home landscaping is that east or west home is the best as home ensures security, shelter, rest, peace and enjoyment. The man being a civilized animal prefers to live in association of nature and plants. The labour and pains taken in developing and maintaining home and home garden later on give immense pleasure, joy, thrill and satisfaction. Home garden is made for personnel interest to secure reasonable amount of comfort and convenience as the home and home gardens have sentimental and psychological attachments. Creating outdoor rooms is the newest concept in landscape design. Outdoor rooms are segments of the landscape designed to separate, to seclude, and to provide intimate areas for relaxation. Every room flows from one to the next. The average home can greatly benefit from this concept. Hence, home and home gardens are made on the basis of individual preferences and requirements.

General functions for home landscaping:

- Extending the living area of the home.
- Screening for privacy
- Protection from wind and sun.
- Absorb and filter summer sun.
- Reduces need for artificial air conditioning.
- Protect home building from heat robbing winds
- Reduces electricity heating and cooling bills.
- Proving outlet for overflowing energy of children.
- Minimizes noise.
- Ground covers prevent soil erosion.
- Absorb air pollutants.
- Provides shelter for wildlife especially birds.

- Source of food (fruits, vegetables, herbs, etc.)

What is need analysis?

It is the first stage of planning and is the compilation of an inventory of what should be accomplished by means of the landscaping and what the landscape will include, based on the preferences, requirements and life styles of the family members. To facilitate the need analysis, property area is divided into three areas as given below:

- Public area/ Approach area/ Front area
- Family area/ Private living area
- Service area/ Utility area

What is site analysis?

It is the second stage of planning in which an inventory of all existing property items including the architecture of the proposed home building, plot size, landscape, various view points, soil characteristics, climate, etc. are prepared. Both positive and negative points of the property area are mentioned for developing a successful and fruitful home landscape for fulfilling the family preferences and requirements.

Public area

Public area is that part of the home garden which can be viewable from the street or is seen by everyone one entering the home premises. Normally, this area conveys the initial impressions about the residents of the house. Poorly designed and ill-kept landscape gives impression of sloppiness, while sparsely planted or rigidly pruned leads to austerity and if walled as a courtyard, then it will projects the sense of seclusion. The main functions of public area are given below:

- Blending the house with its surroundings.
- Providing a pleasant and readily accessible approach to the house.
- Entertaining formal guests.

Key features in the public area:

- Entry gate
- Drive in road
- Parking
- Walk way
- Steps
- Entry court
- Front lawn
- Focal point
- Basic and foundation planting
- Frame work planting for the house
- Auxiliary planting
- Small private area

Do you know?

Like any indoor having three basic components of floor, walls and roof; in outdoor has also the same components as floor is made by lawn, walls by shrubbery/ hedge and roof by gazebo/ pergola/ canopy of tree.

- Terracing for changing levels
- Privacy from street
- Shade
- Night lighting

General guidelines for developing public area:

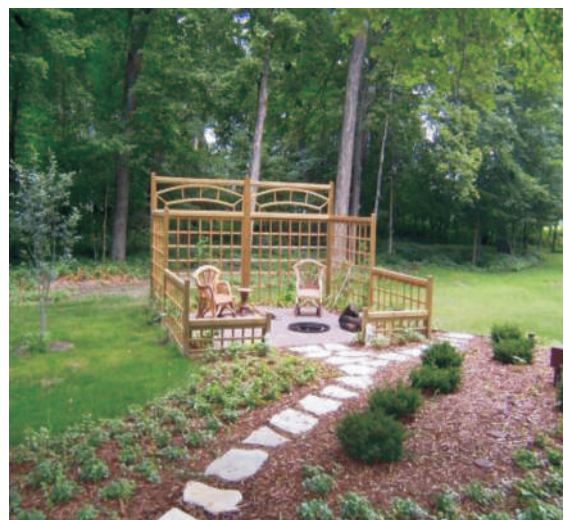
- Making the front lawn open and spacious in right proportion.
- Trying not to save every plant in this area.
- Avoiding use of garden ornaments.
- Confining shrubs to the borders, corners and near the foundation or base of the home building.
- Balancing (formally or informally) the planting with trees and shrubs about imaginary line through entrance of the house.
- Using only those plants which complement the architecture of home building to its best advantage.
- Using most appealing design.
- Avoiding use of tall hedges in this area.

Family or private area:

This is also known as outdoor living area. Outdoor rooms are intended to be an extension of the rooms inside your home. As rooms inside your house have different functions, each outdoor room has its own purpose and every outdoor is related to overall design of the home garden. A costly addition to your house is not necessary in outdoor rooms, but your property becomes a valuable new living space. Outdoor rooms provide the transition from the street to the interior of your house. The use of different elements and features in this area vary enormously with the preferences and requirements of the family and agro-climate of the area. Outdoor rooms can make the most out of any size property from the smallest to the largest.

Entry to a room can be created by the use of tall, thin plants to form a passageway or low plants highlighted with a few taller ones to form the entrance. Creating the layout for outdoor rooms takes the skill of a landscape designer. Just as an architect designs the house, a landscape designer plans the areas around the house. One of the best uses of a designer's skills is to create a master plan of the overall property. Once the master plan is prepared and reviewed by the customer, it can be implemented in stages, if desired. Generally, the main functions of this area are given below:

- Screening neighbors from viewing and hearing.
- Screening from wind and shading from sun.
- Providing comfort to the family members.
- Entertaining personnel guests.



Outdoor room

General guidelines for developing outdoor room:

- Enclosing this area to ensure privacy.
- Providing background for displaying flowering plants including annuals to their best advantage.
- Arranging flower beds, rockery, ornamental pool and other features around periphery.
- Allowing the centre to remain open, which give visual impression of more area and allowing better space utilization for social functions.
- Making this area easily accessible to other parts of the garden.
- Planting small trees for ensuring close intimacy between family members, space, home building, landscape and nature.

Main Features for the Outdoor Rooms

- **Hearth:** Wood burning fireplaces, gas fireplaces, fire-pits, chimneys, fire and fountain combinations.
- **Cooking:** Barbecue grills, wood-fired pizza ovens, refrigerators, dishwashers, sinks, cocktail bars, food preparation areas, etc.
- **Furniture:** Dining tables, couches, chairs, end tables, hammocks, chaise lounges, etc.
- **Water:** Swimming pools, spas, waterfalls, ponds, bird baths, etc.
- **Flooring:** Wood, brick, stone, slate, blocks, tiles, stamped concrete pavers, etc.
- **Shelters:** Greenhouses, pool houses, gazebos, pagodas, arches, sunrooms, awnings, umbrellas, etc.
- **Lighting:** Landscape lanterns, pathway lighting, up lighting, candles, etc.
- **Decks:** Natural woods, plywood, vinyl, fiberglass, recycled plastics, etc.
- **Heaters:** Free-standing or table-top patio heaters, heat pillars, heat blowers, etc.
- **Accessories:** Sound systems, art sculptures, portable gates, wood logs, fences, plants attracting birds, etc.



Outdoor room for relaxing



Outdoor room for morning/ evening tea

Basics outdoor room:

- Determine the ideal use of the outdoor space. Use a notepad to jot down ideas about how the space will be used in all of its applications, from entertaining to relaxing.
- Create a wish list of the family. The increase in the number of magazine and newspaper articles has created an abundance of information on outdoor rooms or outdoor living spaces. Clip or print pictures and put them into a notebook/ file.
- Review the home's style, design, etc. It is important to have an understanding of a home's architectural style when creating an outdoor room so that the outdoor spaces accentuate the home's indoor spaces.
- Visit a specialty retailer. A specialty retailer is a key partner in creating an outdoor room. In addition to expertise and products, a specialty retailer can offer key insights about what's available in a particular area and what works best in a certain climate. Then take your notebook/ file and your wish list with you.
- Research the products and after obtaining the details from a specialty retailer, go online or in person to review products and manufacturer information.
- Consider outdoor furniture, fire and food. These are key elements in every well-designed outdoor room. Position the fireplace as the focal point, blend in the cooking and eating areas and then consider the furniture.
- Think of foundation and basic foundation elements are stone patios, retaining walls, fences and decks.
- Draw a plan. The best way to achieve the desired end result is to sketch out a plan. Don't worry about picture-perfect drawings -it's the general idea that counts in overall achievement of the outdoor room you intended to develop.
- Build the space and have fun putting the space together. Consider multiple conversation areas for enhanced functionality and interest.
- Using landscaping as an accessory. Carefully placed trees, shrubs and climbers can add important texture and appeal to an outdoor room. Select plants that change with the season, offering different colors, blooms or scents depending on the time of year.
- Adding the furnishings. Select comfortable patio furniture that invites people to settle in for an extended period of time, regardless of style, outdoor furnishings are available to add beauty and character, creating the atmosphere of a lush oasis. In addition to tables and chairs for the eating area, consider chaise lounges, deep seaters, couches, conversation and side tables.
- Considering lighting to extend the amount of time spent outdoors and consider lighting for pathways, around pools, or to accentuate landscaping.
- Decorative details such as an attractive table or a favorite work of art can help turn a backyard patio into a stunning outdoor room.
- Taking it in stages; the outdoor rooms can be created over any period of time to accommodate large wish lists or limited budgets.

Service or utility area:

This is that part of the home garden which provides room for necessities for the family members.

Key features in the service or utility area:

- Cut or loose flower garden
- Firewood and implements storage
- Garage
- Garbage pit
- Greenhouse
- Irrigation system
- Orchard
- Out house
- Pet run strip
- Vegetable garden

General guidelines for developing service area:

- Screening this area from public and private area.
- Kitchen door should be accessible to this area.

What are enrichment items?

Enrichment items are the elements of the outdoor room which are not essential for making walls, ceiling or floor but, make the place more useable. These are of two types:

- **Natural Enrichment Items:** These are formed by the nature and are either present at the site or moved to the site by the landscape designer. These may be tangible (touchable) or intangible (not touchable).
- **Manmade Enrichment Items:** These items are created through a manufacturing process.

What are different natural tangible and intangible enrichment items?

- **Tangible Enrichment Items:** Stones, specimen plants, water, animals, birds, etc.
- **Intangible Enrichment Items:** Fragrance, sound of waterfall, view of natural scenery and sound of pods or foliage when gentle wind blows.

Points to Remember

- Beautiful landscaped house has more monetary value
- Concept of outdoor rooms increases the utility and value of the house
- Public area provides the initial impression about the house and its residents
- Family or private area is developed by keeping in view the preferences of the family
- Service area is developed to fulfill the daily needs of the family
- Enrichment items increases the utility of public, private and service area in the garden

Activity

1. Visit different home gardens created in your locality.
2. Enlist different features you would like to create in your dream home garden design.
3. What enrichment items you would like to add in outdoor room of your garden.
4. Draw preliminary and final landscape plan for your home garden.

Check your progress

A. Fill in the blanks

1. Area of the home which is viewable from the street is called as area.
2. Part of home landscape which provides space for necessities is known as area.
3. Mobility in garden is created by use of
4. The items which are created through a manufacturing process are called as
5. Family or private area is primarily called as
6. Screening from neighbours is essentially done in area of home garden.
7. Focal point is commonly created in area of home garden.
8. is an intangible enrichment item in the garden.
9. is the natural tangible enrichment item in the garden
10. Outhouse and pet run areas are created in area of the garden.

B. Short answer/ Descriptive questions:

- Q.1 What do you mean by Outdoor room?
- Q.2 What are the key areas of home landscaping?
- Q.3 What are the main functions of landscaping home?
- Q.4 What the basics of Outdoor room concept?
- Q.5 What are the main features of outdoor room?

Chapter 4

Different Garden Features

Objectives

After studying this chapter, students will be able to:

- understand various natural features of a garden
- understand various man made ornaments of a garden

Introduction

Garden features refer to the objects or things which when placed in a planned manner in an area, create a picturesque effect. These are the physical elements living or non- living and natural or manmade which are the basic prerequisites for any garden design. Attractive garden features and ornaments make an invaluable contribution to garden design. Discriminate use of a large number of garden features makes the garden design more eye-catching. However, indiscriminate and haphazard use of these features results in clutter. In the old gardens, enrichment items and ornaments were more important than plants whereas, in present day gardening include a fascinating wealth of available plant varieties. To decide the proper number of features and ornaments in a landscape garden, the designer must be able to predict their effects. Selection of features and positioning of ornaments in a garden are the visible evidence of the owner's taste and good sense. It should be kept in mind that whatever features may be chosen, they must add charm, create an atmosphere of naturalistic design and add character to the quality of a landscape design. These components should be such that both living and non living components looks proportionate and should compliment with each other and also to the surroundings. Garden features provide good aesthetics to garden by breaking the monotony. In this chapter you will learn various natural features and man-made ornaments and enrichment items of a garden.

Garden Features

1. WATER

Adding water in a garden is one of the oldest arts of gardening. It adds great charm and expression in any landscape. It gives beauty and pleasure in the form of running, still or dropping and falling water. References of water plants are found in the ancient literature of India. The Muslim rulers developed many water gardens using fountains and other adornments. In modern gardening, much attention is now paid to the culture of water- loving plants, more specially the lovely hybrid water lilies. Pool, artificial streams, swimming pools, waterfalls and fountains are constructed to enjoy the charm of water in many different ways in the garden.

Stream: A low sound stream winding through the garden brings life and movement into an otherwise quite and passive scene. It adds charm and beauty to the garden.

Waterfall: It helps in enhancing the beauty of the landscape. In some types, equal quantities of water fall from two lips of a high steep rock, while in another type, water falls off one side of the lip of a rock. However, other types have water running over irregularities on the rock face of the cliff, water divided into many falling threads by numerous irregularities along the lip of the cliff, water falling in a series of two or

more cascades down step-like clips. These waterfalls are made functional either through natural sources of water or by connecting water pipes.

Island: Different types of islands are made in garden lakes and ponds. These are decorated with trees, flowers, with other features and connected with bridges. Sometimes these islands are accessible only by boats. It is an important feature of Japanese gardens and a special representation of nature and a retreat for quiet meditation and repose.

Fountain: Fountains alone are attractive features of a garden and with them various designs are made. These can either be placed in a line along the centre of a water course or in the centre of a pool.



Fountain is life in any garden

Garden Pool

Pools are the most popular feature in a garden and charming and versatile component of any landscape. These are utilized for various purposes such as catching reflections of the sky, plants or flowers or some artificial features like fountains, for growing aquatic plants. These are of various sizes and shapes can be made with different materials such as bricks, blocks, poured concrete, etc. Pools are of three types viz., formal (rectangular, square or circular), informal and natural.

2. TOPIARY

It is the art and science of developing living sculptures or shaping of plants in various decorative of geometrical shapes, birds, animals etc. Generally it involves clipping, cutting of the plants into different forms or shapes. The term topiary is derived from the roman word '*ars topiaria*' that is used to denote ornamental gardening. The most common shapes of topiary are that of globe, cube, table, chair etc and are easy to create whereas complex shapes of birds, humans, animals are difficult to create. The foremost choice for the topiary is the shrubs, small trees and sometimes herbaceous perennials.

Characteristics of plants suitable for making topiary:

- Should have lush, shiny dark green foliage
- Should be hardy and able to withstand the frequent cutting and clipping
- Should have dense growth

The most suitable plants for making topiary are *Clerodendron inerme*, *Duranta plumieri*, *Murraya exotica*, *Thuja*, *Cupressus* sp., *Bougainvillea* sp., *Jasminum* sp., *Buxus sempervirens*, *Taxus baccata* etc.

3. GARDEN WALLS

It is one of the essential components in the garden as they are required for safety and security of the garden. These are necessary from safety or beauty point of view i.e to obscure the ugly sites of an area. The garden walls are generally erected around the periphery of the garden area. The garden walls can be made of bricks, stone, concrete etc. Generally in earlier times, high walls are one of the important features of Mughal gardens as they provide safety from the enemies and also interrupt the hot winds. Now-a-days, it is not advisable to erect the high walls so generally walls of 2-5 m are erected, otherwise small wall of 1 m erected and over it some wires, grills, fences are erected so that the garden view is not totally obstructed. In recent times with the concept of urban landscape, modern concept of green walls has come. The green walls refers to concrete walls are covered with vegetation. e.g. *Ficus repens* or *Hedera helix* is used to cover the walls.

4. SHRUBBERY

An area planted with shrubs either in group or as an accent in the form of a specimen plant. For example, Rosary, it refers to specific area where only roses are planted. It is the permanent feature of the garden as it is laid once in specific place and thereafter maintained for years. Hence, proper planning of shrubbery is an essential criterion. Shrubbery can be laid in both in formal or informal manner. The year round flowering can be obtained in shrubbery by planting shrubs having different flowering season. The shrubbery can also create the diversity by planting different colour shrubs.

5. ARCHES

It refers to the archway or arbour like structures that are erected over walkways so as to provide support to the climbers and ramblers. It also serves as a decorative structure to grow ornamental vines, climbing roses etc. The height of arch should be at least 2-2.5 m or may be over it so that climbing plants will not interfere in walk. The minimum width for the arches should be at least 1.2m. The arches are made of two basic structural units i.e. supporting poles and roof. The supporting poles can be made of either of wood or sometimes it can be of stones. The roof top can be made of wood or angle iron. The three main types of arches made of angle iron which are commonly observed in gardens are – angular roofed, flat roofed and arch roofed. Among them the arch roof type is dominant in most of the gardens. Rustic arches are best suited for cottage or country gardens; however wooden arches are suited for most of the gardens. Some of the climbing plants suitable for arches are *Hedera helix*, *Clematis* spp., *Allamanda violacea*, sweet peas, and shorter climbing roses.

6. PERGOLAS

A series of arches forming a covered walk are called pergolas. They are also used for growing climbers in long rows. The supporting poles can be of wood, stone etc. and can be held together with wooden sticks or iron rods respectively. The roof can be made of angle iron and on the top it is covered with wire mesh. The minimum width of the pergola is 2-2.5 m and height of pergolas is either same as the width or it is slightly on higher side. The most prevalent shapes of pergolas are either flat or arch shaped. Generally pergolas provides shady place for walkways and if space permits one can grow shade loving plants in it. The shade loving annuals like *Salvia* and *Cineraria* can also be grown as pot plants under pergolas.

7. HEDGES

Hedges refer to row planting of shrubs or dwarf trees at regular intervals so that it forms a fence or acts as a boundary. Sometimes hedges also include palms, cacti and succulents, etc.

Uses

- Hedges can be used as a live fence
- It serves as walls for outdoor rooms
- Hedges can also be used to screen unwanted areas or places
- Hedges can be act as dividers and used to separate different areas of the gardens
- It acts as a best background for display of annuals
- Hedges can be for protection against strong winds.

Types of hedges

- ❖ **Hedges for protective purpose:** These types of hedges provide protection against theft, trespassing etc. They can act live fences. e.g. *Agave americana*, *Cereus*, *Euphorbia bojeri*, *Opuntia*, *Bougainvillea*, *Duranta*, *Carissa carandas* etc.
- ❖ **Hedges for ornamental purpose:** These types of hedges provide aesthetic value or for screening. e.g. *Murraya exotica*, *Putranjiva roxburghii*, *Duranta*, *Clerodendron inerme*, *Hamelia patens*, *Poinsettia pulcherrima*, *Hibiscus rosasinensis*, *Galphimia gracilis*, *Aralia*, *Acalypha* etc.



Hedges in garden

Plants suitable for making hedges should have following characteristics

- Plant should be vigorous and quick growing
- It should be hardy and able to withstand regular clipping
- It should be dense in growing habit
- It should not attract rodents and snakes etc
- It should be easily propagated either by seeds or vegetative means
- When used as a protective hedge, it should possess thorns
- When used as ornamental hedge, it should possess good foliage or flowers or both
- The hedges should be drought tolerant

Hedges suitable for temperate areas (1000 msl and above)

Euonymus japonica, *Hydrangea* sp., *Spiraea* sp. *Aucuba japonica*, *Buxus sempervirens* *Berberis asiatica*, *Hibiscus syriacus*, *Duranta repens*, *Azaleas*, *Camellia*., etc.

8. EDGES

Edges refers to low growing herbaceous perennials that act as a lining of the paths, or walks, borders, lawns, flower beds, etc. Generally, edges are low growing and their height is less than the hedges. These are meant for lining and demarcation of the boundary. They can also act as dividers but not utilized for screening.

TYPES

Formal edges: These types of edges are made of non living material such as stones, tiles, bricks, concrete, etc.

Informal edges: These types of edges are made of living plants. The examples of informal edges are grass verges, stone crazy path with prostate plants in between them.

Plants Suitable for making edges are as follows:

Foliage plants: *Alternanthera* spp., *Eupatorium cannabinum*, *Iresene herbstii*, *Iresene lindenii*, *Pilea muscosa*, *Coleus*, etc.

Flowering plants: *Gazania splendens*, *Zephyranthes*, *Amaryllis*, pansy, *Verbena*, etc.

9. CARPET BEDDING

Carpet bedding refers to planting of low growing herbaceous plants according to set design or pattern in beds. It is intensive form of bedding and involves so dense and compact planting of the plants that it creates intricate and complex geometric patterns like a carpet of flowers and foliage. The design of carpet bedding is dependent on the colour and texture of the foliage. Generally, in carpet bedding design some logos, figures or letters are made with the use of plants having contrast colours and different growth habit. In order to produce good design, first background is made by growing plants of single colour and then grows the plants in groups or specific pattern through this background by utilizing contrasting colours. Generally, carpet beddings are found mainly in commercial complexes, government institutions, park depicting their names and logos. The design should first be drawn in graph paper and then finally executed on the actual site by utilizing low growing, contrast colour herbaceous perennials.

Plants suitable for carpet bedding are *Alternanthera* sp., *Coleus* sp., *Iresene herbstii*, *Iresene lindenii*, *Echeveria secunda*, *Pilea muscosa*, *Portulaca*, *Sedum*, etc.

10. GARDEN DRIVES AND PATHS

A garden must have a carriage drive leading to the house and the garage besides several other paths or walks leading to different parts of the garden. A good garden drive or path is to provide a flat, dry and



Living and non-living edges in garden

pleasant passage for the persons or vehicles and should harmonize with the other features of a garden. A path in the garden should give an artistic appeal. Too many paths may spoil the artistic value. A path with graceful and gentle curves will look much better than a straight path. Garden drives can be constructed using material like gravel, asphalt or concrete whereas garden paths are generally made up of gravel, paving stones, crazy paving, bricks, grass, etc.

11. GARDEN STEPS

These are the means by which different levels of the garden can be connected. It is the most important feature of the gardens having sloping sites. This feature is mainly created primarily for the comfort of the visitors. Garden steps are used by visitors to safely climb or get down from one level to another. These can be made of stone, gravel, wood, etc. The ratio between the tread (the part you stand on) and the riser (the vertical part of the step) is crucial for having comfortable walk. Hence, it is advisable that the treads should be broad and keep the risers low. Too high risers and narrow treads makes the walk very uncomfortable. Garden steps also require strong foundation so that steps are comfortable in walking. Avoid the use of those materials which become slippery when come in contact with water.

12. FENCES

Fences have a specific function as well as beauty. It provides privacy, separate different areas of gardens and ensures safety. They have almost infinite possibilities and variations in design material and usefulness. Fences may be solid or open. These may be made up of materials like wood, bamboo, wire, wire netting, chain link fencing, etc. Fences are used as a screen against an objectionable view, an enclosure for an area, as a boundary for a formal garden or merely as a background to accentuate planting or as a support to vines. These may be of several kinds e.g. boundary line fences of post and rail or hurdle fencing, screening fences and picket fencing.

13. GATES

Gates are functional as well as ornamental. They provide access to any property and can also serve as decorative accents if properly designed. The gate is also built in a style and material that matches the fence. The minimum width of a gate is usually 1 meter, while larger gates create a more gracious feeling. The materials for gates are usually wood or wrought-iron.



Ornamental gate in the garden

14. LAWNS

A lawn is defined as the green carpet for a landscape. Lawns are very much an element in design. They make a landscape attractive and give a restful appearance. They provide an appropriate setting for planting materials and different kinds of flower beds and shrubberies. A grass lawn is the common and most conventional of all ground cover treatments in an average garden. The detail of developing and maintaining lawn is given in separate chapter.

15. ROCKERY

Natural rock garden is one of the most important, attractive and interesting features of a garden. Rock

garden should be laid out in open and sunny situations. In such gardens, the arrangement and placement of stones is important. Stones of different sizes and shapes and huge rocks are used as per design of the garden. They must have continuity in order to give a more natural look and to grow a good range of rock plants. A large number of plants such as seasonal flowers, bulbous plants, cacti and succulents, dwarf trees, shrubs, conifer, etc. can be grown in the garden.

16. TERRACES

A terrace is a raised space of ground constructed around a dwelling house or at the corner of a garden or on the sides of a hill. When this terrace is used for some gardening, is known as terrace gardening. These gardens are basically meant for a place of leisure and pleasure. It is constructed just in front of the house from where a view of the whole garden can be obtained.

17. PAVED GARDEN

It should be laid in a path which is not used very often. A paved garden, if properly laid, can be a very attractive feature of a garden. There are some specific plants which adapt themselves well to a paved garden. These plants should be dwarf in nature and stand a considerable amount of wear and tear from the shoes of different weights. Plants suitable for a paved garden are *Achillea rupestris*, *Alyssum montanum*, *Dianthus deltoids*, *Euphorbia splendens*, *Gypsophila repens*, *Lantana sellowiana*, *Vinca rosea*, *Viola cornuta*, *Zinnia linearis*, etc.

18. MARSHY OR BOG GARDEN

Bog garden is an area where there is stagnant acid water and only plants such as sundew, butterwort, etc. grow. But the bog garden which we find in landscape gardening is actually a marsh where the soil is not sour or acid and a shallow stream or trickle runs through it. The main criterion of a marsh garden is to keep it moist and in a swampy state all throughout.

19. SUNKEN GARDEN

This garden is laid below the ground level. It brings variety in the garden. It can be laid out in an already existing depression of land or a portion of the garden may be specially dug to lay out such a garden. There is no hard and fast rule as to what is to be planted in a sunken garden. It depends on the area available and the choice of the grower. In a small area, some annuals and herbaceous perennials are grown in formal beds. But in a large sunken garden an elaborate formal and informal garden can be laid with paths, lawns, flower beds, shrubbery, trees, rose garden and greenhouse. The ideal depth of a sunken garden is about 120 cm.

20. GREENHOUSE, GLASSHOUSE AND CONSERVATORY

These are specialized structures erected in a garden for comfortable accommodation of some special groups of plant material. These structures are designed in relation to the architecture of the glass house and landscape of the surroundings. A conservatory leading from one section of the place to another or as a place to sit in the shade of climbers to rest, can be a delight. To design such structures for the garden requires technical knowledge as well as an artistic approach.



Conservatory in garden

GARDEN ORNAMENTS

21. BIRD BATHS

Bird baths are nothing but large bowl shaped containers, generally made of concrete, fixed over a pillar or column which is about one meter tall. Water is stored in the bowl for the birds to come and drink or bath in it.

22. SUNDIALS

A sundial can be used as a focal point in a garden, can form a centre piece of a formal flower bed and can be placed in the centre or at the end of the lawn and at junction or termination of a path.

23. FLORAL CLOCKS

Floral clocks are nothing but huge clocks, generally operated by electricity, having huge hands for showing the seconds, minutes and hours. The machinery of the clock is concealed in an underground chamber with only the hands showing above the ground against a dial of carpet bedding plants or flower beds.

24. GARDEN SEATS

These are necessary in any garden. These seats should be comfortable, durable, artistic looking and should not look out of place. Wooden and fabric seats are comfortable to sit compared to those built in stone or iron.

25. ORNAMENTAL TUBS, URNS AND VASES

These add beauty to a garden. Plants displayed in ornamental tubs or urns at suitable places look beautiful. These can be made of timber or preferably of bricks, concrete or carved out of stone. They may either be permanently fixed or removable. Ornamental urns preferably of metal with carvings outside look beautiful in the terrace, near the staircase or even inside the house.



Garden bench for enjoying beauty of flowers

26. STATUES

Statues of animate or inanimate objects are also used in the garden to improve the looks. The statues can be carved out of stones or made of bronze. The concrete statues can be placed in the midst of a running stream or a pool, at the intersection of two roads or at the end of a road or near the doorway of the house.

Activity

1. Visit different gardens of your area and make an inventory of garden features
2. If your school does not have a rockery then develop a small rockery by collecting locally available stones and plants

Check your progress

A. Multiple Choice Questions

- i. A series of arches forming a covered walk is known as:
a) Pergola b) Hedge
c) shrubbery d) None of above
- ii. The minimum width for the arches should be
a) At least 1.2 m b) At least 3.0 m
c) At least 5.0 m d) None of above
- iii. Row planting of shrubs or dwarf trees at regular interval so that it form a fence, is known as
a) Edge b) Arch
c) Topiary d) Hedge
- iv. *Alternanthera sp.* is commonly used for making
a) Edge b) Topiary
c) Both a and b d) None of above
- v) The garden laid below the ground level is called as
a) Paved garden b) Terrace garden
c) Mash garden d) Sunken garden

B. Fill in the blanks

- I. *Murraya exotica* is suitable for making_____.
- II. An area planted with shrubs either in group or as an accent in the form of a specimen plant is known as_____.
- III. Three suitable plants for paved garden are_____,_____,_____..
- IV. Three suitable flowering plants for making edges are_____,_____,_____.
- V. Three suitable plants for making hedges in temperate areas are_____,_____,_____.

C. Short answer/ Descriptive questions:

Q.1 Define hedge and edge. Suggest suitable plants for making hedges and edges?

Q.2 Define topiary. Enlist the plants suitable for making topiary?

Q.3 Write short note on the following?

- I. Sunken garden
- II. Bog or mash garden
- III. Terrace garden
- IV. Rock garden
- V. Paved garden

Chapter 5

CAD (Computer Aided Design)

Objectives

After studying this chapter, students will be able to:

- understand the importance of CAD (Computer Aided Design)
- enlist the basic requirements for CAD in landscaping
- elaborate the different components of CAD
- highlight the benefits of using CAD in Landscaping
- apply the various CAD software used in Landscaping

Introduction

Computer-Aided Design (CAD) is the technology concerned with the use of computer systems to assist in the creation, modification, analysis, and optimization of a design. Prior to the advent of computer-aided design (CAD) software, the development of any type of design or prototype was done manually. As such, development of landscape plans was typically tedious and time-consuming, often laden with costly trial and error. Since, it digitizes and simplifies the entire design processes; CAD software has all but replaced the traditional drawing board. It is widely known that **CAD software** and is frequently used in engineering-based industries. Nowadays it has also found applications in landscaping. From college campuses to shopping malls and playgrounds, landscape architects focus on creating design for functionality, beauty, and compatibility with the natural environment. In their designs, landscape architects plan the location of buildings, roads and walkways, and the arrangement of flowers, shrubs, and trees keeping in consideration their importance and role. They apply their knowledge of the environment and their aesthetic sense to historic preservation and natural resource conservation and reclamation. Landscapers use CAD software to conceptualize stunning outdoor creations and determine the best placement of various landscaping components such as trees, fences, gardens, patios and more. All the plant and non plant components in a garden are to be in a perfect scale with each other so as to bring an authentic display. This needs an ideal design or plan that suits the respective environment. Garden design is the creation of plans for the layout and planting of gardens and landscapes. Garden design may be done by the garden owner themselves, or by professionals. To develop or design a garden plan for a small area is always been a challenging task than designing for a larger or open area for any professional designer since it requires more creativity. Therefore, landscape architects, landscape designers or the horticulturists involved in landscape garden designing needs good aesthetic, creative, scientific, thematic and computer oriented skills to make an ideal garden plan to match the specific requirements in any locality. The contemporary garden designs in this digital era have revealed the importance of the role of computer applications in this arena. The garden plans designed through different/various softwares are called as 'Computer - Aided Designs'.

With computer aided design you can have at your fingertips a library of pre-drawn landscape and irrigation symbols. You can prepare preliminary layouts to fit varying types of landscapes. These landscape

templates would just be waiting for simple modifications and customizing. Your design and estimating time would be cut in half or more, particularly if you tie your templates together with pre-made material lists and cost sheets. Therefore, using CAD you could be able start a new business of landscaping of any area with few efforts and by reducing time taken to prepare a plan on paper. Most firms use CAD in a range of applications including project design, construction and production application. Current CAD software has been designed with add on to AutoCAD or any other landscape software which include a range of applications like land form manipulation, cut and fill, drainage calculation, roadway alignment and other landscape construction application. It may be used to design curves and figures in **two-dimensional** (2D) space; or curves, surfaces, and solids in **three-dimensional** (3D) objects. The use of this technology and tools in landscape business, if used properly, can **improve productivity**, efficiency and competitiveness.

Basic requirements of Computer aided design in landscaping

- The most important requirement of CAD is suitable hardware and software
- Computer Aided design (CAD) software preferentially requires Windows-based Personal Computers. Some of them also work on UNIX and very few on Linux machines.
- High-end Open GL Graphics card are one of the important requirement of CAD
- Computers should have high speed processors
- A high amount of Random Access memory is needed for the creation of landscape designs
- The understanding of landscaping principles, elements, features etc are also one of the basic requirements
- The landscape plans are dependent on the creativity of the designer who creates beautiful designs by the use of CAD
- The basic knowledge of planting material is also required by the landscape architects for the real execution of the plan.

Types of CAD systems

There are mainly three basic types of CAD systems

- Two dimensional (2D) designing systems
- Three dimensional (3D) solid feature modellers
- High-end 3D hybrid systems

Components of CAD Systems

1. Hardwares

Hardware is the most important component for any CAD system to be used in landscaping of any area. Following are the devices of any CAD system which we have to check before purchasing any system for landscape management of any area.

- a. Computing machine
- b. Data storage devices
- c. Communication devices
- d. User input devices

Do you know?

Like CAD (Computer Aided Design), CAM (Computer Aided Manufacturing) in industry has become very popular and useful tool.

- e. User output devices, etc.

2. Softwares

Current computer-aided design software packages range from 2D **vector**-based drafting systems to 3D **solid** and **surface** modellers. Some of the CAD softwares used in landscaping are:

- a. AutoCAD
- b. ArchiCAD
- c. Advance Design
- d. Advance Steel
- e. Advance Concrete
- f. BricsCAD
- g. BRL-CAD, etc.

Do you know?

Adobe Photoshop is very useful in Computer Aided Designing of Landscape plans.

Benefits of use of CAD in Landscaping

The most important benefit of using CAD is the reduction in time for making designs as compared to early times when landscape plans were made on canvas. Hence, there is saving of both time and money. Generally the designer creates the design based on following points

- Individual's idea or preference and generally based on their basic requirements and personal interests
- Photographs of actual sites are also used for creation of landscape design.
- Previous design of the project sites can also be used for further modification with the help of CAD

Major benefits of CAD:

CAD is a type of software used for creating blueprints and schematics. CAD programs produce designs in 2-D, 3-D, or both, depending on the specific software. Many companies make CAD software which ranges from open-source to extensive commercial packages and its use provides several benefits.

1. Accuracy

3-D imaging and multiple viewing angles allow landscaping experts to double-check for problems before designs are implemented. This results in a significant cost saving as potential problems are fixed prior to a design going to production.

2. Productivity

Increased productivity is another benefit of CAD software. Most CAD software offers features to help with repetitive tasks such as creating a list of materials, placing symbols on the document and automatically creating detailed views of individual parts of the design.

3. Time Frame

The wide adoption of CAD software has reduced the amount of time it takes for a landscape expert to go from the design stage to implementation stage. CAD designs are uniform in style and measure so information is shared easily among engineers and other project members when multiple designers are involved.

4. Editing

Not every design is going to be perfect on the first try, even with CAD software. If the design doesn't work as well as it should, the landscape architects don't have to go back to the drawing board. He just has to bring up the saved CAD designs and make edits from there.

5. Training

CAD software requires specialized training offered by software vendors or colleges. Landscape architects can learn new software packages more quickly than learning hand drafting. A part of a design is created in one click with CAD. That same part might take a hand drafter many hours to complete. Hand drafting also requires a steady hand and a talent for drawing, which some Landscaping experts might not have.

Beneficiaries

- Landscape designers, architects and planners
- Landscape engineers
- Floriculturists
- Professionals
- Amateur gardeners
- Students
- Costumers
- Industries

Amongst different CAD softwares for landscaping, AutoCAD and ArchiCAD (Architectural CAD) are originally meant for developing engineering drawings and 3D Max is meant for developing 3D models with animation.

AutoCAD

AutoCAD is a CAD software application for 2D and 3D design and drafting. It is developed and sold by Autodesk, Inc. First released in December 1982, AutoCAD was one of the first CAD programs to run on personal computers, notably the IBM PC. At that time, most other CAD programs ran on mainframe computers or mini-computers which were connected to a graphics computer terminal for each user. Auto Cad and its vertical products are incompatible with Bit Defender security software.

ArchiCAD is a CAD software developed by the one of the famous Hungarian company "Graphisoft". The initial development of ArchiCAD was started in year 1982 and most suitable for Macintosh and Windows. This software is regarded as the first CAD software for the creation of both two dimensional (2D) and three dimensional (3D) designs.



Computer Aided Designed Landscape plan of Home Garden



Computer Aided Designed Landscape plan of Home Garden

Table 1: Some of the CAD softwares used in Landscaping

Application and developer	Latest Version	2D/3D or Speciality fields	Runs on Unix-like systems	Runs on Windows	Other Platforms
Advance Design by GRAITEC	Version 2011	2D/3D	No	Yes	No
Advance Steel by GRAITEC	Version 2011	2D/3D	No	Yes	No
Advance Concrete by GRAITEC	Version 2011	2D/3D	No	Yes	No
Alibre Design by Alibre, Inc.	-	2D/3D + Rendering	No	Yes	No
ArchiCAD by Graphisoft A	2010-05	2D/3D Architecture, BIM	Mac OS X	Yes	Unknown
Argon by Ashlar-Vellum A-M-E	2009 v8 SP2	2D/3D, Concept, Detailing, Drafting, Rendering, Animation	Mac OS X	XP/Vista/7	Mac OS X
AutoCAD Architecture 2011 by Autodesk 1-M-E	2009-03-24	2D/3D AEC	Mac OS X	Yes	Unknown
Bricscad by Bricsys A	2010-10V11	2D/3D AEC, Parametric modeling, Rendering	Fedora OpenSuse Ubuntu	2000 XP Vista 7	No
CYCAS by Ferlag Frese A	2008-02-22	2D/3D AEC Rendering	Linux	Yes	No
DataCAD by DATACAD LLC A	2009-06	2D/3D AEC	No	Yes	No
Autodesk Inventor by Autodesk M+E	2009	3D	No	Yes	No

Points to Remember

- Computer-Aided Design (CAD) is the technology concerned with the use of computer systems to assist in the creation, modification, analysis and optimization of a design.
- CAD is very useful to Landscape designers, architects and planners; Landscape engineers Floriculturists, Professionals, Amateur gardeners, Students, Costumers and Industries
- 2 D and 3 D designs for home and public gardens are developed through CAD
- AutoCAD and ArchiCAD are very popular software being utilized in CAD
- Adobe Photoshop is also useful in CAD

Activity

1. Prepare a list of various professional courses on CAD
2. Either try the trial version online or attend the classes which are provided by various professional institutes.
3. Prepare landscape plan for your home and school and present in class room.

Check your progress

A. Fill in the blanks

1. CAD is the abbreviated form of
2. CAD designing requires speed processors.
3. CAD softwares mainly run on..... based personal computers.
4. There are mainly basic types of CAD systems
5. The design created through CAD is available in and dimensions
6. AutoCAD was first developed by
7. ArchiCAD was first developed by
8. Most important benfit of using CAD is saving
9. and are the hardware used in CAD
10. AutoCAD and ArchiCAD are the..... used in Computer Aided Design

B. Short answer/ Descriptive questions:

- Q.1 What do you understand by Computer Aided Design?
- Q.2. Write down importance of CAD?
- Q.3 What are the basic requirements of CAD in landscape gardening?
- Q.4 What are the main components of CAD?
- Q.5 What are the major benefits of CAD?
- Q.6 Who are the main beneficiaries of CAD?

Chapter 6

Lawn Establishment and Management

Objectives

After studying this chapter, students will be able to:

- elaborate the benefits of lawn in garden
- understand and apply different methods for establishment of lawn
- use various lawn management practices
- understand about various insect-pests and diseases of lawn and their management

Introduction

A **lawn** is an area of aesthetic and recreational land planted with turf grasses or other resilient plants. It can also be defined as green carpet for a landscape. A lawn is a ground covered with perennial fine grass which persists under rather continuous close mowing and requires proper maintenance practice. It is considered as an integral part of landscape ecological systems worldwide which provide aesthetic value. Lawn is a basic feature for home ground development and an essential feature for any other type of garden, parks, public landscape, sports fields, etc. It improves the appearance of the house, enhances its beauty, increases conveniences and usefulness which enhances economic value to the real estate.

History of Lawn

In the past, a lawn was an imitation of a natural meadow rather than pure grass. Early gardens had an area carpeted with grass intermixed with other flowering plants. Chamomile grass (*Anthemis* sp.) was used in lawns in England. In the 18th century, lawns became a more desirable feature in gardens. Around 1830, Edwin Budding in England invented the lawn mower which has revolutionized turf/lawn management. During 1900, the first motor driven lawn mower was made. Mr. J. B. Olcott at Manchester in the United States first started experiments on turf grasses. Around 1890, at the university level, for the first time, turf grass research was started at the Rhode Island, College of Agriculture. After the first world war, research on turf grasses were initiated in different experimental stations of the U.S.A., the U.K., Canada, Australia, South Africa, New Zealand and many other countries.

Benefits of Lawn

Functional benefits

- Turf grasses serve as an inexpensive, durable ground cover and protect our valuable, non-renewable soil resources. Turf grasses offer one of the most cost efficient methods to control wind and water erosion of soil, which is very important in eliminating dust and mud problems around homes, factories, schools, etc.
- The dense plant canopy of mowed turf grasses is very effective in the entrapment of water and airborne particulate materials as well as in absorbing gaseous pollutants. Turf grasses offer one of the best known systems for catchments of the runoff water and pollutants.

Do you know?

Lawn is considered as the carpeted floor of the outdoor room in garden.

- A healthy lawn absorbs rainfall six times more effectively than a wheat field and four times more than a hay field. This attribute is certainly important in enhancing ground water recharge.
- Lawn helps in entrapment and biodegradation of organic chemicals and conversion of carbon dioxide emissions
- It enhances heat dissipation and temperature moderation. Turf grasses through the cooling process of evapo-transpiration serve an important function in dissipating the high levels of heat generated in urban areas.
- The rough surface characteristics of turf grass function in noise reduction as well as in multi-directional light reflection that reduces glare.
- Lawn provides safety in vehicle operation/equipment longevity. Roadside turf grasses are important in highway safety as well as erosion control. They function as a stabilized zone for emergency stoppage of vehicles.

Aesthetic/social benefits

- Lawn improves mental health through a positive therapeutic impact.
- It reduces illness specifically by reducing risk of heart disease and type II diabetes.
- It increases life expectancy, reduce tension and violence in urban areas
- Lawn improve recovery from depression as a result of better exercise opportunities contributes to social harmony, improved productivity and contribute towards national economy
- The outdoor sports viz., badminton, baseball, cricket, field hockey, football, golf, lawn bowling, lawn tennis, etc and other recreational activities utilize turf grasses.
- It provides a perfect setting for a flower bed, a border, a shrubbery or a specimen tree or shrub

Site Selection

Generally, a sunny site is preferred for lawn establishment. In shady or semi shady locations, satisfactory effects of a good lawn are not visible. The site should have sufficient water for preparation and maintenance of the lawn.

Leveling and Grading

Properly leveled land is required for uniformity of growth throughout the entire area and it helps in proper maintenance and management of the lawn area. Grading of ground is needed to get drainage away from the main area and, if possible the slope should be 30 cm in 15 meters. Good drainage provides a suitable physical condition of the soil for the proper development of the grass roots.

Soil Preparation

The area where lawn is to be developed should be cleared from all the building and stones. The soil should be dig up to a depth of 45 cm manually or with the help of a tractor to destroy weed seeds. Soil should be exposed to scorching rays of the sun for 15 to 20 days to kill weed roots. Ploughing is done two to three times to break clods of earth and to remove undesirable material like weed roots, hard stones, rocks, etc. The soil should be flooded with water several times to encourage the growth of weeds, if any, which are to be removed. Then, mixing of half to full basket of well rotten farm yard manure along with 40 g single super phosphate and 35 g Murate of potash per square meter area should be done and roll it. Finally, level the soil, irrigate and let the soil settle down.

Turf Grass Selection

Turf grass selection for various corners, pockets, situations and environments is an important criterion for successful lawn establishment and management. Among thousands of grass species, only 15-20 species are used for lawn development. For warm tropical and sub tropical climates, *Cynodon dactylon* commonly known as Bermuda grass is suitable for lawn. This is very hardy grass and can be used for lawn and playgrounds and parks. It responds to frequent mowing and provides a good turf. It is highly tolerant to cold and drought. However, it does not tolerate shade, poor drainage and high soil acidity. Now-a-days Calcutta Selection No.1 is the most commonly used grass for making the lawn. Other species like *Zoysia japonica* (Korean grass), *Zoysia matrella* (Manilla grass) and *Zoysia tenuifolia* (Korean velvet grass) are also suitable for same climate. These grasses form a very good lawn even in shade, however, they are very slow to grow. Coarse textured grass species like *Axonopus affinis*, *Eremochola ophiuroides*, *Paspalum notatum* and *Stenotaphrum secundatum*, etc. are suitable for warm humid regions and used for erosion control. However, *Poa pratensis*, *Festuca rubra*, *Agrostis tenuis*, *Lolium perene*, etc. are used in cool climate or temperate regions. *Dactylis glomerata* is another hardy grass for temperate regions and is mostly used in orchards or shaded areas.

Planting Methods of Lawn grass

1. Seeding

The propagation of lawn through seeds is known as seeding. The timing of seed sowing depends on the type of grass species whether cool season or warm season. Warm season grasses are best seeded in the spring as soon as a soil temperature is high enough to achieve germination. However, cool season grasses are established in the later summer or early fall. 250-300g seed is sufficient for sowing 100 m² area. Seeding is done through various methods like hand seeding, mechanical seeding and hydro seeding, etc. In **hand seeding method**,

divide the required amount into two lots. Spread the seeds from the first lot going back and forth across the area as uniformly as possible. Spread the remaining seed working at right angles to the first application. This method is suitable for seeding in small areas only. **Mechanical seeding** is the most common and least expensive method of planting turf grass. Better results depend upon uniform seed distribution, adequate soil cover over seeds and soil firmness around the seed. Seed drills, however, reduce the seeding rate and may be appropriate on large or unimproved areas. Broadcast seeders are the fastest method of seedling. **Hydro-seeding** is appropriate for use in large areas. It is a planting procedure that employs the use of hydraulic equipment to disperse a thick suspension or slurry of seeds, mulch and water. The slurry is dispersed over the ground by use of a sprayer tank that is typically transported by truck or trailer to the locations. The benefits of hydro seedling are rapid sprouting and growth of seeds and the prevention of soil erosion. Hydro seeding can be very effective for hillsides and sloping lawns to help with erosion control and quick planting. The greatest



Lawn extends living area of the home

disadvantage of hydro-seeding is that the seed is placed on the soil surface where it is more susceptible to the effects of drought.

2. Sprigging/ Dibbling

This method is most commonly used method for making lawn. The process of spreading stolons on the soil surface is known as stolonizing. Sprigging is a modification of stolonizing that involves placing the stolons in narrow furrows spaced 15-20 cm apart. It is another effective way of establishing stoloniferous grasses. One quintal full gunny bag of grass is enough for planting in 100 m² area. The best time for planting grass is Feb.-March and July-August. The roots and stem portions are dibbled into soil 10-12 cm apart. 2/3 portion of root should go into the soil and it should be pressed and watered with sprinklers.

3. Turfing/ Sodding

Sodding is another effective but expensive method of planting turf grass. It involves transplanting of established turf from one area to another. The use of sod should be limited to areas where quick turf establishment is required to repair previously planned areas. The soils, on which sod is laid and chosen, should be similar to the soil on the area that is to be laid. In this method, pieces of turf (1 ft wide) of uniform thickness are laid and rolled in each direction to allow the turf to settle down. After laying the turf, watering is done for proper establishment. Turfing or sodding is the best method for developing grass on terrace and roof garden.

4. Bricking

This method is used to replace unhealthy patches in lawn. In this method, pieces of grass along with soil in the shape of bricks are planted and watered immediately.

5. Plugging

Plugs are small pieces of sod that are planted at regular intervals. Plugging is the process of using small pieces of sod transplanted in the soil at intermittent intervals. The plugs are formed by cutting up sod strips or by removing plugs of turf from an intact sod. In this process, base soil areas are left uncovered and the plugs are allowed to spread and fill in the openings. The plugs measure from 5-10 cm and are placed in 10-30 cm centers. Plugging establish at much slower rate to sod and weeds become problem. Plugging takes one to two seasons for complete establishment depending on the spacing of the plugs and environmental conditions. Any spreading type of grass can be established by plugging.

6. Planting on polythene

In this method, lawn is grown on polythene of 800 gauge thickness. Mixture of soil of 3-4 cm thickness is spread over the polythene sheets and grass is grown over it.

Lawn Maintenance

In order to enjoy a beautiful lush green, disease free, turfs or lawn, a number of maintenance operations such as irrigation, weeding, mowing, rolling, fertilization, dethatching, raking, over seeding etc. are required. These are as follows:

1. Irrigation

Lawn requires frequent light irrigation rather than heavy irrigation after long intervals. Use of sprinkler irrigation saves water and labour to a considerable extent. The frequency of irrigation varies with the climate. In summers watering is done at two days interval while in winters irrigation frequency is reduced to once a week. The winter dew is important and each morning the dew should be brushed into the grass by

drawing a hosepipe over the grass, before the dew evaporates. Stagnation of water should not be allowed as it may kill the grass.

2. Weeding

Regular mowing helps to control the population of weeds by the removal of upper portion of weeds and starving of roots. However, there is a large population of weeds which remains in the lawn. In small areas, weeds can be removed manually but in larger areas different weedicides can be used. The most difficult weed to eradicate is *motha* (*Cyperus rotundus*) as the root system of this weed is quite deep. It is the most common weed in Indian lawns.

3. Mowing and rolling

Mowing is a very important operation in lawn management. When a new lawn is cutting for the first time, do not use a lawn mower because newly established grass will be uprooted. The grass is trimmed with the help of a sharp scythe or hedge shear initially. Rolling is a method of correcting minor variations in the turf grass surface particularly those caused by pedestrian traffic. The lawn is rolled slightly while the same is being established. Roller should never be run on a wet lawn. The lawn grass should be cut at a height 3 cm while mowing. The mowing may be done at an interval of 10 to 15 days, depending upon the season and grass species. A well-maintained lawn gives a pleasing effect when grass is properly mown along the edges and beds.



Lawn looks attractive after mowing and rolling

Do you know?

Lawn mower is a machine used for cutting lawn grass and was developed by Edwin Budding in 1830.

4. Fertilization

Fertilization is one of the most basic and important components of a lawn management programme. A number of plant nutrients are required for the growth of turf grasses. These elements are divided into major elements and trace elements depending on the amount required. Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Iron, Manganese, Zinc, Copper, Molybdenum, Boron are required for the growth of turf grasses. These plant nutrients are taken from the soil through fertilizer and manures. Lawn fertilization contributes greatly to lawn grass colour, density, uniformity, and growth. Properly fertilized lawn is able to compete with weed as well as to recover rapidly from damage caused by insect, pest, disease and environmental stresses. An application of 40g N/m² in the form of Calcium Ammonium Nitrate (CAN) is very much useful for the lawn. It should be applied in four equal splits i.e. February, May, September and

November to keep the lawn green throughout the year. While applying fertilizer, the soil should be sufficiently wet. The nitrogen can be applied in the form of liquid fertilizer by using 2% urea.

5. Scarping and Raking

Continuous rolling, treading and mowing may result in the formation of a hard crust and the lower part of the lawn may get matted and woody. For such lawns, the grass is scraped at the ground level with the help of a *khurpi* in the months of April and May. Scarping is followed by raking to break the crust. A series of sharpened metal hooks is gently raked over the lawn and open the surface by removing thatch. When the condition of the lawn is good, hard and thorough raking is done both ways to loosen the old runners and to aerate the soil. At this stage, the mower blade is lowered and the grass is mowed close to the ground.

6. Slicing and Spiking

Slicing is the process by which a turf is penetrated to a depth of 7-10 cm by a series of V shaped knives mounted on disks. In this process, there is no removal of soil cores and hence, disruption of the turf is minimal. Spiking is similar process except that the penetration is limited to approximately 3 cm and the length of the perforations along the turf surface is short. In areas with severe surface compaction, slicing and spiking is done along with coring to improve infiltration.

7. Top Dressing

After scraping or raking, a compost consisting of good garden soil, coarse sand, and leaf mould in the proportion of 1:2:1 (in sandy soil the proportion of sand should be reduced or eliminated altogether) is spread over the lawn to a depth of 3-5 cm. 100kg of compost will be required for an area of 100 m². The same compost is used as top dressing again during September or October. From October to April, ammonium sulphate is applied once every month at the rate of 2 kg per 100 m² area followed by watering.

8. Dethatching

The process of removing a layer of dead and decaying organic debris and the living roots, crown and stems of the grass commonly (thatch) from the top layer is known as dethatching. This is also known as vertical mowing or scarification or power raking. Excessive nitrogen and water, chemical imbalances in the soil, macro organisms like earthworms and burrowing insects, fungicides, etc. cause thatch accumulation in turf grass lawns. Deep penetration of the knives of vertical mower removes more quantity of accumulated thatch in the lawn and grounds.

9. Liming

Growth of moss over the lawn area is an indication of acidic soil, which means the soil requires liming. Under such condition powdered chalk or lime should be applied at the rate of 250 gm per m² area. Even otherwise, application of lime once a year, except in alkaline soils, is beneficial. After liming, watering should be done.

Sulphuring

Alkaline soils (pH >7.0) are not desirable for turf grass growth because of the reduced availability of plant nutrients. Problem of alkalinity can often be corrected by applying elemental sulphur as per need. Elemental sulphur (not exceed 2 kg per 100 square feet) can be applied on established turf in the spring or fall. Since, sulphur reacts slowly, so re-test soil pH after 6 to 12 months to measure changes.

Diseases

Fairy ring

It is caused by soil borne fungi *Marasmius ordeades*, *Psalliota compestris*, *Leipiota morgani*, etc. These fungi cause a circular ring of thin coloured or dead grass. Grass turn brown and rings widen in the circles from few cm to meters. This can be controlled by drenching of soil with Bordeaux mixture (4:4:50) (4 Kg Copper Sulphate : 4 Kg Hydrated Lime: 50 L Water).

Pale or Yellow Lawn

Yellowing of lawn may be due to water logging, poor water drainage, and nitrogen deficiency of some other reasons. Application of nitrogenous fertilizers and loosening of compact soil with *khurpi* will reduce yellowing of lawn.

Insect-pests:

White grubs

The larval stage damages the turf by feeding on root system below plants crown. The damage is best diagnosed by grasping the blades of the grass and lifting the grass breaks away at root level. If damage is recent, the grubs are visible on the soil surface, but they may burrow deeper into the soil and may not be visible. These are very difficult to control as their location below the thatch protects them from insecticides. Apply insecticides viz., 0.05% Quinalphos and Carbofuran, 10% phorate @ 10 Kg/ha to wet turf and then immediately apply water to a depth of 1.25 cm more so that insecticide percolate down to the level where the grub is feeding.

Termites

They are the most destructive pest capable of causing massive damages to turf grounds. Their attack starts under dry soil conditions. They mainly feed on roots and spread to leaf blades. They convert grass into a heap of organic matter. Termiticides are the quickest method to get rid of termites. Drenching soil with chloropyriphos 0.05% or endosulfan 0.07% or malathion 0.1% before planting is useful to control termites. Biological methods like introducing ants or earthworms that feed on the termites can also be used. Deep ploughing and timely irrigation destroys termite colonies. If not control, digging up of soil up to 15 cm or more and removal of termite affected soil.

Points to Remember

- Lawn is the most important element of the garden and is considered as the carpeted floor of the outdoor room
- Bermuda grass and Korean grass are most important grasses for developing lawns in India
- One square foot lawn can cover about ten square feet area by dibbling method
- Turfing is the fastest method to develop lawn, while seeding method requires less labour and less money for developing lawn
- Mowing and rolling are very useful for maintaining attractive lawn
- Fairy ring is the common disease in lawn

Activity

1. Visit different gardens in your area for collecting and identifying different grasses used for lawn.
2. Develop a small lawn of 20 m² or develop a small garden area at your house and school and plant flowers of your choice.

Check your progress

A. Fill in the blanks

1. The lawn mower was invented by _____ in _____ during _____.
2. A healthy lawn absorbs rainfall _____ times more than a wheat field.
3. *Cynodon dactylon* L., popularly known as _____, is suitable for _____ areas.
4. _____ gm seed is sufficient for sowing 100 m² area.
5. Liming is an important operation in _____ soils.

B. Multiple Choice Questions

1. The process of removing a layer of dead and decaying organic debris i.e. thatch is known as:
a) Dethatching b) Aerification
c) Slicing d) Scrapping
2. The frequent and most common operation in lawn management is
a) Liming b) Mowing
c) Leveling d) None of above
3. The most common weed in Indian lawn is
a) *Cyperus rotundus* b) *Agrostis palustris*
c) *Poa pratensis* d) None of above
4. The most commonly used method for making lawn is
a) Seeding b) Dibbling
c) Turfing d) Plugging
5. Which of the following grass is suitable for shady areas
a) *Zoysia japonica* b) *Cynodon dactylon*
c) *Poa pratensis* d) None of above

C. Write whether True or False

- i. Mr. J. B. Olcott first started experiment on turf grasses.
- ii. A shady situation is preferred for any lawn establishment.
- iii. Lawn helps in entrapment and bio degradation of organic chemicals and conservation of CO₂ emissions.
- iv. Sulphuring is done in acidic soils.
- v. *Dactylis glomerata* L. is suitable for warm season tropical areas.

D. Short answer/ Descriptive questions:

- Q.1 Define lawn and explain different methods of planting turf grass?
- Q.2 Prepare a list of turf grasses suitable for warm and cool climates.
- Q.3 How would you manage the established lawn?
- Q.4 Describe diseases and insects of lawn and their control.

Chapter 7

Production of Indoor Plants and their Maintenance

Objectives

After studying this chapter, students will be able to:

- visualize different light conditions in the home and how it affects the choice of plants for a specific location.
- understand the difference between various conditions needed for growth of indoor plants and their maintenance.
- determine when and how much to water indoor plants.
- identify the key insect-pests and diseases of indoor plants and their control measures
- get acquainted with various propagation techniques of the house plants
- understanding when to do repotting of the house plants.

Introduction

Almost every indoor place is more pleasant and attractive when living plants are a part of the house. In apartments, condominiums and single family residences, plants add warmth, pleasant personality and year-round beauty. Shopping centres, hotels and resorts take full advantage of the colourful, relaxed atmosphere created by green and flowering plants. Offices, banks and other commercial buildings rely on interior plants to “humanise” the work environment and increase productivity. There are other important, often overlooked functions performed by indoor plants. These include directing or controlling pedestrian traffic, subdividing or enclosing space into separate areas, reducing glare and reflection from artificial lights or sunlight entering through a window and screening to block out undesirable views or to create privacy. Indoor or house plants also purify toxic chemical substances, absorb chemical substances from water, air and soil and transported them to rhizosphere where they decomposed or converted into energy with the aid of various microbes.

Real enjoyment and consistent success with indoor plants depend on selecting the right plant for a given environmental situation. Light, temperature and humidity are key considerations. Soil and water satisfy the remaining basic needs of living plants. A good soil mixture, proper watering and fertilization are important keys for the maintenance of attractive indoor plants.

Purpose served by indoor plants

Use	Function
Emotional and symbolic	1. Maintain a person's contact with nature
	2. Mentally and emotionally carry a person to an unspoiled environment
Sensual	1. Mood delineators
	2. Sounds, odours, touch feelings stimulated, enhanced, gratified
Architectural	1. Control of privacy
	2. Screening of unpleasant views
	3. Progressive realization of views
	4. Articulate space

Use	Function
Engineering	1. Control of traffic
	2. Reduction of glare
Aesthetics	3. Acoustical control
	1. Background
	2. Sculpture
	3. Line calligraphy
	4. Softening architecture
	5. Frame views

Culture of Indoor plants

Proper environment is essential for healthy growth of indoor plants. This environment includes physical factors such as light, temperature, humidity, moisture, growing medium and nutrition as well as biological factors such as pathogens, insect-pest and weeds.

Light: Light is essential for plant life processes and optimum level ensures healthy, long-lived indoor plants. Plants grown in correct light conditions are vigorous, compact and bushy. Colour is vibrant, leaves are normal size, and stems are sturdy. Flowering is promoted. Plants grown at a light intensity below their optimum will have smaller leaves and less vivid colour. They often grow more open and leggy and pruning may be necessary for compact form. A plant that receives significantly less than its required amount of light may survive for several months to a year, while gradually deteriorating in appearance and vigour. When light levels are too high, plant leaves show an overall yellowing that results from the destruction of green pigment. Eventually large brown spots of dead tissue may develop. This is often referred to as leaf scorch or leaf burn. In general, on the basis of light requirement, indoor plants may be categorised into:

1. **Sun lovers:** These are the plants that require 100% sunlight and cool winter. e.g. Rhoeo, Saxifraga, Bryophyllum, Echinopsis, Crassula, Pelargonium, Sedum, Opuntia, etc.
2. **Bright light:** These indoor plants require 60-75% sunlight i.e. lightly filtered sun light from south-east or west facing window and three hours Sun a day from east or west facing windows, e.g. Achimenes, Coleus, Hibiscus, Rosa, Thunbergia, etc.
3. **Good light:** These plants require 25-50% sunlight, e.g. Aechmea, Aloe, Begonia, Campanula, Cordyline, Cyclamen, etc.
4. **Light shade:** These indoor plants require only 10% sunlight. These include Aspidistra, Aglaonema, Cyperus, Hedera, Hydrangea, Monstera, Pilea, Syngonium and Zebrina.

Temperature: Most of homes and offices are heated and cooled with human comfort in mind rather than the growth requirements of indoor plants. Fortunately, the desirable temperatures for humans fall within the optimum range for most foliage and flowering plants. In general, most of the indoor plants grow best at a day temperature ranging from 18-24°C and night temperature of about 10°C. Plants are categorised as per their temperature needs into following

1. **Cool:** These are the plants that thrive best under a temperature range of 7-13°C.
2. **Medium:** These plants thrive best under a temperature of 13-18°C
3. **Warm:** These indoor plants thrive best at a temperature range of 18-24°C.

Humidity: Humidity may determine whether certain plants that are native to moist regions will do well in the average indoor location. In dry air, the leaves of these plants turn yellow or show brown tips and margins. Some fails to flower while others produce flower buds that shrivel and drop suddenly from the plant. Indoor plants do best at a relative humidity of 70-80%. In moderate humidity range of 20-40% it is possible to grow a variety of flowering and foliage plants. However, cactus and succulents do well in a humidity range of 5-15%. One of the simplest ways to increase the humidity around plants is to group them close together. Water constantly evaporates into the air from leaf pores (stomata) as well as from soil and some container surfaces, creating a humid microclimate in the immediate area of the plants. **A general rule of thumb is that plants with low light requirement will need higher humidity levels.**

Ventilation: Fresh air is required by plants for survival, but not to an extent needed by man or animals. Draughts should be avoided, and therefore a location between doors or windows where there are cross-currents of air is not suitable. Natural gas from stoves or furnaces is harmful to indoor plants. The affected plants become yellow, drop their foliage and appear pale.

Watering: Water is among the most important requirements of a plant for survival but the required amount varies with the species and with the season. One of the main causes for the injury or death of house plants is improper watering, particularly inadequate or overwatering. Besides this the frequency of watering will also depend on the stage of plant growth, size of the plant in relation to its pot, soil, light, temperature and humidity. Improper watering is the underlying cause of many plant problems. There are several basic points to consider during watering:

- a) Plant with large or very thin leaves and those with fine surface roots usually requires more frequent watering than succulent plants with fleshy leaves and stems that are able to store water internally.
- b) In warm, dry, sunny location, plants need more frequent watering than they do in cool, low light situations.
- c) A large plant in small pot will need water more often than small plant in large pot.
- d) Flowering plants and rapidly growing plants dry out more quickly than plants with slow growth rates.
- e) Different soil mixes require different watering schedules. Heavy fine-textured potting media and those that contain a lot of peat moss hold more moisture than loose, porous mixtures of bark, sand and perlite.
- f) Water evaporates rapidly from the sides of an untreated porous clay pot, but not at all from plastic or glazed ceramic containers.
- g) Apply enough water to moisten the entire soil volume, plus a little extra to leach soluble salts out of the container.

Nutrition: The applied nutrients must be of the right kind and in the right quantities. It is also important that soil which provides the platform for growth is of good quality and is maintained in good condition. Generally, the nutrients for indoor plants should contain nitrogen, phosphorus and potassium. Most indoor plants grow vigorously with a 1-1-1 ration (i.e. 20-20-20:: N-P-K) fertilizer. As a rule, applications should be more frequent when the plants are in a growth stage. This is usually in the spring and summer when sunlight intensity increases and the warm days are longer. During the short days of winter, many indoor plants that receive little or no artificial light enter a resting stage. If plants go into a winter rest period, it's best to give them little, if any, fertilizer. Plants that have just been transplanted or repotted will obtain sufficient nutrients from potting soil for at least 4 to 8 weeks. They do not require supplemental nutrients during this time.

Potting media

The most common ingredients used in potting soil are peat moss, composted vegetation, sand and perlite. Some potting soil mixtures contain particles of vermicompost or vermiculite for imparting water retention. Commercially available potting soil is sterilized and adjusted for the pH. It is possible to reuse commercial potting soil, provided the remnants of plant roots, fungi, weeds and insects are removed by heat treatment.

A good potting medium like a good garden soil, must meet all the basic requirements of the plant to be grown. It must provide the plant with support, good drainage, adequate air circulation, and retention of water and nutrients. Soilless mixes meet these requirements admirably. Soilless media are maintained at a pH of 5.5 to 6.0.

Typical ingredients of potting mix

- ❖ Peat moss
- ❖ Sphagnum moss
- ❖ Bark products
- ❖ Perlite
- ❖ Styrofoam
- ❖ Vermiculite
- ❖ Water retention crystals
- ❖ Coarse sand

Plant containers

There are several points to consider when selecting a container for an indoor plant, including container size and shape. As a rule, the diameter of the pot should be about one third the height of the plant from the top of the foliage. Plants with shallow roots grow best in shallow containers. Deep rooted plants need more room and require a taller container.

Indoor plant containers are made up of many materials, but clay and plastic are most widely used. Untreated clay pots allow moisture to evaporate from the soil through the sides of the container. This promotes soil aeration and root growth. On the other hand, soil dries faster and plants need watering more often in porous clay pots than in most other types of containers. Plastic pots retain moisture longer. Plastic pots are easier to clean, light in weight, and generally less expensive than clay containers.

Potting

There are two methods of potting indoor plants:

1. Planting directly in the container
2. 'Double potting' wherein a potted plant is placed in another more decorative container.

When plants are potted directly in the container, the container should have a drainage hole and a tray to catch the excess water. In 'Double-potting' only the inner pot should have drainage holes. For transplanting young seedlings into pots, the drainage hole may first be covered with crocks and the soil mixture filled; then a hole with dibbler or a finger may be made in the centre, large enough to receive the seedling, and then firm the soil with fingers leaving 1 cm space below the rim of the pot for watering. The seedling should be watered thoroughly and the pot should be kept in partial shade for few days before shifting to its location inside the room. The pots should never be placed directly in contact with the carpet, floor or furniture as moisture from the pots can damage them.

Characteristic of container

The most important characteristic of an indoor plant container is that it has one or more drainage holes. This permits rapid escape of drainage water, leaching of excess salts, and re-entry of air into larger pore spaces in the soil.

Repotting

Repotting becomes necessary to provide the plant with space for the acquired new vegetative growth and root mass. Usually one move a year into a larger pot is sufficient. Repotting should be done when the plants are growing actively otherwise roots will not resume growth in the new potting mixture.

How to do repotting? The standard procedure is to place one hand, palm downward, across the top of the pot with the plants main stem between your fingers. Turn the pot upside down and tap its rim gently on a hard surface. It should then be possible to pull the pot off the root ball with the other hand. Plants with brittle stems or leaves obviously need to be turned out with great care.

Repotting large plants: Large plants must be laid on their side and the pot rim tapped with a wooden mallet or block to loosen it. If this fails, work the blade of a long sturdy knife around on the inside edge of the pot. Sometimes pots grip so hard that they may have to be broken to take out the plant. The same soil mixture used for potting may be utilized in repotting and firmed with fingers. Below the pot rim 1 cm space may be left to allow for water. The pot should then be thoroughly watered and kept out of direct sun until it is established.

Pinching and Pruning: In pinching, the apical shoots or tips are removed to encourage side growth. This is commonly practised in Coleus, Geranium, Pelargonium, Fuchsia and Chrysanthemum. Faded flowers should be removed from all flowering plants and should not be allowed to seed. It will help in the growth of plants. Roses are pruned once a year to encourage new growth and production of better flowers.

Training: Climbing plants require support to climb and for this purpose moss sticks are ideal. The moss sticks are placed in the centre of the pot. Vines can also be trained on a trellis, bamboo sticks or strings fixed in the pot. They may also be trained on a trellis or strings to form a screen for dividing space in a large room.

Cleaning: The indoor plants must be cleaned regularly by sponging with water, preferably with lukewarm water to remove dirt, dust and grease. A small amount of milk or a few drops of vinegar may be added to the washing water to improve the appearance of leaves. Syringing the foliage with a fine spray of water is also useful, particularly during summer months. The hairy and silvery leaves should be gently cleaned with a soft brush.

Propagation

Indoor plants are propagated by seed, stem cuttings, leaf cuttings, divisions, runners, and air layering.

Seed: For sowing seeds, wooden flats or earthenware pans are used. The soil mixture contains 2 parts soil and 1 part each of sand and leaf-mould or peat. Before sowing seeds, soil should be made fine, free of lumps



Repotting

Green Thumb Tip

Never pull on stems or leaves to remove them. Use sharp pruners or scissors to make clean cuts and to avoid tearing — which can attract a fungal disease



Cleaning Indoor plants

and weeds. Very small seeds may be scattered over the surface, while other should be sown in rows. After sowing, the seed pans or flats should be watered with a watering can having a fine hose. It is preferable to water the plants from the bottom by half submerging the pans in a basin of water or through a wick, particularly in case of very fine seeds. Some of the important indoor plants like Asparagus, Coleus, Cineraria, Salvia, African Violet, Cyclamen, Begonia, Gloxinia, Primrose are raised from seeds.

Stem Cutting and leaf cuttings: The rooting media for stem cuttings consists of coarse sand, vermiculite or a combination of sand and peat. The cuttings are taken just below a node or leaf axils. Before inserting the cuttings, dip their ends in Seradix or any other rooting hormone like IBA, to facilitate rooting. The cuttings may be kept moist until they have rooted. This can be done either by spraying with a fine atomizer frequently or by covering the pot containing the cuttings in an alkathene bag, or placing it under a glass case. The indoor plants which are multiplied by cuttings are Aglaonema, Coleus, Euphorbia, Dieffenbachia, Dracaena, Ivy, Ficus, Geranium, Fuchsia, and Poinsettia.

Leaf cuttings including leaf bud and leaf are used for propagating Cissus, Kalanchoe, Philodendron, while in African violet, Rex Begonia, Peperomia and Sedum only leaf cuttings are used. In Rex Begonia the leaf may be spread on the rooting medium and fixed with toothpicks and each main vein cut with a sharp knife without disturbing the leaf. New plants will develop from these cut ends.

Do you know?
Ferns are propagated through spores

Division

When the plant has made luxuriant growth and appears over green it can be divided for multiplication. The plant may be tossed out with its earth ball intact, the soil shaken off and the clump divided into two or more portions. These new sections may be potted and kept away from direct sunlight for a few days until they are established. Plants such as African violet, Aspidistra, Chlorophytum, Boston fern, Bromeliads, Cyperus, Echeveria, Maranta, Pandanus and Sansevieria can be successfully multiplied by division.

Runners

A few plants like Chlorophytum and Saxifraga throw out aerial runners forming new plants at their ends. In a small pot filled with moist soil mixture containing sand and peat, the runner may be pinned to it and watered frequently. After it has formed new roots the runner may be cut and the new plant established.

Air layering

When the plant becomes lanky as in the case of Dieffenbachia, Dracaena or Rubber plant, air layering can be done to replace the old ones. A length-wise half cut or notch may be made in the stem at the point where new roots are desired, or a ring of bark be removed and the cut wrapped in moist moss and enclosed in a plastic cover with the ends tied with twine. After four to six weeks, when the roots have developed in the moss-ball, they may be cut below the roots and the new rooted plant transplanted in a pot.

Plant Protection

Diseases: Indoor plants are less affected by diseases. The common disease noticed are stem-rot and root-rot found in cacti and succulents usually caused by soil-borne fungi; leaf-spot caused by fungi, bacteria or viruses; and powdery mildew caused by fungi. In the case of stem-rot the affected parts may be removed and sulphur dusted on them for root-rot soil sterilization. Leaves showing symptoms of leaf spot (yellow and brown spots) should be removed and burnt; sometimes spraying with Bordeaux mixture helps to control the disease. Powdery mildew, which causes greyish-white powdery covering on stems and leaves, can be controlled by dusting with sulphur.

Insects: Indoor plants are often attacked by insect pests. Most of them can be easily picked and destroyed. The common insects are Red spider mites, aphids, mealy bugs, scale, green fly, white fly and thrips. The Red spider mites, which inhabit the underside of the leaves of some plants like Dracaena and Azalea and form delicate webs, can be controlled by spraying nicotine sulphate or Malathion. The small, green, black aphids that adhere to the new growth or buds on begonia during cool and cloudy weather are best controlled by a spray of nicotine sulphate and soap or Malathion. Mature scales are brown, while young ones are pale green and are found on Aspidistra, cacti, ferns, Ivy, palm and Indian Rubber plant. The affected plant may be dipped in a dilute solution of nicotine sulphate or sprayed with Malathion or wiped with diluted alcohol. Washing of plants at regular intervals helps to control the scales.

Characteristics of plants used for indoor planting	
Colour	1. Keep variation to minimum, especially in small spaces
	2. Consider colour of all parts-leaves, stems, flowers, fruits
	3. Colour can change due to indoor environment
	4. Consider seasonal changes
Shape or form	1. Usually will use three-dimensional aspect; often can create a two-dimensional picture by using shadows, silhouettes and reflections
	2. The shape of the plant naturally or as controlled by the grower
Texture	1. Does the plant appear fine or coarse?
Fragrance	1. Avoid unpleasant fragrance
	2. Avoid conflicting fragrance
Size	1. At the effective stage
	2. Changes over period of time
Longevity	1. Might depend on skill of the maintenance people

Popular Indoor plants

There are thousands of plants comprising of foliage and flowering plants, which are grown as indoor plants. These can be grown after providing suitable environment in the indoors. Some of these are listed here:

Table 1 Indoor plants for low, medium, and high light locations.

LOW LIGHT

<i>Aglaonema commutatum</i>	Silver Evergreen
<i>Aglaonema modestum</i>	Chinese Evergreen
<i>Aspidistra elatior</i>	Cast-Iron Plant
<i>Chamaedorea elegans</i>	Parlor Palm
<i>Epipremnum aureum</i>	Golden Pothos
<i>Epipremnum aureum</i> 'Marble Queen'	Marble Queen Pothos
<i>Monstera deliciosa</i>	Split-Leaf Philodendron
<i>Sansevieria trifasciata</i>	Snake Plant

MEDIUM LIGHT

<i>Aechmea fasciata</i>	Silver Vase
<i>Aglaonema commutatum</i> 'White Rajah'	White Rajah Aglaonema
<i>Asparagus densiflorus</i> 'Myers'	Plume Asparagus
<i>Asparagus setaceus</i>	Fern Asparagus
<i>Aucuba japonica</i> 'variegata'	Gold-Dust Plant
<i>Brassaia actinophylla</i>	Schefflera
<i>Chamaedorea erumpens</i>	Bamboo Palm
<i>Chlorophytum comosum</i> 'variegatum'	Spider Plant
<i>Cissus rhombifolia</i>	Grape Ivy
<i>Dieffenbachia maculata</i>	Spotted Dumb cane
<i>Dieffenbachia maculata</i> 'Rudolph Roehrs'	Gold Dieffenbachia
<i>Dizygotheca elegantissima</i>	False Aralia
<i>Dracaena godseffiana</i>	Gold-Dust Dracaena
<i>Dracaena marginata</i>	Red-Margined Dracaena
<i>Dracaena sanderana</i>	Ribbon Plant
<i>Fatsia japonica</i>	Japanese Fatsia
<i>Ficus benjamina</i>	Weeping Fig
<i>Ficus elastica</i> 'Decora'	India Rubber Plant
<i>Ficus retusa</i>	Indian Laurel
<i>Gynura aurantiaca</i>	Velvet Plant
<i>Hedera helix</i>	English Ivy
<i>Howea forsterana</i>	Kentia Palm
<i>Maranta leuconeura erythroneura</i>	Red-Veined Prayer Plant
<i>Nephrolepis exaltata</i> 'Bostoniensis'	Boston fern
<i>Pandanus veitchii</i>	Variegated Screw Pine
<i>Peperomia caperata</i>	Emerald Ripple Peperomia
<i>Peperomia obtusifolia</i>	Oval-Leaf Peperomia

<i>Philodendron bipennifolium</i>	Fiddle-Leaf Philodendron
<i>Philodendron scandens oxycardium</i>	Heart-Leaf Philodendron
<i>Philodendron selloum</i>	Tree Philodendron
<i>Pilea cadierei</i>	Aluminum Plant
<i>Pilea involucrata</i>	Friendship Plant
<i>Plectranthus australis</i>	Swedish Ivy
<i>Saintpaulia</i> sp., & hybrids	African Violet
<i>Spathiphyllum</i> ‘Clevelandii’	Cleveland Peace Lily
<i>Spathiphyllum</i> ‘Mauna Loa’	Mauna Loa Peace Lily
<i>Syngonium podophyllum</i> ‘Trileaf Wonder’	Trileaf Wonder Nephthytis
<i>Tradescantia fluminensis</i>	Inch Plant
<i>Zebrina pendula</i>	Wandering Jew

HIGH LIGHT

<i>Aloe barbadensis</i>	Aloe Vera
<i>Alternanthera ficoidea</i>	Joseph’s Coat
<i>Araucaria heterophylla</i>	Norfolk Island Pine
<i>Beaucarnea recurvata</i>	Ponytail Palm
<i>Cissus Antarctica</i>	Kangaroo Vine
<i>Crassula argentea</i>	Jade Plant
<i>Fatshedera lizei</i>	Botanical Wonder
<i>Hibiscus rosa-sinensis</i>	Chinese Hibiscus
<i>Hoya carnosa</i>	Wax Plant
<i>Iresine lindenii</i>	Blood Leaf
<i>Podocarpus gracilior</i>	Weeping Podocarpus
<i>Rhoeo spathacea</i>	Moses-in-the-Cradle
<i>Sedum morganianum</i>	Burro’s Tail
<i>Solenostemon blumei</i>	Coleus

Points to Remember

- Growth and flowering of indoor plants is affected by light, temperature, relative humidity and aeration.
- House plants are grown on soil based growing medium
- For growing house plants on soil-less growing medium the main constituents are peat, perlite and vermiculite
- House plants are grown through sexual and asexual means of propagation
- Over watering is more harmful than under watering in house plants

Activity

- 1 Identify different pot plants in grown in your school campus
- 2 Categorize the plants based on ornamental value like flowering, foliage etc.

Check your progress

A. Fill in the blanks

- 1) Indoor plants grown at a light intensity below their optimum will have _____leaves and less vivid _____.
- 2) In pinching, the apical shoots or tips are removed to encourage _____.
- 3) Most of the indoor plants grow best at a day temperature ranging from _____°C and night temperature of about _____°C.
- 4) Improper _____is the main cause of many indoor plant problems.
- 5) _____ becomes necessary to provide the plant with space for the acquired new vegetative growth and root mass.

B. Short answer/ Descriptive questions:

- Q.1 What are the major factors affecting growth and development of indoor?
- Q.2 Write short notes on importance and purpose served by the indoor plants.
- Q.3 List down different characteristics of plants used in indoor planting.
- Q.4 Explain propagation methods of indoor plants.
- Q.5 Write in brief importance of watering in indoor plants.
- Q.6 Write short note on potting and repotting of indoor plants.

Chapter 8

Commercial Flower Cultivation in Open

Objectives

After studying this chapter, students will be able to:

- identify the flower crops and know their importance
- explain the cultural requirements of flower crops
- identify the problems of flower crops and their management
- identify the major insect-pests and diseases of flower crops and their integrated control measures
- start growing flower crops
- start agribusiness in flower cultivation or development of value added products

Introduction

We all know flowers play an important role in people's celebrations and everyday lives. The feelings of love, affection and joy are conveyed effectively with these non-speaking beauties of nature, for example a lotus conveys purity, rose love, pansy thoughts and narcissus egotism. Flowers have a definite role to play at almost all occasions of human affairs like birth, marriage, worship, adornments and death. You might have seen that most Hindu ladies adhere their hair style with flowers i.e. *gajra* and *veni* and it is one of the important floral ornaments which will add grace to their beauty. All the people irrespective of their origin, race, sex and cadre love flowers. Generally flowers are offered by devotees in temple, gurudwara, church and mosque. Flowers are used as a floral decoration. Even dried flowers are also used in flower craft or arrangement of garlands and bouquets are prepared and offered to welcome the dignitaries. Cut flowers are used for vase decoration that will be a marvelous piece for interior decoration.

Importance of flowers is not restricted up to the beautification, decoration or preparation of *gajra*, garland, *veni* or bouquets but also have the industrial importance too. Some flowers like rose, jasmines, tuberose, *kewda*, *bakul* are used for extraction of essential oils which is base for preparation of perfumes, scents or attar. An important aspect of floriculture is that it is a good avenue to generate gainful employment for youth and women of sub-urban and rural areas.

The floriculture industry is characterized by growing traditional flower (loose flowers) and cut flowers under open field conditions and protected environment conditions respectively. Traditional flowers comprises of rose, chrysanthemum, crossandra, marigold, jasmine, tuberose, China aster etc. In this chapter, we will discuss about the cultural requirements and production technology of important flowers grown in India.

ROSE

Rose is one of the nature's beautiful creations and is universally acclaimed as the “**Queen of Flowers**”. No other flower is a symbol of love, adoration, innocence and other virtues than the rose, and not in our time only, but so it has been for thousands of years. It is certainly the best known and most popular of all the

garden flowers throughout the world and has been growing on this earth for many million years before man himself appeared. Some countries have adopted rose as their national flower e.g. England, USA, Iran, New Zealand, etc.

In India, the rose was referred in old Sanskrit literature as *tarunipushpa*, *atimanjula*, *simantika*, etc. and was adorning not only the royal palaces but also the *ashramas* of saints. It has become the part and parcel of life, being connected with all phases of life right from birth to death. The growing of this beautiful flower in India developed with the distillation of roses as mentioned in *Ayurveda* by Charaka around 100 AD. The interest in cultivation, however, increased considerably mainly during the last three decades and at present it has become the most important commercial flower.

It is a versatile plant and the fantastically large number of types available is one of the reasons for its great popularity. Now roses are grown for every purpose and even the person with only a tiny plot of land will find there are varieties available to him which will provide a welcome splash of colour to a wall or furnish quantities of exquisite cut flowers. Now-a-days, roses are grown throughout the country and perhaps no flower is more loved in India. The roses are valued for worshiping and for making garlands in our country. Recently the Rose Society of India has developed a beautiful National Rose Garden in New Delhi.

Importance and Uses

The rose, because of its utility, occupies a pre-eminent place amongst the flower crops and is one of the oldest of fragrant flowers to be cultivated by man. Its different types having beautiful flowers of exquisite shape, different sizes, bewitching colours and most delightful fragrance has made it an important flower or its varied uses. The various ways in which rose can be used are mentioned in detail here.

A. Exhibition and decorative purposes

Varieties of roses which are most suitable to a particular type of decoration are given here.

1. Shrub or bush

Shrub or bush roses are prepared by budding the desired cultivars on a rootstock at a height of 5-10cm from the ground level to create excellent mass effect in a rose or flower garden. They may also be mixed with other plants in a shrubbery. Flowers on such plants can either be retained on the plants or can be cut for indoor decoration. Cultivars like Christian Dior, First Prize, Gladiator, Kiss of Fire, Montezuma, Paradise, Peace and Super Star are suitable for growing as shrub.

Do you know?

Rose in India is commercially grown as cut flower, loose flower, perfumery crop and garden plant.

2. Standard rose

Standard rose or tree rose is a very important feature in the rose garden. They are allowed to form buds only at the top leaving the entire stem clear of any vegetative growth. According to their height of budding they may be full standard (1.0 -1.5 meters high), half standards (45-60 cm high) or weeping standard (1.5 meters). Hybrid Teas and few Grandiflora cultivars are suitable for making the full standard roses. Floribunda and Polyantha roses are excellent for growing as half standards. For weeping standards, climbing and rambling roses are used, as the long branches of the crown may be allowed to droop down. The most ideal and common type for this purpose is the Banksian rose.

3. Climbers

The climbing and rambling roses can be used to cover the walls of houses or fencing or pergolas, arbours and arches. Ramblers produce flowers only once in a year and flowers are in clusters lasting for several weeks. Unlike ramblers, the flowers of many climbing Hybrid Teas appear singly or in group of twos or threes. The beautiful climbers and ramblers like American Pillar, Blaze, Delhi Pink Pearl, Don Juan, Golden Showers, Mardan White, Mardan Pink, Marechal Neil and Royal Gold add to the beauty in the garden.

4. Hedges and edges

Roses can also be used for making hedge or edge. Rose hedges except when pruned, remain full of life and colour and give protection due to the presence of thorns/ prickles. Vigorous Floribundas are suitable for hedge and if necessary, the plants can be planted in two rows. Some suitable cultivars are Border, Coral, Circus, Frensham and Rumba. Climbing or rambling roses may also be used for making tall hedges. Rose cultivars like Carolin, Lady Reading, Magic and White Button etc. may be used for making edges.

5. Rockery

Roses are also grown in rockeries and for this purpose hardy miniature and pompon cultivars such as Fairy Queen and Magic may be selected.

6. Pot plants

In the recent years, roses have occupied a prominent position in the top ten pot plants in the international market. Roses in suitable containers are kept both indoors as well as outdoors. For beautifying the balconies and terraces which receive limited sunlight, miniatures and dwarf Polyanthas should be selected. The cultivars like Baby Darling, Cinderella and Starina etc. are quite suitable for this purpose.

7. Hangers

Miniatures can also be grown in hanging baskets and cultivars suitable for making rose hangers are Climbing Miniatures-Red cascade and Yellow Doll.

B. Cut-flowers

Apart from making garlands, bouquets, button-holes their use for worship in temples, rose makes one of the best cut flowers and as such is in great demand in the internal as well as foreign markets. Germany is the biggest consumer and importer of cut-flowers. Rose cut-flowers are being exported from Maharashtra (India) to the Middle East countries.

Rose cut-flowers arranged in flower vases looks extremely beautiful and they have a rightful place in the scheme of interior decoration. In general, cultivars with more petallage and opening slowly with long lasting quality are chosen as cut flowers. Some of the cultivars suitable for this purpose are Christian Dior, Happiness, Montezuma, Queen Elizabeth, Sea Pearl and Super Star. Presently cultivars viz., Belinda, Golden Times, Illona, Montreal, Mercedes, Red Success, Sonia and Meilland are in great demand as cut-flower in foreign markets. Two Indian cultivars Arjun and Raktagandha producing flowers with long stems are also suitable for cut-flowers.

Do you know?

Roses are seen almost in all colors except blue and black because for their color synthesis. Now gene is available in rose i.e. Delphinidin, which is responsible for blue color.

C. Perfume and allied products

1. Rose oil (Rose perfume)

Rose oil is an important commercial product obtained from rose petals. Apart from sweet fragrance it has medicinal value and is often used in Ayurveda. Bulgarian rose is largely used in perfuming soaps and cosmetics. Rose oil has antibacterial property. The commonly grown rose species for rose oil are *Rosa damascena*, *R. bourboniana*, *R. centifolia*, *R. alba* and *R. gallica*. In India, *R. damascena* and *R. borboniana* are cultivated for rose oil.

Though France, Cyprus, Greece, India, Iran, Italy, Morocco and the USA are important countries producing rose oil, Bulgaria is a major producer and exporter of the *otto* of roses and the rose perfumery. The oil is extracted by steam distillation and its quantity depends much upon the quality of rose flower picked, the species and cultivars and stage of picking. To obtain good quality rose oil, the flowers are to be harvested early in the morning, as the percentage of volatile oil decreases with the advancing day at higher temperature.

Generally 1 litre oil is obtained from 3,000-4,000 kg petals. Among the different species, *R. damascena* gives the maximum oil yield. The principal constituents of normal rose oil are l-citronellol (40-65%), geraniol, nerol, l-linalool, phenylethylalcohol, small quantities of esters, nonyl aldehyde, citral, eugenol sesquiterpenes and the waxy constituent stearoptene.

2. Rose water

Rose water is also an important commercial product obtained from rose petals. It is used as a perfume and in medicines and confectionary. It has the property of cooling the body and is often used in eye lotion and eye drops for its soothing qualities. It is also used in drinking water and social occasions. The roses used for preparing oil are also used for making rose water.

3. Gulkand

Rose petals are also preserved for direct consumption by making *gulkand* which is prepared by pounding equal proportions of petals and white sugar. It is considered both a tonic and laxative. *Rose damascena*, *R. chinensis*, *R. gallica*, *R. ponifera* and some other scented roses.

4. Pankhuri

Dried rose petals are known as '*pankhuri*' which is occasionally used for preparing sweetened cold drinks.

5. Gul-roghan

It is a kind of hair oil prepared from rose petals by effleurage with wet sesame seeds.

D. Source of vitamins

Rose hips are a very good source of ascorbic acid, i.e. vitamin C. Every 100g of rose hips syrup contains 150 mg of ascorbic acid as compared with only 50 mg present in fresh orange juice, 20 mg in tomatoes and 5 mg in apples. The ascorbic acid content, however, varies with species and some of the promising vitamin C containing species are *R. rugosa*, *R. amblyotis*, *R. acicularis*, *R. davurica*, *R. pendulina*, *R. glauca* and *R. canina*. Apart from Vitamin C, the hips of *R. roxburghii*, *R. acicularis*, *R. rugosa*, *R. davurica* and some other species are found to contain vitamins, A₁, B₂, K and E.

E. Other Uses

In Europe, roses are used for making pot-pouri, conserves, rose- vinegar and rose petal wine. Jams, jellies and syrups have been made for centuries in Bulgaria and exported. Rose aids in digestion and has certain curative properties. In Czechoslovakia, fruits of wild roses are used for preparing a hot drink like tea and a popular wine. In America, bushes of *R. multiflora* are utilized as shock absorber or crash barrier.

Do you know?

Rose hip is rich in antioxidant, high carotenoid content, phenolic compounds and folates

2. Soil and climatic requirement

Although any soil is good for rose cultivation provided it has proper drainage, the ideal soil should be medium loam having sufficient organic matter, pH of 6.0 -7.0. The land where the external drainage is poor and water stagnates during monsoon should not be selected for rose growing. In very heavy soils, gravel and sand may be mixed into the bed to allow drainage. The land with high water table is not suitable for rose beds.

The climatic conditions of India are well suited to rose cultivation. Roses need bright sunshine and free ventilation. Sunshine for six hours is ideal for better growth and flowering. In the northern plains, roses flower best during winter whereas in the temperate hilly regions of the Himalayas during summer. Most rose cultivars grow best at a temperature range of 15° to 25°C producing good quality and quantity of flowers. Western parts of India have excellent agro-climatic conditions for rose growing. The plains of eastern India are suitable for the cultivation of many rose cultivars. Bangalore has mild climate, where roses can be grown for flowers throughout the year.

3. Commercial cultivars

A brief description of some of the cultivars:

Hybrid Teas

1. **Dr. Bharat Ram:** High centered pointed buds of peach pink colour are borne on long stems of vigorous bush. Apricot flowers of pink shade are produced in big bunches during spring.
2. **Pusa Bahadur:** Red coloured high centered buds open slowly to flat flowers having long keeping quality on long, straight and strong stems. Good for cut flowers production.
3. **Pusa Garima:** Very long, high centered, deep pink buds open to exquisitely shaped, large flowers of medium pink on long and sturdy stems. It is good for garden and exhibition purposes.
4. **Pusa Gaurav:** Large sized flowers of deep pink to red colour are produced on very long and sturdy stems. It flowers round the year and tolerant to most of the diseases, particularly die back and black spot.
5. **Pusa Priya:** It produces attractive light pink flowers which borne on uniformly thin, long and sturdy stems. Flowers have long lasting quality and opens fully.

Floribundas

1. **Pusa Barahmasi:** It has attractive deep pink flowers produced in bunches. Very hardy plants, flowers round the year.

2. **Pusa Pitamber:** It produces very attractive golden yellow coloured flowers with sweet fragrance. It is tolerant to powdery mildew and black spot.
3. **Pusa Virangana:** Large deep red flowers produced freely on vigorous tall and spreading bushes.

4. Layout and preparation of Beds

The plan of rose garden and design of the beds should be simple and informal. Rose beds may be of various designs, depending upon the liking of the grower. However, rectangular beds are advantageous for maintenance. The width of the beds should be such that operations like weeding, hoeing, forking, cutting of flowers etc. can be done from both the sides of the bed, without stepping into the bed. A plot size of 6.0 x 1.2m or 6.0 x 1.65m is better for rose plants management.

Preparation of Beds

Preparation of soil is the key to success with roses. It should be rich, porous and well drained. The initial preparation of rose beds should preferably be started during summer season, so that soil gets exposed to sun and air and during the monsoon it gets a chance to settle down before planting. The area selected for rose growing should be cleaned of weeds. According to the plan, the borders of the proposed beds should be properly marked.

If the soil is light, sandy and stony, the top 30 cm of the soil in the trench should be dug as deep as possible. The dug up soil is heaped on the ground. After that about half portion of the dugout soil, heaped on the ground surface, should be returned to the trench. This layer needs manuring with organic manure @ 50-60 tonnes/ha or FYM or compost. The remaining portion of the dugout soil should be returned to the trench. On the other hand, if the soil is heavy it would be necessary to dig out the second 30 cm layer of the soil and heap on the ground surface. The next layer of the soil should be deeply dug, pulverized and leveled. The second layer of soil after it is pulverized and sun-dried, should be returned to the trench and manured with organic manure @ 50 tonnes/ha.

5. Propagation

Among propagation methods, budding is most popular in our country because it produces better quality flowers and faster growth of plants. Other methods like, seed propagation, layering, grafting is also important.

1. Budding

Budding is the most popular and successful method for multiplying roses. It provides larger number of plants than cuttings, layering or grafting, as a single shoot of the desired scion furnishes a number of buds for budding. T-budding is the method ordinarily used. On the selected rootstocks, the buds are inserted into a T-shaped incision and then tied with suitable wrapping material. It takes 3-4 weeks for the buds to unite. The side branches of the stocks are removed which compete with the scion for supply of nutrients and water.

2. Grafting

Inarching or grafting is another method of propagating roses but the cost of a grafted plant in the long run may be higher than that of budded plant. The rootstocks are raised in small pots or polythene bags. The scions are selected and the stocks are brought near the selected scion shoots. A strip of bark, about 3 cm long with a part of wood, is removed from the stock as well as from the scion, and the latter is attached properly on

to the stock and wrapped. After union the scion shoot is cut below the graft and the rootstock above the graft union.

3. Layering

This type of vegetative propagation is usually practiced in climbing and rambling roses during the monsoon or early spring season. Layered plants thrive and bloom quite well as budded or grafted plants. This method has two types, ground layering and air layering.

4. Cutting

Propagation of roses by cuttings is normally done to raise stocks for grafting or budding. Climber, Rambler, Polyantha and Miniature roses respond quite well to this method.

5. Stem-cutting

Raising plants by stem-cuttings is one of the least expensive and easiest methods of rose multiplication. Usually, stem cuttings give satisfactory results when rooted during the period from late June to November. Cuttings should normally be taken during the monsoon or spring. Each shoot should be cut clean just below the node and lower leaves removed.

Sand is the best rooting medium but vermiculite or perlite also gives satisfactory results. The cuttings are usually planted 3 cm apart in a row and 8 cm between rows and watered as per the need. Within a month or so, roots and shoots will develop from the cutting and in about a fortnight, the plants may be transplanted in another well prepared bed or in pots.

Regeneration of rose plants from cuttings is influenced by various factors such as type of cutting, treatment of cuttings, the age and physiological condition of the stock plant, type of wood selected for cuttings and environmental conditions during rooting. Hardwood cuttings are widely used in the propagation of rose rootstocks.

5. Seed propagation

This method of propagation is generally adopted by breeders for developing new cultivars with desirable characters. When the fruits are fully ripe, they are harvested and thoroughly dried before the extraction of seeds. Most rose seeds when mature are in a resting condition requiring an after-ripening period before germination. Stratification of seeds at 1.6-4.4° C is required after harvest. Hybrid rose seeds usually respond best to a stratification temperature of 1-4°C for 69-90 days.

Clean seeds are sown about 5 cm apart in pans or in small plots to raise the seedlings. Soil used for this purpose should be prepared adding a good quality of well rotten farm yard manure. Though the time of sowing mainly depends upon temperature, sowing in the months of October- November is ideal in most of the places. Seeds may take several weeks to germinate.

Rose seedlings tend to flower, even when they are very small and this exhausts them. Therefore, the flower buds should be pinched off as soon as they appear, until the plants are reasonably large and sturdy. It is important to keep the seedlings growing continuously without any check in development.

6. Selection of rootstocks

For grafting or budding, proper selection of rootstock is of immense importance. Rootstocks are known to impart marked effects on the vigorous, precocity, productivity, quality of flowers, longevity of bushes, disease resistance, adaptability to soil climatic conditions etc, and therefore, it is important to choose the most suitable rootstocks for budding or grafting roses. The rootstock should have the following qualities:

- It should produce fibrous root system.
- It can easily be propagated from cuttings.
- It should have vigorous growth habit, be healthy and resistant to diseases and frost.
- Plants should have uniform growth.
- It should have a bark, thick enough to hold the bud firmly and provide sap to the budded plant.
- It should be reasonably free from suckers
- It should support the budded plant for a long time.
- It should withstand a wide range of soils and climatic conditions.

Some of the commonly used rootstocks are: *Rosa bourboniana* (Edward rose), *Rosa canina* (Dog rose), *Rosa indica* var *odorata* (better for northern plains), *Rosa laxa*, *Rosa manetti*, *Rosa multiflora* (widely used rootstock for outdoor roses and well suited for hills).

7. Cultivation

Planting, pruning, application of manures & fertilizers, irrigation and weed control are some of the cultivation practices that are described here.

A. Planting

Few important preliminaries for planting are given here:

- Cut away all immature, dead or diseased shoots and snags. Also as far as possible, each shoot to the next outward growing bud should be cut.
- Remove all suckers growing below the point of union.
- Reduce the possibility of loss of moisture; leaves including dried and yellow ones should be removed.
- If the roses are with shriveled bark, immersing of the plants in water for 24 hours is necessary to plump them.
- Immerse each plant in a suspension of two grams blitox per litre of water to lessen the risk of attack of fungi.

Though the planting of roses in North Indian plains can be done from August to March but the best time is September to October. In hills, the best planting time is either during October to November or February-March. In the plains of Eastern India, roses are best planted in September to December.

B. Pruning

Pruning refers to the removal of certain portion of plant. It is an important operation for maintenance of floriferous-ness and flower quality along with vigor of rose plants. The practice of rose pruning consists of two operations.

- Thinning out, i.e. removal of old, weak, dry, twigs and diseased stem and branches from the point of start.
- Shortening of stems, which aims at cutting down of last year's growth to a desirable height.

The best time to pruning is the period when the activity of the rose plant is least and the plant is almost dormant. Thus pruning time will depend entirely on the climatic conditions of the region. In temperate climate, it is normally done in November-December. In most of India and especially in the Indo-Gangetic

plains it is done only once. In mild climatic conditions, roses are pruned towards the end of November and again towards the end of June and hence there are two distinct flowering seasons.

C. Plant management practices

Other plant management practices are: pinching, disbudding, de-shooting, defoliation and removal of faded flowers are the plant management practices done for rose cultivation.

1. Pinching

Removal of a part of terminal growing portion of stem is called pinching. It reduces the plant height but promotes axillary branching and also prevents maturity of flower bud.

2. Disbudding

Removal of undesirable buds is known as disbudding. Keeping only the central bud and removal of others causes development of a quality bloom.

3. Deshooting

Deshooting is generally followed in Hybrid Tea roses. Young vegetative shoots developing from the axils of leaves of basal and lateral shoots are removed to allow only one terminal shoot. In several rose cultivars such side shoots develop from the eyes down the stem below the terminal flower bud. If these shoots are not pinched off at the initial stage, plants become much branched and produce a number of small flowers.

4. Defoliation

Although defoliated plants produced about twice as many shoots as un-defoliated, many of them are blind and the total number of flowers is less. Complete defoliation causes atrophy of almost all flower buds. Removal of only mixture leaves causes about 50% blindness. Removal of only young leaves however does not cause blindness.

Removal of leaves on dormant shoots result in the production of short and non-flowering shoots. Removal of the upper most leaf at the time of pinching results in highly significant increase in flower production. Leaf removal from semi mature shoots is more effective on flower production than from young shoots.

5. Removal of faded flowers

Removal of faded flowers is called deflowering. If the spent blooms are not removed in time, there is a chance of developing fruit bearing seeds. Once the hips are formed and reach the advance stage of development, growth and flowering are severely reduced during the season. Cutting of faded flowers forces a strong lateral which produces a good quality flower.

8. Manuring and fertilization

Rose is a nutrient loving plant and both major and micro nutrients play an important role for its proper growth. Manuring in case of new planting is done at the time of preparation of rose beds or pits, and for the established plants the normal practice is to add well decomposed FYM @ 8-10 kg/plant or 2 tons per 100 m², every year just after pruning. For applying NPK through fertilizers it require a mixture of about 50 g per plant or 10 kg per 100 m² having urea, single super phosphate and potassium sulphate in the ratio of 1:3:2 each time for 3 applications i.e. first at pruning second at the end of December when the first flush is over and third at the end of February when second flush of blooms is over but spring blooms follows immediately after it.

The foliar feeding is made up of urea 2 parts, dihydrogen ammonium phosphate 1 part, potassium

phosphate 1 part and potassium nitrate 1 part. Three grams of this mixture per litre of water is sprayed along with 1.5 gm of *teepol* or liquid soap at 10 days interval until last flush in March.

9. Irrigation

Adequate soil moisture at all stages of vegetative growth and flowering is essential for the rose plants to meet the water loss through transplantation and evaporation from soil. Water requirement also depends upon the size of the plant and the growth period. In lighter soil more frequent irrigation is required than that in heavy soil. Rose beds can be watered once a week or 10 days in winter and twice a week during summer season.

10. Mulching

Mulching conserve soil moisture, supply humus making material and suppress weeds resulting in improved growth and flowering. Mulches also keep the soil some what cooler in summer. Among the substances used for mulching, well rotten garden compost, FYM, peat, straw, sawdust, ground or whole corn cobs and other similar materials make satisfactory mulches. Mulches can be applied soon after the newly benched plants are established and growing satisfactorily.

11. Hoeing

Light hoeing is a very effective way to keep the soil porous so that light, air and water may reach the roots better to improve moisture retention capacity and to keep rose beds free from weeds. Roses are shallow rooted plants and roots of established plants tend to grow near the surface. Therefore, shallow hoeing is preferred.

12. Weed control

Weeds pose a very serious problem in rose cultivation as they not only consume water and nutrients from the soil, but also act as hosts for a number of diseases and pests. Manual weed control is effective if done frequently. Chemical weed control is comparatively economical, convenient and efficient in eradicating weeds. Application of Diuron 2.0 kg a.i./ha or Oxyfluorfen 0.5 kg a.i./ha or Glyphosate 1.0 kg a.i./ha effectively control the weeds without any phytotoxic effects.

13. Diseases and Pests

Pest and diseases, if not controlled properly in time, may result in considerable loss of flowers and plants. Therefore proper spraying schedule should be followed to combat them effectively. Some of the rose diseases which have been found very destructive are described below:

1. Die-back

The causal organism is a fungus namely *Diplodia rosarum*. The disease causes death of the plant from top to downwards. When plants are pruned, sometimes, blackening of twigs starts below the pruned surface which extends further down, killing the whole plant. The older plants are more prone to the attack of the disease.

Removals of affected part about an inch below in the healthy tissues and use of bavistin paste/spray afterwards control the disease. Some systemic fungicides like carbendazim (1g/litre) should be used as soil drench.

2. Black spot

This disease is caused by *Diplocarpon rosae* characterized by dark brown, circular spots with fringe borders, present on both sides of leaflets. At a later stage, the leaves become yellow and fall. If left

uncontrolled, the whole stem is defoliated and the plant becomes weak. Leaf buds and the flower buds are also affected.

Since the black spot fungus is located under the protecting cuticle, no fungicide can kill it without destroying the leaf. Hence, cure of this disease is difficult and prevention seems to be the only hope. The infected leaves, as soon as they are observed should be clipped off, taken out of field and burnt. Preventive sprays of fungicides like Zineb reduce the damage to a large extent.

3. Rose wilt

It is a viral disease caused by *Marmor flaccumfascines*. The first symptom appears in the form of recurving of leaflets at the tip of young shoots which are brittle. Defoliation may happen, with leaves turning yellow and falling off. The stem also gets infected and the whole plant dies. In epidemic form, one infected plant could ruin the whole garden within a couple of years. Control of aphids, which transmit the disease, helps to control the infection. The affected plants should be removed and burnt.

4. Rose mosaic virus

Chlorotic areas along the midribs of the leaflets and localized distortion are the principal symptoms. Sometimes one finds ring and watermark pattern. Another strain of this virus causes brighter and light yellow patterns. Diseased plants should be destroyed and never used for propagation.

B. Pests

Roses attacked by a large number of pests which cause considerable damage. At almost every stage, be in the nursery or in beds, rose plants are prone to attack by various pests. Some of the commonly reported insects and other pests attacking roses are mentioned in detail here.

1. White ants

White ants also known as termites cause damage to rose plants even before they are established. Small colonies are formed inside the soil and the insects multiply very rapidly during the rainy season. The insects destroy the underground parts including the roots of the young as well as old plants. Sometimes rose plants wither. Drenching of chloropyriphos (0.05%) in the pits before planting roses controls the damage in established gardens.

2. Red scales

They infest roses in the green house and in the garden and the affected branches become dry. The insects can easily be detected by the reddish brown encrustations on the lower portion of old stem and at times the younger shoots also which sucks the plant sap.

The menace can be removed by rubbing the scurfy encrustations with a used tooth brush, or a cotton swab dipped in methylated spirit. Spraying the affected plants with insecticides like malathion or rogor will control the insect. Application of granular insecticides like carbofuron at 1.5 kg a.i./ha and Disulfoton and Phorate at 3.0 kg a.i. /ha also gives good control of rose scales.

3. Jassids

These are very small, light grey or pale green insects which suck the cell sap from the leaves. It causes yellowing or whitening of the attacked surface, giving the plants a sickly appearance. Jassids can easily be controlled by spraying with 0.03% parathion, 0.1% Metacid or 8% Thimet as soil application.

4. Red spider mite

As a result of their feeding, white specks appear on the leaves and these specks coalesce and appear as white patches. Ultimately, affected leaves become mottled, turn yellow and fall. Some Polyantha and Floribunda roses completely lose their leaves prematurely due to the attack of this pest. The damage is more pronounced during warm and dry season.

Frequent spray with wettable sulphur helps to control this mite. Several mite-killers such as dicofol, kelthane, morestan, omite, pyromite, ethion have been reported to be very effective in controlling rose mites.

CHRYSANTHEMUM

Chrysanthemum (*Dendranthema grandiflora* syn. *Chrysanthemum morifolium*) belongs to family *Asteraceae* and commonly known as autumn queen or *guldaudi*, is next to rose in importance among the flower crops in the world. It grows both for aesthetic and for commerce. Historically, Confucius, the great Chinese Philosopher has in his writings mentioned chrysanthemum as early as in 500 BC making it one of the most ancient cultivated flowers of the world. It was proclaimed as the National Flower in Japan by Emperor Uda in AD 910 and a sign of royalty. Its present-day colourful varieties have risen through indiscriminate inter varietals hybridization, spontaneous and induced mutations and selection. Two kinds of florets are present in a bloom. The florets which are present at the centre of the bloom are called disc florets. The outer broad florets are called ray florets. In some cases the disc is visible and well-developed, whereas in others it is covered with florets. Ray florets may have different directions of growth and be arranged on the receptacle in distinctive patterns. Some of the florets may curve upwards and inwards.

The chrysanthemum bloom type depends mainly upon the relative number of 2 kinds of florets, their shapes and directions of growth. They are mainly classified as large-flowered and small flowered. Its commercial cultivation is being done in Maharashtra, Rajasthan, Madhya Pradesh and Bihar. Its cultivation in Delhi, Kolkata, Lucknow, Kanpur and Allahabad is, however, mainly for the sake of decoration of surrounding and participating in flower shows, with the help of pot grown plants.

1. General Uses

- Tall and erect varieties are suitable for background planting in borders.
- The compact & dwarf varieties are used for pot culture
- Flowers with attractive colours with long stem having long vase life are suitable for cut flower production
- The decorative small flowered varieties are used for loose flower and garland making and hair decoration
- The varieties having large flowers are used for exhibition material

2. Types of flower

In chrysanthemum flowers are classified by the kind and arrangement of florets into five broad groups:

1. **Single:** Strap like ray florets in not more than 5 whorls. The disc is conspicuously visible.
2. **Anemone:** The disc is raised as a result of well-developed disc florets. The ray florets may be ligulate or tubular.
3. **Pompon:** Ray florets short, broad and regularly arranged to give the bloom a compact, hemispherical shape. Disc not visible.

4. **Decorative:** Like double flower except that the disc is not visible due to the presence of ray florets all over the capitulum.

5. **Large flowered**

3. Soil and climatic requirement

A well-drained, sandy loam soil of good texture and aeration, with a neutral or slightly acidic pH (6.5-7.0) and a high organic content is ideal for Chrysanthemum. Very light sandy soils are not recommended owing to their poor moisture, binding properties. Chrysanthemum is a short day plant which means that flower bud initiation and flower development are controlled by the day length. Depending on the location, planting date should be adjusted so that cultivars are exposed to long days to attain sufficient vegetative growth and short days for flower production.

Among the climatic factors, light is the most important factor which influences the growth and flowering behaviour. Under long day condition, chrysanthemum tends to remain vegetative and when the day length of the dark period exceeds 9.30 hours, flower bud initiation occurs and bud development takes place when the dark period exceeds 10.30 hours.

Do you know?

Chrysanthemum normally flowers about one month earlier in hills than north India plains/ South India under natural open field conditions.

Based on temperature requirements chrysanthemum cultivars are classified into 3 groups.

- A). Thermo zero cultivars which flower at any temperature of 10-27°C; consistency is at 16°C.
- B). Thermo positive cultivars require a minimum of 16°C for bud initiation and at 27°C there will be rapid bud initiation.
- C). Thermo negative cultivars, bud initiation occurs at low or high temperature between 10°C and 27°C but continuous high temperature delay bud development.

4. Commercial varieties

Chrysanthemum varieties have been categorized depending upon the purpose for which they are used. A cultivar suitable for pot-culture may not be fit for growing as cut flower. Similarly, a cultivar may be suitable for cut flower purpose into for garland making. Some important varieties are:

Standard cultivars: Purnima, Yellow Star, White Star, Snow Ball, Tata Century, Basanti, Sonar Bangla, Shanti, Indira, Rakhi, Red Gold, Vaatika, Sharad Mala, Jaya and Thai Ching Queen.

Spary cultivars: Apsara, Birbal Sahani, Jayanti, Jubilee, Baggi, Nanako, Riot, Arctic, Kundan, Surf, White Bouquets, Cameo, Ajay and Charlia.

5. Propagation

Chrysanthemum is propagated by seed, cuttings and suckers. To get true type, it is mostly propagated by cuttings and suckers. All varieties do not set seed. Only a few varieties set seed in large-flowered chrysanthemums, whereas more varieties set seed in small flowered ones.

1. Seeds

Small-flowered varieties are grown from seeds, suckers and cuttings due to its polyploidy and heterozygous nature, a wide range of variations are observed from seedlings. Garden chrysanthemums do

not reproduce true-to-type from seeds. Seeds are collected during last week of December or first week of January when blooms are dried. The seeds are sown after 15 February either in earthen pots or nursery beds. The seeds are covered with a thin layer of leaf-mould and soil and then watered. They germinate within 7-10 days. Seedlings are ready for transplanting, within 40 days. Seedling propagation method is not used normally for routine, cultivation. Due to wide range of variability, sometimes superior varieties are selected from seedlings.

2. Suckers

After flowering, the stem is cut back just above the ground. This induces the formation of suckers which are separated from the mother plant and are planted in sand bed. Well rooted suckers can be directly transplanted to the main field. The advantages of this method are natural availability of suckers, their easy establishment, almost 100% survival and early take-off due to already persistent roots. The main disadvantages are transmission of parental diseases to progeny and lack of uniformity and poor flower quality.

3. Cuttings

Terminal cuttings of 5-8 cm long are taken from healthy stock plants, shearing basal leaves and cutting half of the open leaves. The cuttings are dipped either in 500 ppm Indole Butyric Acid or Seradex. Cuttings are inserted 3 to 5 cm apart in sand and watered immediately and thereafter regularly. They are ready for transplanting in 3-4 weeks. The advantage of this method is that the plants developed from cuttings are mostly uniform and the risk of disease transfer is less. Growth is comparatively slow than suckers, mortality rate is higher due to rooting process. All the plants are encouraged to grow fast from the time of planting.

6. CULTIVATION

Soil preparation and Planting

Chrysanthemum needs well prepared soil. Addition of organic matter in the form of peat or rotten manure improves the soil structure and helps in the development of plant. Before planting, soil should be properly sterilized to prevent diseases and pests.

It is extremely important to plant the cuttings immediately after they are rooted. Rooted cuttings should be graded according to size and those of same size be planted together for uniform growth. A small plant surrounded by larger plants cannot develop properly and bound to remain weak and produces an indifferent crop. While planting, the roots should remain spread out in all directions and should not be buried deeper than 12 mm.

Planting density

Planting density not only influences the growth and development but also plays an important role on production and quality of flowers. This also varies according to cultivar, place and time of planting. Closer spacing suppressed plant growth. The best plant population is 25-32 cuttings/m² economic returns.

7. Manuring and fertilization

The growth of newly propagated sapling largely depends upon the nutrient supply made available to it. Chrysanthemums are heavy feeder and have large requirements for both nitrogen and potassium. The emphasis in the early stages should be on nitrogen supply using organic manures. Phosphorus is best applied as basal dressing since it is released slowly. Proportion of potassium should be increased as the flower buds appear. The rate of nitrogen application should be reduced as buds appear. Application of 50 kg nitrogen,

160 kg P_2O_5 and 80 kg K_2O per hectare as basal is done. Top dressing of crop with 50 kg nitrogen/ha at the time of first pinching is also recommended.

8. Irrigation

The frequency of irrigation depends on the stage of growth, soil and weather condition, besides on whether the plant is grown in the ground or in the pot. The soil is to be kept constantly moist till the plants get established from planting, after which the condition of scarcity and sufficiency of water should alternate for ideal growth. To avoid water-logging during the rainy season plants are usually planted on rides. While irrigating the beds, a thorough drenching is preferable to surface wetting.

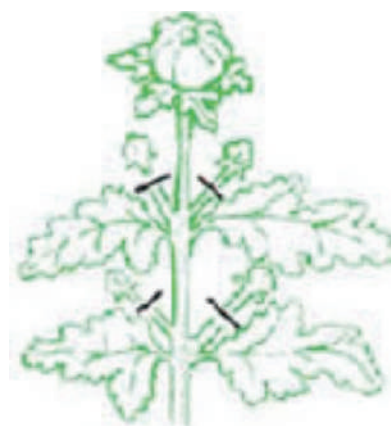
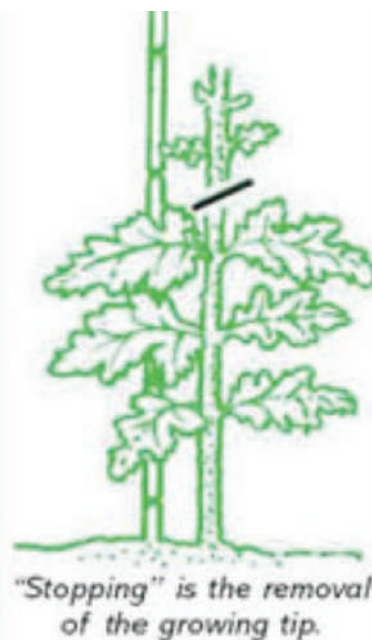
9. AFTER CARE

1. Staking: Staking is necessary to keep plants erect and maintain proper shape of plants and bloom. There are only few flowering varieties which neither require pinching nor staking and hence known as 'no stake no pinch' varieties. Stakes are prepared mostly from bamboos. Staking of plants is required for vertical support of the plants. Number of stakes to be used mostly depends upon the grower. Only one stake is used when a grower needs single bloom/plant. The stakes are inserted in the pot slightly slanting outward so as to provide sufficient space for flower development at the top. When the bloom starts showing colour the surplus length of the stake is uniformly cut below the level of bud for uniform growth of bloom.

2. Stopping: It is the act of removing the growing tip of the plant, whether they be blooms or sprays, to encourage the earlier production of side shoots which will in turn bear the flowers. "Stopping" is best done when the plants are 10-15cm (4-6") tall and is the simple act of pinching out the growing tip. If there are signs that the plant is already forming a bud then it is of paramount importance to cut back to perhaps less than 10cm (4") to remove the budding tendency. Once "stopped" the plant will be encouraged to produce side shoots.

3. De-suckering: During the vegetative growth phase, plants grow upwards. New suckers continue to develop from base of plants. For proper and vigorous growth of plants, suckers are removed time-to-time.

4. Disbudding and de-shooting: These operations are mostly performed for large flowered and decorative chrysanthemums. Disbudding varies according to the type of chrysanthemum grown. Many of the varieties are disbudded or standard types, in which the largest terminal bud is reserved and all axillary buds are removed. Disbudding of spray varieties is very easy because in this case only the large apical bud is removed and the axillary buds are allowed to develop. There is no specific rule for disbudding of spray varieties. It varies with the type of spray produced. Disbudding operation is an important factor in the maintenance of high quality product.



10. Growth regulation

Growth regulation can be done by controlling the environment as well as by use of plant growth regulators. Long day condition result in extended vegetative growth and immediate shift into a short day condition results in flower bud initiation.

Chemical growth regulation can be done with growth regulators. GA₃ (500ppm) spray at 30, 45, 60th day after planting will increase the total flower yield. Number of quality flowers can be increased by spraying triconanol (100mg/l). Ascorbic acid spray at a concentration of 1000ppm either on 30th day or 70th day after transplanting significantly increased the overall growth rate. B-nine (5000ppm) spray resulted in highest number of flowers per plant.

11. Off-season flower production

It can be obtained by either selecting suitable cultivars or by controlling photoperiod.

A. Cultivars

Early (70-100 days:	Jaya, Jubilee
Mid season (100-130 days)	Ajay, Kundan, Shyama
Late (more than 130 days:	Gulmohar

B. Controlling photoperiod

Flowering in chrysanthemum can be regulated by controlling photoperiod. Artificial long days are provided for getting vegetative growth while artificial short days for getting flowering. These both are provided during the times of unfavourable natural photoperiod.

Procedure of controlling photoperiod

1. **Artificial long days:** Artificial long days are provided with the help of 60 watt incandescent lamps (one/m²) at 80-120 cm above the plant during night for 4 hours (12-4.00 AM)
2. **Artificial short days:** Artificial short days are provided by covering the plants completely with dark thick black coloured tarpaulin cloth for 16 hours (5.00 PM to 9.00AM).

12. Insect, pest and diseases

Pests

Aphids: These are small greenish to black dot like insects which are seen in large number sucking the sap from tender parts like stem tips, flower buds and young leaves. The insecticides like Malathion, Metasystox, Monocrotophos, Rogor are effective against them.

Red spider mite: Very minute dot like insect of red colour seen on the under surface of leaves, particularly in hot dry season. Spraying with Dicofol, Omite, Pyromite or Kelthane controls the pest.

Hairy caterpillar: This insect also called Bihar caterpillar, attacks the plants in the rainy season and continues till winter. Manual collection in mild attacks and spray of endosulfon, cypermethrin, ekalux at weekly intervals have been found an effective control.

Grub: This pest cuts the underground part of stem and roots specially in hot weather. Soil drenching with chloropyrifos (0.05%) is effective control measure.

Diseases

Root rot (caused by *Phythium* spp. or *Rhizoctonia* spp.). It is also called collar rot or foot rot. It is the damping-off disease of the cuttings which turn soft at soil level and wilt. Use of sterilized medium and treatment of cuttings and the medium with Thiram and Captan effectively control it.

Leaf spot (*Septoria chrysanthemella*). Greyish brown spots appear on leaves which turn yellow and ultimately die. The disease spreads from below upwards. It can be controlled by Bavistin and Dithane M. 45.

Wilt (*Verticillium* spp.). The leaves turn yellow to grey and the branch or whole plant wilts gradually. The use of disease free planting material and planting in sterilized medium prevent the infection.

Chrysanthemum mosaic disease

1. Cuttings should be obtained from virus – free indexed stocks.
2. Removal and destruction of infected plants.
3. Destruction of the weed host.
4. Spraying Monocrotophos controls the vector and reduces the disease.

Aspermy (caused by *aspermy virus*). This virus is transmitted by aphids and results in distortion of flower and reduction in flower size with florets becoming wavy. Heat therapy considerably reduces the incidence and consists of keeping the plant at 40°C for 2 hours.



Chrysanthemum mosaic disease

GLADIOLUS

Gladiolus (*Gladiolus x grandiflorus*) commonly called sword lily, is very much liked for its majestic spikes containing attractive, elegant and delicate florets. These florets open in sequence over a longer duration and hence have a good keeping quality of cut spikes. There is a wide range of colours-self or bi-colour with or without central mark varying from white to darkest crimson. The spikes of gladiolus are mainly used for garden and interior decoration, and for making bouquets. West Bengal, Maharashtra, Uttarakhand, Punjab, Haryana and Andhra Pradesh are the major gladiolus growing states.

Do you know?

Gladiolus corms are rich source of vitamin C and carbohydrates. These are eaten in Africa and Europe especially in Russia.

1. Soil and climatic requirement

It can successfully be grown in a wide variety of climatic conditions. The planting should be adjusted in such a way that gladiolus crop enjoys favourable weather conditions throughout its growing, flowering, corm and cormel production period. The favourable temperatures are about 16°C (lower) and 23°-40°C (higher). There should not be rains especially during flowering period. Gladiolus requires open sunny conditions. The longer day length improves its spike quality. About 12 hr day length with high light intensities is preferred over short days with low light intensities. The site should also be well protected against strong winds by planting a hedge or windbreak. Fertile and well-drained soil is better than heavier soils. The texture of heavy soils can be improved by mixing organic manure and sand. The soil reaction should be around neutral. If it is acidic or alkaline, it should be corrected.

2. Commercial varieties

Gladiolus is very rich in its varieties wealth. The commercial life of a variety is about 10-15 years. Every year new varieties are introduced which replace the old ones. Promising varieties which are popular amongst growers of India are: American Beauty, Anglia, Applause Blue Sky, Eurovision, Friendship, Majesty, Hunting Song, Jacksonville Gold, Jester, Mascagni, Nova Lux, Oscar (highly susceptible to Fusarium wilt), Peter Pears, Priscilla, Rose Spire, Rose Supreme, Sancerre, Suchitra, True Yellow, White Prosperity, Wind Song, Yellow Stone.

There is a great demand of gladiolus flowers round-the-year. Nowadays gladiolus can be produced from October-end to April by adjusting the planting at 15 days or one month interval from July to December in plains of north India. Selection of varieties should be done accordingly. In hilly areas, March-April is planting time to get flowers from June-September. For quality flower production, planting in June, October and November is beneficial, whereas June, February, April and May plantings are better for cormel production. August, September, March and April are not very useful for flower production.

3. Propagation

Gladiolus is propagated through corms and cormels, seed and tissue culture.

1. Corms: Propagation of gladiolus through corms and cormels is most common and commercially used method. A single corm of gladiolus produces an average of 1-3 flower grade daughter corms in a season depending upon its size and cultivar. Normally large-sized corms may produce more daughter corm; than small-sized ones. Large and medium-sized corms are used for production of cut spike, whereas small-sized corms are used as planting stock for the production of flower grade corms for the subsequent planting season. The number of daughter corms/corm may be increased by pre-planting (pre storage or post-storage) treatment of corms with ethrel (500-1000 ppm for 30 min.).

Ethrel breaks apical dominance and promotes the sprouting of lateral buds which eventually increases the number of daughter corms. The large-sized corms are more responsive to the treatment than the small-sized ones.

2. Cormels: Multiplication of gladiolus through cormels is an inexpensive and rapid method. The cormels also escape diseases or viruses even if the parent corm is infested. Therefore, corms produced through cormels are usually healthier than those raised from the corms. The number of cormels produced by a corm varies with the cultivar and planting time. Production of cormels can be improved by shallow planting of corms, removing of flowering spike at an early stage, proper nutrition and improved cultural practices.

Best time of planting cormels in north Indian plains is early to mid-September. In hilly areas (temperate region), the cormels should be planted in early spring. Before planting, the cormels should be soaked in water (15-20°C temperature) for at least 24 hrs to facilitate their uniform germination. The diseased cormels normally float on water and hence, should be discarded.

The large cormels show higher germination than the smaller ones. Cormels can also grow faster by pre-soaking in an aqueous solution of gibberellic acid (100ppm for 24hr). Cormels maturing under cooler climates show better growth than those maturing under warmer climates. The moist conditions of soil facilitate the germination of cormels and also prevent the desiccation of tender plants produced by the cormels. Therefore soil should be kept moist by repeated light irrigations. Waterlogged conditions are, however, harmful.

3. Seeds

This method is not used commercially but practiced only by the breeders to create new varieties. Mature seeds are collected and after a few days when they are completely dry, the seeds are extracted and stored in desiccators till the next season. The seeds of gladiolus do not possess any dormancy unlike corms and cormels and can be made to germinate immediately under favourable environment. Before sowing the wings of the seeds should be removed as it improves their germination. The wings can be removed by simply rubbing the seeds between the hands or against any rough surface. Only bold and healthy seeds should be selected for sowing. The seeds can be sown on flat or raised beds very closely (3-5cm apart) in rows about 15cm apart and covered with about 2-3cm thick layer of leaf mould. The beds should be frequently irrigated to keep them moist as moist conditions facilitate seed germination. Seeds normally take 15-20 days to germinate. It normally takes 3 years to produce flower grade corms from the seeds.

4. Tissue culture

This technique is especially useful for multiplying new cultivars; producing disease free cormels and maintaining germplasm of the elite cultivars. Various parts-axillary buds on corms or spike axes, or stem or floral buds- have successfully been used as explants for *in vitro* cormel production. The axillary buds on the corms or the spike axes are better because they can be made to form shoot buds directly without any intervening callus formation. The explants are washed with tap water: containing detergent teepol (0.1%) and then in running tap water for 10-15 minutes. After this these should be surface-sterilized with sodium hypochlorite (2.5% free chlorine) or mercuric chloride (0.1 %) for 2 minutes.

The sterilized explants are cultured onto autoclaved MS medium containing sucrose (30g/litre), myo-inositol (100mg/litre) and benzylaminopurine (BAP, 5mg/litre) gelled with agar (7g/litre). The cultures should be maintained at 20°-25°C temperatures and 16hr light (about 3,000 lux intensity) and 8hr dark conditions. The shoot bud cultures thus established should be sub-cultured on MS medium containing BAP (5mg/litre).

5. Corm dormancy

Corm/cormels of gladiolus undergo a period of dormancy or rest during which they do not sprout. Dormancy is more pronounced in cormels and corms produced under warmer climates than those produced under cooler climates. On the other hand they possess very little or even no dormant period. The dormancy of corms/ cormel can be broken by storing them under low temperature (4-5°C) for 3-4 months. The period of dormancy differs in different cultivars.

Physiological basis of corm or cormel dormancy has been ascribed to the accumulation of growth inhibitory substances, especially abscisic acid (ABA) in tissue as well as the scales encapsulating them. Dormant cormels contain as much as 5-10 times ABA than the non-dormant ones. The dormant corms can also be made to sprout by treating them with growth-regulatory substances like gibberellic acid (50-100ppm). De-scaling also stimulates germination of dormant cormels.

5. CULTIVATION

1. Land preparation

Sterilize the soil by covering with a black polythene sheet during May-June. This kills all harmful fungi in the soil. Twenty tonnes of well-rotten farmyard manure should be mixed at least one month before planting corms; 40kg P₂O₅ (250 kg single super-phosphate) and 40kg K₂O (66kg muriate of potash)/acre should also be added.

2. Planting

Well rested corms measuring more than 5cm are used. This stage can be easily identified by the presence of rootlets at the basal disc. The corms after taking out from cold storage are kept under shade. They are de-scaled and treated with 0.2% Bavistin for 30 minutes. Corms raised through cormels produce better spikes than those raised through corms. Gladiolus is generally planted in flat beds 30cm x 20cm apart and 7cm deep. Thus about 60,000 corms can be accommodated in an acre (1, 50,000/ha). The distance between row-to-row and plant-to-plant can be increased or decreased. If there is a danger of water logging even for a few days, planting should be done on ridges made 30 cm apart. Every year field should be changed. After 3-4 years, the same field may be used again.

3. Manuring and fertilization

Corms of gladiolus are rich in stored food which is sufficient to sustain plant growth for initial few weeks. The cormels specially require fairly good amount of fertilizers because they contain limited amounts of stored food on account of being small in size. The nutrient application should preferably be based on soil tests. Gladiolus requires both macro as well as micronutrients for good growth and flower production. The deficiency of these nutrients in the soil is generally expressed in the form of certain disorders on the plant. The deficiency problems are severe in light sandy soils, which can be corrected by the additional supply of the particular nutrient to the plant. It has been observed that N, P, K and iron nutrients have been found a limiting factor for successful growing of gladiolus.

4. Inter-culture

Weeding and hoeing are important intercultural operations in gladiolus. Since manual labour is involved to carry out operations, its cost of cultivation increases considerably. Weeds should be removed whenever they appear. Otherwise weeds compete with the main crop for nutrition and moisture. Weeding 4-5 times is required to raise a crop successfully. The application of 2.5litres basal/ha as pre-planting treatment keeps field considerably clear for 70 days without any harmful effect on corm and cormel production. Earthing-up twice should be done at 3 and 6 leaf stage which coincides with N application. This results in ridge formation if planting is done on flat land.

5. Irrigation

Irrigation schedule for gladiolus depends upon weather conditions, soil type and rainfall. Normally in sandy loam soils, it should be irrigated at 7-10 days interval.

6 Physiological Disorders

Gladiolus is an indicator plant for fluoride pollution because it expresses the effects of fluorine at very low-level part/billion. The symptoms of leaf scorching appear drying of tip of leaves and drying descends downwards with the increase in its accumulation. Further the tissues are dead. During humid conditions, saprophytic fungi appear. The fluoride present in atmosphere is absorbed and accumulated in the tips of leaves. Fluoride toxicity is also associated with heavy application of super phosphate. Rock phosphate contains hydrogen fluoride and is a source of fluoride in super phosphate. Its injury can be reduced by spraying of 5% lime or magnesium sulphate.

7. Harvesting of corms

Corms and cormels are ready for lifting from the ground 6-8 weeks after harvesting of spikes. Irrigation is withheld at least 2-3 weeks before lifting the corm. Corms show the sign of maturity when yellowing of leaves start. After lifting the corms from the ground, they are kept in shade along with the leaves for drying for a week. Leaves are removed, corms and cormels are cleaned. These cleaned corms and cormels are then dipped in 0.2% Bavistin solution for 30 minutes. These are dried in shade for 2-3 weeks, packed in shallow wooden crates or gunny bags and kept in cold storage at 3°-4°C and 90% relative humidity till the next planting season.

8. Insect-pests diseases

Gladiolus corms and plants are infected by various fungal and bacterial diseases and infested by insects which cause substantial loss to the crop and planting materials. Clean cultural practices, preventive measures for pest and disease control with regular application of plant protection chemicals are essential for quality flower and planting material production. The most common insect pests and diseases are described here:

Aphids: It infests the gladiolus crop in the warm months. They suck the sap from very tender shoots and produce inferior quality flowers. They also spread viruses in the crop. Spraying of systemic and contact insecticides such as malathion, Rogar and Metasystox @ 2 ml per liter of water at an interval of 15- 20 days during the early part of the growing season can control the aphids.

Cut Worms: They attack different parts of the plant and cut the basal region at young stage. Cut worms hide in the soil surrounding the plants during day time and appear when it is dark. It can be controlled by fumigation of infested soil and fortnightly spray of 0.2% methyl parathion.

Mites: Several species of mites attack gladiolus plants during warm, humid and shady conditions and norish on the leaves. White specks appear on the leaves, which ultimately cause brinze or silvery appearance to the affected plants. Timely spraying of suitable miticide can control it.

Diseases

Botrytis Dry rot: It is caused by the fungus *Botrytis gladiolorum* and is highly destructive, soil borne and most common cause of leaf and flower spot of gladiolus infections. To control the disease during storage of corms, the relative humidity is kept low and good air circulation is maintained. Cultural control measures should also be practiced such as sufficient crop rotation and avoidance of dense planting.

Fusarium rot: This disease is commonly known as vascular disease. This is the most serious storage disease of gladiolus corms. The fungus may be present on the corms when they are lifted from the soil and rot develops rapidly in storage, especially if the corms have not been dried thoroughly and cured before being

stored. Initially, only the leaf tips of the plants are yellow and afterwards the whole plant turns brownish yellow and dies. For Effective control of this disease, remove the plants from the soil as soon as the symptoms appear. Dusting with 10-20% benomyl before planting and after harvesting of corms is found very effective to control the disease.

Curvularia blight: It is a serious soil-borne disease of gladiolus that limits the quality flower spike production. When the stems are heavily infected, florets fail to open. Dithane M-45@ of 0.2% sprayed at fortnightly interval can control the disease.

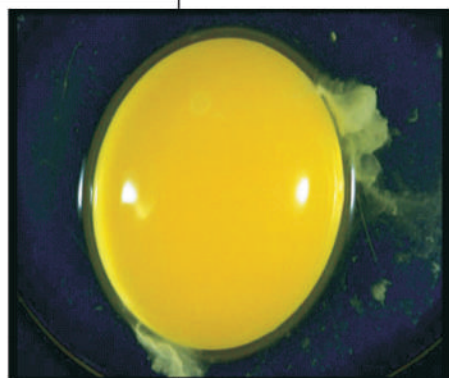
Bacterial blight: It is caused by *Xanthomonas gummisudans*, which results in neck rot and spots on leaves. This disease is serious especially in wet weather or on plants grown in poorly drained soils. At initial stages, irregular water-soaked spots appear on the leaves which dry out and turn brown at later stages.

MARIGOLD

Marigold, belongs to family *Asteraceae*, is very popular amongst the gardeners and florists because of its easy culture and wide adaptability. Its habit of free flowering, short duration to produce marketable flowers, wide spectrum of attractive colour, shape, size and good keeping quality attracts the attention of flower growers. In India, it is one of the most commonly grown flowers and extensively used in religious and social functions, in one form or the other, ego garlands or loose form.

It has been established that marigold is native of Central and South America especially Mexico. From Mexico it spread to different parts of the world during early part of the 16th century. African marigold was first introduced into Spain and became popular in Southern Europe, under the name “Rose of the Indies”. The name *Tagetes* was given after Tages, a demigod, known for his beauty. Marigold is also known as “friendship flower” in United States.

1. Commercial uses: Marigolds are grown commercially for the extraction of carotene pigments. Xanthophylls are the major carotenoid fraction in the flower petals. Marigold pigments are the major source of pigment for poultry feed. The pigment added to the feed for the intensification of yellow colour of the egg yolk and broiler skin. Lutein from the flower petals of African marigold is the best source of carotene for colouring foodstuffs.



Intensity of yellow colour of egg yolk

Do you know?

In India, marigold is one of the important crop among loose flower crops and Tamil Nadu is the leading producer of loose flowers including marigold closely followed by Karnataka both in terms of area and production



Marigold

The leaves of marigold plants are characterized by the presence of distinct odoriferous oil. Among all the species of *Tagetes*, *Tagetes minuta* (wild marigold) is valued for its characteristic essential oil of superior quality with high recovery. Marigold oil is used in high grade perfumes and cosmetics. The oil also has juvenile hormonal and insect repellent activities against flies, ants and mosquitoes.

Besides flower production, marigold plant has very good medicinal value. Floral extract is used as remedy for various eye diseases and ulcers. The juice extracted from petals and heated with an equal quantity of ghee is given thrice daily as a remedy against bleeding piles.

2. Soil and Climatic requirements

Marigold is adaptable to different types of soil conditions and thus can be grown successfully in a wide variety of soils. However, a deep, fertile, friable soil having well water holding capacity, well drained and near to neutral soil reaction (pH 7.0 -7.5) is most desirable.

Marigold requires mild climate for luxuriant growth and flowering. In very high temperature, plants cease to grow, flower production is affected adversely and flower size is also reduced to a great extent. During severe winter, plants and flowers are damaged by frost. Therefore, depending on environment, planting is done in three seasons' i.e. rainy, winter and summer; and seeds are sown accordingly. Hence, flowers of marigold can be obtained during larger part of the year.

The environmental conditions after the seedlings are transplanted markedly influence the growth and flowering. Mild climate during growing period (14.5 -28.6°C) greatly improves flowering while higher temperatures (26.2 -36.4°C) adversely affect flower production.

3. Commercial Species and Cultivars

The genus *Tagetes* includes 33 species, where as *Tagetes erecta*, *T. patula* and *T. minuta* are of commercial importance. *Tagetes erecta*, and *T. patula* are of great horticultural significance and are commercially grown for their beautiful blooms.

1. *Tagetes erecta* (African marigold): The plant is hardy, annual, about 90 cm tall, erect and branched. Leaves are pinnately divided and leaflets are lanceolate and serrated. Flowers are single to fully double and large sized of globular heads. The florets are either 2-lipped or quilled. Flower colour varies from lemon-yellow to yellow, golden yellow to orange.

2. *Tagetes patula* (French marigold): A hardy annual, about 50 cm tall forming a bushy plant. Foliage is dark green with reddish stem. Leaves are pinnately divided and leaflets are linear lanceolate and serrated. Flowers are small single or double, borne on proportionately long peduncles. The flower colour varies from yellow to mahogany red.

CULTIVARS

Cultivars of marigold belong to two main groups African and French. All these cultivars differ in plant height, growth habit, flower shape and size.

I. African marigold

African marigolds have yellow and orange colours in various shades. They are grouped into carnation flowered and chrysanthemum flowered. Commercial cultivars are: Pusa Narangi Gaiinda, Pusa Basanti Gaiinda, Alaska, Apricot, Cracker Jack, Fire Glow, Golden Age, Honey comb, River Side, Tiger yellow and F1 hybrids includes Apollo, climax, First Lady, gray ladies, Showboat, Inca yellow, Inca gold, Inca Orange, Brownie Scout, Burpees, Nugget, Cupid Yellow, Petite -Gold and Yellow Pygmy etc.

2. French marigold

Cultivars under this category are available in various shades of yellow, orange, crimson and mahogany red which are very attractive. Commercial cultivars are: Pusa Arpita, Dainty Marieta, Sunny, Tetra Ruffled

Red, Carmen, Cupid Yellow, Lemon Drop, Melody etc.

4. Growth and Flowering

Growth and flowering in marigold is generally governed by day length, temperature and other environmental factors. Certain growth substances also influence these processes. These have been briefly mentioned here.

A. Environmental factors

Marigold is long day plant but medium temperatures ranging from 12-24°C, while the plants failed to grow under short days at higher temperatures. Intermediate classes, however, grow and produced flowers under short days at 12.8°C.

The flowering of *T. erecta* or Golden Eagle, a short day type was unaffected by the daily application of abscisic acid (ABA). With this treatment, the stem growth was inhibited without promoting flowering. Repeated application of 25 ppm gibberillic acid (GA) slightly improved flowering but TIBA did not affect flowering of African marigold. Gold cultivar was not markedly affected by either day length or temperature. When marigold plants were grown at 21°C (night temperature) the plants had higher fresh weight but the post harvest keeping quality of flowers was best with plants grown at 10-15°C.

5. Role of growth substances

Marigolds are excellent pot plants, especially the cultivars of *T. patula* and *T. tenuifolia* which are grown in pots for window garden, verandah or other situations. The cultivars of *T. erecta* usually grow taller and growth retarding chemicals have been recommended for reducing the height and improving the appearance of the pot plant. Reduction in plant height and dark green colour of the foliage was observed when the plants were sprayed with SADH at 2500 ppm.

The plant height of *T. erecta* can be controlled most effectively by 300-600 mg ancymidol/m² as a drench or granular incorporation. During two successive seasons, *T. erecta* was treated with GA, at 100-400 ppm or SADH at 250-1000ppm at 4 weeks from planting out and again a month later. GA, generally, increases plant height whereas SADH decreases it.

6. Propagation

There are two common methods of propagation of marigold i.e. by seeds and by cuttings. Plants raised from seeds are tall, vigorous and heavy yielder and hence, seed propagation is preferred to cuttings.

SEED PROPAGATION

Seeds of wide range of cultivars of *T. erecta*, *T. patula* and *T. tenuifolia* are easily available and germinate quickly. It is, therefore, an easy method to propagate marigold through seeds which germinate well at temperature from 18-30°C. For raising seedlings, seeds can be sown in pots, seed boxes, on flats or raised nursery beds. Nursery beds are thoroughly prepared by digging and incorporating well rotten farm yard manure (FYM). To minimize the mortality of the plants in the nursery, the soil should be drenched with 0.2% captan before sowing. Seed rate per hectare is from 800g -1.0 kg. As soon as the beds are ready, seeds should be sown in lines spaced at 3 to 5 cm.

Marigold can be raised three times a year rainy, winter and summer seasons. Table-1 shows the seasons of sowing and transplanting of seedlings for obtaining flowers at different seasons of the year.

Table 1: Raising of marigold flowering season sowing time transplanting time

Sl. No.	Flowering Seasons	Seed Sowing	Transplanting
1	Late rains	Mid-June	Mid-July
2	Winter	Mid-September	Mid-October
3	Summer	Jan-February	February

7. Transplanting

The seedlings are transplanted in the field after one month of seed sowing. A spacing 40 x 40 cm for African and 30 x 30 cm for French marigold is optimum for commercial cultivation. During summer and rainy seasons, transplanting must be done in the afternoon or during cloudy weather. The terminal portion of the plants can be pinched as and when plants establish well in the field. This will help in the production of more side shoots.

8. Irrigation

During the hot months of summer, the plants are liable for desiccation due to hot winds. Therefore, the plants should be irrigated at an interval of 4-5 days to keep the soil moist and cool. Rainy season crop is irrigated as per the atmospheric conditions. Winter crop needs watering at 8-10 days intervals depending upon the water requirements of the plants.

9. Manures and Fertilizers

In addition to farmyard manure, it is advisable to apply 200kg/ha of nitrogen and 80 kg/ha each of phosphorous and potash for getting good vegetative growth and flowering. Whole quantity of phosphorus and potash should be applied at the time of land preparation, whereas the nitrogen should be applied in two split doses after one month of transplanting. It will be better if two foliar sprays of 0.2% urea are done at an interval of 25 days.

10. Pinching

In tall cultivars of *Tagetes erecta*, development of axillary branches and flower production are influenced by the presence of apical dominance. In such, cultivars are first growing upward to their final height and later on produce terminal flower buds. After the formation of terminal flower bud, axillary branches develop which also bear flowers. However, if the apical portion of shoot is removed early, large number of axillary shoot arises resulting in well shaped bushy plants bearing more number of uniform flowers.

11. Weed Control

In marigold production, control of weeds is an important operation. If the weeds are not removed in time, a great loss would occur in terms of growth and productivity of marigold. Normally 3-4 manual weeding are required for the entire period. Weeds can also be controlled by chemical herbicides such as EPTC 3.5-4.5 kg/acre, and triflurabin and diphenarnid @ 2.0 kg per acre.

12. Insect, pests and diseases

Marigold plants are infested by many pest and diseases. Red spider mites are the serious insects of marigolds. They make the web on the foliage and suck the sap from tender portions. They can be controlled by spraying the plant with Dicofol, Kelthane, Omite, Pyromite, etc.

Powdery mildew, rust, Alternaria blight and viruses are the most serious diseases which infect marigold plants. Powdery and rust can be controlled by spraying with 0.2% wettable sulphur. The plants infected with viruses should be uprooted and buried or burnt. Application of systemic insecticides like nuvacron, nuvan and dimecron (0.03%) and metasystox (0.1%) at fortnightly intervals is very necessary for controlling vectors for carrying virus infection.

13. Harvesting and Yield

Plucking of flowers at proper stage is important during harvesting to keep the flowers fresh for a longer time for export purposes.

A. Harvesting

Marigold flowers are plucked when they have attained the full size. Plucking of flowers should be done in cool hours of the day either in the morning or evening. Field should be irrigated before plucking so that flowers keep well for longer period after harvest. Plucking is done easily by hand. Flower stalk is hollow which breaks off easily when twisted between thumb and fingers. Productivity of plants increases considerably by regular plucking of flowers. Marigold flowers are mainly used for making garlands and, hence, plucked flowers are collected in polythene bags or bamboo baskets for carrying to the market.



Harvesting and packaging of Marigold

B. Yield

The yield of flowers in African and French marigold not only varies with cultivar but also with cultural practices including planting, spacing and fertilization. There is a marked variation in flower number from 6 to 8 million and from 1.5 to 2.5 million per hectare in French and African marigold, respectively. The corresponding ranges of variation in the weight of flowers were 8 -12 tonnes/ha in French marigold and 11-18 tonnes in African marigold.

TUBEROSE

The tuberose (*Polianthes tuberosa*) occupies a very selective and special position amongst the ornamental bulbous plants for its beauty, elegance and sweet pleasant fragrance. It has a great economic potential for cut-flower trade and essential oil industry. Due to their great demand, it is currently cultivated in most of the tropical and sub-tropical countries of the world.

Tuberose is a native of Mexico from where it spread to different parts of the world during the 16th century. In India, tuberose is commonly known as Gulchari and Galshabbo in Hindi, Rajanigandha in Bengali, Sukandaraji and Nelasanpengi in Telegu, Nilasompangi in Tamil and Sugandharaja in Kannada. In India, the commercial cultivation of tuberose is confined mainly to West Bengal, Karnataka, Tamil Nadu and Maharashtra. However, it is adapted to the North Indian climatic conditions and grows well in Uttar Pradesh.

1. Importance and Uses

Tuberose has gained considerable importance and it is cultivated commercially for its varied uses.

1. It can successfully be grown in pots, beds and borders.
2. The flower remains fresh for a pretty long time and stands long distance transportation and fills a useful place in the flower market.
3. Flowers are used for artistic garlands, floral ornaments, bouquets and buttonholes. The long flower spikes are excellent as cut-flowers for table decoration when arranged in bowls and vases. The variegated type with golden striped leaf margins is very attractive and suitable for the beautification of gardens.
4. Flowers are the source of the tuberose oil. The natural flower oil of tuberose remains today one of the most expensive of the perfumer's raw material. The most common constituents of tuberose concrete are geraniol, nerol, benzyl alcohol, methyl benzoate, methyl salicylate, engenol, benzyl benzoate and methyl anthranilate.
5. Fragrant flowers are added alongwith stimulants or sedatives to the favourite beverage prepared from chocolate and served either hot or cold as desired.
6. The bulbs are reported to contain alkaloid lycorine, which causes vomiting. Two steroidal sapogenins namely hecogenin and a small amount of tigogenin, a poly fructosan have been isolated from the bulbs. Presence of transfructosidase has also been observed.
7. The bulbs are considered diuretic and emetic. They are rubbed with turmeric and butter and applied as a paste over red pimples of infants. Dried tuberose bulbs in the powdered form are used as a remedy for gonorrhoea.

2. Morphology and Classification

Tuberose is a half-hardy, bulbous perennial perpetuating itself through the bulblets. Bulbs are made up of scales and leaf bases and the stem is a condensed structure which remains concealed within scales. Roots are mainly adventitious and shallow. The leaves are long, narrow, linear, grass-like, light green, and arise in rosette. The flowers have a funnel shaped perianth and are fragrant, waxy white, about 25 mm long, single or double and borne in a spike. The terminal flower spikes arising from the bulb produce flowers for a number of days. Stamens are six in number, anthers dorsifixed in the middle, ovary 3 locular, ovules numerous and fruits are capsule.



Tuberose flower in field

The determination of the family to which the genus *Polyanthus* belongs, had long been a matter of difference of opinion among taxonomists. Ultimately, the genus was placed in the family *Agavaceae*, and it was accepted by most taxonomists.

3. Commercial Cultivars

There are three types of cultivars in tuberose:

- i. single with one row of corolla segments;
- ii. semi-double bearing flowers with 2-3 rows of segments;
- iii. Double having more than three rows of corolla segments.

Named cultivars are few, except a double petal cultivar called the Pearl or Dwarf Pearl Excelsior, one or more variegated forms and a single form usually called Mexican Single but sometimes Mexican Ever blooming. Often the florets of the double cultivars some time fail to open completely which results in the reduction of its fragrance. Single flowered type is more fragrant and is widely cultivated than the other types. Rajat Rekha and Suvarna Rekha are two cultivars released by NBRI, Lucknow. Sometimes cultivar names are given after places like Calcutta Single and Calcutta Double. In India, Calcutta Single, Suvansini and Mexican Single have been identified as promising ones for large scale cultivation.

Do you know?

Tuberose is grown as ratoon crop upto three years as cut flower, loose flower and perfumery and garden flower crop.

4. Soil and Climatic requirement

The tuberose grows in a wide range of soils. Loam and sandy loam soils having a pH range from 6.5 to 7.5 with good aeration and drainage are considered suitable for its cultivation. The soil should be rich in organic matter and retain sufficient moisture for proper growth. For cultivation in pots, a mixture of garden soil, FYM and leaf mould in the proportion of 2:1:1 should be used.

Tuberose grows in mild climate without extremes of high or low temperatures. In India, the commercial cultivation of tuberose is mainly confined in warm humid areas with average temperature range from 20° to 35° centigrade. For its luxuriant growth, it requires high humidity and a temperature around 30° centigrade. Temperature above 40°C reduces the spike length and quality of the flowers. Very low temperature and frost also damage the plants and flowers. Tuberose grows well in sunny situation.

5. Propagation

Tuberose is mainly propagated by means of bulbs. Seeds, if produced, are difficult to germinate and are seldom used for raising plants. Although, not very common, propagation may also be done by the division of bulbs. To get virus-free material or for a very rapid multiplication, the propagation is done through tissue culture.

a. Seed propagation

Under favourable climatic conditions, seed setting is observed only in the single flowered cultivar. Seeds are sown in well prepared growing medium containing leaf mould and garden soil in equal proportion. Moisture and temperature have a marked effect on germination. The soil temperature of 26.6°C is optimum. The seeds are sown in rows 10 cm apart and 1.5 cm deep in heavy soil and 2.0 cm in light soil. Seeds start germinating within 10 to 15 days after sowing.

b. Vegetative propagation

The tuberose can also be propagated vegetatively by the following methods.

1. Propagation by bulbs

This is the most common method practiced commercially for the multiplication of tuberose. Spindle-shaped bulbs free from diseases and having an average diameter of 1.5 cm are preferred than conical or flat bulbs.

2. Propagation by division

Another method of propagation is by using bulb segments. Bulbs (2 cm or more in diameter) are cut into 2-3 vertical sections, each containing a bud and a part of the basal plate. Each of these sections is treated with fungicide and planted vertically in a rooting medium with their tips just showing above the surface. A moderately warm temperature, slightly higher than for mature bulbs should be maintained. New bulblets along with roots develop from the basal plate. At this time they are transferred to the ground to continue growth.

c. Micropropagation

The conventional method of propagation through bulbs is rather slow to meet the growing demand and, therefore, clonal propagation through tissue culture may be utilized for rapid and large-scale multiplication.



Tuberose bulb

6. Cultivation

The various cultivation practices for the growth of tuberose are described here.

A. Site selection

For optimum growth and high yield of flowers it is preferable to choose a place having plenty of sunlight. Tuberose is sensitive to wet heat, hence drainage should be good and water-logging even for a short period damages the root system and affects the growth and flowering.

B. Soil preparation

Land preparation is very important for the cultivation of tuberose. The field should be worked deep to a good tilth. Well rotten cow dung or farmyard manure @ 50 tonnes/ha, should be incorporated with the soil about a month before planting. Care should be taken to make the land free from weeds.

C. Bulb selection and planting

Selection of good planting material is necessary for obtaining higher yield and good quality of flowers. Clumps of bulbs should be dug from the soil when plants cease its growth and stored in the well ventilated semi-shady place for at least one month before planting. The bulbs before planting should be treated with fungicide. They should carefully be placed upright by land and covered with soil. Clumps as such should never be planted as the plants grow vegetatively rather than produce flowering spikes. For pot cultivation, 2-3 bulbs are planted in the centre of a 20 cm pot.

D. Irrigation

Soil moisture is an important factor affecting growth and flowering in tuberose. Irrigation should be done before planting to provide optimum moisture for sprouting and further irrigation should be avoided until the bulbs have sprouted. Too much moisture in the soil at the time of sprouting results in the rotting of bulbs and similar condition during flowering adversely affects the development of spikes and flowers. The tuberose fields should be irrigated at interval of 10-15 days, if the weather is dry.

7. Manuring and Fertilization

High dose of, N and P markedly promotes leaf and bulb formation in tuberose. These treatments also improve flowering. The effect of K has been less pronounced than N and P in these respects. The plants applied with low dose of N and P shows growth inhibition and fails to flower.

Tuberose responds to fertilizer application but it should not be fertilized with excessive N as the flower spike become quite tall and soft, making it vulnerable to wind and the plants become more susceptible to diseases and pests. The flower quality is also affected adversely. The effect of deficiency of various elements is given in Table 1.

Table 1: Effect of fertilizer deficiency

S. No.	Fertilizer element	Deficiency symptom
1	Nitrogen	Reduction in number of spikes and number of flowers per spike; typical pale green foliage
2	Phosphorus	Dark green upper leaves and purple coloration in lower leaves; reduction in growth and flowering
3	Calcium	Cracking of the spike, bud rot in case of acute deficiency
4	Magnesium	Interveinal chlorosis of older leaves
5	Iron	Interveinal chlorosis of new leaves
6	Boron	Cracking of leaf margins, deformed leaves and stunted inflorescence
7	Manganese	Yellowing between the veins of lower leaves

In a neutral clay soil, having high amount of potassium, the best nutrient combination is N @ 200 kg/ha and P₂O₅ @ 60 kg/ha. K₂O (potash) has not shown any response. However, for tuberose cultivation soils low in potassium, application of K₂O @ 50 kg/ha have been given.

8. Growth and Flowering

Tuberose bulb goes through a characteristic cycle of development beginning with its initiation as a growing point. In the vegetative stage the bullets grow and attain their maximum size. The subsequent reproductive stage includes the initiation of flower differentiation of floral parts, elongation of the flowering shoot and finally flowering and sometimes seed production.

Tuberose normally begins to flower in 80 to 95 days after sprouting. It flowers profusely during summer and rains (April-September) in the plains of eastern parts of India, in the hills it flowers in May-August, while in milder climate this flowers well throughout the year.

A. Environmental factors

The various environmental factors affecting the growth and flowering of tuberose are:

1. Temperature

Temperature is the most important factor affecting growth and initiation and subsequent flower development of bulbous plants. High (40°C) as well as low temperature (10°C) reduce spike length, weight

and quality of tuberose flowers. The optimum temperature range for growth and development is 20 to 30°C.

Storage temperature also influences the sprouting of bulbs after planting and subsequent growth and flower production. Pre-plant storage of bulbs at 10°C for a period of 30 days was found to improve the plant growth and increase yield of spikes and flowers. The bulbs remain dormant during winter months in places where the temperature is low.

2. Light

Although tuberose is not strictly photosensitive, long day exposure promotes vegetative growth as well as early emergence of the first flower spike, and also increases the length of the flower spikes. Though the influence of light on growth and development of tuberose has not been methodically studied, reduction in light intensity promotes the leaf length whereas increase in the intensity and duration of light result in production of quality blooms, provided there is optimum temperature. Low light intensity adversely affects flowering, therefore, in short-day conditions i.e. winter growing, supplementary light may help producing better blooms.

B. Role of growth substances and other chemicals

Growth and developmental behaviour of bulbous plants is also regulated either by a single or by an interaction of several endogenous growth hormones like gibberellin, auxin, cytokinin and abscisic acid (ABA). They play a major role in directing the movement of organic metabolites and in establishing sinks.

9. Weed Control

Weeds become serious problem in the cultivation of tuberose as heavy manures and irrigation requirements of this crop create conducive conditions for the growth of various types of weeds. If these weeds are not removed in time, growth and productivity will be markedly reduced. Manual weeding is effective if done frequently. Certain chemicals effectively controlled both monocot and dicot weeds. Pre-emergence application of Diuron (80%) @2.8kg a.i./ha and ATP+CIPC mixture @2.0+1.5 Kg a.i./ha, is very effective.

10. Disease Control

Tuberose is hardy and there are no serious diseases and pests posing problems for the cultivation of this crop. However, it is attacked by some diseases and pests which are described here.

a. Stem rot

The stem rot disease is caused by a fungal organism known as *Sclerotium rolfsii*. The disease symptom is preceded by the appearance of prominent coarse mycelial masses on leaf surface at or near the soil level. Soon the infected spots lose green colour due to rotting which extend and cover the whole leaf. The infected leaves fall on the soil surface and become detached from the plant. As a result the infected plants become weak and send out few or none of the flowering shoots in case of severe damage. The disease can be controlled by soil application of Zineb at 3-week interval. Infection can also be minimized by reducing soil moisture or planting at wider spacing. Destruction of infected plant debris is also important because it harbours the fungus.

b. Botrytis spots and blight

This disease is caused by *Botrytis elliptica*. This organism seriously damages the leaves. This disease can be controlled by spraying the plants with Bavistin (0.2%). The treatment should be repeated at fortnightly interval.

c. Flower bud rot

This disease is caused by *Erwinia* spp. The disease appears mainly on young flower buds and results in dry rotting of the buds with brown scorched necrotic discoloration of peduncles. At later stage, buds shrivel and become dry. The disease can be controlled by segregation of plants and application of corrosive sublimate (1 part in 1000).

d. Bunchy top disease

A contagious disease known as bunchy top causes mal-formation of the inflorescence like a ball and the flower spike grows to only one-third of its normal height. Control of thrips which is associated with this disease, check this malady.

11. Pests and their Control

1. Grasshopper

The insects feed on young leaves and flower buds. Spraying the plants thoroughly at fortnightly interval with 0.1 % Rogor or 0.1 % Malathion keeps away these pests.

2. Weevil

The adult weevils which become active in darkness damage the shoots and feed on the leaves. Generally they feed at the edge of the leaf producing a characteristic notched effect. The larvae feed on roots and tunnel into the bulbs. Larvae can be controlled by dressing the soil with Carbofuran before planting.

3. Aphids

Aphids are very small in size, feed on the flower buds and growing points. These pests may be controlled by spraying 0.1 % Malathion at 10-day interval. Spraying with dimethoate (Rogor), Metasystox or Monocrotophos is also effective.

4. Thrips

Thrips feed on leaves, flower stalks and flowers. They suck sap from these parts and ultimately damage the whole plant. Sometimes they are associated with a contagious disease known as bunchy top where the inflorescence is mal- formed. Thrips can be controlled by spraying the plants with 0.1 % Rogor or 0.1% Malathion.

5. Red spider mites

Mites such sap and yellow stripes and streaks appear on the foliage, which spread until the leaves become yellow, silvery or bronze and distorted. Spraying with Dicofol, Kelthane, Omite, Pyromite has been found very effective to control the mites.

6. Nematodes

a. Greasy streak

This is caused by *Aphelenoides besseyi* and believed to be the first report of a foliar normative on tuberose.

b. Root galling

Root galling is caused by nematodes and a survey revealed the association of *Meloidogyne incognita* and *Mjavanica* with *Polianthes tuberosa*. The plants showed yellowing, drying up of

leaves and retarded growth. In severely affected plants the emergence of spikes was suppressed resulting in an absolute loss of flowers. Emergence of side shoots from bulbs was also affected and the numbers were conspicuously less.

12. Harvesting of bulbs

Harvesting of tuberose bulbs at proper stage of maturity is important for storage of bulbs and their growth. The bulbs reach maturity when the flowering is over and plant growth ceases. At this stage, the old leaves become dry before digging out the bulbs. The leaves are cut at the ground level and bulbs are taken out of the soil.

Bulb Yield

The bulb yield varies with cultivar, initial bulb size at planting and cultural practices adopted. Investigations on cv. Single, reveals that bulbs, having a diameter between 2.6 and 3.0 cm planted 6.0 cm deep at a distance of 20x20 cm produces 21.3 tonnes bulb when harvested after a period of three years from planting.

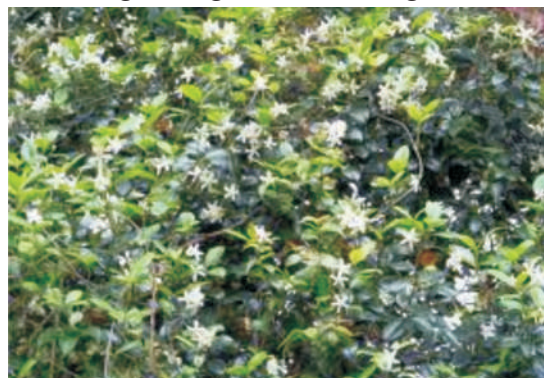
Storage of Bulbs

The soil adhered to the clumps is removed and the offsets are separated by rubbing off. Loose scales and long roots should be removed and bulbs are graded into different groups depending upon the size of bulbs. They are stored separately in a cool, dry and shady place. During storage the bulbs should be stirred every few days to prevent and check the spread of mould and rot. Storage for 4-6 weeks is necessary before the bulbs are ready for planting.

The bulbs are often left undisturbed in situ, the leaves are cut above the ground level and irrigation is withheld during this period. At the onset of spring, the plants start growing and blooming as usual. Replanting at three year's interval has been found beneficial and economical.

JASMINE

The name Jasmine is of Arabian origin. They are natives of tropical, sub-tropical and temperate regions and were introduced in the mid-sixteenth century. Jasmine (*Jasminum* spp.) is one of the oldest fragrant flowers cultivated by man. It has been cultivated for various purposes since very early times. In recent years, demand for high grade perfumes has increased and there is tremendous scope for the development of essential oil industry based on this plant. Plants are grown as both shrubs and climbers. In India they are cultivated throughout the country. The country exports jasmine flowers to the neighboring countries like Sri Lanka, Singapore, Malaysia and Gulf countries, which gives a good amount of hard cash. In India out of 40, about 20 species are found in Madras, Bombay, Bihar, Orissa, Chota Nagpur, upper Gangetic plain and sub-Himalayan tracts.



Commercial cultivation of Jasmine

1. Uses

Flower and buds are used for making garlands, bouquets, *veni* (used for decorating women hair) and for religious offerings. They are also used for the production of perfumed hair oils and *attars*. The world famous jasmine oil is extracted from the flowers of Spanish jasmine (*J. grandiflorum*). The jasmine oil is regarded as unique because it blends well with other floral extracts and it is highly valued throughout the world for producing high grade perfumes. The oil is also used in soap and cosmetic industries. The flowers of the Arabian jasmine (*J. sambac*) are reported to be used in China for flavoring tea.

Historic evidences shows that even 200-500 years ago, the jasmines were extensively used for hair ornamentation by the women in China. The flowers were used for decorating lamp shades, buildings etc. during religious ceremonies, and the other uses to which the flowers are put to include scenting food, wine and drinks. In Malaysia, the flowers are said to be used for scenting coconut hair oil. They also contain yellow pigments and hence used as a substitute for saffron. The flowers and other parts of the plant also find use in medicines.

Do you know?

Highest number of refineries for jasmine perfume extraction in India is in Madurai district of Tamil Nadu.

The natural oil of jasmine is used in high grade perfumes and almost all superior perfumes contain at least a small quantity of jasmine oil. It is used for perfuming expensive soaps and cosmetics, mouthwashes and dentifrices, both salts and tobacco. Jasmine flowers owe their fragrance to a volatile oil present in the epidermal cells of the inner and the outer surface of both petals and sepals. The species of jasmine used in most countries for oil extraction is Spanish jasmine (*J. grandiflorum*) and the cultivar-used is the one having pink streaks on the exterior of the petal lobes.

2. Botany

The genus *Jasminum* belongs to the family *Oleaceae*. They are climbing, trailing and erect shrubby flowering plants and having both evergreen and deciduous species. Leaves are opposite or alternate, simple, trifoliate or pinnate, leaflets are entire. The flowers are white, yellow or rarely reddish, sometimes solitary, more often in cymose clusters of three to many usually fragrant. The corolla of the flower is tubular with four to nine lobes and the stamens are two in number. The ovary is 2-loculed with 1-4 erect ovules and the fruit is a berry and black in colour.

3. Soil and Climatic requirement

Jasmines prefer well drained rich sandy loam to clay soils. The ideal conditions for their successful cultivations are warm summer and mild winter with ample water supply and sunny days. *Jasminum* spp. is usually grown in the open for commercial flower production.

4. Species and Cultivars

Jasminum auriculatum, *J. grandiflorum* and *Jasminum sambac* are the three commercially important *Jasminum* spp. of India.

In case of *J. auriculatum* (Juhi, mugohee, sunika oosi mallige, pindari, kadaru mallige) flowers are white, sweet scented, and are used for production of perfumed oil and attar.

Jasminum grandiflorum (Spanish jasmine, chameli, jathimalli, safed chambeli) bears flowers which are white often tinged with purple on the outside; delightfully fragrant and are used in making garlands, decorative bunches and *veni*. Small quantity is used for preparation of hair oil and attar. Presently jasmine

concrete is extracted from the flowers of this species only. This species is cultivated in Tamil Nadu and Uttar Pradesh.

In *Jasminum sambac* (Arabian jasmine or Tuscan jasmine; moghra, champa, motia, malli, mogri, and gundumalligai) flower buds are white, with single or multiwhorled petals; widely used in making garlands, bouquets, in religious offerings, extraction of perfume (otto) and in cosmetic industry.

In *Jasminum arborescens* (*muta bela*, *naba malliga*) flowers are white, very fragrant. This is grown in west Bengal and Uttar Pradesh.

Jasminum calophyllum (*pandal malli*) is a profuse-flowering species generally grown in home garden with staking flowers which are scented, white, produced practically round the year and are free from pest and disease attack.

Jasminum flexile (*malati*, *nitya mallige*) is a profuse flowering species grown widely in home compounds for its scented flowers. It bears flowers practically throughout the year and free from insect pests.

Jasminum humile (Yellow jasmine, semmalligai, pellichambelli) bears flowers which are yellow, fragrant and are used in perfumery.

Jasminum pubescens (*J. multiflorum*, Kunda, kundo). Its plants are very ornamental; flowers are slightly fragrant and white and flower throughout the year with a peak in winter. This is popularly grown in north India since its performance is better in cool climate. Cultivars The species-wise commercial varieties are Gundumalli (*Jasminum sambac*), Co-1, and Co-2 (*J. auriculatum*) and Co-1 and Co-2 (*J. grandiflorum*).

5. Growth and Flowering

Growth and flowering in jasmines are influenced by several factors like genotype, environment, pruning, nutrition and other management practices. Certain chemicals are also effective in regulating the growth and flowering.

The vegetative bud (*apical meristem*) of *J. auriculatum* differentiates into opposite leaves to protect the centre of the bud. The apical meristem gradually narrow and constrict from which two lateral branches arises. If the plants are pruned from 8th November to 18th December, it takes 45 to 60 days to flower bud initiation. As pruning time is delayed the time taken for flower bud initiation is shortened.

In *J. grandiflorum*, the vegetative phase is characterized by pointed and elongated meristematic apices which give rise to an apical meristem. It is gradually enclosed by two lateral leaves and becomes broad and flattened. As growth proceeds, the apical meristem becomes trilobed and is enclosed by well developed leaf primordia on one side and at a later stage; on either side of the apex initials of sepal primordia are seen.

The flower bud initiation and differentiation occur in acropetal succession with sepals developing first followed by petals, stamens and ovary. Corolla tube development becomes complete only in advanced reproductive stage with differentiation of the ovary.

6. Propagation

Jasmines are usually propagated by cutting and layering. Seed propagation, though uncommon, is necessary for crop improvement through planned hybridization. Multiplication through sucker, grafting, budding and tissue culture has also been found successful. The different methods used for propagation is described here.

a. Vegetative propagation

Propagation by vegetative means is mostly practiced in jasmines. Here, the different methods of vegetative propagation are dealt in detail.

1. Layering

Layering has been the mode of vegetative propagation in jasmines until recently. Simple layering during June-July to October-November gives good success in 90-120 days. Stems of some species develop adventitious roots when the branch comes in contact with ground and these can easily be propagated from layers. This method of multiplication, however, involves more time and restricts the number of plants propagated from a bush.

2. Cutting

This is the easiest method of propagation for the species that are cultivated for commercial purposes. Softwood cuttings of 15-20cm long with two leaves should be taken from the middle portion of the shoot. Rooting percentage as well as number of roots per cutting increases with the increase in number of leaves. A single node cutting with one leaf is the best material for quick, cheap and efficient multiplication of *J. sambac*. Time of taking cuttings varies from place to place. Cuttings taken in the month of March roots better than those taken in June, July, September or December.

Sand, vermiculite, moss and mixture of these are some of the commonly used media for root formation in cuttings of jasmine. The highest percentages of rooting and larger number of roots are found when the coarse sand is used as a medium, followed by a mixture of sand and moss (1:1 or 1:3) and vermiculite. Maximum rooting (95%) is recorded in cuttings planted in coarse sand. The best rooting is noted in full daylight. The numbers of days taken for rooting have been found to differ with different species, being 45 days in *J. grandiflorum*, 70 days in *J. auriculatum* and 68 days in *J. sambac*.

3. Grafting and budding

Interspecific grafting was successful with a take of 76% in *J. auriculatum* on *J. sambac*, 72% on *J. sambac* and 90% in Jathimalli (*J. grandiflorum*) on Mullai. The time taken for separation of grafts ranged from 16 weeks to 24 weeks. *Jasminum grandiflorum* is compatible with *J. sambac* Mathuria and single Mogra, provided patch budding is resorted to, and it takes a month of bud take.

7. Cultivation

Adoption of appropriate cultivation practices is essential in growing of jasmine. This gives a good yield per unit area.

A. Spacing and planting

Spacing is one of the factors which determine the ultimate flower production. In commercial cultivation it varies from place to place and also depends upon the species cultivated and the soil conditions. The famous Spanish jasmine is planted at a closer spacing of 80 x 10 cm with 100,000 to 150,000 plants per hectare. For planting, pits of 45- 90 cm³ are prepared depending upon the type of soil and are exposed for a week. Afterwards, half the pit is filled with dried leaves and burnt to kill the disease organisms present in the soil. A day later, the lower half of the pit is filled with top soil. The upper half of the pit is filled with the top soil after mixing with 10 to 20 kg of well rotted farm yard manure or compost to a level of 10 cm above the ground level. Then a soaking irrigation is given to the pits for soil to settle down properly.

B. Manuring and fertilization

Although commercial cultivation of jasmines has a long history behind, systematic investigations to determine the nutrient needs of the crop have been attempted only since the last two decades. Nutritional studies revealed that application of different nutrients markedly improves the growth, flowering and oil content. The procedure and dosage is discussed here in detail.

1. Frequency and rate of application

In *Jasminum auriculatum*, flower yield is highest when Nitrogen is applied @ 120 or 240 g/plant annually. If nitrogen is applied at 120g/ plant, an equal quantity of potassium application is also necessary. In *J. grandiflorum*, the yield, flower bud diameter and weight of 100 flower buds is maximum with FYM and NPK applied together in 6 split doses. The maximum flower yield (3.642 kg/plant) and essential oil content (9.69 g/plant) can be recorded when 15 kg FYM + 60 g N + 120 g P_2O_5 + 120 g K_2O are applied per plant in 12 monthly applications followed by the same dose in bimonthly application.

Treatment with nitrogen (as urea) up to 100 g/plant significantly improves all vegetative characters, flower quality and yield; P_2O_5 (phosphate) and K_2O (potash) application increases flower yield and the number of branches plants and P_2O_5 increased the weight of the flowers.

2. Time and method of application

Application of fertilizers, to the soil in split doses has been found very useful in improving the growth, flowering and oil content. Soil application of nitrogen is better than foliar application in *J. grandiflorum*. In *J. sambac* however, foliar application of nitrogen will not show any significant difference on flower yield compared with soil application. Treatment with N as foliar spray @ 30 g/plant is reported to be more economical than the conventional method of applying nitrogen @ 120 g/plant through the soil. NPK should be applied in two split doses, once in January and another in July every year to give a good yield (around 10 tonnes of flowers per hectare in *J. grandiflorum*).

C. Pruning

Pruning is an important practice for manipulation of growth and flowering as it influences growth, flower bud initiation, differentiation and ultimately the flower production. Normally, irrigation is withheld prior to pruning and plants are pruned by removing all the past season shoots including dead and diseased branches. All the leaves in the bushes are stripped off. Following pruning all cut ends are smeared with Bordeaux paste to prevent infection. The height of pruning depends on the species in a particular environmental condition.

Use of chemical defoliant as an alternative to manual pruning is effective to certain limit. Chemical defoliant like the Paraquat dichloride, Pentachlorophenol, potassium chloride and sodium chloride can be used. While paraquat chloride caused quickest and heaviest defoliation, pentachloro-phenol and sodium chloride application showed higher yield than the unpruned plants.

D. Irrigation

Sufficient moisture in the soil is necessary for proper growth and flowering in jasmines. Normally, plants are irrigated by flooding once a week. Sprinkler irrigation can also be done. Though there is a 30% saving of irrigation- water under sprinkler, there will be a considerable reduction in the yield of flowers.

E. Weed control

Weeds cause enormous loss to jasmine crop and increase the cost of cultivation. Manual weed control is effective if done properly, but this is very expensive. Chemical weed control is comparatively economical, convenient and efficient in eradicating weeds by one or two applications. Treatment with Oryzalin controls the weeds for 10 weeks on a silt loam soil. Good vegetative growth and flowering of jasmine is also recorded with the application of this chemical. Mulching also reduces the weed population.

8. Diseases and Pests

Jasmines are affected by various diseases and pests which affect growth and cause loss in flower yield. Here, some of the major diseases and pests are discussed in detail.

1. Leaf blight

It is a fungal disease caused by *Cercospora jasminicole* and *Alternaria jasmini*. Reddish brown circular spots, 2-8 mm in diameter are produced on the upper surface of the leaves, spreading rapidly in the rainy season. Affected leaf margins show inward curling and become hard and brittle. In severe cases of infection, vegetative buds and young branches dry up. The disease appears in the month of May/June and the peak incidence occurs from August to November. Flower production is adversely affected and may cause 50% loss in yield. This disease can be controlled by spraying 0.4% Benlate or 0.2% Dithane - M-45 or 0.1 % Bavistin at monthly interval commencing from May and continue up to pruning.

2. Rust

The disease is caused by a fungus *Uromyces hobsoni*. This disease occurs in the month of July, August during monsoon rains, in severe form. The leaves show the presence of orange coloured aerial cups on both sides, but predominantly on the lower surface. Numerous blisters are produced in advanced stages of infection causing yellowing and wrinkling of the leaves. The stems and branches are also infected, causing splitting of barks and subsequent death of the branches. Dusting of Sulphur @20-25 kg/ha or spraying with Bordeaux or Copper oxychloride effectively controlled the rust.

3. Mosaic

It is a viral disease. The diseased plants show slanted and yellowish green appearance with small leaves. Yellowish green to chlorotic flecks of 1-2 mm in diameter appear irregularly on the leaf and these streaks form into a ring. The symptoms are more conspicuous on older leaves. Control of insect vectors will prevent the transmission of the disease.

4. Phyllody

Mycoplasmas are responsible for the occurrence of this disease. The affected plants produce malformed, reduced greenish flower-like structure instead of fragrant white panicles which are highly congested and green in colour. The greenish corolla lobes become reduced and ovate in shape. Flower parts are transformed into leaf-like structures. The disease may be controlled by spraying with tetracycline hydrochloride (250 ppm).

B. Pests

1. Bud worm

The bud worm *Hendecasis duplifascillis* is a greenish larva with a black head. It bores into immature jasmine buds and feeds on floral structure and in severe cases webbing of buds is also noticed. Spraying

during blossoming with 0.4-0.6% solutions of 50% Diptrex combined with hand picking of larvae and pupae is beneficial.

2. Mites

The causal organisms include several species like red spider mite, gall mite, and cydamen mite. The incidence of red spider mites is high during warm and dry weather, especially during summer. The mites are seen feeding on under surface of the leaves which become yellow and drop off. Severe puckering and discolouration of leaves are caused by gall mite. A considerable reduction of infestation can be obtained by spraying Malathion @ 0.1 % or miticides like Dicofol, Omite, Pyromite, etc.

CROSSANDRA

Crossandra is one of the important commercial flowers, mainly grown in India, tropical Africa and Madagascar. The flowers are commonly used for hair adornment and bouquets. Though it is not fragrant, flowers are very popular because of its attractive bright colours, light weight and good keeping quality. It is most easily available flowers all the time since it is easy to grow. It can be cultivated even by small farmers. Its flowers are used for making garland, either alone or in combination with jasmine flowers. Using Crossandra flowers in combination with jasmine is becoming increasingly popular in India, particularly in southern parts, because the jasmine flowers provide colour contrast and the desired fragrance.

1. Species and Cultivars

Crossandra belongs to the family *Acanthaceae*. There are 20-25 species but only few like *Crossandra undulaefolia*, *C. guineensis*, *C. mucronata* and *C. subacaulis* are cultivated. The species grown for commercial flower production is *Crossandra undulaefolia*. These are small, evergreen shrubs freely producing flowers in dense sessile spikes. Orange, Delhi, Lutea Yellow and Sebaculis Red are four important cultivars of the crossandra.

1. Orange Crossandra is tetraploid ($2n=40$), sets seeds profusely, breeds true and produces bright orange coloured flowers.
2. The cultivar Delhi is triploid ($2n=30$) and produces more attractive flowers of bright deep orange colour.
3. Lutea Yellow is tetraploid ($2n=40$) and the flowers are orange yellow colour.
4. Sebaculis Red is tetraploid ($2n=40$) and hardy cultivar, which possesses high degree of tolerance to nematodes.

2. Climate and Soil

Crossandra is a tropical plant and cannot tolerate low temperature and frost. It grows well in places where the temperature is around 30°C and requires a well-drained soil rich in organic matter. Alkaline or saline soils are not suitable because plants develop deficiency symptoms showing chlorosis.



Crossandra flower

3. Propagation

Propagation is done by seeds or cuttings under mist. Seedlings are ready for transplanting when they have 4-5 pairs of leaves. Similarly, cutting should be transplanted when sufficient roots are developed.

4. Planting

Seedlings or rooted cuttings, treated with fungicide and nematicide, should be planted on the side of ridges at a spacing of 30 cm between plants and 60 cm between the ridges. Planting should be done in moist soil. Providing partial shade to the plants is beneficial to maintain the health of plants and obtain higher yield of flowers.

5. Manuring and fertilization

High fertility in the soil is essential for good yield. In addition to the basal application of farmyard manure, periodical top dressing with fertilizers and organic manure is essential. The first application of fertilizers should be done in 50-60 days after planting. The doses of chemical fertilizers are, urea @ 50 kg/ha, super phosphate (SSP) @ 100 kg/ha, and muriate of potash (MOP) @ 60 kg/ha. These must be applied twice at an interval of 6 months, except in the rainy season. The application of fertilizers is to be necessarily followed by irrigation. Weeding, application of manure, fertilizer and earthing up are combined together and done simultaneously for easy operation.

6. Flowering

Crossandra reaches to flowering stage after 2-3 months of planting and continues to bear flowers throughout the year with a drop in production during the rainy season. The flowers open in sequence from the base of the spike. Two flowers, which are diagonally opposite in the spike opens at the same time. It takes about two days for complete opening of the flower. Therefore, picking of flowers has to be done on alternate days. Depending on the length of spike, it takes nearly 15-25 days to complete flowering on a spike. After the flowering is over, the spent spikes are removed. The fully opened flowers remain fresh on the plant for about three days but when picked they fade away in 36-48 hours.

7. Diseases and Pests

Disease

The most damaging disease is wilt, caused by *Fusarium solani*. The characteristic symptoms of the disease are dropping of leaves, marginal yellowing and rotting of roots and rootlets. The invasion by nematode (*Pratylenchus* sp.) will predispose the plant for the fungus to penetrate and cause severe wilting. The affected plants should be removed. If the symptoms are noticed at the early stage, drenching the soil with Carbendazim 0.1 per cent or Copper oxychloride 0.25 per cent will keep the pathogen under control.

Pests

Scales, white fly and bug are important insect pests. Spray of methyl parathion 0.01% or twice at fortnightly interval will control these pests.

Nematodes

Several species of nematodes have been found to affect Crossandra. The common ones are *Meloidogyne incognita* (root knot nematode), *Pratylenchus delattrei* (lesion nematode) and

Longidorus african (needle nematode). Plants affected by these nematodes exhibit stunted growth, curled leaves with purple discoloration, chlorotic symptoms and discoloration of flowers. The size of leaf and flower is also reduced. The roots affected by lesion nematodes show brownish necrotic streaks initially and later the whole roots decay. In case of infestation by root-knot nematode, root galls of various sizes are formed on the roots. The needle nematode causes forking and clubbing of root tips. In case of severe infection, the plants decline and die. Crossandra should not be raised in nematode infested field. In the nursery, application of nematicide viz. Temik 10 or Phorate 10 G at 25 g per m² will control the nematodes.

Points to Remember

- Marigold, jasmines, rose, chrysanthemum, crossandra and tuberose are important loose flower crops grown in India over in 2/3rd area
- Gladiolus, rose, tuberose and chrysanthemum are popular cut flowers grown in open in India
- Rose, jasmines and tuberose are also popular flower crops for perfumery in India

Check your progress

A. Fill in the blanks:

- 1) Rose is commonly known as _____
- 2) In India, the rose was referred in old Sanskrit literature as _____.
- 3) Ramblers produce flowers only once in a year and flowers are in _____ lasting for several weeks.
- 4) Rose petals are used for making _____.
- 5) In India, _____ and _____ species are cultivated for rose oil.
- 6) Rose hips are rich in _____.
- 7) Black spot disease in rose is caused by _____.
- 8) *Rosa indica* var *odorata* is a better rootstock for _____ plains of India.
- 9) _____ budding is the commercial method rose propagation.
- 10) Stratification of rose seeds at _____ °C is required after harvest for germination.
- 11) Chrysanthemum commonly called _____
- 12) Chrysanthemum is typical _____ day plant.
- 13) *Aspermy* in chrysanthemum is caused by _____
- 14) The act of removing the growing tip of the plant is known as _____.
- 15) Thermo zero cultivars which flower at any temperature of _____ °C.
- 16) A collar rot disease is caused by _____.
- 17) Artificial long days are provided with the help of _____ incandescent lamps
- 18) Chrysanthemum is the National Flower of _____.
- 19) Proportion of potassium fertilizer should be increased as the _____ appear.

- 20) The florets which are present at the centre of the bloom are called _____.
- 21) Gladiolus commonly called _____
- 22) The favourable temperatures for gladiolus cultivation should be _____.
- 23) Gladiolus corms are cold stored at _____°C till next season planting
- 24) Gladiolus is an indicator plant for _____ pollution.
- 25) _____ stimulates germination of dormant cormels.
- 26) Ethrel breaks _____ dominance and promotes the sprouting of lateral buds.
- 27) Dormant cormels contain as much as 5-10 times _____ than the non-dormant ones
- 28) In hilly areas, _____ is best planting time to get flowers from June-September.
- 29) Earthing-up in gladiolus should be done at _____ leaf stage.
- 30) Dormancy in gladiolus cormels is more pronounced produced under _____ climates than those produced under cooler climates
- 31) Marigold belongs to the family _____
- 32) The name *Tagetes* was given after _____, a demigod, known for his beauty.
- 33) Scientific name of African marigold is _____.
- 34) _____ are the major carotenoid fraction in the flower petals.
- 35) Lutein from the flower petals of African marigold is the best source of carotene for colouring _____.
- 36) _____ mites are the serious insects of marigolds.
- 37) Marigold flowers are mainly used for making _____.
- 38) Marigold plants grown at 21°C (night temperature) had higher _____
- 39) _____ blight is the most serious diseases of marigold plants.
- 40) Marigold is a native of _____.
- 41) Tuberose belongs to the family _____
- 42) Dried tuberose bulbs in the powdered form are used as a remedy for _____.
- 43) A contagious disease known as bunchy top causes _____ of the inflorescence.
- 44) Reduction in light intensity promotes the _____ whereas increase in the intensity and duration of light result in production of _____.
- 45) The optimum temperature range for growth and development is _____°C.
- 46) Cracking of the spike, bud rot is due to _____ deficiency.
- 47) High dose of _____ and _____ markedly promotes leaf and bulb formation in tuberose.
- 48) Loam and sandy loam soils having a pH range from _____ with good aeration and drainage are considered suitable for tuberose cultivation.
- 49) Root galling in tuberose is caused by _____.
- 50) Tuberose is a native of _____.

- 51) The world famous jasmine oil is extracted from the flowers of_____.
- 52) The genus jasmine belongs to the family _____.
- 53) *Jasminum humile* bears _____ colour flowers which are fragrant and are used in perfumery.
- 54) _____are responsible for the occurrence of phyllody disease.
- 55) Sufficient_____ in the soil is necessary for proper growth and flowering in jasmines.
- 56) _____cutting is the easiest method of jasmine propagation.
- 57) The ideal conditions for successful cultivation of jasmine are _____ summer and _____ winter.
- 58) *Jasminum grandiflorum* is commonly known as _____.
- 59) The flowers of the _____are reported to be used in China for flavoring tea.
- 60) The incidence of red spider mites is high during _____and _____ weather
- 61) Crossandra belongs to the family _____.
- 62) Orange Crossandra is tetraploid having chromosomes _____.
- 63) The needle nematode causes _____and clubbing of root tips.
- 64) Crossandra grows well in places where the temperature is around _____°C.
- 65) Dropping of leaves, marginal yellowing and rotting of roots and rootlet are the characteristic symptom of_____.

B. Short answer and descriptive type questions:

- Q.1 Enlist the importance and various uses of Rose crop.
- Q.2 Write short notes on quality of rootstock used for Rose crop.
- Q.3 Write short note on pruning and planting of Rose crop?
- Q.4 Write short notes on climate and soil requirement for Chrysanthemum crop.
- Q.5 Elaborate off season cultivation practices of Chrysanthemum crop.
- Q.6 Write short notes on climate and soil requirement for Gladiolus crop.
- Q.7 Explain different propagation methods of Gladiolus crop.
- Q.8 Write short notes on climate and soil requirement for marigold.
- Q.10 Write short notes on
 - ❖ Growth and flowering of tuberose.
 - ❖ Harvesting and storage of bulbs.
 - ❖ Role of environmental factors on growth and flowering
 - ❖ Role of growth regulators.
- Q.11 List down different species and cultivars of marigold.
- Q.12 What is the importance of Crossandra? Enlist its major species and cultivars in India.

Chapter 9

Protected Cultivation of Commercial Flower Crops

Objectives

After studying this chapter, students will be able to:

- know the importance of protected cultivation of commercial flower crops
- know various kind of structures for protected cultivation
- know various ways to commercially grow flower crops under protected structures
- know about the year round production of cut flowers and their planting material

Introduction

Whenever you go to any florist shop or a flower market, you might have seen several types of cut flowers, floral arrangements and its value added products all through the year. You must be interested to know, how such cut flowers are grown and in which areas? In this chapter we will study the importance of protected cultivation of commercial cut flowers.

Do you know?

In Rome protected cucumber cultivation started during 14-37AD.

What do you mean by Protected- cultivation?

Protected cultivation is the technique of providing favourable environmental or growth conditions to the plants. In greenhouses, the growing environment is altered to suit the specific requirements of plants. It is rather used to protect plants from the adverse climatic conditions by providing optimum conditions of light, temperature, humidity, CO₂ and air circulation for the best growth of plants to achieve maximum yield and best quality.

What is a greenhouse?

A greenhouse is a covered structure which protects plants from vagaries of weather or environment i.e. wind, precipitation, excess solar radiation, temperature extremes and considerable attack of pests and diseases.



Modified Quonset type polyhouses for flower cultivation in mid hill areas

What are the basic principles of greenhouse cultivation?

- The greenhouse is covered with a transparent material such as plastic, pvc sheet or polycarbonate sheet or FRP (Fiber reinforced plastic) or glass.
- Based upon its transparency, the greenhouse cover transmits most of the sunlight.
- Crop, floor and other objects inside the greenhouse absorb the sunlight admitted inside the greenhouse.
- Such objects in turn emit long wave thermal radiations for which the greenhouse covering material has lower transparency and as a result of this the solar energy is trapped thus leading to increased temperature inside the greenhouse.
- This is called as greenhouse effect.

History of protected cultivation of ornamentals in India:

- History of protected cultivation is over 200 years old in the world especially in Europe.
- However, in India Indo-American Hybrid Seeds Company has made greenhouses for cultivation of ornamental plants before 1970.
- M/s Feroz Masani and Sons of Nasik started growing carnations in greenhouses during 1980.
- M/s Pune flowers started growing roses on rock wool in 1/4th acre greenhouse in late eighties for export at Pune.
- Presently over 250 private companies have started producing flowers in greenhouses in India.
- Total area under greenhouses in India for commercial flower cultivation has been estimated to be over 700 ha.

Advantages of protected cultivation of flower crops:

- High productivity per unit area
- Ensures the production of any plant at any place and throughout the year
- Off-season flower production
- Blemish-free high quality product (flowers and planting material)
- Easy to control insect-pests and diseases
- Water requirement reduces upto 30 per cent
- Labour requirement is less
- Earliness as well as reduced crop duration

Do you know?

Israel and middle-east counties started protected cultivation primarily to save water.

Advantages of protected cultivation in Indian context:

- Abundant sunshine throughout the year especially in autumn and winter
- The average radiation received at Quito-Equator and Nairobi is 434 and 462 cal/cm²/day, respectively at 1800m AMSL the best centres in the world producing quality cut flowers, which is at par with radiation received at Bangalore (450 cal/cm²/day at 1000m AMSL)
- Ideal temperature
- Shorter production cycle
- Good production during the main international events when demand for flowers is high in Europe and USA.

Basic considerations for protected cultivation of flower crops:

- Feasibility study
- Type of greenhouse structures
- Planting material
- Growing system
- Plant protection
- Post harvest handling
- Supporting facilities for analyzing quality of water and growing media
- Management and coordination

Growing systems for protected cultivation of flower crops:

- Ground beds
- Raised beds
- Pots and trough culture on benches or ground
- Straw bale culture
- Ring culture
- Soil-less culture
- Hydroponics
 - ❖ Gravel culture
 - ❖ Sand culture
 - ❖ Nutrient film technique (NFT)
 - ❖ Rock wool culture
 - ❖ Coco peat culture

Characteristics of growing medium for protected cultivation:

- Provide adequate nutrients to the crop
- Support or anchorage the plants grown
- Good moisture holding capacity
- Sufficiently porous
- Not saline
- Withstand pasteurization with steam or solarization
- Free from weed seeds, nematodes, etc.

Decontamination of growing medium in greenhouses:

- Chemical drenching/ fumigation: formaldehyde, chloropicrin, hydrogen peroxide, captan and vapam
- Steaming

- Pasteurization
- Solarization

Managing High Temperature in protected cultivation:

- Using Naturally ventilated polyhouses with side (1.5m) and top (1m) ventilation
- Use of fan and pad system for cooling
- Use of 50% intensity shade nets (12 noon to 4 pm) installed inside the polyhouses
- Use of foggers/ misters during afternoons once/ twice only in vegetative phase of flower crop
- Photo-selective shading paints with less reduction of PAR allowing 69% light and are useful in late spring and summer @ 450kg/ha in a ratio of 1:3 (paint : water).

Important flower crops for commercial protected cultivation in India:

- Cut flowers (Rose, Carnation, Chrysanthemum, Liliun, Gerbera, Tulip, Anthurium, Orchids (Cymbidium and Dendrobium), Alstroemeria, Eustoma, Gypsophila, Statice, etc.)

1. Rose (*Rosa hybrida*):

Rose (Queen of flowers) is the leading cut flower in the international cut flowers trade and is also the leading cut flower exported from India. In India, over 90 per cent greenhouses grow rose as cut flower mainly for export. Potential areas for setting up commercial cut flower units for rose in greenhouses are Pune, Bangalore, Nasik and hilly states. The leading export cultivars of rose are Cora, Corvetti, Diplomat, Femma, First Red, Grand gala (almost thornless), Kiss, Konfetti, Lambada, Laser, Nicole, Noblesse, Osiana, Papillon, Parea, Passion, Pavrotte, Rodeo, Rossini, Sacha, Samura, Sandy, Sangaria, Soleda, Susanne, Texas, Tineke, Vivaldi. The salient characters of rose cultivars for cut flowers are:

- More number of petals
- Petals open slowly
- More longevity
- Attractive colour
- Long and strong stem

Do you know?

Fossils remains of roses have been reported 30 million years back, while that of man is 0.15 million years back.



Rose cut flowers growing in greenhouse at Bangalore

Environmental factors affecting growth and flowering:

- Temperature (Day: 18-28 °C and night: 15-18°C)
- Light (Photoperiod over 12 hours and intensity: 6000-8000 foot candles)
- Relative humidity (50-60 %)
- Aeration (Good in air and soil)
- CO₂ (1000-3000 ppm)

Do you know?

Gulkand is prepared by mixing rose petals and sugar in equal proportion on weight basis.

Soil and growing medium:

- Light, and well drained
- pH should be around 6.5
- EC should be less than 1.0
- Humus about 10-12%

Constituents of soil-less growing medium:

- sand
- coco-peat or peat moss or sphagnum peat
- rock-wool
- perlite
- vermiculite

Do you know?

Perlite and vermiculite are prepared from rocks by heating at a very high temperature (750-900°C)

Optimum spacing and planting density:

- In greenhouse single, double or four row planting system in bed is being followed and spacing of 30 x 25 cm is kept.
- Optimum plating density in greenhouse is 60-70 thousand per hectare.

Propagation:

- Shield or T-Budding (Commercial method)
- Stenting method (Budding done on cuttings, which are planted for rooting in mist chamber)
- Cuttings (Propagation of rootstocks- 15 to 20 cm long stem cuttings of pencil thickness having at least three buds)
- Micro-propagation especially for fast multiplication of new cultivars

Important root stocks:

- *Rosa bourboniana*
- *Rosa indica* var. Odorata
- *Rosa multiflora*

Time for budding and pruning:

- N.I. plains: Nov.-Dec.
- Low hills: Dec.-Feb.
- Mid hills: Jan.-Mar.
- High hills: Feb.-April.



Rose cut flowers in market

Optimum nutrients (ppm) application:

pH: 6.2-6.8	Calcium: 55
EC: 0.7	Magnesium: 20
Nitrate: 180	Ammonium: 2
Phosphate: 4	Iron: 0.39
Potassium: 45	Manganese: 0.04
Sodium: 25	Zinc: 0.07
Chloride: 35	Boron: 0.08
Sulphate: 105	Copper: 0.05
Bi-carbonate: 30	Calcium: 55

Factors affecting pruning:

- Cultivar
- Class or category of rose
- Health and vigour of plant
- Spacing
- Soil fertility
- Desired quality



Genetically engineered rose

Other plant management practices affecting growth and flowering of rose:

- Pinching
- Disbudding
- De-shooting
- Defoliation
- Removal of faded flowers
- Bending of about 25 % shoots improves quality of cut flowers

Irrigation:

- Irrigation is done through drip irrigation with one line along every row.
- One drip if inserted about 15cm below the soil level helps to maintain optimum moisture around root zone.
- Daily water requirement varies with the outside temperature from 2 to 5 litres/m².
- Water soluble fertilizers are also given along with irrigation.
- During vegetative phase irrigation through sprinkler/ mister/ fogger is beneficial.

Diseases:

- Die back (*Diplodia rosarum*, *Colletotrichum* sp.)
- Black spot (*Diplocarpon rosae*)
- Powdery mildew (*Spaerotheca pannosa*)

- Downey mildew (*Peronospora sparsa*)
- Gray mould (*Botrytis cinerea*)
- Rust (*Phragmidium sp.*)
- Crown ball (*Agrobacterium tumefaciens*)
- Wilt (*Marmor flaccumfasciens*)

Insect-pests:

- Red scales
- Red spider mites
- White ants
- Aphids
- Thrips
- Jassids
- Chafer beetles
- Mealy bugs
- Stem girdler
- Sawflies

Physiological Disorders:

- Bull head
- Bent neck
- Limp neck
- Blind shoot
- Vascular plugging

Stage of flower harvesting:

- For local market: When outer one/two petals start unfurling.
- For distant market: Fully coloured tight buds
- White, pink and yellow cultivars are harvested earlier to red as red may not open if harvested at tight bud stage

Popular grades:

- Large flower cultivars: Stem length 60-90 cm and bud size 3-3.5 cm.
- Small flower cultivars: Stem length 40-50 cm and bud size 2-2.5 cm.

Packaging of cut flowers:

- In bundles of 10, 12, 20 or 25.
- In corrugated card board boxes of 100 x 32.5 x 20 cm (L x W x H) accommodates about 80-100 cut roses of 60-65 cm length.

- Wrap flower bunches in cellophane sleeves.
- Inline the boxes with tissue paper or news paper.

Average yield:

- Indian greenhouses: 150-200 stems/m²/year.
- European greenhouses: 350-400 stems/m²/year.

2. Carnation (*Dianthus caryophyllus*):

Carnation is the leading cut flower grown under greenhouses in mild climatic and hilly areas. Potential areas for setting up commercial cut flower units for carnation in greenhouses are Pune, Bangalore, Nasik, Shimla, Chamba, Solan, Ooty, Kodaikanal, Nainital, Srinagar, etc. This has become popular on account of its following qualities:

- Excellent vase life
- Wide range of flower colours and forms
- Ability to withstand long distance transportation
- Rehydrate easily
- Lighter weight

Florist carnations:

- Standard
- Spray
- Mini
- Micro



Popular standard carnation cultivars:

Dona, Pink Dona, Malaga, White Dona, Rony, Rhodos, Lipstick, Empire, Romana, White Tendra, Corleone, Design, Natila, Dark Tempo, Bagatel silvery pink, Solar, Cobra, Pendy, Lorella, Cabaret, Tanga, Sonsara, Dakar, Liberty, Solar, Green Lady, Tempo, Varna, Sun Shine and Charment.

Environmental factors affecting growth and flowering:

- Light : Photoperiod (long days over 16 hours) and intensity (100 watts bulb spaced at 10.5m at 1.5m height)
- Temperature : Night (winter: 10-11 °C, spring: 12.7 °C and summer: 13-15.4 °C) and day (18-23°C)
- Ventilation : Free circulation of air
- Relative humidity : 50-60%.
- CO₂ : 500-1500 ppm

Propagation:

- Terminal stem cuttings (8-10 cm long with 4-6 leaf pairs)
- Micro-propagation



Carnation propagation

Soil and growing medium:

- Light texture loam or sandy loam soil which is well drained and aerated.
- Soil pH: 6-7

Planting time:

- N.I. plains : Sep.-Oct.
- South India : Throughout year
- Hills : Jan.- April
- Staggered planting at 15 days interval ensure regular supply of cut flowers.

Planting density and spacing:

- Ordinary : 25-32 plants/m²
- High : 40 plants/m²
- Standards : 20 x 20 cm
- Spray : 30 x 30 cm

Optimum nutrition:

- N : 5.4%, P: 0.31%, K: 3.8%
- Standards : FYM: 5 kg, N: 30g, P: 20g, K: 10g/ m²
- Spray : FYM: 5 kg, N: 40g, P: 20g, K: 10g/ m²
- Now commercially nutrition is given through fertigation

Soil moisture and irrigation:

- Optimum soil moisture is 300-500 cm tension
- Irrigation is done through drip irrigation with three lines in five rows in a bed.
- Daily water requirement varies with the outside temperature from 2 to 3 litres/m².
- Water soluble fertilizers are also given along with irrigation.
- During vegetative phase irrigation through sprinkler/ mister/ fogger is beneficial.

Pinching:

- In pinching terminal growing shoot about 2-3 cm long is removed to overcome apical dominance and to promote side branching when the plants are at 6-8 leaf pair stage.
- Pinching types:
 - Single
 - Pinch and half
 - Pinch plus pull pinch
 - Double

De-shooting:

- When the side shoots after pinching are 3-5 cm long then retain 3-5 shoots per plant in standard cultivars.
- When the side shoots after pinching are 3-5 cm long then retain 6-10 shoots per plant in spray cultivars.

Staking:

- Wire mesh, plastic nets, string or bamboo canes are used to support plants.
- Wire mesh or plastic nets having inner size of 10-15 cm squares are placed on the ground in three layers, which are erected at 20, 35 and 50 cm above the ground level with the growing plants.
- String or rope is erected in three rows at the same distance along the rows.

Disbudding:

- Disbudding is the removal of visible (5-10 mm diameter) undesirable buds.
- In standard cultivars terminal bud is retained and all the lateral buds are removed.
- In spray cultivars terminal bud is removed and lateral buds are retained.

Weeding:

- Three-four hand weeding.
- Chemicals viz., oxidiazon and napropamide @ 2.2 and 4.5 kg a.i. per hectare are good in greenhouse.
- In open fluchloralin (basalin) and pendimethalin (stomp) @ 1.0 a.i. per hectare each are effective.

Stages of flower harvesting:

- Standard cultivars for local market are harvested when flowers are half opened or at painting brush or outer petal is perpendicular to stem, while for distant market cross is developed on buds and colour is visible.
- Spray cultivars are harvested for local market when two flowers have opened and others have shown colour, while for distant market when 50% flowers have shown colour.

Popular international grades:

Parameter	Grade		
Bud diameter (mm)	Blue or Fancy	Red or Standard	Green or Short
Tight	50	44	None
Fairly tight	62	56	None
Open	75	60	None
Stem length (cm)	55	43	30

Common grades in India:

- A: over 45 cm
- B: 30-45 cm
- C: less than 30 cm

Packaging:

- In bundles of 10, 12, 20 or 25.
- In corrugated card board boxes of 120 x 60 x 30 cm (L x W x H) accommodates about 800-1000 cut flowers of carnation.
- Wrap flower bunches in cellophane sleeves.

Diseases:

- Wilt (*Fusarium oxysporum f. sp. dianthi*)
- Foot-rot (*Phytophthora*, *Pythium*, *Rhizoctonia solani*, *Sclerotinia sclerotiarum*)
- Stem rot (*Fusarium roseum*)
- Flower bud rot (*Alternaria dianthi*)
- Bacterial wilt (*Pseudomonas caryophylli*)
- Rust (*Uromyces caryophyllinus* or *U. dianthi*)
- Flower blight (*Botrytis cinerea*)
- Fairy ring spot (*Heterosporium enchimulatum*)
- Viral diseases

Insect-pets:

- Red spider mites
- Thrips
- Nematodes
- Aphids
- Helicoverpa/ Heliothis/ Spodoptera caterpillars



Red spider mites in carnation

Physiological disorders:

- Calyx splitting
- Grassiness
- Sleepiness
- Splitting at nodes and bushiness
- Small narrow leaves and tied tips

Tinting in carnation:

A concentrated liquid or powder colour is mixed in small amount of warm pure water (37°C) and stems are placed in it. The colour develops in different patterns on the petals after 10-24 hours.

Average yield:

- 200-300 flower stems/m²/year.

3. Chrysanthemum (*Dendranthema grandiflora*)

Chrysanthemum is grown for cut flower, loose flower, pot-mum, hanging baskets and bedding and border plant. It has become popular on account of its excellent vase life, wide range of flower colours and forms and lighter flower weight. Its cultivars are classified on the basis of inflorescence, photoperiod and temperature. Potential areas for setting up commercial cut flower units for rose in greenhouses are Bangalore, Pune, Kolkata and hilly states.

Different classes of chrysanthemum on the basis of form of inflorescence:

- ❖ Single
- ❖ Anemone
- ❖ Korean
- ❖ Double

Do you know?

Chrysanthemum is a typical short day flower requiring critical day length of less than 9½ hours.

- ❖ Decorative
- ❖ Pompon
- ❖ Incurved
- ❖ Incurving
- ❖ Reflexed
- ❖ Quill
- ❖ Fuji, and
- ❖ Spider

The important cultivars of chrysanthemum for export are Snow ball, Snow Don White, Mountaineer, Sonar Bangla, Bright golden, Anne, Chandrama, Ajay, Birbal Sahni, Lehmans, Nanako and Sonali Tara. The important off-season blooming cultivars of chrysanthemum are given below:



Chrysanthemum cultivation in greenhouse

- April-June : Himanshu, Jawala, Jyoti
- July-Aug. : Phuhar
- Sep.-Oct. : Ajay, Sharda
- Oct.-Nov. : Makhmal, Megami, Mohini, Sharad har
- Nov.-Dec. : Normal season cultivars
- Jan.-Feb. : Jaya, Lilith, Suneel, Vasantica.
- Feb.-Mar. : Maghi.
- Flowering of these cultivars is recorded at NBRI, Lucknow as these cultivars are developed in this institute.

Soil:

Sandy-loam having pH 6.2-6.7 is ideal for growing chrysanthemum.

Climate:

- Light (Intensity: 1.2-1.6 MJ/m²/day, Quality: 600-800nm, Photoperiod: less than 9.5 hours). Chrysanthemum is a short day plant and flowering occurs when the critical day length is less than 9.5 hours.
- Temperature (night: 10-16°C, day: 18-21°C)
- CO₂: 500-1000ppm

Propagation:

- Terminal stem cuttings (4-5 cm) during June-July, and
- Suckers during February to April

Planting density and spacing:

- Greenhouse cut flowers: 40-54 plants/m².
- Loose flowers: 30 x 20 cm or 20-25 plants/m²
- Standards: 20 x 20 cm
- Sprays: 30 x 30 cm
- Pot mums: 3-5 cuttings/pot (15 cm)

Nutrition:

- FYM: 3-5 kg/ m²
- N:P:K::30:10:15g/m² at monthly interval
- Loose flowers: FYM: 10-15 ton, N: 150kg, P: 100kg, K:120 kg/ ha)
- Spray of light solution of cake + SSP at bud developing stage is very beneficial. Apply nitrogen through CAN source as urea causes phyto-toxicity.

Pinching:

- Twice after 4 and 8 weeks of transplanting

De-shooting:

- Retain 4-5 shoots in standard and 8-12 shoots in spray cultivars.

Disbudding:

- Remove lateral buds in standard and terminal bud in spray cultivars.

Irrigation:

- Soil should have 60-70 per cent moisture. Depending upon weather 8-10 irrigations of 2.5-5 cm depth are required.

Staking: Wire mesh, plastic nets, string or bamboo canes are used to support plants. Wire mesh or plastic nets having inner size of 10-15 cm squares are placed on the ground in three layers, which are erected at 20, 35 and 50 cm above the ground level with the growing plants. String or rope is erected in three rows at the same distance along the rows. In pots for standard cultivars single bamboo stick is used and in spray cultivars 3-4 sticks are placed on the sides to protect the plant.

Weeding: Three-four hand weedings are sufficient. Atrazine @ 1.0 a.i. per hectare is effective before transplanting.

Diseases:

- Wilt (*Fusarium oxysporum f. sp. chrysanthemi*)
- Stem and foot rot (*Rhizoctonia solani*)
- Root rot (*Pythium, Phytophthora spp.*)
- Bacterial rot (*Erwinia chrysanthemi*)
- Powdery mildew (*Oidium chrysanthemi*)
- Leaf spot and flower blight (*Alternaria, Septoria spp.*)
- Gray mould (*Botrytis cinerea*)
- Viral diseases (chrysanthemum stunt, tomato spotted wilt, tomato aspermy, flower distortion, chrysanthemum mosaic and chrysanthemum rosette)

Insect-pests:

- Aphids
- Red spider mites
- Hairy caterpillars
- Thrips
- Grubs
- Leaf miners, and
- Nematodes



Aphids- a serious pest in chrysanthemum

Disorders:

- Premature budding
- Quilling of florets
- Crown bud formation
- Heat delay, and
- Petal burn

Harvesting Stages:

- **Standards:** When outer row of florets start unfurling for distant market and for local market half opened flowers.

Sprays: Harvested for local market when two flowers have opened and others have shown colour, while for distant market when 50% flowers have shown colour.

Commodity	Grade			
	Blue	Red	Green	Yellow
Stem length (cm)	75	75	60	60
Flower diameter (cm)	15	12.5	10.0	————
Stem strength			Strong	

Packaging:

In bunches of 10, 20 or 25 in corrugated card board boxes of 91 x 43 x 15 cm (L x W x H) accommodates about 80-100 cut flowers of chrysanthemum. Wrap flower bunches in cellophane sleeves.

Average yield:

- Yield in greenhouse: 150-250 flower stems/m²/year.

4. Gerbera (*Gerbera jamesonii*):

Gerbera is commonly known as Transvaal daisy or Barberton daisy or African daisy. Its name was coined in honour of German naturalist, Traugott Gerber. Important species in genus *Gerbera* are given below:

- ❖ *asplenifolia*
- ❖ *aurantiaca*
- ❖ *jamesonii*
- ❖ *kunzeana*
- ❖ *viridifolia*

Important cultivars of *Gerbera*:

- ❖ Diana, Thalsa, Sonsara, Paganini, Anneke, Nette, Rosetta, Gloria, Ginna, Ingrid, Pricilla, Alexias, Intense, Sunway, Zingaro, Balance and Monique.

Factors affecting growth and flowering of gerbera:

- ❖ Light (Long days are good)
- ❖ Temperature (Day: 16-22°C and night: 12-15°C)
- ❖ Growth regulators (GA₃ and CCC)

Propagation:

- ❖ Seeds
- ❖ Division of plants
- ❖ Cuttings
- ❖ Micro-propagation

Ideal planting density and spacing:

- ❖ 8-10 plants/m² or 30 X 30 cm or 40 x 25 cm

Nutrient status in gerbera:

- ❖ N: 2.7-3.1%, P: 0.19-.0.35%, K: 3.06-3.64%, Ca: 1.66-2.18% and Mg: 0.3-0.48%.

Ideal fertilizer application schedule in gerbera:

- ❖ Vegetative stage: N: P: K: Ca: Mg:: 3: 2: 3: 1: 1 @ 75g/m²
- ❖ Flowering stage: N: P: K: Ca: Mg:: 3: 2: 4: 1: 1 @ 75g/m²

Diseases:

- ❖ Root rot (*Pythium irregularae*, *Rhizoctonia solani*)
- ❖ Foot rot (*Phytophthora cryptogea*)
- ❖ Sclerotium rot (*Sclerotium rolfsii*)
- ❖ Blight (*Botrytis cinerea*)
- ❖ Powdery mildew (*Erysiphe cichoracearum*, *Oidium crysiphoides*)
- ❖ Leaf spots (*Phyllosticta gerberae*, *Alternaria spp.*)
- ❖ Viral disease (Cucumber mosaic virus and Tobacco rattle virus)

Insect-pests:

- ❖ White fly
- ❖ Red Spider Mites
- ❖ Nematodes
- ❖ Aphids
- ❖ Leaf miner
- ❖ Caterpillars



White flies- a serious pest in gerbera

Harvesting stages of cut flowers:

- ❖ Before outer row of ray florets show pollen
- ❖ When outer row of petals is perpendicular on stalk.

Packaging of cut flowers:

- ❖ In insulated boxes to avoid freezing injury
- ❖ Plastic coated metal grids 50 x 70 cm with mesh size of 2 x 2 cm.

Average yield of gerbera cut flowers:

- ❖ Greenhouse: 200-250 flowers/ m²/year
- ❖ Open field: 120-150 flowers/ m²/year

5. Lily (*Lilium* species)

The genus *Lilium* has two distinct groups as Oriental and Asiatic. Important characteristics of these are given below:

Characteristics of Oriental lilies:

- Derived from species *Lilium aurantium*, *L. speciosum* and *L. rubellum*.
- These are late flowering lilies.
- Flowers are mostly white and pink.
- Flowers are mostly fragrant.
- Leaves are broader and almost parallel to ground, and
- Bulbs are large 16-22 cm.
- The important export cultivars are Star Gazer, Macropolo and Casablanca.



Oriental Lilium

Characteristics of Asiatic lilies:

- Derived from hybridization of 12 species viz., *Lilium amabile*, *L. bulbiferum*, *L. concolor*, *L. dauricum*, *L. davidii*, *L. hollandicum*, *L. maculatum*, *L. leichtlinii*, *L. pumilum* and *L. tigrinum*.
- These have extended range of flowering period.
- Flower colour varies from orange, red, yellow, etc.
- Flowers are mostly odourless
- Leaves are narrow and upward growing, and
- Bulbs are small 10-16 cm.
- Important export cultivars are Connecticut King, Gran, Paradiso, Elite, Pollyana, Prato and Solemio.
- The cultivars which do not stain clothes and table with their pollen like Tiara (pink single), Aphrodite (pink double) and Sphinx (red double) are preferred by most of the flower lovers.



Asiatic Lilium

Soil or growing medium:

Well drained soil, rich in organic matter and having pH 6.5-7.5. Adequate growing medium is soil: peat moss:: 1:1 or soil: peat moss: perlite:: one part each.

Climate:

- Temperature (Day: 18-25°C and Night: 12-18°C)
- Partial shade (40-50%)
- Good aeration/ ventilation

Propagation:

- Bulbs
- Bulblets
- Scales, and
- Bulbils in *L. bulbiferum*, *L. sargentiae*, *L. tigrinum* and *L. wallichianum*



Lilium bulbs for planting

Planting time:

- Low hills: Oct.-Nov.
- Mid hills: Feb.-Mar. and July-Sep.
- High hills: March-April

Treatment of Bulbs:

Dip bulbs for about 20 minutes in a solution of Emisan (0.2%), Thiram (0.3%), Captan (0.2%), Bavistin (0.2%) or Benlate (0.2%). Dry in shade before planting or storing. Before planting treat bulbs in systemic fungicide and before storing in contact fungicide. These must be thoroughly dried before planting or storage.

Planting density and spacing:

Planting density and spacing depends upon group of Lilium, bulb size and place of cultivation. In open planting density is 20-40 bulbs/m² and spacing is 40 x 15 cm.

Oriental:				
Bulb size (cm)	16-18	18-20	20-22	>22
Bulbs/m ²	40-50	35-45	30-40	25-35
Asiatic:				
Bulb size (cm)	10-12	12-14	14-16	>16
Bulbs/m ²	65-90	55-80	45-70	40-65

Nutrition:

NPK:: 30: 20: 20 g/m² and for liquid feeding of NPK::14 : 10: 14. Fertilizers should not come in direct contact with bulbs as it leads to rotting.

Weeding:

Three-four hand weeding and herbicides like Propyzamide @ 2.25kg/ha and chloropham 3.5 l/ha are applied as pre-emergence.

Irrigation:

Soil should have 60-90 per cent moisture and no watering is required until bulbs sprout. Depending upon weather 8-12 irrigations of 2.5-5 cm depth are required.

Staking:

Wire mesh or plastic nets having inner size of 15-20 cm squares are placed on the ground in three layers, which are erected at 20, 35 and 50 cm above the ground level with the growing plants. String or rope is erected in three rows at the same distance along the rows.

Diseases:

- Gray mould (*Botrytis elliptica*, *B. cinerea*)
- Soft bulb rot (*Rhizopus stolonifer*)
- Fusarium bulb rot (*Fusarium oxysporum f. lilii*)
- Brown scale (*Colletotrichum lilii*)
- Root rot (*Pythium splendens*)
- Bacterial soft rot (*Pseudomonas* spp.), and
- Viral diseases (mosaic)

Insect-pests:

- Aphids
- Thrips
- White flies, and
- Mites

Disorders:

- Leaf scorch: It is due to deficiency of Mn, Al which occur at over dose of nitrate level and add lime @ 10 ton/ha.
- Bud blast: It is due to storage of water at top of plant, competition for nutrients, fluctuating carbohydrate level, low light intensity and high nitrate level.
- Puffy foliage: It is due to frost injury and stunting of plants.

Harvesting Stages:

- Local market: When 1-2 florets open
- Distant market: When 1-2 florets show colour.
- Cut stems few centimeter above ground level for increasing bulb size.

Storage of Flowers:

- Store flowers at 1-2°C.

Harvesting and Storage of Lilium Bulbs:

Harvest bulbs after 40-50 days of flowering or foliage start turning yellow. Store the bulbs in moist sand at -2°C for initial three weeks and later on at 0-2°C until two weeks before planting. In hilly areas, bulbs can be stored in moist moss and sand.

6. Orchids:

Orchids belong to the largest family of flowering plants *Orchidaceae* having about 600-800 genera, 25-30 thousand species and over 50 thousand hybrids and cultivars. In India over 1600 species are reported and over 50% of which are from north-eastern states, while 200 each from north-western, central and coastal areas of the country.

What are important genera of orchids of commercial importance?

Arandas, Bulbophyllum, Cymbidium, Dendrobium, Mokaras, Phalaenopsis, Paphiopedilum and *Oncidium*.

What are important genera of orchids native to India?

Aerides, Arachnis, Ascocentrum, Cymbidium, Dendrobium, Phalaenopsis, Paphiopedilum, Renanthera, Rhynchostilis and *Vanda*, etc.

How orchids are classified on the basis of habitat?

- Epiphytic: Live on the bark of trees or on moss covered rocks, fixing themselves with their strong fasciculate roots. They take nourishment from fine particles of rain water or from the detritus that collects around the roots, contrary to the assumption of their drawing food from the host plant. These orchids can be successfully grown in hanging baskets. Important examples are *Aerides, Cattleya, Dendrobium, Epidendrum, Phalaenopsis, Rhynchostylis, Vanda*, etc.
- Terrestrial: Live or grow on the ground and can be cultivated in pots. The important examples are *Calanthe, Cymbidium, Habenaria, Phaius, Spathoglottis, Thunia*, etc.



Cymbidium- leading cut flowers orchid in world trade

How orchids are classified on the basis of growing pattern?

- Monopodial: The plants grow upward with new leaves produced at the tip and flowers in the axils. They have neither rhizomes nor pseudobulbs. The important examples are *Habenaria*, *Phalaenopsis*, *Renanthera*, *Vanda*, etc.
- Sympodial: Growth of plant is seized after flowering and new shoots develop every year. The important examples are *Bulbophyllum*, *Cattleya*, *Cymbidium*, *Dendrobium*, *Gramatophyllum*, etc.

Propagation of orchids:

- Seeds
- Cuttings
- Pseudo-bulbs
- Offshoots
- Keiks
- Aerial shoots
- In vitro propagation

Do you know?

Bulbophyllum is the largest genus of orchids

Factors affecting growth and flowering of orchids:

- Light (intensity 200-800 foot candles)
- Temperature (day: 15-25°C and night: 10-15.5°C)
- Humidity (Day: 75-80% and Night: 30-40%)
- Perfect ventilation
- Partial shady location
- CO₂ (2000-3000 ppm)

Do you know?

Orchids produce thousand of seeds per capsule (fruit), but these seeds are devoid of endosperm and do not germinate on its own.

Categories of orchids on the basis of temperature:

- Cool orchids (Day: 15.5-21°C and night 10-12.5°C) are *Cymbidium*, *Paphiopedilum*, *Miltonia*, *Odontoglossum*, etc.
- Intermediate orchids (Day: 15-25°C and night 15-18°C) are *Cattleya*, *Laelia*, *Oncidium*, *Epidendrum*, etc.
- Warm orchids (Day: 21-28°C and night 18-21°C) are *Aerides*, *Arachnis*, *Aranthera*, *Aranda*, *cattleya*, *Dendrobium*, *Mokara*, *Phalaenopsis*, *Vanda*, etc.

Characteristics of potting media for growing orchids:

- Good aeration
- Well drained
- Rich in humus
- Retain adequate moisture
- Supply sufficient nutrients
- pH of the growing medium should be neutral to acidic.

Constituents of potting media for growing orchids:

- Epiphytic orchids: Tree bark, dried fern foliage, coconut husk, brick- pieces, charcoal, vermiculite, peat moss, perlite, leaf mould, etc.
- Terrestrial orchids: Equal parts of leaf mould, soil and sand.

Optimum level of major nutrients in Cymbidium orchids:

Element	Normal range
Nitrogen	1.3 to 2.1%
Phosphorus	0.15 to 0.24%
Potassium	1.3 to 2.5%
Calcium	0.4 to 1.5%
Sulphur	0.12 to 0.27%
Magnesium	0.12 to 0.22%

Fertilizer application in orchids:

- Application of combination of organic and inorganic fertilizers is more beneficial in orchids.
- Liquid fertilizer application is good in orchids.
- Ideal nutrients ratio is NPK (20: 20: 20)

Diseases of orchids:

- Leaf spot (*Gloesporium*, *Cercospora spp.*)
- Seedling rot (*Pythium ultimum*)
- Heart rot (*Phytophthora palmivora*)
- Flower blight (*Botrytis cinerea*)
- Brown speck and blight of flowers (*Glomerella spp.*)
- Bacterial soft rot (*Erwinia carotovora*)
- Viral diseases (Odontoglossum ring spot virus, Cymbidium mosaic virus, Cymbidium ring spot virus, Cucumber mosaic virus, Bean yellow mosaic virus and Calanthe mild mosaic virus)

Insect-pests of orchids:

- Mites
- Thrips
- Scales
- Aphids
- Mealy bugs
- Nematodes



Packaging of orchid cut flowers

Disorders:

- Dry sepal injury (It is due to high humidity and smog)
- Deformed flowers and browning of throat (It is due to low temperature and chilling injury)

Stages of harvesting orchid flowers:

- Orchid flowers do not mature until 3-4 days after full opening.
- Flowers cut prior to their maturity may wilt before reaching the market.
- Harvest flowers preferably in the evening.

Grading, storage and packaging of orchid flowers:

- Grading of flowers is done on the basis of spike length, number of flowers, flower diameter.
- Store flowers at 5-8°C.
- Ideal package should be airtight, waterproof and strong enough to withstand handling.
- *Cymbidium* flowers may be packed as 100 per box.

Average number of flowers per spray/ plant in different orchids:

Species	No. of flowers/spray
<i>Aerides</i>	40-50
<i>Calanthe</i>	2-many
<i>Cymbidium</i>	2-40
<i>Dendrobium</i>	2-many
<i>Habenaria</i>	2-50
<i>Oncidium</i>	2-10
<i>Paphiopedilum</i>	1-2
<i>Phaius</i>	6-8
<i>Phalaenopsis</i>	6-8
<i>Rhynchostylis</i>	50-80
<i>Vanda</i>	2-20

Points to Remember

- Cut flowers have long stem usually with leaves and are used for making bouquets, interior decoration in flower vases, floral baskets, etc.
- Rose is the leading cut flower in global and domestic flower trade
- Rose, chrysanthemum, tulip, Liliun, gerbera, Cymbidium (orchid), carnation, etc. are important cut flowers grown in greenhouses in the world.
- There are about 200 export oriented units growing cut flowers for export in India.
- Longevity of cut flowers is highest (over 30 days) in Cymbidium (orchid).
- Chrysanthemum is commercially being grown for cut flowers, pot plants and loose flowers in India.

Activity

1. Visit commercial cut flower growing units and florist shops.
2. Make inventory of cut flowers being grown and marketed.
3. Note the growing areas for commercial cut flowers cultivation.

Check your progress

A. Multiple Choice Questions.

- Which of the following is leading cut flower in the world?
 - Carnation
 - Chrysanthemum
 - Rose
 - Tulip
- Which of following *Rosa* species is not commonly used as a rootstock in roses?
 - indica* var. *odorata*
 - bourboniana*
 - multiflora*
 - chinensis*
- In hilly areas roses are planted during....
 - October-November
 - February-March
 - July-August
 - All of above
- The best time of pruning roses in North Indian plains is
 - June - July
 - September-October
 - October-November
 - November-December
- Pruning in roses is done twice during November and June at
 - Delhi
 - Bangalore
 - Calcutta
 - Srinagar
- Roses are harvested when buds show colour.
 - Full
 - Half
 - No
 - At any stage
- Sleepiness disorder is associated with cut flowers of
 - Gladiolus
 - Carnation
 - Chrysanthemum
 - Tulip
- Which of the following *Dianthus* species is commercially grown for cut flowers?
 - caryophyllus*
 - chinensis*
 - nobilis*
 - barbatus*
- Which of the type of carnation is grown on large scale in green house?
 - Marguerite
 - Florist
 - Marmaison
 - Border & Picotee
- Which of following is not a Sympodial orchid?
 - Cymbidium
 - Vanda
 - Dendrobium
 - Oncidium
- Which of following is not a warm orchid?
 - Phalaenopsis
 - Vanda
 - Dendrobium
 - Cymbidium

12. For symbiotic seed germination of orchids which *Rhizoctonia* species is identified?
 - a. *repens*
 - b. *mucoroides*
 - c. *languinosa*
 - d. All of these
13. Who first started tissue culture in orchids?
 - a. Morel
 - b. Kundson
 - c. Chang
 - d. None of above
14. Calyx splitting of carnation is because of
 - a. Genetic factors
 - b. Nutritional factors
 - c. Environmental factors
 - d. All of above
15. Sleepiness of carnation is because of
 - a. Ethylene
 - b. CO₂
 - c. High temperature
 - d. All of above
16. Curly tip disorder in carnation is because of
 - a. Low light
 - b. Low temperature
 - c. Nitrogen deficiency
 - d. All of above
17. Stem rot of carnation is caused by
 - a. *Rhizoctonia*
 - b. *Botrytis*
 - c. *Fusarium*
 - d. *Uromyces*
18. Flower but rot of carnation is caused by
 - a. *Botrytis*
 - b. *Fusarium*
 - c. *Pleospora*
 - d. All of above
19. Which of the following is most serious pest in carnation?
 - a. Red spider mite
 - b. Aphid
 - c. Thrips
 - d. Moth
20. Carnation is classified as plant
 - a. Short day
 - b. Long day
 - c. Day neutral
 - d. None of above
21. Perpetual carnations are commercially propagated by
 - a. Terminal stem cutting
 - b. Seed
 - c. Suckers
 - d. All of above
22. Pinching in carnations is normally done at pairs of leaves.
 - a. 4-5
 - b. 6-7
 - c. 8-10
 - d. 10-12
23. Which of following pinching type is practiced to get a single peak?
 - a. Single
 - b. Double
 - c. Pinch and a half
 - d. Single pinch plus pull pinch

24. Calyx splitting is common practice in
 - a. Gladiolus
 - b. Marigold
 - c. Carnations
 - d. Lily
25. Which of following operation is practiced to get large bloom in carnation?
 - a. Pinching
 - b. Disbudding
 - c. Defoliation
 - d. Pruning
26. Chemical defoliation in roses is done by
 - a. Urea
 - b. Copper sulphate
 - c. Auxin
 - d. GA
27. The time for budding in roses in N. I. plains.
 - a. November-December
 - b. September-October
 - c. July-August
 - d. April-May
28. Now a -days thornless rose cultivars are becoming popular among consumers, which of following falls in this category.
 - a. Motrea
 - b. Mercedes
 - c. Grand gala
 - d. All of above
29. Which is most popular variety of roses in protected cultivation in India?
 - a. Grand gala
 - b. First Red
 - c. Konfetti
 - d. All of above
30. Which colour roses are most popular?
 - a. Red
 - b. Pink
 - c. Yellow
 - d. White
31. Which flower is universally acclaimed as the queen of flowers?
 - a. Tulip
 - b. Rose
 - c. Carnation
 - d. Orchid
32. Pyrethrum is extracted from which *Chrysanthemum* species?
 - a. *morifolium*
 - b. *indicum*
 - c. *cinerariifolium*
 - d. *sinense*
33. Which type of chrysanthemum looks globular?
 - a. Incurve
 - b. Pompon
 - c. Anemone
 - d. Decorative
34. Which chemical is used for disbudding in chrysanthemum?
 - a. Oxathiin
 - b. MH
 - c. Cycocel
 - d. SADH
35. Which grade is not recommended by society of American Florists for chrysanthemum?
 - a. Gold
 - b. Silver
 - c. Iron
 - d. Bronze

36. Grey mould in chrysanthemum is caused by
- Fusarium*
 - Botrytis*
 - Alternaria*
 - Septoria*
37. Which of following virus is less common in chrysanthemum?
- Stunt
 - Tomato Aspermy
 - Rosette
 - Tomato Mosaic virus
38. Which is very serious pest in chrysanthemum?
- Aphid
 - Red spider mite
 - Heliothis
 - Thrips
39. Seeds of which of the following are devoid of endosperm?
- Rose
 - Carnation
 - Cymbidium
 - Lily
40. Which of the following cut flower is commercially propagated by bulbils?
- Gladiolus
 - Lily
 - Carnation
 - Rose

B. Match the following:

Flower name

Disorder

- | | |
|------------------|-------------------------|
| a. Rose | i. Bud blasting |
| b. Carnation | ii. Bull head |
| c. Chrysanthemum | iii. Dry sepal injury |
| d. Orchids | iv. Quilling of florets |
| e. Lilium | v. Calyx splitting |

C. Short answer/ Descriptive questions:

- Q.1 What do you mean by Protected cultivation?
- Q.2 What are the advantages of protected cultivation?
- Q.3 What are different ways to propagate roses?
- Q.4 At what stage cut roses are harvested?
- Q.5 What is pinching? How different type of pinching is done in carnation?
- Q.6 Discuss the critical temperature and light conditions for cultivation of chrysanthemum.
- Q.7 How gerbera is grown under protected structures?
- Q.8 What is the difference between Asiatic and oriental lilies?
- Q.9 What are sympodial and monopodial orchids? Give examples?
- Q.10 Discuss different types of growing mixtures for orchids?
- Q.11 Enlist different cut flowers grown under protected cultivation in India.

Chapter 10

Flower Arrangements – Types and Styles

Objectives

After studying this chapter, students will be able to:

- know about the basics of flower arrangements
- explain the prerequisites for flower arrangements
- know about different types of flower arrangements
- get acquainted with different types of Ikebana
- know about different styles of flower arrangements
- adopt flower arrangement as a hobby or start this as an enterprise

Introduction

Floral arrangement in general refers to placing and organising the flowers, foliage, ornamental grasses, other plant material along with other associated accessories in containers like bowls, baskets, vases etc. based on certain principles and elements. Flower arrangement is basically art which follows the art principles and based on skill, creativity of the artist. Flower arrangement is basically an art which gives chance to the creator to express their skill, talent and creativity. It involves arranging the flowers, foliage and other accessories in right place and at right time. The flower arrangements generally have certain theme or idea which depicts the mood of the occasion. The arranging of flowers varies from occasion to occasion, place to place and also varies with the personal choices for e.g. wedding flower arrangement differs from the flower arrangements at the official meeting in the work place. Generally for formal occasions, flowers are arranged in symmetrical pattern whereas for informal occasions, mostly asymmetrical form of flower arrangement dominates. The basic theme of flower arrangement is to make the design more attractive and pleasing but overall it should be simple and should be presented in special way as to make it more attractive. While arranging flowers, harmony between the principles and elements should be maintained. One of the major elements which play an important role in flower arrangement is colour. There should be harmony with respect to various shades, hues and tints of the plant material used. The foremost choice of the flower arrangement is fresh cut flowers followed by dry flowers and synthetic or artificial flowers. Among the flowers, rose is the first choice of the florists followed by carnation, gerbera and chrysanthemums. However, florists nowadays are very keen to involve exotic flowers but it is not mandatory, one can have the best flower arrangement with traditional flowers too. In earlier days it is regarded only as an art which depicts certain meaning and generally used to express certain emotions but nowadays this art has been transformed into a commercial venture. It is one of the important enterprises of the floriculture business worldwide. The flower arrangements have its own history and generally all countries have their own traditional way of arranging flowers. So the history of arranging flowers is not restricted to particular nation. However, some of the nations like China, Japan are involved in the traditional way of flower arranging since a long time and moreover they have their spiritual and religious views associated with flower arrangement. This traditional knowledge has passed from generation to generation, so that why gained popularity worldwide. It is said that Chinese were first to aesthetically arrange the cut flower in the containers. However, Japanese derived the

idea of flower arrangement from China and because of their efforts many schools of flower arrangements has come in Japan. Japanese started giving expertise in this arrangement of flowers since very early days so that why that many designs and theories of flower arrangement have evolved there. But nowadays many western countries are also involved in mass arrangement of the flowers. The main prerequisite for the successful flower arrangement is to have some suitable geometric design or style that should complement the interior and external settings.

Prerequisite for flower arrangement

- ❖ For fresh flower arrangements, always use the plant material that is available naturally at that point of time. Fresh flowers make the arrangement more attractive and bring the visitors more near to the nature.
- ❖ Proper conditioning of the plant material should be given before the arrangement so that the flowers last long in its presentable form.
- ❖ The arrangements for the accessories like pin holders, cross bar fixtures, floral forms should be made well in advance.
- ❖ The colour, size, shape and texture of the plant material should be proper and must be in accordance with the occasion.
- ❖ The size, shape, colour and material of the container should complement with the plant material and other accessories used in flower arrangement.
- ❖ The successful flower arrangement is that which have some theme, aim or idea. It should have its own personality and should be self expressive.
- ❖ The flower arrangement should follow art principles and elements and maintain harmony.
- ❖ The style and design should be properly planned before execution of flower arrangement.
- ❖ Flower arrangement should be simple, attractive and arranged in special way to best suit the occasion. Avoid complexity in flower arrangements.

Flower Arrangements – Types

1. Japanese flower arrangement/Ikebana

This arrangement is basically a Japanese art form, developed and mostly practiced in Japan and is known as Ikebana. It is the most popular method of arranging flowers. Ikebana symbolizes the unity of nature and humanity. This type of arrangement not emphasised on mass arrangement of flowers but on the individuality of the flower, foliage and branches. They are simple arrangements and generally have a spiritual and religious background. The first school of Ikebana was Ikenobo which means arranging flowers of the hermitage along a pool. It was started in early 621 A.D. by Buddhist monk Semmu. Ikebana arrangements in early days were following very rigid rules regarding arranging flowers. But now days, numerous schools of Ikebana have started their own style and design but all the schools of Ikebana are following three basic lines of the traditional Ikebana school, namely Heaven, Man and Earth.

Do you know?

Three basic lines of Ikebana are earth, man and heaven.



(Ikebana) Different types of Ikebana

- **Moribana:** It means “heaped up flowers”. The main feature of such arrangement is the naturalistic shapes and its design and generally called as “natural ikebana”. These types of arrangement are made by utilizing shallow containers and generally uses pin holder (kensan in Japanese) to support flowers and branches.
- **Nageire:** It means “thrown flowers”. It is similar to Moribana but here flowers and branches are arranged in tall vases. The flowers and foliage that have sufficient stem length are more suitable to such types of arrangement. Different types of cross bars fixtures are available to support the flowers and foliage. i.e. single-bar fixtures, cross- bar fixtures and split bar fixtures.
- **Jiyubana:** It means “freestyle” and has its origins in post-World War II Japan. This kind of arrangement can be made in both Moribana or Nageire types and is entirely is based on the skills and creativity of arranger of doing the things whatever the way they likes but it should be in its best presentable form. In this one can use the material like wood, metal, stone in combination with plant material.
- **Zeneika:** These types of arrangement are of abstract kind and are not naturalistic. Generally straight material having disproportionate or unequal heights is used in such arrangements. In this arrangement flower arranger can use any plant material in combination with inert material but the material used should be pleasing and complement with the surroundings.
- **Zeneibana:** It means “avant-garde flower arranging” in Japanese floral art. It is also called as Zenei Ikebana. This was a more expressive form of Ikebana than the classic form. This type depicts some natural scenery and is represented by some sculptured forms made of wood, metal, stones etc.
- **Morimono:** It refers to arrangements involving fruits, vegetables and flowers together. These types of arrangements are triangular in shape and not very strictly in following lines and angles. The flowers, fruits and vegetables are arranged on wooden base (Dai in Japan), shallow bowl, tray etc. The fruits which are best suited for this arrangement are Grapes, Lemon, Oranges, Apple, Pineapple, Custard apple etc. Among vegetables, Tomatoes, Brinjal, Carrots, capsicums, etc are used. In this arrangement mostly fruits and vegetables plays a dominant role.

2. Western flower arrangements:

They are also called as traditional floral arrangements. Here major emphasis is given to mass arrangements. It is a form of art only and major emphasis is to make the design more attractive .They are often elaborate, with attractive containers. Usually the arrangements have some kind of symmetry.



Western flower arrangement

3. Free style flower arrangements

This type of arrangements is created by combining both Western and Japanese flower arrangements. The blending of both the Japanese and Western should be in right proportion so as to make the design in more presentable form. This is based on the creativity of the designer.

4. Abstract flower arrangements

These types of arrangements are highly skilled based and emphasised mainly on geometrical shapes, patterns and designs.

5. Others

All Foliage arrangements

These arrangements are made of the fresh foliage and generally maintain their freshness for long period as compared to flowers. It is not necessary that only green foliage should be incorporated in the arrangement but many coloured foliage like Rex Begonia, Coleus, Crotons can make an attractive flower arrangement. Generally for cascade type of arrangement generally foliage which are climbing and clinging in nature is used for e.g. *Zebrina pendula*, *Hedera helix*, *Tradescantia*, *Setcreasea purpurea* etc. Many times palms, Ferns and cycads foliage is used. Most commonly nowadays fillers like Thuja, Dracaena, Asparagus and Bottlebrush, etc.

Flower arrangements based on shape and overall organisation of flower arrangement

Horizontal arrangements: These types of arrangements are of low and flattened stature. The arrangement does not possess height. Here very shallow containers are used. They are best suited for table decorations. Generally single flower may be a rose, carnation, gerbera is used as a focal point and the leafy branches are used on both sides of the flower.

Vertical arrangements: These types of arrangements are tall in nature and can be made with flowers having more stem length and long length leaves. They are also of symmetrical and balanced in nature. Generally carnations, gladiolus tulips, roses are the most suitable flowers for this kind of arrangement. Here tall vases are used for this arrangement.

Circular arrangement: These types of arrangements are round in shape, mostly symmetrical in nature and very easy to create. These are most common type of arrangement and generally roundish forms gives the similar view from all the directions. Mostly table tops are most suitable place for this kind of arrangement. These types of arrangements suitable for formal occasions like meetings and conferences.

Triangular arrangements: This type of arrangements maintains the shape of triangle by keeping the tall flower stem in the centre point and other flowers or foliages on both the sides. Mostly bouquets are arranged in this triangular form. They come under informal arrangement and can be best viewed from front or back only.

Crescent arrangements: These types of arrangements are of moon shaped and asymmetrical in nature. Generally shallow containers are used and here the plant material i.e. flowers with flexible stems like carnation, gerbera, gladioli can be used. Similar the fillers stem should also be of flexible nature so they can be bent in any directions so as to maintain the crescent shape. This type of arrangement is very attractive in nature.

Hogarth curve or S shaped arrangement: Here flowers are arranged in S shape. It is one of the most complex flower arrangements. Here flower arranger should be very skilful for making this particular shape.

Minimal flower arrangement: This type of flower arrangement is very simple and uses only very less flowers and foliage. Generally such arrangements are suitable for indoors.

Floral Arrangement- Styles

Floral arrangement in general refers to placing and organising the flowers, foliages and other accessories according to suitable geometric design or style that should complement the interior and external settings. There are basically three basic geometric designs viz., Line Arrangements, Mass Arrangements and Line-Mass Arrangements. All the floral arrangements follow one or combinations of these basic style of floral arrangement.

Line Arrangements of Flowers

This type of arrangement have linear pattern and mostly adapted from Japanese designs. The peculiar characteristic of this style is that they emphasise simply on individual flowers and foliage etc that forms the linear arrangement easily. These kinds of designs are bold in nature and mainly make use of the materials that have minimum flowers and foliage. These types of arrangements are of asymmetrical ones and generally well presented and viewed from the front only. Sometimes even bare branches or other similar materials create a well-defined line design. Most of these styles are vertical in nature, but design can also be presented in horizontal, diagonal, circular movements. The best containers for such arrangements are Pinpoint holders but also one can opt for flat bowls. The flowers which are best suited to linear arrangement are Gladiolus, Antirrhinum, Delphinium, Liatris, Tuberose and Bells of Ireland.

Mass Arrangement of Flowers

Unlike Line arrangements, Mass arrangements are adapted from European designs. These types of design are not of linear in nature but they are usually triangular, oval, and circular or fan shaped in their overall outlook. Here, the major focus is given to colour and mass of flowers and foliage used rather than individual bloom. Generally, it was observed that round or mass shapes usually dominate, but spiky or linear forms are good for triangular arrangements. This type utilizes more quantity of plant material as compared to line or Line-Mass arrangement. Mass arrangements can be created in many shapes, such as crescents, circular, domes, ovals, and triangles. The designs having oval and triangles shapes are considered best. This kind of arrangement can be made either to be seen from one side or otherwise from all around. Here, major emphasis is given to colour of the material used. Generally, three or more kinds or colours of flowers are often combined with one or more kinds of foliage. Usually it is best to select more of one kind and colour and less of the others. The containers like vases, urns, medium-to-deep bowls are the considered best for mass arrangements.

Line Mass Arrangements of Flowers

This style of flower arranging is developed in the United States and also known as Contemporary American. This arrangement is combination of Line arrangement and Mass arrangement. In simpler terms, they used to combine linear form of Japanese style and Mass form from European style. Line-mass designs have an open form with symmetrical or asymmetrical balance. These types of arrangements are characterized with definite line, a well-defined mass and having plenty of open spaces. The main focused elements in this style are contrast of texture, colour and line. Generally in this arrangement, linear foliage or branch are placed in upper part of the arrangement whereas roundish flowers are placed at the lower parts where the lines meet and sometimes in between the lines.

Points to Remember

- Arranging flower is an art and science
- Three basic lines of Japanese flower arrangement (Ikebana) are earth, man and heaven
- English or western flower arrangement is based on principle of mass arrangement

Activity

1. Visit different ornamental plants nurseries, commercial flower production units and make list of jobs which are done related to floriculture.
2. Make list after web sites searching for qualification and type of jobs available in Floriculture post graduates.

Check your progress

A. Fill in the blanks

1. were first to aesthetically arrange the cut flower in the containers
2. The first school of Ikebana was
3. Japanese flower arrangement is also known as
4. Three basic lines of the traditional Ikebana school, namely, ..., and
5. refers to arrangements involving fruits, vegetables and flowers together.
6. type of flower arrangements, emphasis is given to mass arrangements
7. Free style flower arrangements are created by combining both..... and.....
8. In Hogarth curve arrangement, flowers are arranged in shape.
9. Line arrangements of flowers are mostly adapted from designs arrangement
10. Line Mass Arrangements of Flowers is also known as

B. Short answer/ Descriptive questions:

- Q.1 What do mean by flower arrangement? What are the basic requirements for flower arrangements?
- Q.2 What is Ikebana and explain its different types?
- Q.3 What are different types of flower arrangement? Explain the basic difference between Japanese and western flower arrangement?
- Q.4 What are the basic styles of flower arrangements?

Chapter 11

Dried Ornamentals

Objectives

After studying this chapter, students will be able to:

- know the importance of dried ornamental flowers and other plant parts
- know various ways and methods to dry flowers and other plant parts
- know various kind of value added products developed from dried ornamentals
- start agribusiness in dried ornamentals and their value added products

Introduction

Whenever you go to any florist shop or a flower market, you might have seen several types of floral arrangements and its value added products displayed. Have you ever thought how these have been dried, developed and from where these are coming? I don't think you have ever thought of it. You may have several queries in your mind. In this chapter, you will come to know about dried ornamental flowers and other plant parts, its importance in national and global flower market, methods of drying and developing various value added products and their care at home or office, etc.

Flowers and ornamental plants have been associated with the mankind from the dawn of civilization. In the modern era flowers and ornamental plants have become an integral part of human life. The love for flowers and ornamental plants is considered as common natural instinct in human beings and the catchy flowers growing and glowing in all their grandeurs with simplicity always makes it tempting to wish the season to continue for never ending, but it may be beyond reach of common human. The answer for it could be by producing and preserving ever-lasting or long-lasting flowers and ornamental plants and their parts. Such everlasting flowers and ornamentals are now becoming a favourite especially with the adventurous flower lovers across the globe. Beauty and fresh look of cut flowers and cut foliage is generally lost due to microbial activities and biochemical changes thus these are retained only for a few days even by using the best techniques of post harvest management. The charm of dried ornamentals can be retained from few months to years with lesser cost if protected from the damage of high humidity as in dried ornamentals the microbial activities in the aging process come to almost stand still.

What are the main advantages of dried ornamentals?

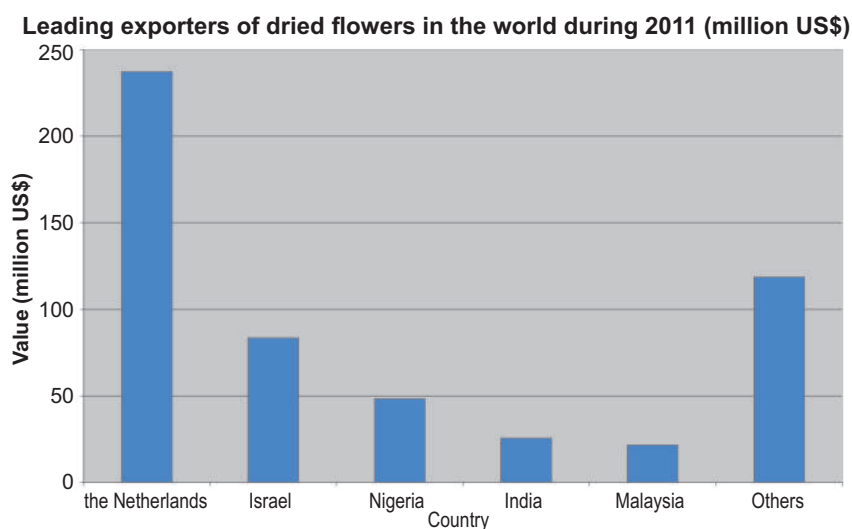
- ❖ Charm and beauty for indefinite period varying from months to years unlike fresh cut flowers for few days
- ❖ Free from bondage of seasons as not dependable on season and availability all through the year
- ❖ No fear of damage as in fresh flowers as these can tolerate heat summer and cold of winter
- ❖ Wide range of ornamental plant parts for drying
- ❖ Transportation on convenience even through road, rail or sea unlike air for fresh cut flowers
- ❖ Preserving elite ornamentals for indefinite period in labs/ museums
- ❖ Employment generating potential as this industry is high labour intensive
- ❖ Improve skill in design studying the composition and corrective measures
- ❖ Rich bio-diversity in India especially in Himalayas and western ghats

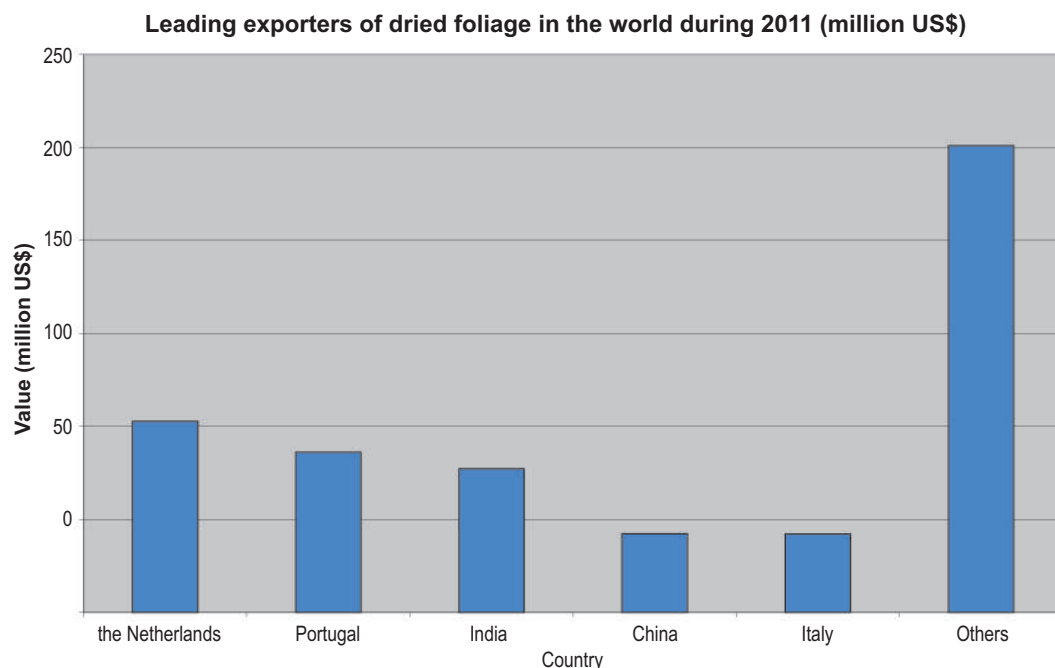
What are the main characteristics of dried ornamentals?

The main characteristics of dried ornamentals are novelty, longevity, aesthetics, flexibility and year-round availability. The dehydrated or dried ornamentals are generally inexpensive and are sought for their everlasting and attractive appearance. Being largely focused on the qualities of attractive flowers, living plants and other plant parts, floriculturists/ gardeners generally pay little attention to dried and preserved flowers and plant parts. Therefore, these products remained overlooked and underrated throughout world. These products are overlooked in the sense that their considerable economic importance is generally unrecognized and these are under-rated in the sense that their aesthetic contribution is largely discounted or under-estimated. In contrast to other areas of commercial floriculture including post-harvest management, relatively very little publicly research and development technologies have been developed on this aspect across the globe. This has slower the pace in optimizing the dehydration- technology of ornamentals and quality of the produce and products. Privately funded research and development work has sustained, but such findings are usually kept secret and limited information is available to the common amateurs. Hence, this component of the floriculture industry has remained ill defined with respect to the processes, products and organizations in the developed and developing countries. As we see in the major cut flower crops, there are defined standards available for judging the quality, however these are lacking in dried ornamentals. Thus, there is an urgent need to start war- footing efforts and mass awareness for the dried ornamentals with a vision to attract greater public support to conduct concentrated research and development efforts with more professionalism in the development of technologies and trade of these products.

What is the status of dried ornamentals?

The demand for dried ornamentals and its value added products has increased manifolds during the last two decades. The world trade of dried flowers and plants has increased from 14.88 million US\$ in 1996 to 775.34 million US\$ in 2011 (Source: UNCOMTRADE). The leading dried ornamental flowers and its products exporting countries during 2011 in the world were the Netherlands followed by Israel, Nigeria, India and Malaysia. The leading dried flowers and its products importing counties during 2011 were Nigeria, France, United Kingdom, Belgium and Japan. The leading dried ornamental foliage and its products exporting countries during 2011 in the world were the Netherlands, Portugal, India, China and Italy. The major importers of dried foliage and its products during 2011 were USA, Germany, the Netherlands, France and United Kingdom.



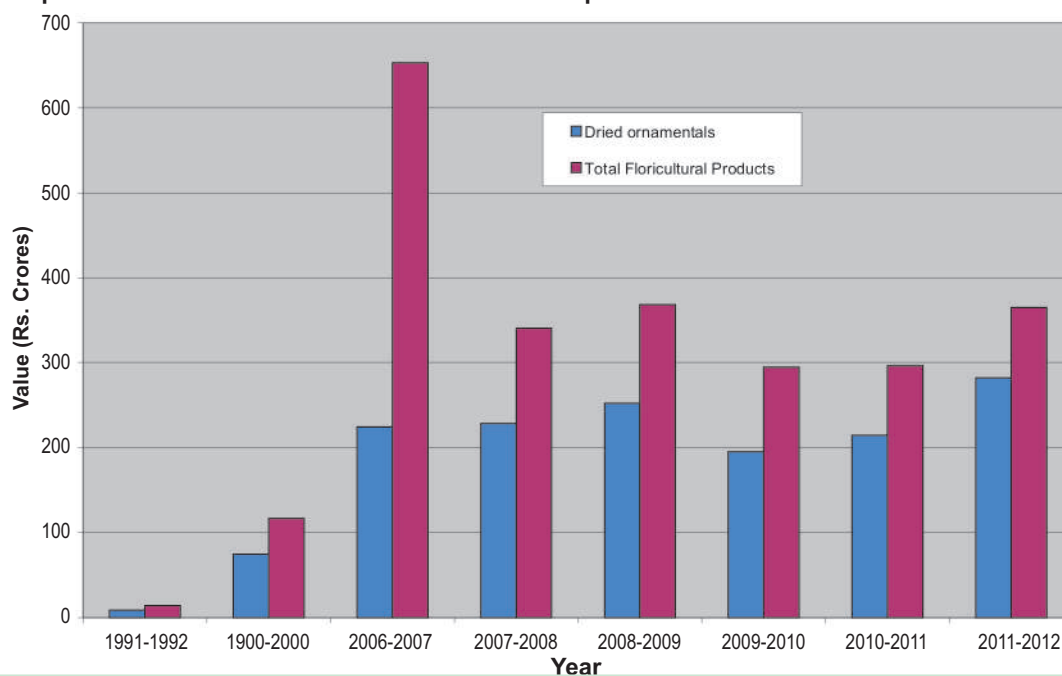


The dried ornamentals market is very profitable in terms of total sales and unit value amongst all floricultural products. The top ten dried flower genera as ever-lasting cultivated are *Helichrysum*, *Helipterum*, *Limonium*, *Nigella*, *Gypsophila*, *Delphinium*, *Amaranthus*, *Papaver*, *Carthamus* and *Rosa*.

Do you know?

Out of the total export of all floricultural products from India, the contribution of dried ornamentals is over 60 per cent during the last two decades. Dried lotus pods over million numbers are exported every year from India.

Export of dried ornamentals and total floricultural products from India w.e.f. 1991-92 to 2011-12



In India flower export has sharply increased after liberalized EXIM policy from Rs. 14.5 crores in 1991-92 to 652.7 crores in 2006-07. However, total export of floricultural products has now decreased to 365.3 crores during 2011-12. The contribution in total export of dried flowers and plants is over 60 per cent and at present the export from India is over 20 thousand tonnes of dried ornamentals to USA, UK, the Netherlands, Germany, Japan, Singapore and other European countries. The main exporting items are lotus pods in addition to dried flowers of camellia, dahlia, bell cups, marigold, jute flowers, wood rose, wild lilies, paper flower and naturally dried plant parts from Himalayan region. The dried ornamentals business is confined to about sixty private companies operating from Kolkata (West Bengal), Tuticorin (Tamil Nadu) and Mumbai close to sea ports, as the material being bulky is usually shipped through the sea routes. Ramesh Flower Limited at Tuticorin is the leading private company exporting dried ornamentals and has about 50 per cent share of the total dried ornamentals being exported from India.

Do you know?

Tuticorin in Tamil Nadu is the largest port exporting dried ornamentals from India.

How much is the range of ornamental plant parts for dehydration?

The range of dried flowers and other attractive plant parts is extensive viz., stems, roots, shoots, buds, flowers, inflorescence, fruits, fruiting shoots, cones, seeds, foliage, bracts, thorns, bark, lichens, fleshy fungi, mosses, sellaginellas, etc.

What is Dehydration technology?

Dehydration technology means to dry something under artificially produced heat through controlled temperature, humidity and air-flow. In dehydration-process moisture is removed from flowers and foliage. In nature the plant material tend to discolour during drying largely due to oxidative reactions associated with loss of compartmentation within the plant cells during desiccation of the plant tissues. Such plant-material turns brown and is particularly used as filler in various floral arrangements. Artificially there are several approaches/ methods to dehydrate or dry flowers and ornamental plant parts. The principle involved is common to all processes, as per which the plant material is exposed to a vapour pressure deficit ($v.p.d. = v.p._{source} - v.p._{sink}$), that induces water vapour to move by transpiration/ evaporation from the plant material (source) into the surrounding environment (sink). The flux of water vapour (J) is proportional to the vapour pressure deficit: viz., $J = k \times (v.p.d.)$; where k is a constant dependent upon the water vapour transfer properties of the particular product.

What are various dehydration techniques?

1. Natural dried ornamentals:

In this method ornamental plant parts are allowed to dry naturally on the plant itself. These are collected as and when completely dried during excursion trips to forests, countryside, gardens or cultivated fields. The important naturally dried plants identified in the outer Himalayan region are as follows:

Aegle marmelos, *Bambusa* spp., *Bauhinia retusa*, *Cassia fistula*, *Caesalpinia sepiaria*, *Clematis grata*, *Dioscorea deltoides*, *Mallotus philippensis*, *Rosa moschata*, *Oroxylum indicum*, *Pinus roxburghii*, *Picea smithiana*, *Sapindus mukorossii*, etc. have beautiful fruiting shoots, whereas plants like *Abrus precatorius*, *Aesculus indica* and *Sapium sebiferum* have beautiful seeds.



Abrus precatorius



Oroxylum indicum pods decorated with silver fern

Activity

1. Visit in the surrounding of your school campus, village and nearby forest in groups.
2. Collect different ornamental plant parts and classify these based on their category as tree, shrub, climber or herbaceous plant and naturally dried plant part as fruit, seed, stem, bark, leaves, roots, etc.
3. Develop various value added product/ arrangements of dried ornamental plant parts.

2. Air drying:

Air drying is the most common process for drying ornamentals. In this process only rope/ wire and newspaper/ blotting sheets are required. Ornamental plant parts are simply kept hanging down under cover on racks or from rafters in dark or kept on newspaper/ blotting sheets. Drying in the sun result in discolouration and browning due to oxidation. Improved control over the rate of drying can be achieved by ensuring air movement around each and every stem and by lowering the relative humidity of the air. Good air circulation assists in sweeping away moisture vapours, thereby decreasing the thickness of the unstirred boundary layer of the water vapour with fresh plant material in surrounding. Relative humidity is lowered by adequate ventilation, heating, dehumidifying and pressure reduction. Ventilation with outside air will flush away the moisture vapours released during the process of drying the plant material. Heating will lower the relative humidity because warm air can hold more water vapours per unit volume than can cool air. Kiln drying is the common method of flower drying used in India by most of the export oriented units in South India. Another energy intensive system is air tunnel, which operates on a convection air system at a minimum 50°C temperature. Dehumidification can be achieved with moisture scrubbers (e.g. silica gel-based or by frosting water vapour out into cold coils. Pressure reduction may be achieved by large exhaust fans fitted to rooms with a restriction imposed on the supply of the air flow or with vacuum pumps. Thus, the entire process of air-drying depends upon the relative humidity, air velocity, pressure, moisture in plant material and type and shape of flowers. This is the most simple and cheap process of dehydration/drying.

The main drawback is its weather dependence and petals/foilage shrinkage, thus lowering the aesthetic value of plant material. Hanging drying of small quantity of plant material with reasonable more success can be achieved by drying in microwave oven, hot air oven or solar dryer within short span in comparison to air-drying. Flowers with crisp texture viz., *Acroclinum*, *Anaphalis*, *Helichrysum*, *Delphinium*, Lemon mint, *Oregano*, *Limonium*, *Rumex*, *Holmskioldia*, etc. are more suitable for vertical hanging drying in microwave/ hot air oven/ solar dryer.

3. Embedded drying:

It is difficult to avoid shrinkage and changes in morphology of dehydrated ornamental plant material during vertical hanging drying in air/ microwave/hot air oven/ solar dryer, due to the loss of moisture/ water vapours from the cells. The petals/foilage generally droop- down and as a result aesthetic value of that material reduces. In embedding the drying medium/desiccant supports the flower/ foliage from all around and maintains perfectly the original shape.

What are main characteristics of desiccants?

The material which removes the moisture quickly from the ornamental plant parts embedded without reacting with the water vapours released during drying or bleaching of petals and foliage, etc. The drying material/ desiccant should normally have the ideal size of 0.02-0.2mm or 20-200 mesh. It should be heavy so as to keep the plant parts perfectly in its original shape. It should not stick to the plant parts during drying. It should also not be very costly as the market value of most of the dried ornamental floral arrangements and craft is low.

Commonly used desiccants:

Silica gel (white and self indicating blue), borax, boric acid, river sand, alum powder, aluminium sulfate, saw dust, corn granules are commonly used desiccants in purely single form or in combinations of two or more desiccants so as to be more effective and economical in drying ornamental plant parts.

What is the embedding process?

Different types of containers are used for embedding various ornamental plant parts which suits to the plant material and the process of drying in room, sun, solar dryer, hot air oven or microwave oven. Containers should get uniformly heated so that the material evenly dried out from all sides. Aluminium or tin containers are commonly used which maybe cylinder or tray type. In microwave nonmetallic containers like glass, china clay, heat tolerant plastics are used. Spread the layer of the desiccant (2-3 cm) on the bottom of the container. Arrange the plant parts according to type, well spaced and with no two items touching each other or the sides of the containers. Pour the desiccant gently, gradually and completely from all the sides until it forms a top layer for about 1.5 cm above the plant parts. In flowers where pedicels/ inflorescence are delicate or hollow, insert a thin wire before embedding so as to maintain their original shape. After embedding the containers are left in the room for drying. But it takes longer time to dry. For quicker drying, containers are kept in sun, solar dryer, hot air oven or microwave oven, in which drying is faster with superior quality of the dried plant parts. These methods/ techniques are described as under:

Do you know?

In vials/ bottles of costly medicines having tablets/ capsules a sachet is always kept, which usually contains silica gel for absorbing moisture, so that medicines are not damaged by high humidity/ moisture.

i. Drying in full sun light:

After embedding the plant material the containers are daily exposed to direct sun light, thereby resulting in rapid dehydration. Containers are shifted under a room in the evening and again on the next morning these are kept in the sun light until fully dried. The efficiency of drying depends upon the prevailing weather in the region.

ii. Drying in solar dryer:

The containers are kept in solar dryer in which movable tray at the bottom is fitted to regulate the temperature. This is quicker method of drying and it is done without use of energy. The results are at par with hot air oven or microwave- oven thus is more economical method.

iii. Drying in hot air oven:

The containers are normally kept in the hot air oven at 45 to 60°C for few hours to three days depending upon the moisture content in the plant material to be dried.

iv. Drying in Microwave oven:

The plant material in microwave oven is dried with the help of electronically produced microwaves. Non-metallic containers in which various plant parts are embedded in desiccants are kept in microwave oven for 2-5 minutes. Then, these are kept in the room for about 5 hours known as setting time before taking out from the embedded plant material from the desiccant. In microwave oven the mostly plant material is dried at a medium range of 300-700 Hz., which may be given once or in splits. The results in split drying are comparatively better than one time drying.

v. Drying vacuum chamber:

The embedded plant material may be dried/ dehydrated under vacuum created in a room/ chamber. The vacuum is created under thick-walled chamber fitted with a heating device, a vacuum pump and condenser. Low temperature is very effective and the quality of the product is exceptionally good.

How to take out embedded plant material?

The embedded plant material after drying/dehydration is taken out by gently tilting the container in order to remove the desiccant over and around the plant material. The dried material is either picked up with the help of fingers or tweezers. It is cleaned by inverting and by slowly and gently tapping with fingers. Any remaining desiccant is gently removed with the help of a fine camel hair painting brush.

4. Freeze drying:

Freeze-drying has become very popular, although expensive method of producing dried flowers and plant parts throughout the world especially in Europe and USA. The worldwide market of freeze-dried products is of millions US\$. The necessary equipment for freeze-drying is more expensive than vacuum drying, but the quality of the finished floral product is almost double and this process is relatively simple. The flowers are arranged in a specimen chamber. Then, these are frozen unto -35° C. Any frozen ice crystals on the flowers are sublimed or vaporized with the application of heat. After transforming into condensation, the vapour is captured into a separate chamber as ice. By eliminating the water, the flowers dry up with life freshness and retain better integrity and more durability. Thus, rapid dehydration particularly at low or ambient temperature tends to result in better-coloured quality products.

5. Drying in water:

The flowers and foliage are kept in water and allowed to dry it. Water drying, which usually seems to be a contradiction in terminology, but gives fairly good results with flowers like Hydrangea, corn flower,

baby's breath and fever few. In water drying first the lower leaves and flowers from the stem are stripped, then these are kept in standing normal water with about 5cm depth at room temperature. The material is kept undisturbed in a dry, well-aerated room until both the holder and flowers are dried. This process takes 6-10 days depending upon the water content in plant material and water taken in container/holder.

6. Press drying:

The flowers and foliage are placed between the pages of any old book or magazine or between the folds of newspapers or rough blotting sheets by giving some space between the flowers/foliage. These sheets are kept one above the other and corrugated cardboard sheets of same size are placed between the folded sheets so as to allow the water vapours to escape. The whole bundle is then kept at room temperature. For quicker drying herbarium press can be kept in hot air oven at 45°C for 12 to 24 hours depending upon the moisture in the flowers or foliage to be dried. Take care that too much material is not pressed simultaneously. Material of varied thickness should also be avoided in the same folders. When press drying is practiced in room, one must over-turn the flowers/foliage daily which will help in maintaining the original colour and prevent the plant material from discolouration. This method is laborious and time taken for drying is more than drying in solar dryer/ hot air oven.

How to store press dried material?

The press-dried material can be stored in cardboard boxes. These boxes are lined with blotting sheet/ paper, which keep flowers/foliage dry for longer duration. These boxes are better stored in herbarium vasculums fitted with cork sheet. The press-dried material is used for preparation various kinds of greeting cards, wedding cards, wall plates, sceneries, table- tops, interior designing and other festive decorations.

Activity

1. Visit school campus, village or nearby agricultural fields and collect different types of flowers, petals, leaves, ferns, sellagiellas, etc.
2. Press these in old books/ notebooks/ newspaper sheets.
3. Develop various dried floral craft items like greeting cards, wedding cards, wall plates, sceneries, table- tops, interior designing and other festive decorations.

7. Polymer preservation:

Polymer preservation method (called as Polyset) is applied to the flowers/foliage about 45 minutes before drying. It is a chemical pre-treatment, which is used before air drying to improve the quality of the dried flowers. This method lessens the drying time and improves the intensity of flower colour. It also minimizes shattering and wrinkling of the petals, which may occur during drying process. Polyset treatment is applied to the freeze-dried flowers to hold them together or to help the flowers in retaining their colour for longer duration.

8. Humectants preservation:

Dried ornamental plant parts can be preserved (plasticized) by treatment with humectants. Humectants are hygroscopic chemicals, which help to maintain the suppleness of dried plant material by attracting water vapour from the surrounding atmosphere. Therefore, the preserved plant material is less brittle than dried material, making it less prone to shattering and mechanical damage. This material is more life like in appearance and to touch. Humectants used for preserving plant tissues are drawn from four general groups

of chemicals viz., sugar and sugar alcohols (e.g. glycerol), polyols (e.g. polyethylene glycol), salts (e.g. KCl) and quaternary ammonium compounds (e.g. Comfort). These humectants have different moisture sorption isotherm characteristics. These can be applied by uptake or immersion, where the former method is not used commercially. Relationships between specific plant characteristics and humectants uptake are poorly defined, despite the common perception that some species preserve easier and better than others. Although relatively more volume of solution is required for immersion method of preservation but this offers some unique advantages as dried and/ or bleached plant parts can be treated. There is more uniform penetration and distribution of the humectant. Waxy plant cuticles are removed by NaOH or organic dip treatment prior to preservation in order to facilitate penetration of aqueous humectant solution. The risk of sweating can be reduced by using any humectant with a relatively low moisture attracting capacity and/ or by reducing the amount of humectant taken up i.e. shorter treatment time at low concentration of humectant.

9. Dehydration by bleaching and sulfuring:

Otherwise aesthetically attractive plant material, which is inherently coloured by unwanted pigments or brown or discoloured due to oxidative browning can be bleached or sulfured for their use in various floral arrangements. In bleaching, both the oxidative or reductive bleaching agents can be used on the plant material, where former tends to break down coloured compounds and the latter tends to modify into colourless compounds. Multiple bleaching specially with hypochlorite- chlorite peroxide as used for lily offers many advantages in terms of reduced brittleness, cost and yellowing. In sulfuring, sulfur dioxide acts to bleach coloured (e.g. green) plant material and below certain concentration, to fix red colours in some flowers. Colour fixation is associated with acidification of the tissues. Sulfuring of fresh material is achieved by burning sublimed sulfur powder (e.g. 10g/m³) or by injection of sulfur dioxide gas (1-3%) into a sealed chamber. The plant material is usually treated over night prior to ventilation of the chamber and subsequent completion of the drying process. Both bleaching and sulfuring are dangerous processes by virtue of the use of chemicals, thus should be taken up by trained persons with all safety equipment.

10. Artificial colouring:

Artificial colours or dyes can be applied to fresh, dried or bleached ornamental plant parts in order to increase their aesthetic value as per the changing seasons and fashions. Dyes are usually applied by immersion to dried and bleached plant material. Australian plants viz., *Banksia hookeriana* and *B. prionotes*, inflorescence is commonly marketed after artificial colouring. Dyeing of ornamental plant material is considered much as an art. Accordingly for determining the optimum treatment protocol for a particular product is often a matter of systemic trial and error. Immersion dyeing is improved by removing the waxy cuticle with Na OH from dried plant material and by adding surfactants to improve the contact between the dye bath solution and the plant material. In addition to dyeing, which is properly called staining the plant material can also be coloured by painting and commonly silver or gold paints are used.

What are important precautions to be kept during dehydration?

For better results and quality dried ornamentals/ their products the following points must be considered:

- i. Collect material after the dew and surface moisture has evaporated
- ii. Collection should be made in dry season and on a sunny day
- iii. Material should be collected after irrigating fields a day or two
- iv. Fresh material should be collected

- v. Undesirable plant portions should be cut before embedding
- vi. All stages of flower development in an inflorescences should be collected, which have sufficiently harden as immature shrivel very fast
- vii. Ornamental plant parts should be harvested when highest possible quality product can be harnessed
- viii. Material should be embedded immediately after plucking
- ix. One type of flowers and foliage should be embedded at one time in one container
- x. Spread uniformly all plant parts/ petals in herbarium press

What are major uses of dried ornamental plant parts?

These dried items may be used with fresh flowers or alone as floral arrangements, bouquets, gift boxes/packs, festive decorations, collages, flower pitchers, floral balls, pomanders, wall sceneries, sweet smelling pot-porries have become very popular among the flower lovers especially in European countries.



Dried flowers bouquets



Wall sceneries

What is a Pot-porris?

Pot-porris is a special dried floral arrangement and is the mixture of sweet smelling leaves, spices, seeds, roots and distilled essential oil, which are usually filled in pillows or sachets. The important dried ornamental plants used for making pot-porris are roses, lilacs, lavender, pinks, hyacinths, lilies, violets, wall flowers, marigold and many others which are associated with perfume viz., geranium, daisy bush, bergamot, sage, savory, thyme, angelica and sweet cicely. In addition, foliage of ferns, pine- cones, lily pods and driftwood and other items from nature's treasure of exotic bloom are collected from forests and gardens. The material used for pot-porris should be resistant to moulds, non-toxic, free from noxious odours and sufficiently robust to withstand mechanical bending. Pot-porris is normally designed in a transparent glass bowl or a ceramic jar or high grades plastics and stored in a colourful salin or muslin sachet, while other arrangements are designed in a beautifully coloured or specially designed pots/ containers.



Pot-porris

How packaging, handling and storage of dried ornamentals done?

The primary benefit associated with dehydrated/ dried ornamentals is that these are relatively non-perishable in nature in comparison to fresh parent plant material. As a result packaging and handling should theoretically offers little problem, but due to less moisture in dried ornamentals, these are very brittle. Thus, packaging for delicate dried ornamentals should serve to both contain and protect the product/ material. Therefore, it is advisable to use superior grade or standard cartons/ boxes for packaging dried ornamentals. Dried ornamentals should not be roughly handled during transportation and distribution and it can be done through properly educating or by creating awareness of the product characteristics. Dried ornamentals should be protected from moisture throughout marketing channels. Dried ornamentals absorb atmospheric moisture and loose shape/ figure, therefore, should be stored immediately in moisture proof containers. Different containers like glass desiccators, tin boxes, cartons, wrapped with plastic sheets or wax paper and herbarium vasculums fitted with cork sheet are used for storing dried ornamentals. Small quantity of silica gel in sachets may be placed at the bottom and sides of dried ornamentals for absorbing moisture. Always protect dried ornamentals from direct sunlight or more light intensity especially from incandescent lamps. The storage should be dust free and keep on cleaning the cartons/ boxes from time to time. Store separately

different types of dried ornamentals and fix proper label outside with complete description of the product and dried ornamentals kept inside, which will be very helpful during handling, transportation and marketing.

How insect-pests and diseases of dried ornamentals controlled?

Insect-pests can badly affect all types of dehydrated ornamentals. These can be controlled by application of various insecticides, which are applied in solid pest strips (dichlorvos), liquid (synthetic pyrethroids, ethyl parathion- 0.01%) or gas (methyl bromide, phenyl tablets). Book lice, silver fish, mice are the major pests infesting dried ornamentals. Microbes notably fungi can be controlled by regulating the relative humidity to keep the water activity of the dried ornamentals below threshold level, which does not allow spore germination, mycelia growth and spore development. As a general principle the development of fungi is negligible below 65% relative humidity. The dried ornamentals should be packed at low relative humidity and the containers should be properly sealed which preclude fungal growth and prevent suppleness during later handling in storage, transit and marketing. The main genera of fungi infecting dried ornamentals are *Aspergillus*, *Penicillium* and *Rhizopus*. The plant material before collection should be treated with contact type fungicides like Captan or Dithane-M. 45(0.2%). Burning sulfur or fumigating sulfur dioxide also controls these fungi during storage and transit.

Activity

1. Visit florist shops in the nearest markets and collect information on various value added products of dried ornamentals, price and place of manufacturing and identify the plant material used for making such products.



Dias in meeting decorated with dried ornamentals

How dried ornamentals marketed?

In comparison to fresh ornamental plants the profitable marketing of dried ornamental plant material requires the understanding of various aspects viz., economics, psychologically attraction for such products and physical consideration like ware- housing, distribution and sale facilities. Being delicate material losses are more and little attention is given to maintain the quality. This sector could get least attention; therefore, both consumer and producer are at loss, whereas middleman is earning the huge profit. NBRI Lucknow has carried out feasibility study for export and domestic marketing, commercial exploitation of dried ornamental plant material and floral craft items. It is possible to start a home scale establishment with a meager amount of Rupees fifty thousand and one may supplement his/her income by employing the members of respective families. If properly explored, this can develop into a successful cottage industry or entrepreneurships in our country especially in rural areas. Till date as industry, it is poorly defined in terms of producers, products, handling systems, marketing and consumers/ customers. It can earn huge financial gains if professional profile is enhanced primarily as a discrete entity. Further quality assurance in this sector has to be given and followed in respect of processing conditions, defined temperature and relative humidity limits, proper description of the product, performance characteristics, longevity, uniformity in grading, packaging and overall quality of the product. Thus this urgently warranted more scientific investigations on dehydrated/dried ornamentals so as to develop it into a full-grown separate cottage industry in the country.

Points to Remember

- Dried ornamentals can be retained from few months to years
- Pot-porris is the most important dried floral arrangement throughout the world
- For decades, India was the leading exporter of dried ornamentals
- Europe and USA are the major importer of dried ornamentals
- Silica gel (60-120mesh) is most important desiccants for drying ornamental plant parts
- In freeze drying ornamental plant parts are dried at -35°C
- Major fungi infecting dried ornamentals are *Aspergillus*, *Penicillium* and *Rhyzopus*.
- Book lice, silver fish, mice are the major pests of dried ornamentals
- Most of trade of dried ornamentals is being done through sea-routes

Check your progress

A. Multiple Choice Questions.

1. At low cost..... can decorate the office or home from months to years.
 - a. Cut foliage
 - b. Dry flowers
 - c. Cut flowers
 - d. All of these
2. Which of the following is/are characteristics of dry ornamentals?
 - a. Nobility
 - b. Longevity
 - c. Aesthetics
 - d. All of these
3. Which of the following was largest importer of dry ornamentals during 2011?
 - a. Nigeria
 - b. Spain
 - c. UAE
 - d. China
4. Which of the following was exporter of dry flowers during 2011?
 - a. Netherland
 - b. Australia
 - c. South Korea
 - d. India
5. Which of the following flowers is not commercially grown for dry flowers production?
 - a. Paper flower
 - b. Straw flower
 - c. Lilium
 - d. Statice
6. Indian export of dry ornamentals for the last two decades constitute about per cent.
 - a. below 20
 - b. 30-40
 - c. 55-65
 - d. over 90
7. The main product of dry ornamentals being exported from India is.....
 - a. Lotus pods
 - b. Lilium
 - c. Camellia
 - d. None of these
8. is the largest dry flower exporting company from India.
 - a. Kasturi Flowers Ltd.
 - b. Ramesh Flower Ltd.
 - c. Deccan Flora Ltd.
 - d. Indo-American Hybrid Seeds Ltd.
9. Most of the companies exporting dried ornamentals are situated at
 - a. Tuticorin
 - b. Shimla
 - c. Srinagar
 - d. Panji
10. a famous product of dried ornamentals is very common in Europe and USA.
 - a. Wall sceneries
 - b. Potpourris
 - c. Hanging baskets
 - d. Flower arrangements
11. The plant material suitable for drying should be resistant to
 - a. Moulds
 - b. Toxins
 - c. Noxious odours
 - d. All of these

12. means to dry something under artificially produced heat through controlled temperature, humidity and air flow.
- a. Drafting b. Dehydration
 - c. Decomposition d. None of these
13. Which of the following plant has beautiful natural dried fruits?
- a. Amaltas b. Bael
 - c. Pines d. All of these
14. a climber has beautiful natural dried seed pods.
- a. Indian liquorice b. Golden shower
 - c. Money plant d. Wood rose
15. Which of the following annual is most suitable for air drying?
- a. Straw flower b. Anaphalis
 - c. Paper flower d. All of these
16. Any material which removes moisture without reacting with it is known as.....
- a. Absorbent b. Dehydrator
 - c. Drier d. Desiccant
17. The desiccant should have an ideal size of mm.
- a. 1-2 b. 0.02-0.2
 - c. 2-5 d. All of these
18. Which of the following is suitable desiccant for flower drying?
- a. Silica gel b. Sand
 - c. Boric acid (G) d. All of these
19. In hot air oven which is the optimum temperature (°C) for drying?
- a. 20-30 b. 80-90
 - c. 40-60 d. Any of these
20. Which of the following is the quickest method of embedded flower drying?
- a. Drying in Microwave b. Drying in Hot air oven
 - c. Drying in Solar dryer d. Drying in Room
21. drying is done at very low temperature up to -35°C.
- a. Cool b. Freeze
 - c. Vacuum d. Air
22. Which of the following ornamental plants are dried by water drying method?
- a. Hydrangea b. Baby's breath
 - c. Corn flower d. All of these

Chapter 12

Post Harvest Handling of Commercial Flower crops

Objectives:

After studying this chapter, students will be able to:

- understand the importance of post harvest handling of cut flowers
- explain the postharvest requirements of cut flowers
- identify the problems regarding postharvest handling of commercial flower crops
- manage the postharvest problems of commercial cut flowers
- start agribusiness in commercial flower cultivation or development of value added products

Introduction

Floriculture is an important segment of horticulture which has the potential for enhancing the income of growers. Flowers are highly perishable unlike other horticultural or agricultural crops and prone to post harvest losses during storage, transport as well as at the retail outlets. The fresh flowers have short vase life and lose their quality very quickly if proper postharvest procedures are not followed for their handling. It is estimated that about 30 percent of fresh flowers are being spoiled during post harvest handling. The post harvest behavior of flowers is an outcome of the physiological processes occurring in leaves, stem, flower bud, leafless peduncle or scape connecting bud to stem. Some of these processes may act independently to affect the senescence and vase life of cut flowers but most of them are inter-related. The nature and extent of post harvest damage is typical for each crop or cultivar. The postharvest losses become important especially when dealing with the export of fresh flowers to distant and foreign market. Therefore, patient, soft and expert handling of flowers is of utmost important after harvest.

Factors affecting post harvest quality:

Pre harvest factors: Post harvest lasting quality of flower species and cultivars vary considerably due to differences in their genetic make-up. Most cut flower crops needs well lighted conditions. Flower crops are also specific in their temperature, light, humidity, CO₂ and nutrient requirements. High light intensities during cultivation cause scorching and dropping of leaves and abscission of petals.

Do you know?

It is estimated that only 50% of the expected flowers in field are reaching consumers.

What are harvest factors?

Flowers maintain a fresh appearance much longer if they are harvested at the appropriate stage of development. In general, flowers cut at more advanced phases of development have a shorter vase life than younger flowers. The optimum stage of harvest depends upon the plant species, the cultivar, the season, the distance to market place and consumer preferences. Flowers destined for direct sale are usually harvested at a more advanced stage of development than flowers destined for

Biocides: a substance that kills all living organisms (microorganisms) pathogenic or non-pathogenic. Important biocides are: 8-hydroxyquinoline citrate, silver nitrate, aluminum sulphate and citric acid.

longer transport or storage. Optimal time of harvest is important for the quality of cut flowers. Morning cutting has advantages in term of better turgidity; but at the same time, flowers which may be still wet with dew are more susceptible to postharvest fungal infection. Evening harvest has advantages in terms of higher carbohydrate concentration in flowering stem. Morning harvest is beneficial for flowers which lose water quickly after picking as in case of roses. Sharp tools are used to cut the flowers from mother plant. Flowers are usually cut close to the soil to provide the longest stems possible.

Flower Name	Harvest stage (local)
Chrysanthemum	when outer florets fully expanded
Carnation	Paint brush stage
Gerbera	Fully open flowers
Gladolus	1-5 florets open
Tuberose	maximum florets open
Rose	1-2 petals begin to unfold

Evening harvest has advantages in terms of higher carbohydrate concentration in flowering stem. Morning harvest is beneficial for flowers which lose water quickly after picking as in case of roses. Sharp tools are used to cut the flowers from mother plant. Flowers are usually cut close to the soil to provide the longest stems possible.

Post harvest factors:

Water Relations: The termination of life of harvested flowers depends on water uptake and transport, water loss and the capacity of flower tissue to retain its water. The rate of water uptake of cut flowers depends on transpiration pull, temperature and composition of solutes. Acidification of water and addition of wetting agent and flower food in holding solution markedly improve water uptake of cut flower.

Floral preservatives: The term “Floral Preservative” is used for any chemical formulation used for extending the vase life of flowers. It has two basic constituents: sugar and biocide. Sugar provides a source of additional food to cut flower whereas the biocide checks the growth of bacteria, fungi and other microorganisms in the vase water. These preservatives can be applied as “Pulsing solution” refers to short duration (16-24 hours) pre-shipment with higher levels of sucrose (10-20%), “Bud opening solutions” with low concentration of sucrose (1-5%) and “holding or vase solutions” means to hold flowers continuously till the termination of vase life with very low levels of sucrose (0.5 to 2%).

Pre-cooling and storage: Pre-cooling is a treatment given to flowers to remove the field heat immediately after harvest. There are different methods of pre-cooling like forced air cooling, hydro-cooling, room cooling and vacuum cooling. Flowers are stored for a longer period at low temperature. There are two methods of cold storage- wet and dry. In controlled atmospheric storage the level of CO₂ is increased and O₂ is decreased.

Grading, packing and transport: Grading refers to categorization of flowers on the basis of their quality. Major parameters on which the grading of flowers is done based on appearance, harvest maturity, injuries, colour, size of bud, stem strength as well as length of stem. Flowers are generally made into bunches of 5, 10, 12, or 20 stems and loosely tied with rubber band, The flowers like gerbera, orchids, anthurium and standard chrysanthemum are packed individually. The bases of some tropical flowers such as Dendrobium and anthurium are kept moist by putting them in specially designed vials filled with water or in moist wool. Bunches are held in polyethylene sleeves or buds are wrapped in corrugated paper to protect them from mechanical damage. The flowers are held tightly in the boxes to avoid the damage during transit. Flowers are usually transported by air and refrigerated vans/trucks for long distance.

Rose:

Rose, a universally celebrated flower, has been used as a garden plant since the dawn of civilization. Rose is a symbol of perfection, elegance, romance and love. It was called “The Queen of Flowers” firstly by Greek poetess in her “Ode to the Rose”. Rose is indisputably the top ranking cut flower and comprises over

60% share in the international flower trade. Roses have vase life of 6-13 days depending upon the variety and other factors such as light, temperature, stage of harvest, season and postharvest handling procedures. Rose stems are highly prone to water stress which is caused by contamination of vase water by bacteria, fungi and other microorganisms and air entering into the stem from the cut end. The air bubbles block the xylem vessels and obstruct the movements of water up in the stem. The water deficiency in the neck region causes loss of turgor and eventually drooping of the flower bud. This disorder refers to a 'bent neck'. Roses also respire considerable quantities of carbohydrates, which shortens their vase life. Breakdown of proteins leads to formation of ammonia which also causes bluing of petals in red colored cultivars. Bluing of petals is a sign of termination of vase life.

Harvesting of flowers:

Roses are harvested at tight bud stage when one or two petals begin to unfold. Roses cut too early contain insufficient soluble sugars and hence may fail to open. Stage of harvest varies greatly with the variety, distance to the market, prevailing temperature conditions and requirement of the market. For local markets, buds can be harvested at more advanced stage of opening. Flowers should be preferably cut during cooler hours i.e. in the morning or evening. Rose varieties with long thorns like First Red should be handled with extra care otherwise the thorns may damage the leaves and petals on the other stems and spoil quality of the bloom. After harvesting the stem should be put in buckets containing water. The buckets should be kept clean to avoid the microbial growth which adversely affects its vase life.



Pulsing of Rose

Pre-cooling:

Immediately after harvest, the flowers should be shifted to cold rooms (3-5°C). Cooling remove field heat from the flowers, slow down respiration, lowers water loss and arrests the excessive opening of the bud. During cooling, the stems should be put in a solution of aluminum sulphate or citric acid (300ppm).

Pulsing:

Pulsing is a pre-shipment treatment given to the cut flowers with high concentration of sucrose and germicide for a short period of time to improve the shelf life and promote flower opening. Pulsing is beneficial especially for flowers destined for long storage period or long distance transportation. Pulsing of rose cut stems with sucrose (3%) + aluminium sulphate (300 ppm) or with AgNO_3 (20-40 ppm) for 24 hours increase the vase life and improve the quality of rose cut flowers.



Harvesting stage of Rose

Holding solution:

After pulsing and storage flowers are held in a solution containing sucrose, germicide, ethylene inhibitor and growth regulators. The level of sucrose in holding or vase solutions is kept very low (0.5 to 2%). In cut roses, combination of chemicals as holding solution showed a much better response, such as glucose (2%) + $\text{Al}_2(\text{SO}_4)_3$ (100ppm) + 8-HQC (200ppm).

Storage of flowers:

Since roses have relatively short vase life and wilt rather quickly, these should be transported immediately after grading. The flowers can be wet stored for 5-7 days at 2-3°C, with stems dipping in water. Roses can also be dry stored in sealed polyethylene sleeves for about 7 days.

Grading:

After cooling of flowers, the stems are shifted to air-conditioned grading room. In the grading room, defective stems with blemishes or symptoms of diseases or pest infestation are removed. The stems are sorted out in different grades of length by colour coded board or automatic grading machines. The quality parameters which are kept in mind for grading are:

1. Long stemmed varieties are graded from 40 cm onward with the difference of 10 cm whereas short stemmed varieties are graded from 40-65 cm with the difference of 5 cm.
2. Leaves should be dark green and healthy
3. The flowers should not be bull head, too open, too tight with bent neck.
4. Bud size should be representative of the variety
5. The neck should be too long



Grading and packing of rose

Packing and packaging:

The graded stems are made into bundles of 20 each and tied loosely with the rubber band. The buds should be wrapped with 2 ply soft corrugated paper and tied loosely with a rubber band to secure the buds in position. The buds of long stemmed varieties can be packed in different layers of 4 flowers in each layer at two different levels. A short stemmed variety has small sized buds which can be packed keeping all the buds in the same plane. Leaves from the lower 4 to 5 cm portion of the stem should be removed and stems put in buckets containing chlorine (50ppm), aluminium sulphate or citric acid (300ppm). The bunches are packed in pre-cooled 4 to 5 ply teleboxes of fiberboard in such a way that lower heads face in opposite direction i.e. towards the width. The bundles should be placed in rows along the width. The second layer is placed opposite to the first layer. In the packing box, the layers of flowers are covered with soft papers. After packing of flowers, the box is closed with the lid and strapped properly. Mixing of varieties or stems of varying lengths in the same box should be avoided. The boxes should be properly marked with symbol 'Fresh Flowers' on both sides so that they are handled with care at the airports. Besides, the boxes should have stickers indicating name of the variety, number and length of the stems it contains. The dimension of the packing boxes depends upon the length of the stem and number of the stems to be packed as well as type of the cargo space available in the aircraft so that the boxes can fit well into the available spaces. Generally, a telescopic corrugated fiberboard (5 ply thickness and of 106 x 35 x 20 cm size) having strength of 500

newtons and puncture resistance of 197 oz/tear inch with two ventilated holes of 4.7 cm diameter on each side are suitable for bulk transport of cut roses.

Transportation:

Roses from India are exported to far off placers such as Europe and Japan by air transport. The boxes are taken to the airport in the refrigerated vans to keep the flowers cool. The international airports also provide cooling facilities to the growers. In case of limited space in the cold room, air conditioning unit of the refrigerated truck can be plugged to the electric supply provided by airport authorities to use refrigerated trucks as a makeshift cold store at the airport till the flowers are loaded in the aircraft. It should be ensured that the flowers are loaded in a special cabin meant for transport of perishable commodities.

Gladiolus :

Gladiolus is one of the most popular cut flowers in India. It has fascinating spikes bearing a large number of florets possessing good vase life. All the colors except true blue are available in gladiolus. There is hardly any florist shop that does not sell gladiolus spikes. Since gladiolus spike bears many florets, it requires considerable amount of sugars for their opening. The spikes cut too immature, remain deficient in food reserve and hence exhibit poor opening of florets and short vase life. Microbial growth in the vase water blocks the xylem tissues, thereby decreasing water supply to the florets and eventually causing their premature wilting.

Harvesting of spikes:

Gladiolus spikes are harvested at tight bud stage. The spikes should be harvested when 1-5 florets show colour. In cold weather or for local markets and immediate use of the spikes may be cut at an advanced stage of development i.e. when basal floret is $\frac{1}{2}$ or fully open. The spike should be harvested leaving at least 4 leaves on the plant to ensure proper development of corms and cormels.

Pre-cooling:

Gladiolus cut spikes should be pre-cooled immediately after harvest by placing them in a cold storage without packing or in open boxes, until they reach the desired temperature. Pre-cooling of cut spikes reduces respiration, breakdown of nutritional and other stored material in the stem, leaves and petals. Gladiolus spikes pre-cooled at 4°C. During cooling, the stems should be put in a solution of aluminum sulphate or citric acid (300ppm).

Pulsing:

Pulsing is a short-term treatment given to the cut flowers before packaging, storage and transportation, the effect of which should last for the entire shelf life of the flowers even when the flowers are held in water. The absorption of chemical solutions containing sucrose and germicides through the lower cut bases of flower stem is known as pulsing. In gladiolus opening of florets can be improved by pulsing treatment. The sucrose concentration required for pulsing treatment is usually high and varies with the agro-climatic conditions. Gladiolus spikes pulsed with sucrose (20%) + 8-HQC (**8-hydroxyquinoline citrate**) (200ppm) for 24 hours effectively increasing the vase life of the spikes. Besides these, some other mineral salts like AgNO_3 , CaCl_2 , $\text{Ca}(\text{NO}_3)_2$ etc. can also be used for pulsing.

Holding solution:

The holding solution is one in which the cut spikes are kept until they are sold or continuously in the vase. Gladiolus spikes cut at tight bud stage, considerable improvement in vase life in holding solution containing

4% sucrose plus aluminium sulphate (300 ppm) or chlorine solution (50 ppm) prepared from bleaching powder (calcium hypochloride) or sodium hypochlorite.

Storage of spikes:

Gladiolus spikes do not store well for prolonged periods and show inability to open after prolonged storage. The spikes can be stored preferably at 4-5°C. Lower temperatures cause freezing injury to the tissues and failure of buds to open. Gladiolus spikes for wet refrigerated storage, the spikes may be cut when 5-7 florets show color. The spikes thus harvested can be stored for 9 to 12 days. For prolonged storage, the spikes can be stored dry storage. For dry storage spikes are harvested at tight bud stage and treated with pulsing solution containing sucrose (20%) + aluminium sulphate (300 ppm) for 20 hours at 20-25°C. After the treatment, the spikes should be sealed in polypropylene sleeves and stored at 4°C.

Grading:

The good quality spikes of gladiolus should be long, straight, healthy with more number and better color of florets, devoid of side shoots and free from any physical damage and attack of pests and diseases. The spikes are graded into at least three categories depending upon their stem length and number of florets. It is very important before grading to visit the flower market where the flower are to be sell and judge what type of spikes fetch remunerative price in the market.

Different grades of gladiolus:

Grade	Spike length (cm)	Number of florets (minimum)
Fancy (Grade A)	> 107	16
Special (Grade B)	96 to 107	14
Standard (Grade C)	81 to 96	12
Utility (Grade D)	< 81	10

Packing and packaging:

Packing should prevent flowers from physical damage, water loss and external factors during transportation. The most suitable packaging material for cut blooms is corrugated fiber board boxes. The graded spikes should be made into bunches of a dozen spikes, tied loosely with rubber band at the base, and should be tightly packed in fiberboard boxes (4-5 ply thick). The fiberboard boxes (127 cm x 22 cm x 22 cm) used for packing fluorescent tubes can also be used for this purpose. Bunches should be wrapped in polyethylene to prevent moisture loss. For supply to the export markets, it is mandatory to cool the spikes and the boxes before transit. It may be observed that due to their heavy weight gladiolus spikes are mainly sold in the domestic market.

Transportation:

The gladiolus spikes are normally transported under ambient conditions, by air or road. Gladiolus can be transported for up to 48 hours at 18-20°C without any loss of colour and freshness. Cut flowers of gladiolus are sensitive to geotropic bending. These flower spikes must be transported in an upright position.

Carnation:

Carnation is an important cut flower crop which has considerable demand both in the domestic as well as export markets and is among the top five commercial flowers in the world trade. Carnation flowers are very sensitive to ethylene. Ethylene accelerates senescence of flowers and sleepiness of petals. Sleepiness

refers to the curling of petal margins due to which the flower partially closes. Carnation flowers never stored along with fruits and vegetables which releases more quantities of ethylene. The buds of carnation cut too tight do not open in water; as such buds contain insufficient carbohydrates. Besides, bacterial and fungal growth in vase water and on the dipped surface of the stem causes plugging of basal stem leading to decline in water absorption by the stem and subsequent decline in vase life.

Harvesting of flowers:

Standard carnations are harvested at 'Paint Brush' stage when flowers are nearly half open whereas spray cultivars harvested when two flowers are fully open on the stem.

Pre-cooling:

It is the low temperature treatment to cut flowers after harvest to remove field heat, thus lowering the respiration rate and increase in vase life. For carnation, the pre cooling temperature is 1°C. Treatment of carnation flowers with STS (1mM) for 24 hours during pre-cooling at ambient conditions (20- 25°C) before transit effectively improved vase life.

Pulsing:

Pulsing is the postharvest treatment of cut flowers (before packaging and transport) with sucrose, anti ethylene and anti microbial compounds, which causes the flower fresh till it reaches to consumer. Here concentration of sucrose is important. For carnation sucrose (20%) concentration for 12 – 16 hour at 20°C, 2000 lux light intensity is the optimum for pulsing.



Holding solution:

Exposure of carnation cut stems to 1-MCP (1-methylcyclopropene) followed by placing the stems in vase solution containing sucrose (5%) + aluminium sulphate (200ppm) synergistically improved vase life.

Storage of flowers:

Flowers of carnation cut at paint brush stage can be stored under refrigerated conditions for 3 weeks at $4 \pm 1^\circ\text{C}$, both under wet and dry conditions (in polypropylene sleeves) and at $0 \pm 1^\circ\text{C}$ for longer duration (>16 weeks) in dry conditions. During wet storage, high R H of 90-95% should be maintained, and flowers must be shielded against direct streams of cold air from the cooler. Before storage, the flowers should be pre-treated with anti-ethylene preservatives. Carnation flowers cut at bud stage can however be stored for prolonged duration. After storage, the buds can be opened in the preservative solution containing 70g/l sucrose, 50mg/l AgNO_3 and 200mg/l 8-HQC. Prior to storage, the buds should be sprayed with fungicides such as rovril @ 0.1% to control gray mold in storage.

Storage methods and conditions:

Maximum storage period of carnation cut flowers in different methods are as follows:

- Dry storage period: - storage temperature $0-1^\circ\text{C}$, Maximum storage period 16-24 weeks.
- Wet storage period: - Storage temperature 4°C , Maximum storage period 4 weeks.
- Controlled Atmospheric storage/Modified Atmospheric storage:- CO_2 (5%), O_2 (1-3%), storage temperature $0-1^\circ\text{C}$ storage period 30 days.

- Low pressure storage: - Hg (40 – 60 mm), low temperature for 91 days.
- Cold storage (4°C) 10 days

Grading:

Society of American florists set following inspection criteria for carnation cut flowers.

- Bright, clean, firm flowers and leaves
- Fairly tight petals near the centre of the unopened flowers
- Symmetrical of flower shape and size
- No split or mended calyx
- No lateral buds or suckers
- No decay or damage
- Straight stem and normal growth
- No sleepy appearance

Stem strength: It will be determined by holding the stem horizontally at a point 25 mm above the minimum length for the grade, and the deviation of the flower head shall not be more than 30° below the horizontal plane with the natural curvature of the stem down.

Blue grade shall consist of fully symmetrical brown heads, singles, and sleepy appearance, splits, discoloration, insects, diseases and other damages. It shall have straight stem.

Red grade, other than diameter of flower and length of stem, it shall have the same requirement.

Packing and packaging:

- Carnation flowers are packed in corrugated cardboard container (CCC).
- The CCC size is 122 cm x 50 cm x 30cm, which contains 800 carnation cut flowers.
- The boxes or container should be well insulated and should have a lining of vapour barrier like polythene lining to help in maintaining high relative humidity inside the package.
- Bunches of 20-25 flowers are then placed in these boxes with one half of the total number of bunches oriented on each end of the container.
- Close packing of flowers helps to minimize the distance for heat exchange between flowers and container.
- Newspaper layers are placed between the flower layer to maintain high humidity and then, when the container across the box to cover the flowers completely.
- A strip of wood is inserted laterally in the middle of the box, forced downwards and stapled in to place to stems during shipping.
- The lids are fixed to the box by taping or twining it. Sometimes the top lid is made partially or completely transparent for viewing the flowers without disturbing them.
- Ethylene scrubbers containing KMnO_4 may be kept, inside.

Transportation:

- Both standard and spray carnation cut flowers are suitable for dry transportation over a period of several days.
- Cool chain system (low temperature) is important during transportation to slow down respiration, transpiration, slating of bud opening etc.
- For rapid cooling of cut flowers various systems like blowing fan forced cold air over open boxes, pushing cold air through vented boxes, vacuum cooling etc. can be adopted.
- Humidity during transportation should be maintained at the level of 95-98%
- Merely two pollinated carnations in a box can considerably decrease the longevity of other so KMnO_4 may be used in ethylene scribbles during packaging.
- Trunk shipment: – for shorter than 20 hours.
- Air shipment:– Quickest, flowers should be treated with STS (ethylene decreasing) Costly.
- Sea Shipment – Take more time, preferably, cheap.



Fig.1. Different stages of post harvest handling of carnation cut flowers

Gerbera:

Gerbera is another important cut flower crop which is in great demands both in domestic and export markets. Gerbera can be successfully grown in hills or plains. Gerbera flowers are insensitive to ethylene. The stems are highly prone to water stress. The blockage of the stem base with bacteria causes decrease in uptake of water by the stem which eventually causes stem break i.e. breaking of the stem in the center. The stem of gerbera is hollow and cutting of the stem through hollow cavity also improves water uptake because epidermal cells lining the cavity act as an alternate pathway for water absorption besides xylem tissues.



Gerbera cultivation

Harvesting of flowers:

Flowers are generally cut when the outer two rows of disc florets are perpendicular to the stalk. In some cultivar, especially the ones that close at night can be harvested bit later. The stage of harvest is critical as the flowers should not be cut before the outer row of flowers show pollen. They respond very well to recutting of stem before placing in water or preservation solution or at all stages of marketing. Shortage of water as a result of vessel blocking or microbial growth causes drooping or wilting of flowers. Water is absorbed through the medullary cavities that are visible at the cut-surface. Therefore, it is beneficial to prick the stalk 10 cm below the flower head to allow the air to escape from the cavity.

Pre-cooling:

Gerbera flowers are stored at 2 to 3°C with a relative humidity of 90-95% as soon as possible after harvest to overcome the field heat. This temperature /humidity combination lowers respiration and transpiration of the flower. It also slows growth of fungus and production of ethylene which otherwise shortens the shelf life of cut flowers.

Pulsing:

Pulsing involves placing the lower stem ends of cut flowers in a concentrated solution of sucrose and germicides. The optimum temperature for pulsing is 20-27°C at a light intensity of 2000 lux. Pulsing is practiced by the growers, whole-sellers and retailers who need to store the flowers for a long period or for long distance transportation in order to extend vase life of the flowers apart from promoting bud opening and

improving quality of gerbera flowers. The gerbera stems should be cut under water with sharp knife. The cut flowers must be immersed in a solution containing a preservative viz. 1% commercial bleach/ sodium hypochlorite for four hours at 14-15°C.

Precautions during pulsing:

- Gerbera stems are susceptible to bacterial that causes the flower head to droop over. Therefore, clean water and disinfected buckets should be used.
- Preservative should be replenished after every 1-2 days.
- Stems should not be placed too deep in the solution.
- Flowers are to be kept away from heat and direct sunlight.

Holding solution:

The holding solutions or pulsing solutions are used to maintain freshness of flowers. The whole sellers, retailers or consumers may use holding solutions. A holding solution generally consists of sucrose, germicides, ethylene inhibitors, mineral salts and hormonal compounds for prolonging the vase life and quality of flowers. Among the carbohydrates, sucrose and dextrose are used at low concentration (2-6%) in the holding solutions. The holding solution used in case of gerbera consists of $\text{Al}_2(\text{SO}_4)_3$ (300ppm) or AgNO_3 (25ppm) or citric acid (300ppm).

Storage:

Storage of cut flowers has to be evaluated when the produce is not being sent directly to the market. Gerbera cut stems are not suitable for long term storage. Refrigeration is critical to keep flowers looking fresh and to maintain their vase life after purchase. Gerbera flowers can be stored dry at a temperature of 2-5°C for 2 days. Flowers can be stored loose in deionized water for 4-7 days at 4°C. After storage, the stems should be cut once again and placed in water or preservative for 2-3 hours for rehydration.

Grading:

Grading is done on the basis quality of flowers, length and firmness of the stem and any possible foliage and flower bud abnormalities. Quality requirements in the international market include the following:

- Batch must be fresh and in good form, composition and flower and leaf colour.
- Flowers must be uniform in thickness, sturdiness and volume.
- Batch must not have any limp flower.
- Flowers must be free from growth defects including tears during growth and irregularly shaped hearts and flowers.
- They must be free of heels.

Packing and packaging:

Flowers meant for export are usually not bunched but packed individually into special boxes. Gerberas having a minimum stem length of 30-40 cm are packed in interior boxes. For local markets, it is usually placed in a bunch of 5 or 10 stems in a dry condition. A bunch of more than 10 flowers cannot be made as the flowers get damaged at the neck. Individual gerbera flowers are sleeved with poly cover or plastic cups specially designed to hold them. A telescopic cardboard box having the dimension of 100 x 30 x 10 cm holds about 50 flowers.



Packaging of gerbera

Transportation:

Flowers must be fully hydrated and “pulsed” before they are packed dry in tightly sealed moisture retentive polythene foil. The flowers are transported in refrigerated vehicles (2-3°C) or pre-cooled before transportation as this will prevent flower bud development and also protect from harmful effects of ethylene.

Points to Remember

- ❖ Pre-cooling is a treatment given to flowers to remove field heat immediately after harvesting
- ❖ Conditioning is done with de-mineralized water supplemented with germicides and acidified with citric acid.
- ❖ Treating the flowers with high concentration of sucrose and germicides for a short period of time to improve the shelf like and promote flowering called pulsing
- ❖ Temperature management during storage is an important component which determines subsequent vase life of flowers.
- ❖ In dry storage, flowers are sealed in plastic bags to prevent the loss of moisture.
- ❖ Grading refers to categorization of flowers on the basis of their quality.
- ❖ Over packing and under packing both contribute to excessive damage.
- ❖ Senescence is the processes that follow physiological maturity and lead to death of a whole plant, organ, tissue or cell.
- ❖ Germicides are chemical substances, which are used to inhibit microbial growth in the vase water s well as on the stem surface. 8-HQC is the most effective germicide.
- ❖ Over mature or too immature flowers possess very short vase life.
- ❖ Vase life of the cut flowers can be improved by proper handling.
- ❖ Sleepiness refers to the curling of petal margins due to which the flower partially closes.

Activity

1. Go to flower market and study the handling of cut flowers at florist.
2. Plan a visit to some commercial flower growers. Make a list of flower crops and enquire about the different post harvest practice used for different flowers.

Check your progress

A. Fill in the blanks

1. These preservatives can be applied as a short duration _____ treatment to improve the vase life of flowers.
2. _____ is a treatment given to flowers to remove the field heat immediately after harvest.
3. The water deficiency in the neck region causes loss of turgor and eventually drooping of the flower bud. This disorder referred as _____.
4. The most suitable packaging material for cut blooms is _____ board boxes.
5. In gladiolus cut flower fancy grade, the stem length is cm.
6. _____ refers to the curling of petal margins.
7. Gerbera flowers are _____ to ethylene.
8. It is estimated that about _____ percent of fresh flowers are being spoiled during post harvest handling.
9. Gerbera flowers can be stored dry at a temperature of _____-C for 2 days.
10. Humidity during transportation should be maintained at the level of _____%
11. Carnation flowers are harvested at _____ stage.

B. Short answer/ Descriptive type questions:

Q.1 What are different factors affecting post harvest life of cut flowers?

Q.2 Write the Storage methods and conditions for carnation.

Q.3 What are different precautions during pulsing of gerbera?

Q.4 Write short notes of the following:

- i. Packing and packaging of rose and gladiolus.
- ii. Transportation of carnation



FLORICULTURE-II

STUDENT HANDBOOK

for

Class XII



Central Board of Secondary Education
2, Community Centre, Preet Vihar, Delhi - 110092

Floriculture-II Student Handbook for Class-XIII

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Preface

Floriculture is fast emerging money spinning industry worldwide and during the last two decades it has expanded and deepened its roots in India, on account of strong research and developmental base, focused attention of the government coupled with innovative entrepreneurships, progressive flower growers and increased awareness amongst the masses for growing flowers and ornamental plants for export as well as increasing use in homes, offices, social functions, etc. Total trade of floricultural products has crossed 20 billion US\$ in 2011, while total value of these at wholesale has been estimated to be over 50 billion US\$. In India, the acreage under flowers has increased from 34000 ha in 1991 to over 2.5 lakh ha in 2012. The export of various floricultural products has increased from Rs. 14.5 crores in 1991 to 365 crores in 2012. Alone in Delhi, there is consumption of floricultural products of over Rs. 10, 000 crores annually.

Keeping this upcoming trend in Floriculture sector globally and in India, the vocational specialized courses at school level in class XII will generate technically sound manpower to handle the specialized operations in producing high quality flowers and ornamental plants to meet the growing demands of export and domestic market. Further, the students who will opt for specialization in Horticulture at undergraduate level and in Floriculture and Landscape architecture at post graduate level will have sound foundation of the knowledge with respect to different components of commercial floriculture. An attempt has been made to compile the latest and basic information on all facets of Floriculture based on relevant literature and the experience of all the authors in teaching and research on different components of Floriculture. The literature consulted to compile this book has been duly acknowledged.

This book will provide opportunity to the students primarily on global scenario of floriculture, employment opportunities; basic and modern concepts of landscaping, commercial flower cultivation in open and protected cultivation of flowers, dried ornamentals and post harvest handling of flowers.

**Vineet Joshi, IAS
Chairman, CBSE**

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भारत का संविधान

उद्देशिका

हम, भारत के लोग, भारत को एक¹ [सम्पूर्ण प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य] बनाने के लिए, तथा उसके समस्त नागरिकों को:

सामाजिक, आर्थिक और राजनैतिक न्याय,
विचार, अभिव्यक्ति, विश्वास, धर्म
और उपासना की स्वतंत्रता,
प्रतिष्ठा और अवसर की समता

प्राप्त कराने के लिए तथा उन सब में व्यक्ति की गरिमा और² [राष्ट्र की एकता और अखण्डता] सुनिश्चित करने वाली बंधुता बढ़ाने के लिए दृढसंकल्प होकर अपनी इस संविधान सभा में आज तारीख 26 नवम्बर, 1949 ई० को एतद्वारा इस संविधान को अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से “प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य” के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से), “राष्ट्र की एकता” के स्थान पर प्रतिस्थापित।

भाग 4 क मूल कर्तव्य

51 क. मूल कर्तव्य - भारत के प्रत्येक नागरिक का यह कर्तव्य होगा कि वह -

- (क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;
- (ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;
- (ग) भारत की प्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण रखे;
- (घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;
- (ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभाव से परे हों, ऐसी प्रथाओं का त्याग करे जो स्त्रियों के सम्मान के विरुद्ध हैं;
- (च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परिरक्षण करे;
- (छ) प्राकृतिक पर्यावरण की जिसके अंतर्गत वन, झील, नदी, और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;
- (ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;
- (झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;
- (ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई उंचाइयों को छू ले।

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a **SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all;

FRATERNITY assuring the dignity of the individual and the ² [unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do **HEREBY ADOPT ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs. by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "Sovereign Democratic Republic" (W.E.F. 3.1.1977)
2. Subs. by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "Unity of the Nation" (W.E.F. 3.1.1977)

THE CONSTITUTION OF INDIA

Chapter IV A

Fundamental Duties

ARTICLE 51A

Fundamental Duties - It shall be the duty of every citizen of India-

- (a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
- (b) to cherish and follow the noble ideals which inspired our national struggle for freedom;
- (c) to uphold and protect the sovereignty, unity and integrity of India;
- (d) to defend the country and render national service when called upon to do so;
- (e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
- (f) to value and preserve the rich heritage of our composite culture;
- (g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;
- (h) to develop the scientific temper, humanism and the spirit of inquiry and reform;
- (i) to safeguard public property and to abjure violence;
- (j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.

CONTENTS

Chapter No.	Name of the Chapter	Pages
1.	Present Scenario and Scope of Floriculture in Global Market	1-16
2.	Employment Avenues in Floriculture Sector	17-24
3.	Outdoor Room Concept: Public Area, Private Area and Family Area	25-31
4.	Different Garden Features	32-40
5.	CAD (Computer Aided Design)	41-46
6.	Lawn Establishment and Management	47-54
7.	Production of Indoor Plants and their Maintenance	55-64
8.	Commercial Flower Cultivation in Open	65-107
9.	Protected Cultivation of Commercial Flower Crops	108-132
10.	Flower Arrangements – Types and Styles	133-138
11.	Dried Ornaments	139-154
12.	Post Harvest Handling of Commercial Flower Crops	155-167





Floriculture-II

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नया आगाज़

आज समय की माँग पर
आगाज़ नया इक होगा
निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।

परिवर्तन नियम जीवन का
नियम अब नया बनेगा
अब परिणामों के भय से
नहीं बालक कोई डरेगा
निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।

बदले शिक्षा का स्वरूप
नई खिले आशा की धूप
अब किसी कोमल-से मन पर
कोई बोझ न होगा

निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।
नई राह पर चलकर मंज़िल को हमें पाना है
इस नए प्रयास को हमने सफल बनाना है
बेहतर शिक्षा से बदले देश, ऐसे इसे अपनाए
शिक्षक, शिक्षा और शिक्षित
बस आगे बढ़ते जाएँ
बस आगे बढ़ते जाएँ
बस आगे बढ़ते जाएँ.....







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