

Commercial Floriculture



4. Commercial Floriculture (HPF 103) 3(2+1)

Scope and importance of commercial floriculture in India, production techniques of ornamental plants like rose, marigold, chrysanthemum, orchid, carnation, gladiolus, jasmine, dahlia, tuberose, bird of paradise, china aster and gerbera for domestic and export market, growing of flowers under protected environments such as glass house, plastic house etc., post-harvest technology of cut flowers in respect of commercial flower crops, dehydration technique for drying of flowers, production techniques for bulbous.

Practical: Identification of commercially important floricultural crops. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices.

LECTURE-1

TOPICS

- 1.1 Introduction
- 1.2 Importance of floriculture in India
- 1.3 Scope to enter floriculture industry in India
- 1.4 Problems/constraints for Floriculture industry in India
- 1.5 Area and production of flowers in the state and the country.

1.1. INTRODUCTION

- ◆ India has a long tradition of floriculture. As it is an ancient creative skill with imagination and an advanced science that played a very important role in the course of human civilization and its social development.
- ◆ In most part of the country, flower growing is carried out on small holdings and commercial floriculture has assumed importance only in the recent past.
- ◆ Traditionally, flowers have been grown in India in the open fields, where they have been exposed to both biotic and abiotic stresses. Hence, the quality is not up to the standards.
- ◆ However, in the era of globalization, the produce has to be of International quality and globally competitive, as there is lot of demand for different floricultural products in the export market. The modern floriculture will meet the above demand of the present day's consumers.

Definition:

Floriculture can be defined as *“a specialized branch of horticulture which deals not only with the cultivation of flowers, foliage, climbers, trees, shrubs, cacti, succulents, etc., but also with their marketing and production of value-added products from them”*

Floriculture can also be defined as *“a discipline of horticulture concerned with the cultivation of flowering and ornamental plants for gardens and floristry, comprising the floral industry. Floriculture includes bedding plants, flowering plants, foliage plants or houseplants, cut greens and cutflowers”*.

- Majority of floriculture crops are generally herbaceous.
- Bedding and garden plants consist of young flowering plants especially annuals and perennials.
- The floriculture business is growing in the world at around 6-10 % per annum.

- In spite of a long tradition of floriculture, India's share in the International market for these flowers is negligible (At present it is < 0.70 %).
- During the last few years, taking an advantage of the incentives offered by the Government of India, a number of Floriculture units were established in India for producing and exporting flowers to the developed countries. Most of them are located near Mumbai, Pune, Bengaluru, Hyderabad and New Delhi and are getting the technical know-how from Dutch as well as Israeli Consultants.
- Tamilnadu is the leader in floriculture followed by Karnataka, accounting for 75% of India's total flower production and the state is having the highest area under both modern and traditional flowers.
- The country's first and the only Digital Flower Auction Centre is located in Bengaluru, running by Karnataka Agro Industrial Corporation (KAIC) at Hebbal.

1.2 IMPORTANCE OF FLORICULTURE IN INDIA:

Besides food and nutritional security, the aesthetic value is also equally important for our daily lively hood as well as for environmental purity.

Floriculture is important from the following point of view;

1. Economic point of view
2. Aesthetic point of view
3. Social point of view

1.2.1.Economic point of view:

- ◆ Floriculture is a fast emerging major venture in the world, especially as a potential money-spinner for many countries in world.
- ◆ Many flowers and ornamental plants are being grown for domestic as well as for export market will provide more return/unit area than any other agricultural/horticultural crops.
- ◆ For example in markets such as Delhi and Mumbai and other metros a single spike of gladiolus and gerbera cutflower may sell upto Rs. 3-5 in *Kharif* and Rs. 5-10/spike in Rabi/Summer.
- ◆ Gestation period of flower crop is very less compared to other crops.
- ◆ Modern-day floriculture refers to the production of high-value cutflowers such as rose, gladiolus, carnation, mums, orchids, tuberose, anthurium, lilium, gerbera etc.,.
- ◆ Now days, growing of these cutflower crops, suited for flower arrangements/decorations for bouquets preparation and for floral boskets, have increased substantially and its share of the total trade has also improved.

- ◆ The sale of loose flowers of Jasmine, Crossandra, Marigold, China Aster, Chrysanthemums, Berlaria and Gaillardia etc., are a roaring busyness in south India.
- ◆ The present trend in floriculture is for making dry flowers, extraction of natural colours and essential oils.
- ◆ There is lot of demand for good quality flower seeds and ornamental planting materials.
- ◆ At present the global ornamental crop industry is worth about US\$ 70 billion.
- ◆ The global consumption of the flowers is about US\$ 35 billion.
- ◆ More than three lakhs hectare area is under flower production in different countries of the world.
- ◆ Floriculture generates *self employment opportunities* round the year. The employment opportunities in the field are varied such as.
 - i. One can join the floriculture field as farm/estate managers, plantation experts, supervisors and project coordinators and so on.
 - ii. Teaching, Research and Extension scientists/ teachers are some other avenues of employment in all SAUs and NARS.
 - iii. Marketing of Floriculture products for different ventures is emerging as a potential segment of this field.
 - iv. Besides, one can also work as consultant, landscape architect etc with proper training.
 - v. One can also work as entrepreneur and offer employment to others.
 - vi. In addition to these careers which involve research and actual growing of crops.
 - vii. Floriculture also provides service career opportunities which include such jobs like floral designers, grounds keepers, landscape designers, architects and horticultural therapists.
 - viii. Professional qualification combined with an inclination towards gardening and such other activities produces efficient floriculturists and landscaping professionals all over the globe.
- ◆ Presently more than 145 countries are involved in flower production on commercial scale.

1.2.2. Aesthetic point of view:

- Lot of scope for landscaping and is considered as billion dollar earning industry in states which ultimately adds the monitory value of any building/property.
- To a Japanese flower arranger each flower expresses one or more meaning (eg. Ikebana).

- The wealth of any nation is linked with the health of its people. Unless we can ensure the healthy development of our citizens, especially for the younger generation, by providing them for open breathing places through bio-aesthetic planning like in Chandigarh city and landscape gardening, we cannot expect to build up a healthy society and prosperous nation.
- **Horticultural therapy** - is the new dimension of horticultural sciences to heal the psychic debility and the science is to use garden, landscape plants, parts of plants, growing activity as tools to work.
- The bio-force of plants offer a permanent solution to the problems of bio force of human thus, bio aesthetic horticulture is emerging as a new occupational therapeutic tool to restore the lost rhythm and harmony back to human self or inner environment.
- It is being utilized in psychiatric hospitals, general hospitals and physical rehabilitation centers, homes for elderly, prisons and schools.
- The patients can achieve higher level of personal development and satisfaction.

1.2.3. Social point of view:

- Flowers symbolize the purity, beauty, peace, love, adoration, innocence and passion etc. Hence, many flowers are used to express the most sensitive, delicate and loving feelings eloquently what our words fail to express.
- In our society no social function is complete without the use of flowers, floral ornaments, bouquets or flower arrangements they are invariably used in all social functions.
- Used in social gatherings, birthday parties, welcoming friends or relatives and honoring dignitaries. The concept of Valentine's Day is fast catching up in India also.
- The arrival of new born is rejoiced with flowers,
- To an Indian, especially for Hindu's, flowers have a much greater significance in religions offerings. It has estimated that more than 30-40 % of the total flower productions are being consumed in Kolkata city alone used for worshipping purpose.
- Floral garlands, gajras and venis are required in marriage ceremonies for adornment of hairs by women of all ages, especially in the south India.
- In the present modern era sick are wished for speedy recovery by offering beautiful cutflowers, while the deads are bidden farewell with flowers along with tear of sorrow.

- Flowers are very closely associated with mankind from the dawn of human civilization. There is increasing habit of ‘saying with flowers.’ Any Indians born with flowers live with flowers and finally dies with flowers.

1.3. SCOPE TO ENTER FLORICULTURE INDUSTRY IN INDIA

- India is blessed with varied and dynamic agro-climatic condition, good quality soil and water made suitable for floriculture.
- Geographically India is well located between two major markets i.e., Europe and East Asia.
- Winter is being very mild and hence there is lot of scope to export Indian flowers to temperate countries during the winter season, when the demand is in peak because of important winter festivals like Christmas, New Year Day and Valentine’s Day.
- Labour cost is very low in India, nearly 10-15 times cheaper than that of similar employees in the Netherlands, Israel and Japan.
- The Government of India has identified floriculture as ‘Extreme Focus Thrust Area’ for export during IX plan.
- With the implementation of GATT agreement European nations has brought down the import duty on floricultural products, which at present is 15 %.
- The International market is growing @ 8-10 % annually. The International demand is around Rs. 90,000 crore/ year and domestic market at 20-25 %. Hence, the scope to enter floriculture industry in India is unlimited.
- The Govt. of India has setup the infrastructure for floriculture industry in major cities like New Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Pune etc.
- APEDA is giving financial assistance to some extent for various activities connected with export of floriculture products.
- Easy bank financing for hi-tech floriculture.
- 100 per cent export oriented units (EOU’s) are located in and around Hyderabad (Andra Pradesh), Bengaluru, Hosur, Doddaballapur, Devanahalli (Karnataka) in south and Gurgaun (Haryana) in north, Lonavala and Pune (Maharashtra) in West.
- For 100 % EOU’s the government has allowed to sale 50 per cent of produce in domestic markets.
- 100 per cent tax exemption has given on implements / raw materials used in greenhouses.
- The rules and regulations related to import and exports have been minimized.

- Singapore is the nearest International standard flower auction centre, helpful for Indian exports.
- Floriculture products possess 25-30 times more foreign exchange earning ability than cereals or any other agricultural/horticultural products.
- Floriculture is capable of attracting and retaining a large number of progressive farmers / entrepreneurs.
- Due to ample sunlight and optimum temperature during winter, it does not require artificial lighting or heating for greenhouse production of cutflowers.
- The Government of India has identified product specific zones for selective research and development (Table-1) of floriculture.
- APEDA and GOK have established four flower auction centers including one in Bengaluru, Noida (UP), Mumbai and New Delhi.
- APEDA also has setup a marketing center at Aalsmeer (The Netherlands) to promote Indian produce.

Table-1: Products specific intensive floriculture zones in India:

Sl.No.	Zone	Flower crops
1	Area around Delhi, UP and Punjab	Rose, Carnation, Chrysanthemum, Gladiolus
2	Area around Bengaluru	Rose, Carnation, Chrysanthemum, Ornamental Foliage Plants and Seeds
3	Area around Trivendrum	Orchids, Anthurium and Foliage Plants
4	Area around Pune / Nashik	Rose, Carnation, Gladiolus, Dahlia, Chrysanthemum, Aster and Tuberose
5	North Eastern region including Sikkim	Orchids, Gladiolus, Liliiums, Gerbera, Salvia, Anthurium and other Foliage Plants
6	Area around Kolkata	Lotus, Tuberose, Jasmine, Chrysanthemum and Dahlia.
7	Area around Srinagar	Gladiolus, Lilies Carnation and Rose
8	Area around Solan, H.P.	Gladiolus, Other Bulbous Plants and Seeds
9	Area around Coimbatore including Nilgiris	Jasmine, Tuberose, Chrysanthemum, Rose, Carnation and Orchids

1.4. PROBLEMS /CONSTRAINTS /BOTTLE NECKS FOR FLORICULTURE INDUSTRY IN INDIA

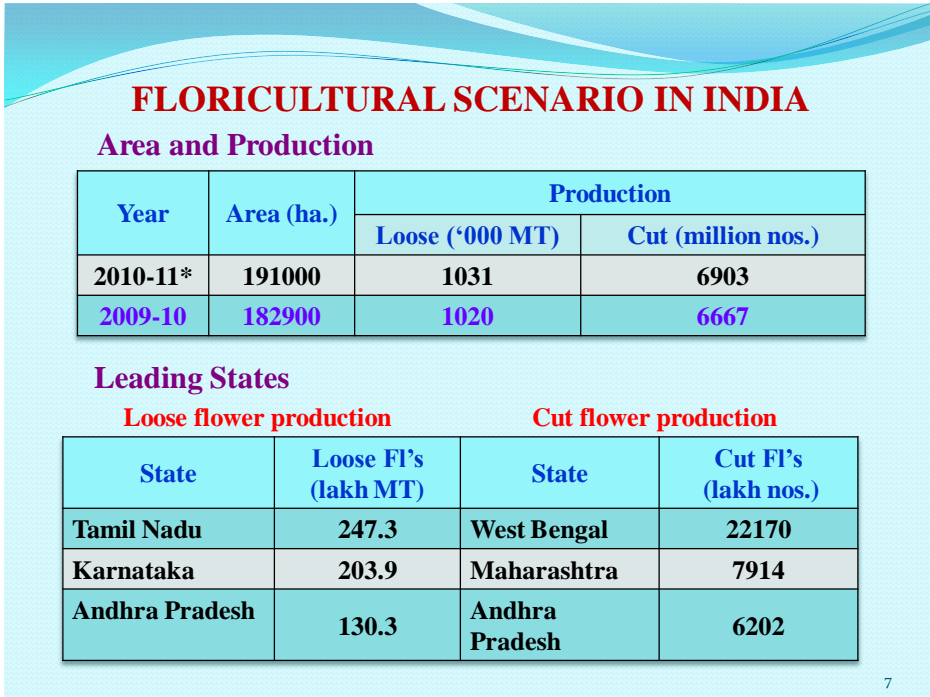
- Lack of specific information on area and production of different flowers which, is a handicap in planning production for domestic and export market.
- Lack of information on new / ruling varieties which, continuously keep changing in the International markets.

- Lack of information on advanced cultivation practices like high density planting, fertilizer and irrigation management, plant protection, packing and grading, etc.,
- Lack of infrastructure facilities like green house/glass house and poly house as well as cold chain.
- There is no direct cargo flight from Bengaluru and Pune which are main production centers, leads to double shipment which increases the cost besides more scope for spoilage.
- The freight rates in India are high which makes produce uncompetitive in the International markets.
- There are no organized marketing co-operatives of other bodies which can take care of floriculture trade in India.
- Lack of research and development in floriculture. Especially on new varieties, post-harvest techniques, advanced cultivation method, etc.
- No detailed economic feasibility studies with reference to establishment, maintenance and cost of production in glass house conditions / protected cultivation.
- Pot plants are produced in soil based container medium which is not allowed in most middle-East and European markets.
- Lack of streamlined quality control mechanism and poor co-ordination between government and private agencies involved in import and export of floriculture products.
- Exemption from import duty by importing countries is needed as some countries like Columbia Mauritius etc. are exempted from such tariffs.
- Phytosanitary certificates are given only in selected cities like Delhi, Kolkata, Mumbai and Chennai.
- Lack of appropriate planting materials and production technologies for export.
- Lack of knowledge about importing and exporting countries.
- Lack of quality consciousness of the produce. This affects the floriculture industry as a whole.
- Lack of sale promotion activities in India.
- Lack of market intelligence regarding leading varieties, selling price, etc.

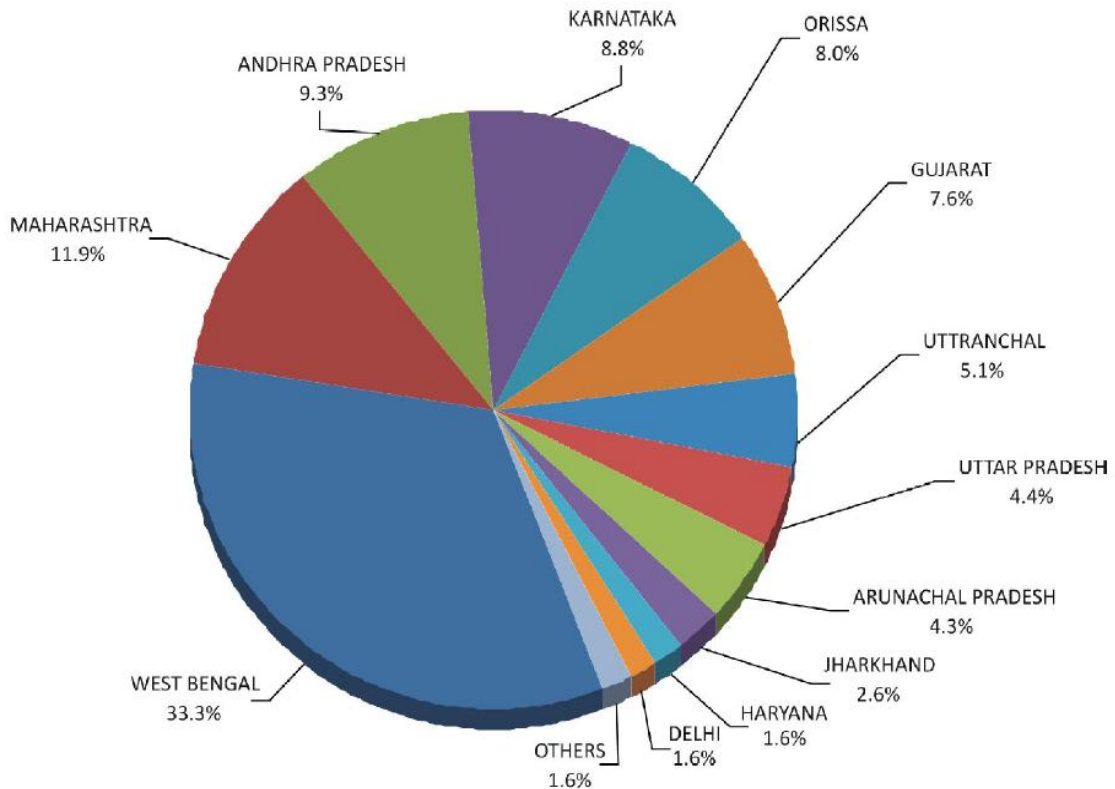
1.5. AREA AND PRODUCTION OF FLOWERS IN THE STATE AND THE COUNTRY

- ◆ India ranks 2nd next to China with an area of 182.9 thousand hectare and produces 1020.6 thousand metric tons of loose flowers and 66,671 lakh cutflowers annually (2009-10).

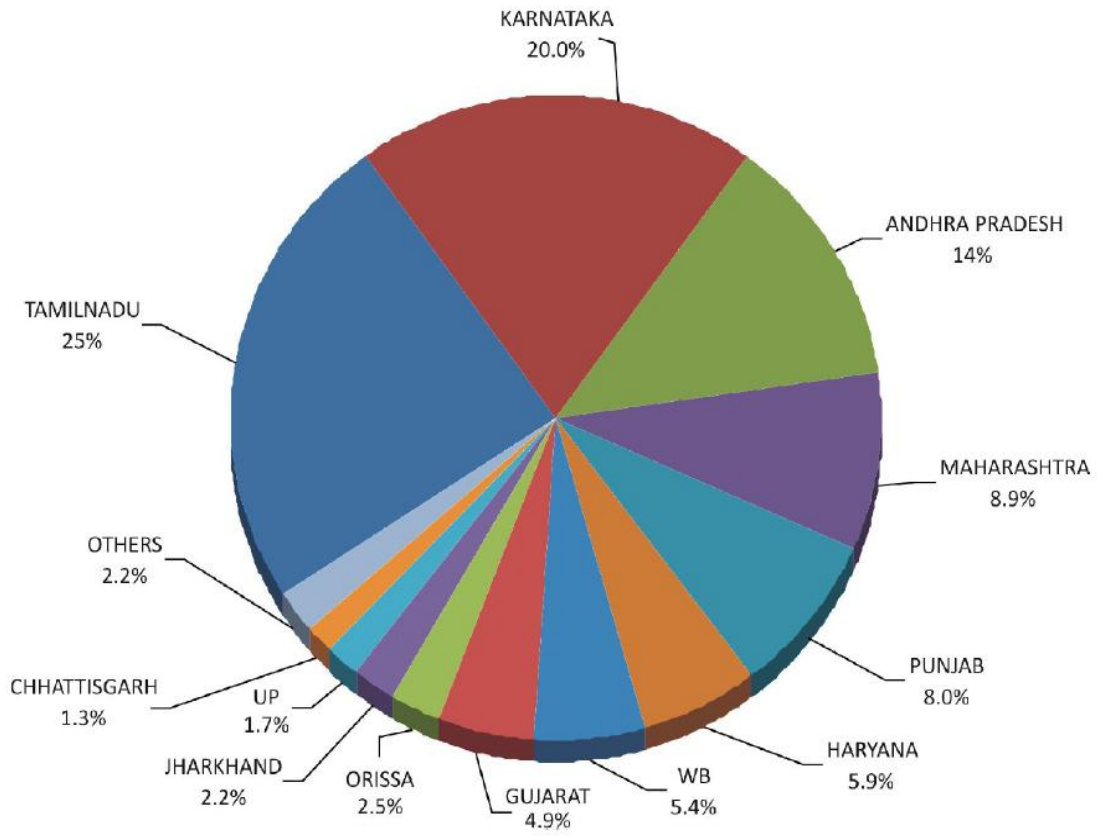
- ◆ Tamil Nadu is a leader in flower production; it occupies 31,970 ha followed by Karnataka (25, 100 ha), West Bengal (21,940) ha and Andhra Pradesh (21,400 ha) (Table-).



MAJOR CUT FLOWER PRODUCING STATES (2009-10)



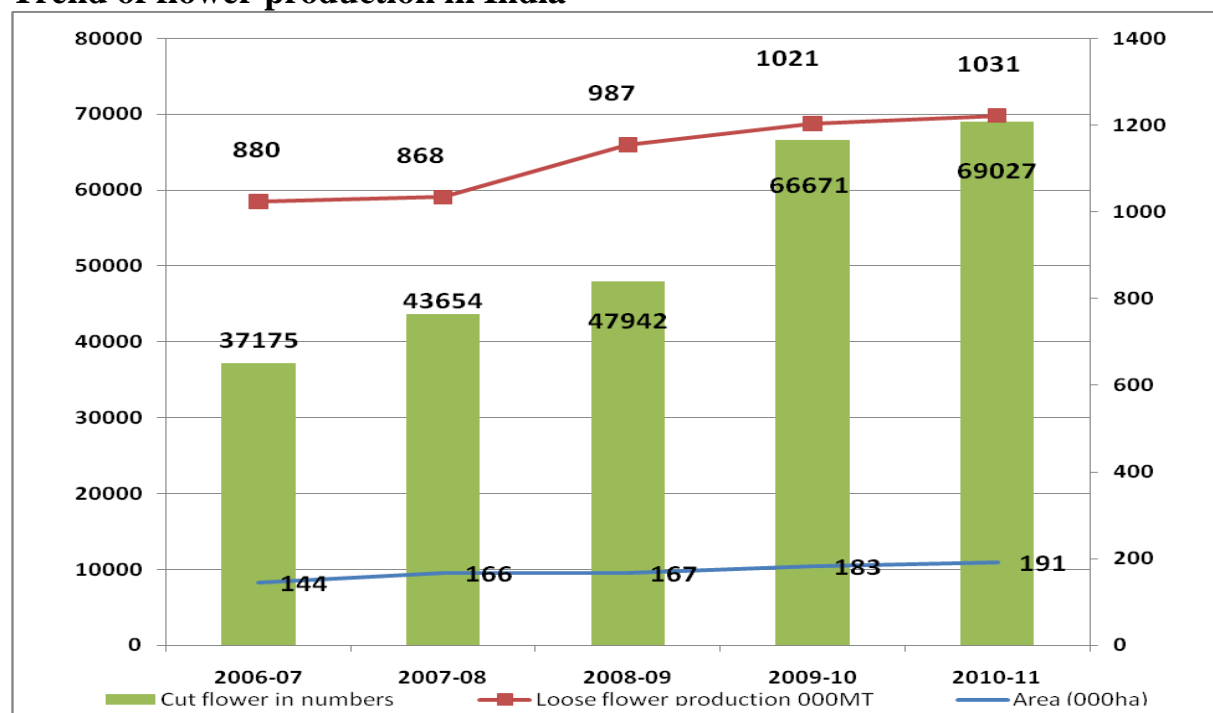
MAJOR LOOSE FLOWER PRODUCING STATES (2009-10)



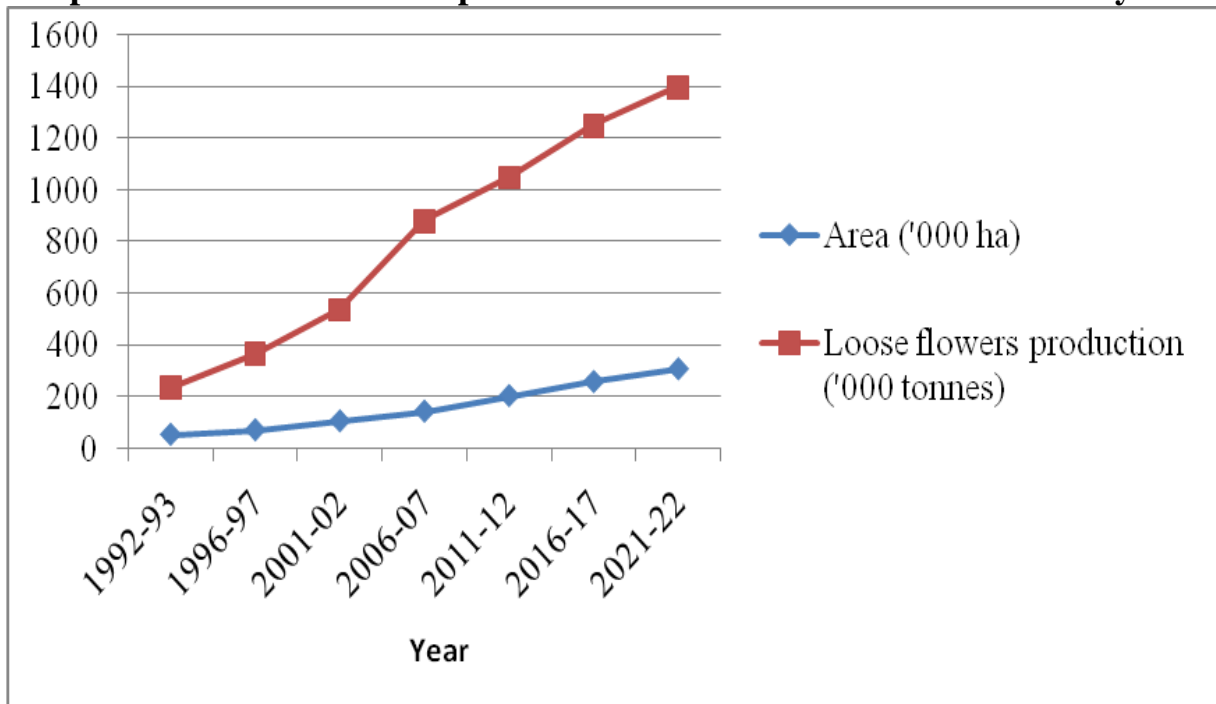
STATE-WISE AREA AND PRODUCTION OF FLOWERS
Area in 000' HA, Production Loose in 000' MT (Loose) and Lakh (Cut)

STATE/UTs	AREA (In 000 ha)		PRODUCTION (Loose In 000 MT and Cut In Lakh Nos)						
	2007-08	2008-09	2009-10	2007-08		2008-09		2009-10	
				LOOSE	CUT	LOOSE	CUT	LOOSE	CUT
TAMILNADU	26.7	29.1	31.97	214.4		233.7		247.3	
KARNATAKA	25.1	26.0	27.01	160.0	5700	203.9	5637	203.9	5630
ANDHRA PRADESH	23.5	19.5	21.40	106.3	3	123.0	3	130.3	6202
MAHARASHTRA	16.7	16.4	17.51	69.5	5726	69.4	5726	91.1	7914
PUNJAB	1.0	1.7	1.70	77.9		82.0		82.0	
HARYANA	6.1	5.5	6.20	61.3	1065	53.9	929	60.3	1034
WEST BENGAL	27.4	21.1	21.34	48.4	10630	52.01	21232	55.2	22170
GUJARAT	9.7	9.7	12.33	49.5	5033	49.5	5033	49.5	5033
ORISSA	2.4	5.7	7.11	7.0		25.4		25.3	5556
JHARKHAND	0.1	1.6	1.60	0.2	73	22.0	1711	22.0	1711
UTTAR PRADESH	10.3	13.5	10.33	17.5	2323	24.3	3457	17.8	2353
CHHATTISGARH	2.4	2.4	4.09	6.9		6.9		13.5	
DELHI	5.5	5.5	5.50	5.7	1033	5.7	1033	5.7	1033
MADHYA PRADESH	2.6	3.0	6.39	1.5		1.6		5.0	
RAJASTHAN	4.3	3.4	3.23	6.2		4.9		4.9	
PONDICHERY	0.3	0.233	0.29	2.7		2.37		2.4	
BIHAR	0.2	0.2	0.20	2.3	11	2.3	11	2.3	11
UTTARANCHAL	0.9	0.9	1.29	0.7	1456	0.6	2058	1.0	3474
HIMACHAL PRADESH	0.6	0.6	0.63	3.4	566	3.4	566	0.6	605
ANDAMAN & NICOBAR	0.03	0.033	0.03	4.7		0.34		0.3	
JAMMU & KASHMIR	0.3	0.1	0.13	1.3	216	0.011	20	0.2	66
MIZORAM	0.03	0.215	0.04		76		163		142
NAGALAND	0.02	0.019	0.02		17		17		17
SIKKIM	0.1	0.151	0.13		45		63		200
ARUNACHAL PRADESH	NA	NA	1.22	NA	NA	NA	NA		2360
TOTAL	166.3	166.5	182.3	663.4	43654	667.4	47942	1020.6	66671

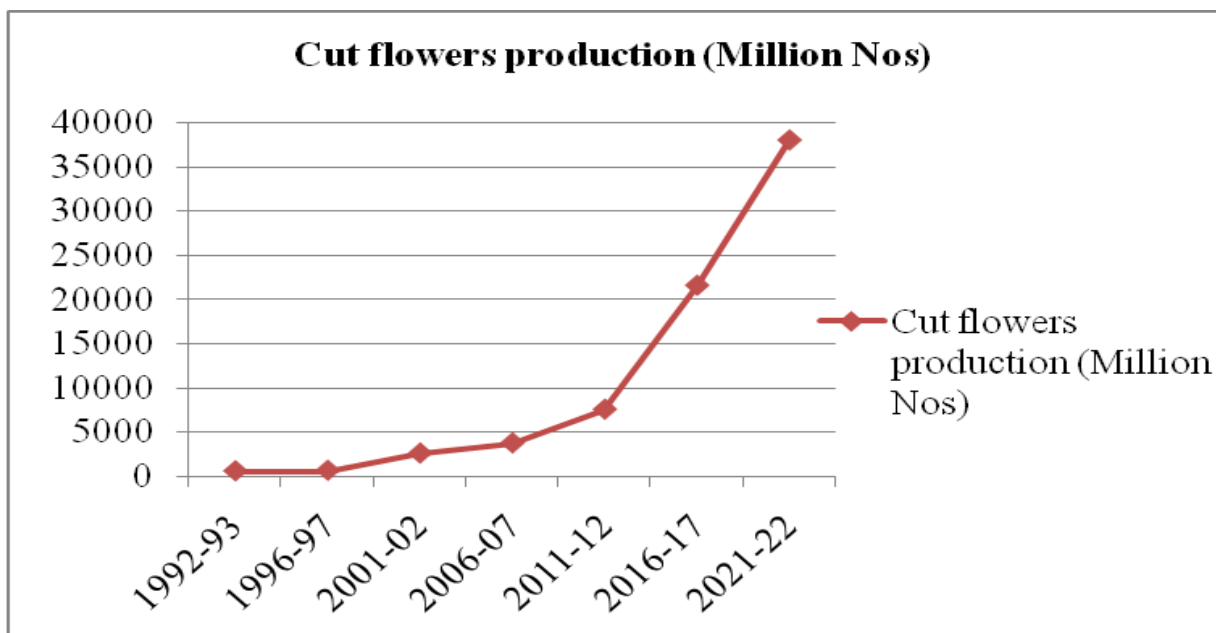
Trend of flower production in India



Expected trend in area and production of loose flowers in the next ten years



Expected growth in cut flower production in the next ten years



KNOWLEDGE ASSESSMENT:

Fill up the Blanks

1. The floriculture business is growing in the world at around ----- % per annum.
2. ----- is the leader in floriculture accounting for 75% of India's total flower production.
3. The country's first and the only Digital Flower Auction Centre is located in -----.
4. ----- is the new dimension of horticultural science to heal the psychic debility.
5. ----- is the nearest International standard flower auction centre, helpful for Indian exports.

(Key answers: 1) 6-10 , 2)Tamil Nadu, 3)Bengaluru, 4)Horticultural therapy , 5) Singapore)

Match the Following

- | | |
|------------------------|---------------------|
| 1. Modern floriculture | Flower arrangements |
| 2. Cut flower | Rose, gladiolus |
| 3. KAIC | Mumbai |
| 4. Markets | Self employment |
| 5. Floriculture | Bangalore |

(Key answers: 1- Rose, gladiolus, 2- flower arrangements, 3- Bengaluru, 4- Mumbai, 5- self employment)

Expand:

- 1) GATT _____
- 2) APEDA _____
- 3) EOU's _____
- 4) KAIC _____
- 5) GOK _____

GATT - General Agreement on Tariffs and Trade, APEDA- Agricultural and Processed Food Products Export Development Authority, EOU's-Export Oriented Units, KAIC- Karnataka Agro Industrial Corporation, GOK –Government of Karnataka.

FLOWERS FOR EXPRESSION OF OUR FEELINGS

- Flower meanings and symbolization are the key elements for flower choice since time immemorial as they express the most sensitive, delicate and ever loving feelings eloquently what our words fail to express.
- Besides the above, flower also adds meaning to the actual life and reinforces faith in nature by filling the whole atmosphere with its delicate fragrance.
- So it may help the flower lovers to make the right decision in offering the right flowers to their belongings.

The following is the list of flower types and the meanings/ sentiment/ feelings.

Flowers	Flower meanings/ Symbolization /Feelings
1. Aster	Symbol of Love, Daintiness
2. Azalea	Take Care of Yourself for Me, Temperance, Fragile Passion, Chinese Symbol of Womanhood
3. Carnation (General)	Fascination, Woman Love
4. Carnation (Pink)	I'll Never Forget You
5. Carnation (Red)	My Heart Aches For You, Admiration
6. Carnation (Purple)	Capriciousness, Whimsical
7. Carnation (Striped)	No, Refusal, Sorry I Can't Be With You, Wish I Could Be With You
8. Carnation (White)	Sweet and Lovely, Innocence, Pure Love, Woman's Good Luck Gift
9. Carnation (Yellow)	You Have Disappointed Me, Rejection
10. Chrysanthemum	You're a Wonderful Friend, Cheerfulness and Rest.
11. Chrysanthemum (White)	Truth
12. Chrysanthemum (Yellow)	Slighted Love
13. Daffodil	Respect, Regard, Unrequited Love, You're the Only One, The Sun is Always Shining when I'm with You
14. Daisy	Innocence, Loyal Love, I'll Never Tell, Purity
15. Fern	Magic, Fascination, Confidence and Shelter
16. Gladiolus	Give Me a Break, I'm Really Sincere, Flower of the Gladiators
17. Hydrangea	Thank You for Understanding, Frigidity, Heartlessness
18. Ivy	Wedded Love, Fidelity, Friendship, Affection
19. Lily (White)	Virginity, Purity, Majesty, It's Heavenly to be with You
20. Lily (Yellow)	I'm Walking on Air, False and Gay
21. Lily (Calla)	Beauty
22. Lily (Day)	Coquetry, Chinese Emblem for Mother
23. Lily (Eucharis)	Maiden Charms
24. Lily (Tiger)	Wealth, Pride
25. Marigold	Cruelty, Grief, Jealousy
26. Orchid	Love, Beauty, Refinement, Beautiful Lady, Chinese Symbol for Many Children, Thoughtful, Maturity, Charm
27. Primrose	I Can't Live Without You

28. Rose (Bridal)	Happy Love
29. Rose (Dark Crimson)	Mourning
30. Rose (Hibiscus)	Delicate Beauty
31. Rose (Leaf)	You May Hope
32. Rose (Pink)	Perfect Happiness, Please Believe Me
33. Rose (Red)	Love, I Love You
34. Rose (Tea)	I'll Remember Always
35. Rose (Thorn less)	Love at First Sight
36. Rose (White)	Innocence and Purity, I am Worthy of You, You're
37. Rose (White And Red)	Heavenly, Secrecy and Silence
38. Rose (White-Dried)	Unity, Flower Emblem of England
39. Rose (Yellow)	Death is Preferable to Loss of Virtue
40. Rosebud	Decrease of Love, Jealousy, Try to Care, Friendship
41. Rosebud (Red)	Beauty and Youth, A Heart Innocent of Love
42. Rosebud (White)	Pure and Lovely
43. Rosebud (Moss)	Girlhood
44. Roses (Bouquet of Mature Blooms)	Confessions of Love Gratitude
45. Roses (Single Full Bloom)	I Love You, I Still Love You
46. Sweet pea	Good-bye, Departure, Blissful Pleasure, Thank You for a Lovely Time
47. Tulip (General)	Perfect Lover, Frame, Flower Emblem of Holland
48. Tulip (Red)	Believe Me, Declaration of Love
49. Tulip (Variegated)	Beautiful Eyes
50. Tulip (Yellow)	There's Sunshine in Your Smile
51. Wisteria	Welcome
52. Zinnia (Magenta)	Lasting Affection

Traditional colour choice

These traditional colour choices mainly apply to roses but may also be applied to other flower types.

- **Red** roses mean romantic love.
- **Purple** roses signify that the giver has fallen in love with the recipient at first sight.
- **Orange** roses signal desire.
- **Yellow** roses are joy and friendship.
- **Pink** roses express our gratitude and appreciation.
- **Light pink** roses show feelings of admiration and sympathy.
- **Peach** is more indefinite, as it can signify either sympathy or gratitude.
- **White** roses show meaning of reverence and humility.

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LECTURE-2 : INTRODUCTION (Contd....)

Topics

- 2.1 Hi-Tech Floriculture
- 2.2 Export Market
- 2.3 World Floriculture Trade
- 2.4 Cut Flowers Export Potential
- 2.5. Top Ten Major Importers
- 2.6. Top Ten Cutflowers and Pot Plants in the World Trade
- 2.7 India's Export Efforts
- 2.8. Major Import Markets for Floriculture Product
- 2.9. Per Capita Consumption of Flowers and Plants
- 2.10 Global Trade in Floricultural Products
- 2.11 Role of Indian Government and other Agencies for Export
- 2.12 Institutional Assistance to Floriculture

2.1. HI-TECH FLORICULTURE

- The liberalized seed policy in late 80's globalization of Indian economy and economic reforms initiated in early 90's paved the way for the advent of state of the art of protected cultivation technology in India.
- Indian horticulture which was hitherto an individual driven become corporate driven, which could sense the potential and scope the modern protected cultivation technology can offer for furthering the floriculture industry.
- As on today, Karnataka alone has more than 100 floriculture units surpassing all other states (185 hi-tech units).

2.2. EXPORT MARKET:

- ◆ Traditional flowers like jasmine and tuberose are being exported as fresh flowers to Malaysia, Singapore, Sri Lanka and Gulf countries from India.
- ◆ The international market price for Jasmine concrete and absolute oil is around ₹ 30,000/- and ₹ 60,000/- per kg, respectively. The exported flowers fetch ₹ 30 crores to ₹ 40 crores foreign exchange annually.
- ◆ Extracting essential oils from flowers is another major industry in India.

- ◆ Damask rose is widely cultivated particularly in Azmir, Udaipur areas in Rajasthan, Palampur and Kullu districts in Himachal Pradesh, Aligarh, Kannauj and Lucknow in Uttar Pradesh.
- ◆ The rose petals are also used to prepare rose water and gulkand. These products are being exported to UK, France, Germany and Middle East countries.
- ◆ Tuberose flowers are used for extraction of oils and it is considered as the high value concrete in the world market.
- ◆ Tissue cultured plants of jasmine; scented rose etc. can also be propagated and supplied to Taiwan, Korea and Japan.
- ◆ All these floricultural products can be sold in the International market at Singapore.
- ◆ The varied agro climatic conditions prevailing in the country with ample sunshine can maintain regular supply of any floricultural commodity throughout the year.
- ◆ India's geographical location particularly its proximity to the developing Far East, offers tremendous competitive advantage.
- ◆ Keeping in view of pollution problems and other aesthetic values of the flowers, we must try to sustain our floriculture industry.
- ◆ Due to rapid urbanization and multistoried flats system the local demand of flowers would definitely be increased.

2.3. WORLD FLORICULTURE TRADE:

The Global trade in floriculture products is recorded in terms of live plants and bulbs, cut flowers and cut foliage. World imports cut flowers and foliage together accounts for a share of 51 to 55 % whereas, live plants and bulbs accounts for 45 to 49 %.

Floriculture industry has been the monopoly of a few countries (mainly Netherlands),

- Netherlands is the largest trader of floricultural products, with a lion's share of 70% followed by
- Columbia 12% and
- Israel with 6% share of the global floriculture trade.

2.4. CUT FLOWERS EXPORT POTENTIAL:

- The cut flowers generally grown under greenhouse/polyhouses are being exported to The Netherlands, Japan and Germany.
- Of the total export, 60% is being exported to the Netherlands.
- In India, the export-oriented projects are sending the flowers through cool chain.

- The international buyers are re-exporting the goods which they import from various developing countries.
- The Netherlands is the biggest exporter (59%), followed by Columbia (10%), and Italy (6%).
- Spain, Kenya and Israel have also started exporting the flowers, accounting 2, 1 and 4%, respectively.
- The other countries including developing ones have only 20% of the total export, India's share in the total world export being less than 1%.
- The new markets for Indian flowers may be Japan, Northern America, South East Asia and the Gulf countries.
- India's geographical location particularly its proximity to a developing Far East offers a tremendous competitive advantage.
- Now the floriculture has become one of the extreme focus segments for development of export by the Government of India.
- The growth of floriculture industry from 1962 to 1990 was very slow but there has been a significant rise in floricultural export from Rs.14.55 crores in 1991-92 to Rs.30.60 crores in 1994-95, and Rs.57.80 crores in 1995-96.
- Developing countries have only 6% share in the world market. This help in increasing the export from India which is otherwise negligible.

2.5. TOP TEN MAJOR EXPORTER, IMPORTERS AND PRODUCERS:

S. No.	Exporters	Importers	Producers
1.	Netherlands	United Kingdom	The Netherlands
2.	Colombia	Germany	Japan
3.	Ecuador	US	Italy
4.	Kenya	The Netherlands	Colombia
5.	Italy	France	China
6.	USA	Japan	France
7.	Belgium	Italy	Germany
8.	Denmark	Switzerland	South Korea
9.	Costa Rica	Belgium	USA
10.	Israel	Russian Federation	Ecuador

2.8. MAJOR IMPORT MARKETS FOR FLORICULTURE PRODUCT:

Europe is the largest market for floricultural products. Among the major importing countries U. K, Germany, USA, Netherlands, France, Japan Italy and together accounts for nearly 64 % of the world imports. Germany is the single largest market accounting for nearly 25 % of the world imports.

2.6. TOP TEN CUT FLOWERS AND POT PLANTS IN THE WORLD TRADE

SI No.	Cut flowers	SI No.	Pot plants
1.	Rose	1.	Ivy
2.	Tulip	2.	Kalanchoe
3.	Chrysanthemum	3.	Ficus
4.	Gerbera	4.	African Violet
5.	Lily	5.	Chrysanthemum
6.	Alstoemeria	6.	Spathiphyllum
7.	Freesia	7.	Hyacinth
8.	Carnation	8.	Dracaena
9.	Iris	9.	Potted Rose
10.	Gypsophila	10.	Primrose

2.7. INDIA'S EXPORT EFFORTS:

- India has long recognized production and export potential of flowers and other floriculture product.
- The new seed policy of 1988 and liberation of Indian economy have encouraged many investors to take to floriculture business mainly for export.
- India's exports of floricultural products are growing steadily as more and more investors are evincing interest in the field supported by various measures and schemes launched by Govt. of India through institutions such as
 - National Horticultural Board (NHB) and
 - *Agricultural and Processed Food Product Export Development Authority (APEDA) etc.*
- The economic, investment and EXIM policies are providing the Philip to the growth of production and export of floricultural products.
- India's exports of floricultural product have increased from Rs. 5.57 crores in 1989-90 to Rs. 100 crores in 1998-99

INDIAN SCENARIO

In India, floriculture industry comprises *i.e.*, Income generating activities in Floriculture are,

- Cut Flowers
- Loose Flowers
- Cut Greens
- Foliage and Flowering Pot Plants
- Dry Flowers
- Production of bulbs and tubers
- Hybrid seed production
- Nursery production
- Perfumery
- Plant rental services
- Garlands and venis
- Flower arrangements and floral craft
- Wild ornamental plants
- Landscape Designing
- Flower baskets, pots and containers etc.
- Production of nursery plants and potted plants,
- Seed and bulb production,
- Micro propagation and
- Extraction of essential oils.

2.9. PER CAPITA CONSUMPTION OF FLOWERS AND PLANTS:

- The consumption of floriculture products is linked to the GDP of the countries. Developed countries with high per capita income obviously are the major consuming markets.
- With rising income, consumption of floricultural products is on the increase both in developed and developing countries. It is estimated that, the Global demand for floricultural products is growing @ 8-10 %. In India the demand for cut flowers and pot plants is growing @ 20-25 %.

2.10. CATEGORIES OF FLORICULTURAL PRODUCTS IN GLOBAL TRADE:

1. Live plants and buds,
2. Cutflowers
3. Cut foliages
4. Dry flowers
5. Seeds of different seasonals,
6. Pigments (Xanthophylls) and
7. Essential oils etc

2.11. ROLE OF INDIAN GOVERNMENT AND OTHER AGENCIES FOR EXPORT:

- ◆ In recent times, the Indian government has done a lot for promotion of exports of floriculture products. The Government has identified floriculture industry as thrust focus area for export.
- ◆ The import duty on seeds, bulbs, cuttings etc. has reduced to zero and that to on goods for green house items, seed development machinery has been brought down to 25%.
- ◆ Income tax and other tax concessions have been granted to new floriculture exporting companies.
- ◆ Subsidy of freight charges equal to 25 % of IATA approved rates i.e., Rs. 10 per kg Europe and United States and Rs.6 per kg for South East Asia and Middle East.
- ◆ The eighth five year plan also contains a provision of Rs. 320 million to boost horticulture and floriculture.
- ◆ Reduction in the tariff from 55 to 10 % on import of live plants and other plant bulbs, root, cut flowers and other ornamental foliage.
- ◆ The import of flower seeds and tissue culture material of any plant origin is now allowed without an import permit.
- ◆ The Agricultural and Processed Food Product Export Development Authority (APEDA) and National Horticulture Board (NHB) have also helped for export promotion.

2.12. INSTITUTIONAL ASSISTANCE TO FLORICULTURE HI-TECH PROJECTS:

2.12.1 NABARD Soft Loan Assistance:

1. National Bank for Agriculture and Rural Development (NABARD) has evolved a scheme for extending soft loan assistance to prospective entrepreneurs.
2. The entrepreneurs could be individual, proprietary / partnership firm, group of individuals, co-operative societies etc.
3. The assistance will be restricted to the shortfall in promoters contribution stipulated under relevant schemes.

2.12.2 NATIONAL HORTICULTURE BOARD (NHB):

1. NHB has evolved a scheme for development of post harvest infrastructure during the eighth five year plan period.

2. Registered farmer's organization, Co-operative societies and corporate sector are eligible for financial assistances.
3. Promoters have to contribute 20% of the project cost. 40% will be provided by NHB as soft loan @ 5% p.a. Remaining cost of the project will be financed by commercial banks.

2.12.3 APEDA SCHEMES TO ASSIST EXPORT ORIENTED FLORICULTURE

1. For development of Infrastructure and services @ 25% of cost of the project and Rs. 1.5 lakhs for purchase of refer van.
2. For development of post-harvest infrastructure @ 50% of cost/ Rs. 5.0 lakhs for pre cooling and cold storage units.
3. Scheme for packing development – 30% of cost; maximum Rs. 1.0 lakh.
4. Scheme for export promotion and market development; maximum Rs. 0.5 lakh.
5. Scheme for survey, feasibility, consultancy and data base, - 40% of cost and maximum Rs. 20.0 lakhs.
6. Scheme for air freight subsidy – 25 % of IATA rates; maximum Rs. 10/- per kg for Europe and USA and USA and Rs, 6/kg for West Asia and South-East Asia.
7. It has already setup cold storage and cargo handling facilities which are operational at Indira Gandhi International Airport, New Delhi, Bengaluru, Chennai and Thiruvananthapuram.

2.12.4 Nationalized banks *viz.*, SBI, Canara

2.12.5 Agri-Commercialization and Enterprise funded by the United States Agency for International Development (ACE-UASIG)

2.12.6 State finance Corporations.

QUIZ:

I. Choose the correct answers:

1) Traditional flowers exported as fresh flowers to Malaysia, Singapore, Sri Lanka and Gulf countries from India.

- A) Jasmine B) Tuberose C) Rose D) Both A & B

2) The high value concrete in the world market is for

- A) Rose B) Jasmine C) Tuberose D) None

3) The largest trader of floricultural products in the world is

- A) Columbia B) Israel C) Netherlands D) India

4) Top ten cut flower in the world trade

- A) Gerbera B) Carnation C) Jasmine D)Both A & B

5) Major importer of cut flowers in the world

- A) Netherlands B) USA C) Germany D) UK

6) Major exporter of cut flowers in the world

- A) Netherlands B) USA C) Germany D) Columbia

7) The rose petals are also used for preparing

- A) Rose Water B) Gulkand C) Attar D) All these

8) Top ten Pot plants in the world trade

- A) Dracaena B) Chrysanthemum C) Azalea D) All these

Key answers: 1) a, 2) c, 3) c, 4) d, 5) a, 6) c, 7) d, 8) d

II. Expand:

NHB _____

NABARD _____

NHB - National Horticulture Board

NABARD - National Bank for Agriculture and Rural Development



Topics

- 3.1. Classification of Floricultural Products
- 3.2. Classification of Flowers
- 3.3. Industrial Importance of Commercial Flowers in Indian & abroad
- 3.4. Commercial Flower Industries in India Have Collaboration with Dutch

3.1. CLASSIFICATION OF FLORICULTURAL PRODUCTS FOR TRADE

Floricultural products are classified as per the International Classification (ITC) are as follows.

- 1. Bulbs, Tubers and Tuberous roots
- 2. Live plants: Includes trees, shrubs, bushes, rooted cuttings and slips.
- 3. Cut flowers and flower buds: fresh or dried, dyed, bleached etc.,
- 4. Cut foliage, branches and other parts (other than flowers or buds) of trees, shrubs, bushes and other plants i.e. twigs, grasses, shoots etc.
- 5. Masses, lichens & grasses, fresh or dried, bleached:
- 6. Dry flowers
- 7. Pigments (Natural colours)
- 8. Essential oils
- 9. Prepared/processed food products like gulkand, gulroghan, pankhuri etc
- 10. Seed production of different seasonals

3.2. CLASSIFICATION OF FLOWERS:**1) Based on Season of growing**

- a) **Summer season annuals** : Zinnia, Kochia, Portulaca, Tithonia, Gaillardia, Gomphrena, Sunflower, Daisy, etc.
- b) **Rainy season annuals** : Balsam, Cock's comb, Celosia, Gaillardia, etc.
- c) **Winter season annuals** : Antirrhinum, China aster, Cornflowers, Larkspur, Sweet Sultan,

Phlox, Verbena, Candy tuft, Petunia, etc

2) Based on flower colours:

- a) **White flowering:** Antirrhinum, Alyssum, Dianthus, China aster, Zinnia, Chrysanthemum, Gladiolus, Gerbera, etc.
- b) **Purple, Lavender or Blue:** Daisy, Rose, Carnation, Dahlia, Ageratum, China aster, Clitoria, Delphinium, Petunia, Viola, Verbena, Tithonia, Torenia, Daisy, etc.
- c) **Yellow or orange:** Antirrhinum, Marigold, Calendula, Zinnia, Gaillardia, Rose, Gladiolus, Carnation, etc.
- d) **Red pink:** Antirrhinum, Rose, Gladiolus, Carnation, Gerbera, Dahlia, etc.

3) Based on purpose of Growing

- a) **Rockery:** Ageratum, Alyssum, Brachycome, Phlox, Portulaca, Linum, Nemesis, Saponaria, Godetia, Euphorbia, etc.
- b) **Hanging basket:** Dwarf Ageratum, Petunia, Portulaca, Verbena, Torenia, Begonia.
- c) **Edging of beds or path:** Dwarf Ageratum, Alyssum, Brachycome, Dianthus, Nigella, Portulaca, Mesembryanthemum, Pansy etc.
- d) **Fragrant flowers:** Sweet Alyssum, Sweet Sultan, Sweet pea, Stock, Phlox, Carnation, Rose, Jasmine, Tuberose, etc.
- e) **Bedding purpose:** Dahlia, Marigold, Phlox, Verbena, Carnation, Petunia, Ice Plant, Candy Tuft, Balsam, Portulaca, etc.
- f) **Aromatic:** Rose, Jasmine, Tuberose etc.,
- g) **For pots:** Carnation, Chrysanthemum, Dahlia, Rose, Antirrhinum, Petunia, Agloenema, Alocasia, Anthurium, Orchids, Aralia, Begonia, Chlorophytum, Dracaena, etc.
- h) **For loose flowers:** Marigold, Jasmine, Crossandra, Barlaria, Chrysanthemums, China Asters, Sunflowers, Zinnia, Gaillardia, Rose, Dahlia, etc.
- i) **For Dry flowers:** Statice, Helichrysum, Acroclinum, Gomphrena, Limonium, Marigold, Rose, Lady's Lace, Nigella, etc.
- j) **For Hedge purpose:** Lawsonia, Duranta, Tecoma, Bougainvillea, Thevetia, Hibiscus, Murraya, Dodonea, Acalypha, Aralia, Ipatorium, *Clerodendron* spp, etc.
- k) **Cut flowers/modern flowers:** Rose, Chrysanthemum, Carnation, Gerbera, Anthurium, Orchids, Gladiolus, Tuberose, etc.

4) Based on Nature of Growth:

- a) **Annuals:** Nasturtium, Ice plant, Holly hock, Sweet pea, Annual Chrysanthemum, Carnation, Cornflower, Sweet Alyssum, Dahlia, Marigold, Verbena, Phlox, Pinks, Calendula, etc.
- b) **Perennials:** Rose, Jasmine, Crossandra, Anthurium, Orchids, Chrysanthemum, Berlaria, Hibiscus, Gerbera, Carnation, Bulbous Crops.

5) Based on Mode of propagation:

- 1) **Bulbous plants:** Lily, Narcissus, Tulip, Tuberose
- 2) **Cormellous plants:** Gladiolus, Crocus
- 3) **Rhizomatous plants:** Canna, Iris
- 4) **Tuberiferous plants:** Dahlia

6) Based on their end use/purpose

1. **Traditional flowers:** They are offered in religious and social ceremonies, used as an adornment by women, and offered for worships at home as well as in temples.
Eg. Jasmine, Rose, Mums, Marigold, Crossandra, Tuberose, Barlaria, Gaillardia, etc.
2. **Non-traditional flowers:** They are referred to as cut flowers or modern flowers. Generally flowers are harvested along with a long stem/ stalk.
Eg. Hi-tech roses (Dutch roses), Gerbera, Carnation, Chrysanthemum, Gladiolus,
Orchids, Anthuriums, Goldenrod, Bird of Paradise, Limonium, Liatris, Stock, etc
3. **Industrial Flowers/Value Added flowers:** They are used as raw material in industries for extraction of essential oil and also preparation of some edible products like gulkand, gulroghan, pigments as natural colours and also dry flowers.
Eg. Tuberose, Jasmine, Rose, Marigold etc.,

3.3. INDUSTRIAL IMPORTANCE OF COMMERCIAL FLOWERS IN INDIAN & ABROAD:

Flowers are traded round the year all-over the country and bulk of them are used in making garlands, bouquets, venis, gajras and other adornments.

1. Perfumery Industry:

The extracts from fragrant flowers such as rose, lavender, champak, Jasmine, tuberose, marigold, etc

2. Dry flower industry:

Some of the flowers are used for drying purpose and are traded as dry flowers in the flower trade.

Example: *Helichrysum*, *Acroclinum*, *Gomphrena*, Marigold, Rose, Limonium/ Statice, Gerbera, Zinnia, China Aster, some foliage plants also.

3. Pigment extraction:

Some of the flowers are grown for extraction of their natural colours and used in various preparations *viz*, foods, poultry feeds, textile, pharmaceuticals, etc.

Example: Marigold, Calendula, Hibiscus, Carnation, Bixas, Saffron, Safflower, etc.

3.4. COMMERCIAL FLOWER INDUSTRIES IN INDIA HAVE COLLABORATION WITH DUTCH

1. Bumbna major Biotech Ltd, Jambhul village pune. Collaboration with Moerheim Roses and Trading BV., Holland with 6 million flowers. Rs. 7.5 crores; 100% EOU
2. Deccan Flora Base Ltd. with a transaction of Rs. 7.0 crores, 100% EOU of roses, 9 million cut roses (11.25ha). Talegaun (Pune); collaboration with Flodae B.V., Netherlands.
3. Essar Agrotech Ltd.: Lonarala (Pune). 6 Million roses, (7 ha); Rs. 5.5 crores, collaborated with Moerhein roses a trading B.V., Holland.
4. Harrisons Universal Flowers Ltd. Collaborated with Universal Plants SA of France (Meilland groups in France) – Bangalore; 6.0 crores; 2 ha.
5. Indryani Biotech: Rs. 7.14 crores, 6 million cut flowers; near Pune, collaborated with Florax Max of Malaysia.
6. Indo Bloom Pvt. Ltd, Bangalore.
7. Karishma Floriculture Ltd. Collaborated with Dalsem BV of Holland at Sohana in Haryana.
1. Laxmi Flori-tech Ltd: Bangalore (Nelamangala) with Flodae BV. Holland.
2. Oriental Flori- tech Ltd. (by TATA Industries) in 1990 collaborated with Van Dijk Flora BV of Holland (Pune); 4 million roses in 3.2 ha.
3. Meghana Flori-tech Ltd, Bangalore.
4. Vasavi Florex Ltd. Bengaluru
5. Sachin Flori-tech Ltd Bengaluru, etc.

QUIZ:

1) Summer season Annuals are

- A) Zinnia B) Kochia C) Portulaca D) All Of These

2) Rainy season annuals

- A) Sweet Sultan B) Phlox C) Verbena D) Gaillardia

3) Winter season annuals

- A) China Aster B) Larkspur C)Both A & D)Balsam

4) Purple, Lavender or Blue coloured flowers

- A) Tithonia B) Ageratum C) Gaillardia D) Both A & B

5) White coloured flower

- A) Marigold B) Calendula C) Gaillardia D) Chrysanthemum

6) Flowers Annual in habit

- A) Berlaria B) Orchids C) Gerbera D) None of These

7) Flowers Perennial in habit

- A) Nasturtium B) Holly Hock C) Verbena D) Anthurium

8) Bulbous plants

- A) Gladiolus B) Crocus C) Lily D) Dahlia

9) Traditional flowers

- A) Carnation B)Marigold C) Limonium D) Goldenrod

10) Flowers used in Perfumery Industry

- A) Marigold B) China Aster C) Lavender D) Zinnia

(Key answers:1) d, 2) d, 3) d, 4) d, 5) d, 6) d, 7) d , 8) c, 9) b, 10) c)



LECTURE- 4

ROSE

TOPICS

- 4.1. Introduction
- 4.2. Scenario in the world
- 4.3. Important Rose Importers
- 4.4. Morphology of Rose
- 4.5. Importance and uses
- 4.6. Origin & History
- 4.7. Evolution

4.1. INTRODUCTION:

- Rose is '**Eros**' (The Greek Love - God).
- It is one of the 'Nature's Beautiful Creations'.
- Hence, it is universally acclaimed as the 'Queen of flowers' called by a 'Sappho' a poetess about more than 2500 years ago.
- No other flower is a better symbol of love, adoration, innocence, peace, friendship, affection, passion and other virtues than the rose since thousands of years.
- It is certainly the best known and most popular of all the cut flowers throughout the world and has been growing on this earth for many million years before the man himself appeared on earth.
- Rose is considered as National flower of England.
- In India, it was referred in old Sanskrit literature as Tarnipushpa, Atimanjula, Simantika, etc.
- The rose adorned not only the royal palaces but also the ashrams of saints.
- It has become the part and parcel of life being connected with all phases of our life right from 'birth to death'.
- The growing of roses 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 four five decades and at present it has become most important commercial flower.
- As a result of the great demand for modern roses (HT roses) / standard roses, many nurseries have been established in an around the big cities.
- It is the largest traded flowers in the world, worth 1.5 billion dollars globally.
- The Holland alone 500 million dollars and is growing 7-8% annually.

4.2. WORLD SCENARIO:

The area in rose production in the Netherlands has stayed the same or is infact increasing as growers change from small to large varieties and rootstock. Where as in USA it is declined and in Italy, France, Hungary, Poland and Russia the production for home consumption is increasing so also in India and China.

Columbia	980 ha.	Zimbabwe	230 ha.
Holland	900 ha.	Israel	180 ha.
Kenya	900 ha.	India	180 ha.
Japan	600 ha.	Tanzania	25 ha.
USA	450 ha.	Zambia	55 ha.
Germany	250 ha.	Uganda	90 ha.

4.3. IMPORTANT ROSE IMPORTERS AND EXPORTERS:

- ◆ Germany is the highest importer followed by USA, The Netherlands, France, Switzerland and U.K.
- ◆ Whereas, the main exporter is the Netherlands followed by Columbia, Ecuador, Kenya, Israel and Zimbabwe.

4.4. MORPHOLOGY OF ROSE:

- ✓ The rose is an ornamental shrub/bush with upright or climbing stems usually prickly.
- ✓ Leaves are alternate, compound, oddly pinnate with stipules adherent to the leaf stalk.
- ✓ Flowers are solitary (single) or in corymbs (cluster).
- ✓ Calyx is five lobed, either simple or compound.
- ✓ Petals & sepals are generally five; however *Rosa sericea* has only four petals and sepals.
- ✓ Carpels are many, inserted at the base of the calyx tube and with simple projecting style and stigma.

- ✓ Fruits are known as hips, contain many seeds and are rich in Vit. C, A₁, B₂, K & E.
- ✓ Seeds are hard and fresh seeds have dormancy.

4.5. IMPORTANCE AND USES:

- The rose because of its multi-utility occupies a prominent place amongst the flower crops and is one of the ancient fragrant flowers cultivated by man.
- Its different types having beautiful flowers of exquisite shape, different shades, bewitching colours and most delightful fragrance has made it an important flower for the varied uses.

USES:

1) Garden display:

- Shrub or bush is prepared by budding the desired cultivars on a root stock at a height of 5-10 cm above the ground level.
- They are planted in small groups to create excellent mass effect in a rose garden.
- They are also the most important garden plant in almost all every part of the world due to its perennial growth habit.
- They can be used as bush, standards, climbers, hedges and edges, hangers and in rock gardens.

2) Standard roses (Hybrid Tea roses): Also called as tree roses. HT roses and floribundas having vigorous growth and spreading habit hence are budded on straight vertical stem of a suitable root stock at different height from the ground level to make standards.

Classification of Standard Roses:

According to height of budding the standard roses are classified into;

- a. **Full standards:** The height of the budding has to be done at 100-115 cm above the ground level. H T roses and few Grandifloras are suitable.
- b. **Half standards:** In this case the budding may be done at 45-60 cm height. Floribundas and Polyantha roses are excellent for growing as half standards.
- c. **Weeping standards:** 150 cm or even higher the budding may be done on drooping branches. The growing crown is look like hanging crown.
Example, Climbers / Rambler roses

3) **CLIMBERS:** The climbing and rambling roses can be used to cover the walls of the houses or fencing or pergolas, arbours and arches.

DIFFERENCE BETWEEN RAMBLER AND CLIMBER ROSES:

RAMBLER ROSES

- 1). Rambler produces flowers once in a year.
- 2). Produces flowers in clusters.
- 3). Flowers lasting for several weeks.
- 4). Rambler is very vigorous.
- 5). Produces heavy crops of small flowers in clusters for several weeks.

CLIMBER ROSES

- 1). Flowers perpetually (round the year).
- 2). Produces singly or in groups of 2's or 3's.
- 3). Flowering spreads over the season.
- 4). Medium in vigor.
- 5). Produces bigger flower than rambles round the year.

- 4) Hedges or Edges:** Any rose cultivars can be used for these purposes for protection, beautification and demarcation of different features in the landscaping.

3.1. Hedge: Any thorny cultivars are suitable for the purpose preferably floribundas are ideal as they are vigorous types. Ex. Border Coral, Circus, Frensham and Rumba

3.2. Edge: Button /miniature roses are commonly used to form edges for demarcation of one feature to another. Ex. Carolin, Lady Reading, Magic, White Button etc.,

- 5) Rockeries:** Some hardy miniature roses may be grown to beautify the rock garden. Hardy miniatures and pompon cultivars such as Fairy Queen and Magic may be selected..
- 6) Pot plants:** Roses as pot plants in suitable containers are also commercially grown. Miniature and dwarf *Polyanthas* should be selected for the purpose. The cultivars like Baby darling, Cindrella, Starina, Sweet Dream etc.,
- 7) Hangers:** Button roses can also be used for growing in hanging pots / baskets. Climbing miniatures like Red Cascade and Yellow Doll may be used.
- 8) Loose flowers:** Used for garland making, extraction of essential oils, for button holes i.e. Coat button holes and Cora sages (a single rose with foliage) – referred as mini bouquet.
- 9) CUT- FLOWERS:** Besides garlands, bouquets, buttonholes and preserves and their use for worship it makes one of the best cut flowers. In floriculture, roses are of foremost commercial importance and cut-roses have the highest demand throughout the world and year round. European countries, USA, Canada, Japan, Korea, Kenya, Colombia, etc. are the largest producers of cut-roses under protected structures.

10) PERFUME AND ALLIED PRODUCTS:

a) **Rose water:** Important commercial product obtained from rose petals, used as perfume, medicine and confectionary. It's important uses are,

- ◆ Cools the body, used in eye lotions, eye drops for its soothing qualities.
- ◆ Used in drinking water.
- ◆ It is sprinkled on guests at weddings, feasts & other social functions.

b) **Rose oil (Rose perfume):** It is also obtained from rose petals, sweet fragrance; medicinal properties; used in Ayurveda. Bulgarian '**rose otto**' is largely used in perfuming soaps & cosmetics.

- ◆ Used in flavoring soft drinks and alcoholic liqueurs.
- ◆ It has antibacterial properties against *Shigella dysenteriae* and *Mycobacterium tuberculosis*.

Species suitable are: *Rosa damascena*, *R. borboniana*, *R. centifolia*, *R. alba* & *R. gallica*. In India *R. damascena* and *R. borboniana* are cultivated for rose oil.

c) **Gulkand:** Rose petals are also preserved for direct consumption prepared by beating equal proportion of petals and sugar – considered as tonic and laxative. *R. damascene*, *R. chinensis*, *R. gallica*, *R. pomifera* & some other scented roses like Edouard roses are commonly used.

d) **Pankhuri:** Dried rose petals are known as pankhuri, they are occasionally used for preparing sweetened cold drinks.

e) **Gulroghan:** The rose hair oil is prepared from rose petals by effleurage (fragrance) with wet sesamum seeds.

11) As a source of vitamins:

- ◆ Rose hips are very good source of ascorbic acid (Vit C). Every 100 g of rose hip contains 150 mg of ascorbic acid compared with only 50 mg in fresh orange juice, 20 mg in tomato and 5 mg in apples.

Species: *R. rugosa*, *R. amblyotis*, *R. Acicularis*, *R. davurica*, *R. pendulina*, *R. glauca* and *R. canina*.

- ◆ The hips of *R. roxburghii*, *R. acicularis*, *R. rugosa*, *R. davurica* also found to contain Vitamins A₁, B₂, K & E.

12) Other uses:

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

4.6. ORIGIN & HISTORY:

- It is said that rose came first and man afterwards. It is estimated to be more than 30 million years old.
- According to Klougart and Fairbrother (1966), the history of man and of the rose is linked together for about 5000 years.
- The rose was called 'Queen of flowers' by 'Sappho' a poetess more than 2500 years ago.
- No other flower has such a remarkable written record.
- There is evidence that, roses reached Rome before Christ.
- Preparation of rose water and attar was also in practice even before the 17th century.

"The rose is the perfume of the Gods, the joy of men, it adores and graces at the blossoming of love". Rose is the favored flower of Venus.

MYTH AND LEGEND STORIES ON THE EARLY HISTORY AND EVOLUTION:

- It is said that when 'Cybele' became angry with 'Venus', she took her revenge by bringing to life something more beautiful than the Goddess of beauty herself and thus created the roses.
- According to Myth story the rose blooming in the 'Garden of Eden' was white in colour and became red when 'Eve' (Acc to Bible she is the first women name mentioned in Bible) saw it and kissed it.
- Another story relates that, roses which were originally white which became red from the blood of 'Venus' dropped from her foot wounded by a thorn while hurrying through.
- According to a Legendry story, once Lord 'Vishnu' taking bath and Lord 'Brahma' came out of one lotus and claimed that, lotus is the beautiful flower in the Universe.

- Then Vishnu took 'Brahma' to his Paradise 'Vaikunta' and showed him a rose flower which was very beautiful with "Pale Moon Beam colour and heavenly fragrance". After seeing this Brahma also agreed rose is the most beautiful than lotus.
- Muslim's believed that, the roses were born from the sweat of the Prophet Mohammed and hence, they show great respect to rose.
- The Roman king 'Nero' loved rose so much that, he had them every where in his palace. Flower petals were used by the women in their baths and for the decoration of special beds, feasts and graves.
- Rose is also mentioned in the Bible and is believed to be known before the Bible era and was under cultivation before the birth of Christ.

DISTRIBUTION:

- There are about 150 recognized and described species were identified; all are indigenous to the 'temperate regions of the northern hemisphere' have been reported to be growing.
- In India, several species are found growing wild mostly in the Himalayan ranges.
- There are eleven species were reported to be growing wild in India. They are as follows,
 1. *Rosa brunonii* (Himalayan Musk rose),
 2. *R. eglanteria* (Syn *R. foetida*, Austrian rose),
 3. *R. involucrate* (Syn. *R. sempervirens*),
 4. *R. leschenaultiana* (Syn. *R. sempervirens*),
 5. *R. longicuspis*,
 6. *R. macrophylla*,
 7. *R. moschata* (Musk rose),
 8. *R. rubiginosa* (Sweet briar/ Eglantine rose),
 9. *R. walpoleana*,
 10. *R. sericea* (Ladakh rose)
 11. *R. multiflora*

4.7. EVOLUTION:

- In the beginning some of the rose species were hybridized in nature and the present day improved forms have been evolved over centuries.
- Till the 19th century only four species of roses played a role in the development of varieties cultivated at that time. These are
 - 1) *Rosa gallica* (Red rose) (French rose)
 - 2) *R. canina* (Dog rose).

3) *R. moschata* (Musk rose)

4) *R. phoenicia* (Phoenician rose)

- *Rosa gallica* (French rose) came originally from ‘Caucasus’ and the Middle-East and is an ancestor of Moss roses.
- *R. centifolia* (Cabbage rose) came to France in 1580 from Mediterranean region.
- *R. damascena* (Damask rose) is natural variation of *R. gallica*, *R. damascene* in course of time produced variant with a tendency to bloom in the autumn and summer and this variant was named as Autumn Damask (*R. damascena bifera* and *R. damascena semperflorens*).
- In the modern roses apart from these species *R. chinensis* (Pink China rose) was also used in breeding of modern roses.
- In the early 19th century itself, one or two hybrids closely related to *R. chinensis*, due to their recurrent flowering habit were introduced to Europe from China.
- These were actually hybrid between *R. odorata* and *R. gigantea* and these gave rise to the popular ‘Tea roses’.
- These Tea roses so named because they had the flavour as found in the chest of leaves of China Tea which are delicately sweet with some what smoky aroma.
- “Thunberg” a Swedish botanist, described a rose which he had seen in Japan and collected the *R. multiflora* by virtue of its many flowers. This was later called *R. polyantha* by Zuccarini, the German botanist.
- ‘Multiflora’ in ‘Latin’ and ‘Polyantha’ in Greek both meant “Many flowered roses. These roses were crossed with the Tea roses and gave rise to low growing, permanently flowering forms which came to be known as Polyantha roses.
- Later *R. polyantha* x *R. moschata* and produced Hybrid musk rose: This played an important part in the development of floribundas.
- In India, several species are found mostly in the Himalayan ranges.
- The cultivation of rose was perhaps taken up during the Mughal period. Babar introduced the Persian or Damask rose into India (1526).
- The Edouard rose (*R. borboniana*) was introduced in 1840 during the British rule.
- These two roses viz. Damask and Edouard roses are highly scented and are being extensively cultivated in the country. Commercial cultivation of roses for cut flower trade has increased during last four decades.
- The major rose producing regions in India are Karnataka, Maharashtra, Punjab, Uttar Pradesh, Delhi and Chandigarh, while in Gujarath, Haryana, Himachal

Pradesh, Madhya Pradesh, Rajasthan, Tamil Nadu and West Bengal they are being grown to a limited extent.

KNOWLEDGE ASSESSMENT

I. Choose the appropriate answers from the following:

- 1) Queen of flowers is
a) Tulip b) carnation c) gladiolus d) Rose
- 2) The word "ROSE" is derived from _____ word.
a) Latin b) Greek c) French d) none
- 3) ROSE is national flower of _____

- a) England b) Japan c) Italy d) UK
- 4) Fruit of rose is known as
a) Hips b) Heps c) Heeps d) all
- 5) Hips are the rich source of _____
a) Vitamin A b) Vitamin B c) Vitamin K d) Vitamin C
- 6) Standard Roses are classified as
a) Full standards b) Half standards c) either a or b d) both a & b.
- 7) In Climber roses flowering spreads
a) over the season b) for few weeks c) throughout the year d) none
- 8) Roses suitable for hedges
a) Floribundas b) miniatures c) Button roses d) all
- 9) Dried rose petals are known as _____
a) Pankhuri b) potpourri c) Gulroghan d) both a& b
- 10) Species of rose utilized as shock absorber or crash barrier in America
a) *R. cannina* b) *R. multiflora* c) *R. grandiflora* d) *R. moschata*

(Key answers: 1)d, 2)b, 3)a, 4)a, 5)d, 6)d, 7)a, 8)a, 9) d, 10)b)

Match the Following

	A	B
1)	<i>R. sericea</i>	French rose
2)	<i>Rosa brunonii</i>	Cabbage rose
3)	<i>R. moschata</i>	Ladakh rose
4)	<i>R. canina</i>	Damask rose
5)	<i>Rosa gallica</i>	Himalayan Musk rose
6)	<i>R. centifolia</i>	Edouard rose
7)	<i>R. damascene</i>	Dog rose
8)	<i>R. borboniana</i>	Phoenician rose
9)	<i>R. Phoenicia</i>	Austrian rose
10)	<i>R. eglanteria</i>	Musk rose

(Key answers: 1) Ladakh rose,2) Himalayan Musk rose,3) Musk rose,4) Dog rose, 5) French rose,6) Cabbage rose,7) Damask rose,8) Edouard rose, 9) Phoenician rose,10) Austrian rose)

LECTURE - 5

ROSE

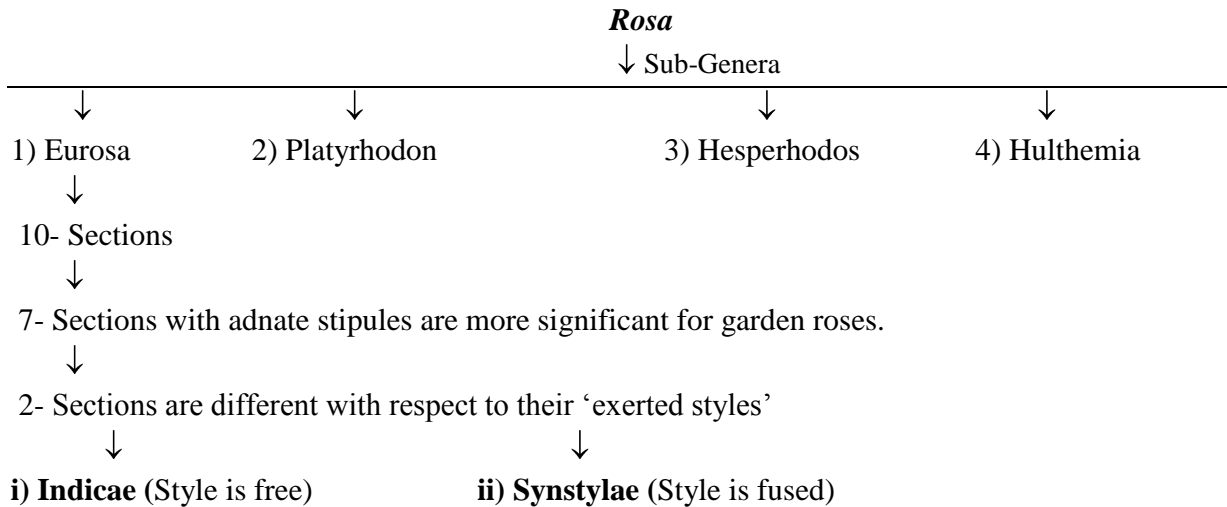
TOPICS

- 5.1. Classification
- 5.2. Classes of present day garden roses.
- 5.3. Rose species

5.1. CLASSIFICATION:

Family: Rosaceae

According to Rehder (1940) the American taxonomist, the genus *Rosa*, contains about 120 species.



Both sections are diploid ($2n = 14$) in nature. The short styled sections includes,

- 1) ***Pimpinellifoliae*** (Have both diploid and tetraploid species) – which contain *R. spinosissima* and *R. foetida*
- 2) ***Gallicanae*** – (Tetraploid) contains *R. gallica* and the ancient hybrids which originated from it, viz., the Damasks, the Centifolias, the Mosses and the 'Albas'
3. ***Cinnamomeae*** (48 species) contains *R. rugosa* and *R. cinnamomea* which have played minor role in development of modern roses.

- The genus *Rosa* contains 150 species; only 7 have contributed to the development of modern cultivars (Veda, 1994)

5.2. CLASSES OF PRESENT DAY GARDEN ROSES:

1) **Hybrid Tea:** Originally developed from crossing between hybrid perpetuals and Tea roses

- ◆ Most popular rose.
- ◆ Bearing large highly centered flowers.

Eg: 'La France' (1867) – First cultivar of hybrid tea group.

2) **Floribunda (Hybrid polyanthas)**

- ◆ Developed in 1924 from the cross between a Hybrid Tea x Polyantha.
- ◆ They combined the beautiful forms of the Hybrid Teas with the perpetual flowering habit of the Polyanthas.
- ◆ Flowering in clusters with small size and open centre.
- ◆ Good for garden display.

Eg: Wekplapep (2000), Jumpin Jack (1998)

3) **Hybrid perpetuals**

They are the immediate forerunners of Hybrid Teas. These are considered to be the offspring's of *R. chinensis*, *R. gallica* and *R. centifolia*.

- ◆ They are not perpetual flowering types, as the name suggests, but may be called "remontants" being the type which flower more than once in a season/year.

Eg: Princesse Helence

4) **Teas:** Also called "Tea scented China roses" they derived their names from their distinct aroma, believed to be feet when a chest of tea leaves are opened.

- ◆ They known to have originated from *R. chinensis* and *R. gigantean* (Manipur Tea rose)
- ◆ Free flower types.

Eg: Anna Olivies., Lady Hillingdon

5) **Grandifloras:** Mainly obtained from crosses between 'Hybrid Tea' and 'Floribunda' type.

- ◆ Produces large number of flowers in cluster with fine form.

Eg: Buccaneer (1952), June Bride (1957), Montezuma (1955), Queen Elizabeth (1954), Jazor (2000).

6) Polyanthas:

- ◆ Dwarf with small flowered polyanthas are the forerunner of Floribundas. Blooms for several months.
- ◆ Their Ancestry includes crosses of *R. multiflora* and *R. wichuraiana* (Climber) and the Bengal hybrid *R. indica major*(*R. chinensis*)

Eg: La paquette (1875), Baby Faurax (1924), Echo (1914)

7) China roses: (*R. chinensis*)

- ◆ It is responsible for nearly all the present day popular roses.
- ◆ Bears red to nearly white flowers in small clusters.
- ◆ Also called 'Bengal rose' or 'Monthly roses'
- ◆ Perpetually flowering types.
- ◆ Green roses also included in this group *R. chinensis viridiflora*
- ◆ Eg: Comtessedu cayla (1902)

8) Miniature / Button Roses

- ◆ Popularly known as 'Baby roses' with small leaves & flowers.
- ◆ They are hardy and good for pot culture.
- ◆ Multiplied by cuttings as well as budding on root stocks.

Eg: Baby gold star (1940), Baby Masquerade (1956), Cinderella (1952), peon (1936), etc.

9) **Climbers and Ramblers:** They bears large clusters of small, single or double flowers, mainly belong to two groups.

a) Multiflora ramblers from *R. multiflora*,

Eg: Blush Rambler (1903), Crimson Rambler (1890)

b) Wichuriana ramblers from *R. wichuriana*

Eg: American Pilla (1902)

- Used for training on arches, pergolas, etc.

10) Damask roses

- ◆ These are belongs to the species *R. damascene*.
- ◆ Originated from cross between *R. phvenicia* and *R. gallica*.
- ◆ Bears clusters of very fragrant pale pink to red, double petalled flowers.

Eg: Madame Hardy (1832), Celsiana Hebe's Lip (1921)

11) Bourbon roses: (*Rosa borboniana*)

They have originated from a natural cross between China rose and the Damask rose. It is named after the name Island *i.e.*, Isle de Bourbon (1817). Floriferous over a long season

- ◆ Flowers are scented have large petals, double and silky
- ◆ Borne singly or in cluster.

Eg: Rose Edouard, Bourbon Queen (1935)

12) Cabbage roses: These belong to the species *R. centifolia* and they are also called as 'Provence rose'. Petal arrangement is like cabbage, hence the name. They bear large, solitary, very fragrant pink flowers.

Eg: Demeaux and chapeau de Napoleon (1827)

13) Moss Roses: They belong to cabbage rose class and arose as sports of the centifolias. Growing closely like moss, all over the seed pod and sepals.

Eg: Old pink Moss (1845)

14) French roses: Also known as 'Gallica roses' having developed from *R. Gallica*.

- These are perhaps the oldest types of cultivated roses known.
- Includes pink or crimson colours with good fragrance.
- Having medicinal properties.

Eg: Belle de Crecy, Cardinal de Richelieu.

15) Albas: Along with the *Gallicas* and the Damasks, the Albas constitute the truly old garden roses.

- ◆ Originated from cross between *R. corymbifera* and *R. gallica*.

- ◆ Very hardy and bear white or pinkish flowers with delightful fragrance.

Eg: Celestial, Queen of Denmark.

16) Musk roses: *R. moschata* is the musk rose, derived its name from the musky fragrance of the flowers. They make good shrub roses as well as pillar roses.

Eg: Eva, Felicia, Moon light, etc.

17) Noisette roses: Originated from *R. chinensis* and *R. moschata* (hybrid of China rose and musk roses). Climbing in nature.

Eg: Lamarque, Marechal Niel.

18) Rugosas: (*R. rugosa*)

- ◆ Very hardy type, which do well on the seashore.?’
- ◆ Very vigorous and resistant to cold.
- ◆ Good for hedge, because of its highly thorny nature.
- ◆ Bears large, red or white flowers. Eg: Blanc Double de Coubert.

19) Austrian briars: (*R. foetida/ R. lutea*)

- ◆ Considered to be the main source of yellows in the modern rose.
Eg: Austrian copper (*R. foetida bicolor*),
- Persian yellow is introduced by Babar (*R. foetide persiana*)

5.3. SPECIES:

The number of species under the genus *Rosa* recorded in different literatures, varies from 120 – 200.

SOME IMPORTANT SPECIES AND THEIR DESCRIPTIONS ARE AS FOLLOWS.

1. *Rosa X alba* (White rose) [*R. corymbifera* x *R. gallica*]

- ◆ An erect bush with glaucous (grayish blue) foliage.
- ◆ Flower white, semi double, fragrant and born in clusters.
- ◆ It was under cultivation before 1597.

2. *R. banksiae* (Banksian rose;1796)

- ◆ A vigorous evergreen climber, grow upto 9 m high.
- ◆ Stems are thorn less with yellow-green foliage.
- ◆ Flowers are white or pale yellow.
- ◆ Originated in Western China.

3. *R. borboniana* (*R. chinensis* x *R. damascena semperflorens*) Bourbon Rose

- ◆ Vigorous shrub with erect shoots.
- ◆ Stem dark green with hooked prickles.
- ◆ Floriferous over a long season.
- ◆ Flowers double, deep rosy red, scented and flowers are 7.5 cm diameter.
- ◆ It was under cultivation in 1817.

4. *R. canina* (Dog Rose)

- ◆ Vigorous and very prickly shrub having stout stem.
- ◆ Foliage toothed all round margins.
- ◆ Flowers single, white or pink scented, small and in clusters.
- ◆ Hips are oval in shape.
- ◆ Chiefly used as root stock for budding or grafting.
- ◆ Popular in Britain, N-Europe and W-Asia

5. *R. centifolia* (Cabbage Rose) (1596)

- ◆ Is a complex hybrid which contains four species viz., *R. gallica*, *R. phoenicia*, *R. moschata* and *R. camria*.
- ◆ Loose growing shrub.
- ◆ Medium in vigour.
- ◆ Flowers large, fully double with overlapping petals, deep pink with a slight purplish blue towards centre.

6. *R. chinensis* {Syn. *R. indica* (China Rose;1759)}

- ◆ A large climbing evergreen shrub.
- ◆ Flowers single, blush-pink, pink or crimson, rarely white in colour.
- ◆ Non fragrant.
- ◆ Native of China.

7. *R. clinophyllia* Syn. *R. involucrate* (Wild rose of Bengal)

- ◆ An erect or semi-climbing compact shrub with blackish bark.
- ◆ Leaves are composed of 5-9 leaflets.
- ◆ Flowers are white, appear solitary or in small clusters.
- ◆ Fruits roundish, hairy and pale.
- ◆ Native of Bengal.

8. *R. damascene* (Damask Rose)

- ◆ *R. gallica* x *R. phoenicia* (Summer damask rose);
- ◆ *R. gallica* x *R. inoschata* or *R. canina*
- ◆ A strong climber with white flowers in clusters.
Autumn Damask – *R. bifera* came from *Rosa gallica*
Crossed with *R. moschata* x *R. canina*
- ◆ Vigorous shrub with exquisite fragrance (Sweet scented)
- ◆ Flowers in large clusters, semi-double.

9. *R. eglanteria* syn. *R. rubiginosa* (Sweet Brier) (1551)

- ◆ Vigorous shrub with dense prickly branches.
- ◆ Small leaflets with scented foliage.
- ◆ Flowers bear singly or in clusters.
- ◆ Hips are bright red and rounded.
- ◆ Native to North-Europe including Britain.

10. *R. foetida* syn. *R. lutea*, *R. eglanteria* (Austrian Briar rose)

- ◆ Erect shrub, with prickly stem.
- ◆ Flowers single, bright golden yellow
- ◆ Native to India

11. *R. gallica* syn. *R. rubra* (French rose) (1542)

- ◆ Thorn less but an abundance of small prickles.
- ◆ Foliage dark green.
- ◆ Flowers single, purplish – crimson, in small clusters.
- ◆ Hips sub-globose dark red.
- ◆ Native to Central and Southern Europe.

12. *R. giganteana* syn. *odorata* var. *gigantean* (Manipur Tea Rose)

- ◆ Very vigorous climber with thick, hooked prickles on the glabrous stem.
- ◆ Foliage dark glassy green, partially evergreen.
- ◆ Flowers large (7.5 – 12.5 cm across), white or pale yellow.
- ◆ Fragrant, borne singly.
- ◆ Common in Manipur, Nagaland and Sikkim
- ◆ Native to Western China.
- ◆ An important ancestor of the Tea, Hybrid Tea and Noisette roses.

13. *R. moschata* (Musk rose)

- ◆ A vigorous climber with reddish, sparsely prickly stem and evergreen.
- ◆ Foliage very fine and flossy, bright green.
- ◆ Flowers white, usually semi-double but sometimes single with musk fragrance.
- ◆ Hips ovate, orange – red or dark brown.
- ◆ Native to Middle East Himalayas.

14. *R. multiflora*

- ◆ A deciduous shrub with vigorous climbing branches.
- ◆ Foliage with upto 9 leaflet.
- ◆ Flowers single, white with golden yellow stamens.
- ◆ Born in clusters, scented.
- ◆ Hips are small, red, oval.
- ◆ Originated in North China, Korea & Japan.
- ◆ Introduced to India in 1872.

15. *R. wichuraiana* (Memorial rose)

- ◆ A vigorous Rambler, producing single flowers – white with yellow centre.
- ◆ Scented, produce in large clusters.
- ◆ Hips small, ovoid, dark red.
- ◆ Originated in Japan, East China, Korea & Taiwan.
- ◆ Introduced to India in 1891.

16. *R. persica* syn. *berberifolia* (Rose of Persia)

- ◆ Dwarf shrub with silvery-grey foliage.
- ◆ Flowers deep golden yellow, single.
- ◆ Hips are small.
- ◆ Native to Iran, Afghanistan and USSR.

17. *R. rugosa* (Ramanas rose, Rugosa rose)

- ◆ A vigorous erect shrub distinguished by strong, sturdy growth and bright apple-green foliage on very prickly stems.
- ◆ Flowers in small clusters, single, large, purplish rose to violet – carmine.
- ◆ Slightly scented, variable in colour
- ◆ Hips large, rounded, orange-scarlet and very decorative.
- ◆ Originated in China, Japan & Korea.
- ◆ Used as root stock also.

KNOWLEDGE ASSESSMENT:

1) Rose belongs to _____ family.

- a) Compositae b) Rosaceae c) Araceae d) Caryophyllaceae

2) According to Rehder (1940) the American taxonomist, *Rosa* contains _____ species.

- a) 120 b) 200 c) 122 d) 140

(Key answers: 1) b, 2) a)

3) Match the Following

<u>A</u>	<u>B</u>
1 Hybrid Tea	<i>Hybrid Tea x Floribunda type,</i>
2 Floribunda	<i>R. indica</i>
3 Hybrid perpetuals	Hybrid Tea x Polyantha
4 Teas	Baby roses
5 Grandifloras	Tea scented China roses
6 Polyantha	Isle de Bourbon
7 China roses	Training on arches, pergolas
8 Button Roses	Hybrid perpetual x Tea roses
9 Climber and Rambler	Remontants
10 Bourbon rose	Baby Faurax

(Key answers: 1) Hybrid perpetual x Tea roses, 2) Hybrid Tea x Polyantha, 3) Remontants, 4) Tea scented China roses, 5) Hybrid Tea x Floribunda type., 6) Baby Faurax, 7) *R. indica*, 8) Baby roses, 9) Training on arches, pergolas, 10) Isle de Bourbon)

4) State True or False:

- a) *Rosa alba* are called as White roses.
b) Parents of *R. borboniana* are *R. chinensis* x *R. d. semperflorens*.
c) *R. chinensis* is native to India.
d) *R. rubra* is commonly called as Manipur Tea Rose.
e) *R. eglanteria* is native to India

(Key answers: a) True ,b) True, c)False ,d) False, e) True)

LECTURE - 6

ROSE

Topics

- 6.1. Rose Cultivation in Open Condition
- 6.2. Cultivars
- 6.3. Crop Improvement in Rose
- 6.4. Genetics and Breeding of Rose
- 6.5. Breeding of Roses
- 6.6. Methods of Breeding
- 6.7. Techniques of Hybridization
- 6.8. Rose Breeding in India
- 6.9. Biotechnology
- 9.10. Protected Cultivation

6.1. ROSE CULTIVATION:

Roses are grown in gardens in all parts of the world.

- In Temperate countries, the most important period of flowering is summer.
- In Tropical climate winter and spring, whereas,
- In Subtropical climate round the year

SOIL:

- Although any soil is good for rose cultivation. However, for proper drainage, the medium loamy soil with sufficient organic matter is essential.
- It grows well in a soil with a pH of 6.0 to 7.5. It can sustain little acidity (5.5 to 6.5), good aeration;
- The land with high water table is not suitable.

CLIMATE:

- The most important factors are light (photoperiod, intensity and quality), temperature (aerial and root zone), humidity, CO₂, ventilation, etc.

LIGHT:

- Light is one of the important growth factors which influence both temperature and water.
- Primarily light is necessary for assimilation (photosynthesis). Through chlorophyll in the leaves, light is transformed into sugars, a process also requiring CO₂ and water.
- This energy source is essential for growth and development of flowers, stems, leaves and roots.
- The degree to which a plant can use the amount of light available depends on several factors, for example chlorophyll contents of the leaves, CO₂ supply, temperature and humidity.
- The other indirect effect of light is the stimulation of vascular transport through the plant.
- Rose prefers bright sunshine for the whole day, if not at least for the normal part of the day i.e., the forenoon.
- Sunshine for six hours is ideal for better growth and flowering.
- The plants should be free from shades of trees and protected from the strong winds.
- As light raises the leaf temperature, the leaves respond by opening the stomata to allow a higher evaporation in order to cool down.
- This process also increases the water transport, enabling nutrients, necessary for plant growth, to be distributed through the plant.

TEMPERATURE:

- Temperature influences almost all processes of life.
- Too much light at a low temperature causes an unnecessary surplus of sugars.
- Due to the high temperature the respiration process works at maximum capacity, while production of energy (photosynthesis) is maintained at a low level.
- The differences in temperature during the day/night (light/dark) period have a major effect on plant growth.
- It is assumed that through a raise in temperature early in the night period, more energy is put in generative growth (flower development).
- Higher temperatures during the night period, compared to the day period, will stretch internodes and vice versa.
- Under poor light conditions this is a possibility to obtain the required 24-hour temperature without creating a weak and elongated crop.
- The greenhouse temperature is generally maintained from 20⁰C to 21⁰C on cloudy days and 24⁰C – 28⁰C on sunny days. Whereas the night temperature is 16-17⁰C.
- However, the temperature range of 15-27⁰C is optimum.

HUMIDITY:

- Plays an important role in the incidence of pests and diseases affecting the growth and flowers. Mildews are highly associated with high humidity.
- The climatic condition of India is well suited for rose production.
- In the northern plains rose flowers best during winter where as in temperate hilly region of the Himalayas best flowers are produced in summer.
- Under Bangalore, Pune and such other mild climatic region we can produce good quality roses round the year.

6.3. CULTIVARS:

- ❖ The beauty of roses seems to have no limit, no end and that is the reason that, the search for a more beautiful rose will always continues.
- ❖ Every year many new cultivars are added and marketed all over the world.
- ❖ The success of rose culture greatly depends upon the proper choice of class and cultivars.
- ❖ At present there are more than 20,000 cultivars of roses, differing widely in form, shape, size, colour, fragrance and flowering habit.

SELECTION OF ROSE CULTIVARS: Depends on the purposes of growing, viz

- i. Garden display
- ii. Cut flower, for decoration, sale and export for making garlands and worshipping.
- iii. Exhibition purposes.

1. Garden display:

- The first step in the selection of rose cultivation for this purpose will be the kind of roses, which will suit the location and fulfill the object.
- Form, size, shape, floriferous-ness, color and fragrance have to be taken into consideration.
- Cultivars should be resistant to insect pests and diseases.

2. Cut flowers:

- The HT cultivars producing beautiful shaped blooms of long lasting quality,
- Born singly on long straight stalks.
- The cultivars which open slowly and the blooms last for a longer period when placed in water are suitable for export purpose.

Eg. Cultivars like Passion, First Red, Sonia Milland, Mercedes, Red Success, Miracle, Orange Gate, Prophyta, Nobless, Somantha etc., are in great demand.

3. **Exhibition:** For this purpose certain specific qualities are essential.

In “Rose show” under different classes are required. The most important sections are as follows

- a. H.T. specimen bloom
 - b. Floribundas
 - c. Polyanthas
 - d. Miniature /button roses.
 - e. Fragrant roses
 - f. Climbers
- a. **H. T. Specimen bloom:**
- These are major attractions in a rose show.
 - Specimen blooms are the top quality blooms of large sized, high centered having sufficient number of petals which are arranged symmetrically in an attractive outline, forming a high circle 3-6 flowers are arranged in specimen section.
- b. **Floribundas:**
- In this section the main considerations is the floriferousness and quality of the spray.
 - The floribundas are judged on the basis of inflorescence.
 - The arrangement of flowers and number of symmetrical and well balanced spray.
 - They are called ‘Spray roses’.
- c. **Polyanthas:** They are mostly miniature like but single petals.

6.4. CROP IMPROVEMENT IN ROSE:

6.5. GENETICS AND BREEDING OF ROSE:

- ❖ The present day gardens roses are complex hybrids involving inter specific hybridization, polyploidy with high female and male sterility.
- ❖ The basic chromosome number $n=7$.
- ❖ Species of Asian origin are diploid ($2n=14$).
- ❖ Whereas, the species found in Siberia and Alaska are polyploidy with $n=14, 28, 42$ and 56 chromosomes.

- ❖ Western species were crossed with Asian diploid ($n=14$) to produce modern roses' (*R. moschata*, *R. gigantea*) *R. multiflora*, *R. chinensis*),
- ❖ Tetraploid species like, *R. gallica*, *R. foetida*, *R. damascena* & *R. centifolia* ($2n=28$),
- ❖ The hybrids arising from the crosses between European and Asian parents are triploids with 21 chromosome numbers.
- ❖ Colours in roses is governed by the expression of water soluble pigments called anthocyanidin,
- ❖ The three important Anthocyanidins are pelargonidin, cyanidine and delphinidines.
- ❖ 'Pelargonidin' is present in Orange-Red to scarlet flowers.
- ❖ Cyanidine is present in Crimson to blush red flowers and
- ❖ Delphinidin present in blue and violet flowers.
- ❖ Besides anthocyanidin there are other numbers of pigment. Such as flavonols and carotenoids for white, yellow and brown pigments in flowers.
- ❖ The reds and pinks derived their colour from the presence of cyanidine, while the pale yellow is due to flavonols.
- ❖ The deep yellow colour in rose came from the crosses made with bright yellow rose species *R. foetida* in 1930.
- ❖ The gene for production of pelargonidine is inherited in roses.
- ❖ The pink colour is dominant over dark red, orange-yellow, yellow, white and scarlet. Deep yellow colour is recessive to light yellow and white is recessive to cream & light yellow.
- ❖ The greenish white is dominant over pure white. Crosses between parents having multi colour or bicolour produced a range of variable.
- ❖ The fragrance in rose is due to the presence of various substances like phenyl ethyl alcohol (PEA), Citronello (Rhodinol), Geraniol Nerol, Nonylaldehyde etc.
- ❖ The inheritance of fragrance do not follow a definite pattern as its, expression is governed by the ultimate effect of many genes similarly the other characters like vigorous of plant thorniness, strength of neck, leaf width, stalk length, shape & bud and open flowers are also due to the interaction of many genes.

6.6. BREEDING OF ROSES:

Creation of a new form of a plant is truly very fascinating, creating a new rose is not different but creating a good new rose is a matter which requires special skills, tools etc.

1. To create novelties with different colour pigment.
2. To introduce the fragrance and extend the vase life.
3. Resistance to vase water bacteria.
4. Resistance to beetles and caterpillars.

5. Resistance to mildew and black spot
6. Resistance to whitefly, red spider mites and thrips.
7. Resistance to root knot bacteria.
8. Resistance to root knot nematode
9. Breeding in rootstock with increased vigour.
10. Cultivars that root more easily.
11. Cultivars that are thorn less.
12. Resistance to mechanical damage in harvest and transport. (i.e. withstanding long transport by surfaces, air or water)
13. High yielding varieties/cultivars.

6.7. METHODS OF BREEDING:

1. **Introduction-** simple method, introduce any new cv. from new source and evaluate for their performance.
2. **Selection:** Selection among the introduced/existing cultivars.
3. **Mutation:** Natural mutants – Dwarf habit in *R.chinensis*
 Chemical treated –Methyl Ethyl Sulphonate, EMS, 2, 4-D, etc.,
 Irradiation – X-rays, radio isotopes etc. Gamma-rays @3-4 KR (K. rads)

4. Hybridization:

- ❖ Hybridization is an important method for obtaining new forms of roses and almost all modern roses (HT floribundas) are developed by hybridization.
- ❖ Rose breeding now practiced extensively in many countries including UK, Australia, Canada, Germany, the Netherlands, and the united states have strong research programmes for creating new forms.
- ❖ Breeding in roses is a continues process some of the early workers in rose are Darkness, Wheatcraft, Meilland, Kordes, Morey, Ratsek, Flory Yarnell, and many other nursery men worked an breeding and roses.
- ❖ In India Dr. B.P. Pal, Shahare & Shashtri, Banda, Banerjee, Kasturirangan, M.S. Veeraghavan, M.N. Hardikar, J.P. Agarwal & Lata etc. However, B.P. Pal is the pioneer rose breeder in India.

6.4.1. TECHNIQUES OF HYBRIDIZATION:

STEPS:

1. The anthers of stamens are removed from female parents just before the flower open/ bud stage. It is done with scissor/sharp knife without damaging the stigma this process is called '*emasculation*'.
2. Petals of the flower which is selected as the male parent are removed and when the anthers burst they are gently rubbed on the stigma of the female parents.
3. Butter paper bag is covered over the crossed flower to avoid further cross-pollination by insects.
4. The pollinated flowers are labeled indicating the cross and date of crossing.
5. Within a week of pollination the ovary swells if it is successfully crossed and forms the 'hip' when the hip turns yellow/orange/red is the indication of its maturity. It takes about 3-6 months for maturity after pollination.
6. Harvest at brown stage, dry them and extract the seeds. Most of the rose seeds are in dormancy when they mature. Before sowing the fresh seeds they have to be stratified at 1.6 –4.4°C for 6 weeks in cold storage. In some species it requires up to 10 weeks it is better to treat the seeds with warm and then cold stratification for uniform germination.
7. Sow the seeds about 5cm deep in carefully prepared media.
8. It takes several days to weeks for germination.
9. When the seedlings are 10-12 cm they are transplanted into pots and
10. Subsequently they may be used for budding on the best root stock.

6.9. ROSE BREEDING IN INDIA:

- The rose breeding work in India is comparatively a recent origin and was taken up in right earnest in the last five decades or so.
- Though B.S. Bhattacharjee a rose nurseryman from Deoghar (Bihar) is acclaimed the pioneer rose breeder in India who evolved a fairly large number of roses,
- The breeding work done by Dr. B.P. Pal, evolved several outstanding cultivars like Dr. Homi Bhabha (white), Delhi princes and Banjaran (Red) under his guidance, a comprehensive rose breeding programme was started in 1960 at IARI leading to the evolution of more than 100 rose cultivars so far more than 300 cultivars have been developed in India.

IMPORTANT CULTIVARS DEVELOPED BY DR. B.P. PAL AT IARI, NEW DELHI:

HT ROSES - Anurag, Arju, Bhim, Chitwan, Dr. B.P. Pal, Homi-Bhabha, Jawahar, Kanakangi, Mridula, Mrinalini, Poormina, Rajasurendra Singh of Nalagrath and Raktagandha among Hybrid Tea groups.



FLORIBUNDAS GROUP:

Banjaran, Chandrama, Delhi Princes Loree, Mohini, Neelambari, Prema, Rupali, Sadabahar, Shabnam, Sindoor, Suchitra and Suryairan.

DEVELOPED BY AMATEURS AND NURSERYMEN:

- Srinivasa, Sugandha, Raja Ram Mohan Roy, Dr. Radha Krishnan in H.T. Roses.
- Several cultivars have been evolved through natural mutation or as bud sports of the existing cultivars.
- At IARI three cvs were developed through induced mutation.
 1. Abhisarika from Kiss of Fire;
 2. PUSA Christina from Christian Dior and
 3. Madhosh from Gulzar.

6.10. BIOTECHNOLOGY:

1. Tissue culture:
2. Anther culture
3. Protoplast culture
4. Protoplast fusion
 - i. Somatic embryogenesis – leaf, internodes, filament of stamen, root and zygotic embryo
 - ii. Embryo development and germination of somatic embryos.
 - iii. Somaclonal variation.
5. Biochemical and molecular markers
 - ◆ Genetic linkage and identification of genotypes.
 - ◆ Iso-zymes- acid phosphatase, malate dehydrogenase and phospho glucose isomerase, all the three enzymes are useful in identification of the species.
 - ◆ **Molecular markers:** to study the genetic background with the help of iso-enzymes and RAPD markers-are produce specific DNA banding pattern.
 - ◆ **Detection of pathogen:** by use of RFLP & RAPD pattern.

b. Genetic transformation:

Transgenic rose plants were developed using an embryogenic callus line. Friable embryogenic callus was cocultivated with *Agrobacterium tumefaciens* strain RBA 4404.

KNOWLEDGE ASSESSMENT:

- 1) _____ parts are used in somatic embryogenesis of rose
a) Leaf b) internodes c) filament of stamen d) all of these.
- 2) Detection of pathogens is done by _____ techniques.
a) RFLP b) RAPD c) both a & b d) none of these.
- 3) Transgenic rose plants were developed by
a) Protoplast culture b) Protoplast fusion c) Anther culture d) Genetic transformation
- 4) In Subtropical climate rose flowering is in _____ season.
a) Summer b) winter c) spring d) round the year
- 5) An ideal soil pH for rose cultivation is
a) 5.5- 6 b) 6-7.5 c) 4.5- 5.5 d) 5.5 – 6.5
- 6) An ideal sunshine duration sunshine for better growth and flowering in rose .
a) 4 hours b) 8 hours c) 6 hours d) none of these .
- 7) The basic chromosome number of rose
a) $2n=14$ b) $2n= 28$ c) $n= 7$ d) $n=14$
- 8) Anthocyanin responsible for blue colour in rose
a) Pelargonidin b) Cynidine c) flavonols d) delphinidin
- 9) Methods of Breeding in rose
a) Introduction b) Selection c) Hybridization d) all of these
- 10) The pioneer rose breeder in India.
a) B.P. Pal b) Veeraghavan c) Kasturirangan d) all of these
- 11) The cultivar Dr. Homi-Bhabha developed by B.P. Pal is of colour
a) Red b) pink c) yellow d) white
- 12) The varieties evolved at IARI
a) Poormina b) Jawahar c) only a d) both a & b
- 13) Mutent from Kiss of Fire
a) Banjaran b) PUSA Christian c) Madhosh d) Abhisarika
- 14) Mutent from Christian Dior
a) PUSA Christian b) sharadha c) Abhisarika d) none of these
- 15) Mutent from Gulzar
a) Abhisarika b) Delhi princess c) Mrinalini d) none of these

(Key answers: 1)d, 2)c, 3)d, 4)d, 5)b, 6)c, 7)c, 8)d, 9) d, 10)a, 11)d, 12) d, 13) d, 14) a, 15) d)



LECTURE - 7

ROSE

Topics

- 7.1. Propagation of roses
- 7.2. Root stocks
 - 7.2.1. Characteristics of good rootstock
 - 7.2.2. Some of the common rootstocks
- 7.3. Micro-propagation
- 7.4. Growth and Flowering of Roses
- 7.5. Layout and preparation of Beds
- 7.6. Preparation of Rose beds
- 7.7. Irrigation
- 7.8. Manures and Fertilizers
- 7.9. Mulching
- 7.10. Weed control

7.1. PROPAGATION OF ROSES:

Methods:

I. Seed propagation and

II. Vegetative propagation:

II. Vegetative propagation:

1. Cutting:

- Propagation of roses by cuttings normally done to raise root stocks for grafting or budding.
- Also for multiplying vigorous types of cultivars.
- Climbers, ramblers, polyanthus and miniature roses respond quite well to this method.

a. Stem cuttings:

- Easiest and least expensive method. Each shoot should be cut clean just below the node and lower leaves are removed.
- Cuttings may be single, double or triple-eyed below for rooting.

b. Root cuttings:

- Some rose species like *R. blanda*, *R. nitida* and *R. Virginiana* can be propagated by root cuttings.
- More resistant to frost than stem cuttings but the growth & flowering is poor in root cuttings.
- *The growing point should be always top.*

2. Layering:

- Usually practiced in climbing and rambling cultivars.
- Practiced in early monsoon or early spring.
- Not good due to the fibrous root.

a. Air layering:

- It consists of removing of the bark, about 2.5cm long and apply rooting hormone IBA/NAA @10ppm and cover with rooting media.
- The use of damp sphagnum moss around the ringed portion and cover with polyethylene film for quick rooting.

b. Ground layering:

- It is performed by bending the shoots to the ground and covering it with soil, but leaving the terminal and exposed.
- Cutting or notching should be given in the underside of the stem.
- Rooting take place in a month or so and the layered shoots is detached 15-20 days after root formation.

3. Grafting: Inarching is another method of propagating roses, but has many disadvantages.

- Failure is common
- Flowering wood is scarified.
- The cost of grafted plant is costlier than budded plants.
- Not popular due to above drawbacks.

4. Budding: Budding is the most popular and successful method for multiplying roses.

- 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.
- Rooted cuttings of stock or seedlings with roots are used as in grafting.
- T-budding, inverted T and slit method (I).

- Shield or T-budding is commercially practiced.
- On the selected rootstocks, the buds are inserted into a T-shaped incision and then tied with suitable wrapping material or polyethylene sheets /tape, adhesive tape, binding rubber strip.

Time of budding:

- The time of budding varies from place to place.
- The right stage of budding is when the plants have good sap flow and the cambium tissue is highly active.
- The best times for budding in different regions are as follows.
 - In eastern India January-March due to the ideal temperature in spring season.
 - Northern India – December-February.
- In places with mild climate, all the year round, like in Bengaluru, Pune, Dharwad etc. budding can be done almost any time.
- Bud woods can be stored at 0°C and utilized for budding.
- Should be preferably done 5-7cm above the ground.
- It takes 3-4 weeks for bud union. The ideal temperature is 10-25°C.

7.2.1 ROOT STOCKS:

- For grafting or budding proper selection of root stock is very important.
- Root stocks are known to impart marked effects on the
- Vigour, Precocity (early maturity), Productivity, Quality of bushes and Disease resistance
- Adoptability to varied soil and climatic conditions etc. therefore, it is necessary to choose the most suitable root stock for budding or grafting roses.

7.2.3. CHARACTERISTICS/ QUALITIES OF GOOD ROOT STOCK:

- ✓ It should produce strong fibrous root system.
- ✓ It can be easily propagated by cuttings.
- ✓ It should have vigorous growth habit, healthy and resistant to pests, disease and frost.
- ✓ Plant should have uniform growth rate.
- ✓ It should have thick bark to hold the bud.
- ✓ It should be reasonably free from suckers.

- ✓ It should support the budded plant to survive for a long tissue.
- ✓ It should withstand a wide range of soils and climatic conditions.

7.2.3. COMMON ROOTSTOCKS:

1. *Rosa bourboniana* (*Edourad rose*) – Popular in northern plains of India. They have straight and long stem.
2. *R. canina inermis* (Dog rose): popularly used in Europe, very hardy and is an excellent rootstock.
3. *R. indica var adorata*: Tolerant to powdery mildew & other insects. Resistance to extreme soil conditions.
4. *R. laxa*: common in Europe.
5. *R. maneth*: Common in Europe, used for dwarf roses. Resistant to verticillium wilt.
6. *R. multiflora*: Var. *incremis* good for outdoor roses. Resistant to nematodes.
7. *R. rugosa*: Widely used in Europe for standard roses
8. *R. fortuneana*:
9. *R. moschata*:
10. *R. eglanteria*
11. *R. sempervirens*
12. *R. rubiginosa*;
13. *R. chinensis* etc.

7.3. MICRO-PROPAGATION:

- ✓ Propagation *invitro* is a rapid and cheaper method.
- ✓ **Explants:** shoot apices, axillary buds, leaf blade,
- ✓ Media; Murashige & Skoog's (BA @2.0mg and NAA @0.1 mg/litre), MS Media: contains 20g sucrose + 6-8 g agar/litre +1 mg IBA
- ✓ Usually breeders use this method for faster way of multiplication to bulk up a new variety.
- ✓ These are free from pests and diseases.

Drawbacks:

- ◆ They take long time for establishment.
- ◆ Takes minimum one year to produce saleable flowers.
- ◆ These are used for multiplication of pot roses.
- ◆ Cost of plantlets is also high.
- ◆ Not commonly used in rose propagation.

7.4. GROWTH AND FLOWERING OF ROSES:

There are many factors which affects the growth and flowering of roses, viz.,

1. Genetic or inherent factors
2. Environmental factors (light, temp., RH, Aeration, and CO₂.)
3. Managerial factors (nutrition and soil factors, pruning, pinching, defoliation, plant growth regulators).

1. Genetic or inherent factors:

- ◆ Like other plants, growth and flowering behavior of roses is governed by genetic factors.
- ◆ Significant difference in growth & flowering of different rose species and cultivars have been observed which are due to genetic variation existing among them.
- ◆ There are tall cultivars growing several meters high and are suitable for planting in back yard as hedge, on the other hand, Miniature roses with dwarf habit and producing small flowers.
- ◆ Several cultivars are bushy in nature while many are climbers and ramblers, similarly there is wide, variation with respect to days to flowering, flowering duration, size, quality and flowers etc.

2. Environmental factors:

- ◆ Moderately cool climate with bright sunshine and free aeration/ventilation is very good for rose growing.
- I. **Light:** Light is one of the most important factors influencing the flowering, light intensity, duration and quality of light plays an important role.

1. **Light intensity:**

- 6000-8000 ft candles or 6-8 K is good for roses and it was observed that, during winter season flower colour is better than any other season.
- During summer flower colour fades.
- In general rose requires bright sunshine for the whole day. It should be free from shades of trees and protected from the strong winds.

2. **Temperature:**

- It is another imported factor regulating growth and flowering of roses.
- It affects both quality and quantity of flowers.
- Mild temperature is very important about 15.5°C is ideal for its cultivation because of this reason in winter we get good crop.
- On sunny days 25-30°C. Whereas on cloudy day it must be 18-20°C.
- However a maximum of 28°C in day and 15-18°C in the night will be ideal for rose production.

3. **Humidity:**

- RH is very important with respect to pests and disease incidence especially mildews and black spot as they are closely associated with high RH in greenhouses as the high humidity results in condensation of water on flowers and leaves.
- About 60% RH is the most ideal for rose production.

4. **Aeration/Ventilation:**

- An exchange of air in greenhouse is desirable for normal growth and development of roses.
- Air circulation ensures an adequate supply of CO₂ and O₂ for physiological process occurring in the plants and also reduces the RH.

5. **Carbon dioxide:**

- In western countries an additional 1000-3000 ppm of CO₂ are ejected into the greenhouse to increase the growth of the plant as well as quality flower production.
- It also helps in increasing the stem length and reduces the incidence of flower abortion.

7.5. LAYOUT OF BEDS:

- The plan of rose garden and design of the beds should be simple and formal or informal.
- Rose beds may be of various designs, depending upon the preference of the grower.
- However rectangular beds are advantageous for maintenance.
- The width of the bed 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 in the bed.
- The width should be 1.2-1.6 m and the length depends on the size of the garden, preferably not exceeding 6m each.

7.6. PREPARATION OF ROSE BEDS

- Preparation of soil is the key of 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 the soil gets exposed to hot sun and air and during the monsoon it gets a chance to settle down before planting.
- Grasses any perennial weeds should be removed along with their roots, knots, rhizomes, etc. by deep digging.
- The soil should be pulverized; gravels, stones, brick pieces and other foreign materials removed and exposed to sun for at least a week.
- Land should be thoroughly prepared.
- Pits or trenches are to be made and basal dusting with Malathian has to be done. The pit / trench should be filled with soil and FYM mixture (2:1).
- In Trench system, trenches of about 2.5 feet width and between trenches 2-3 feet with any convenient length with 1 – 1.5 feet depth.

PLANTING :

There are two types of planting systems are commonly followed in rose production, viz,

1. **Pit system**: 45 cm^3 (Length x Breadth x Depth)

2. **Trench system:**

- 60 – 75 cm (2-2 ½ ft) Wide
- 30-45 cm (1- ½ ft) Depth
- Any length depending upon availability.
- 60-90 cm (2-3 ft path) between the trenches.

SPACING: It varies from types of roses, soil to soil and place to place and purpose of planting.

Protected cultivation

60x30 cm.
30x20 cm.
30x30 cm.

Outdoor cultivation

75x75 cm for Hybrid
60x60cm for other varieties

However from the management point of view 60 x 60 cm is ideal for outdoor cultivation.

PLANTING: This operation should receive very careful attention and to do this job well there are few operations / steps have to be attended for preparation of planting materials.

1. Remove all immature, dead, inward growing or diseased shorts.
2. Remove all the suckers growing below the point of bud union.
3. Reduce the possibility of loss of moisture by removing some leaves including dried and yellow.
4. If the rose plants are procured with shriveled bark, immerse the plants in water for 24 hours to plump up.
5. Before planting the plants should be immersed in 0.1 % Blitox solution (*i.e.* 1.0 g In 1 liter of water) to lessen the risk of attack of fungi.
6. Planting should be done in thoroughly prepared beds or trenches or pits.
7. At the time of planting the soil should not be too wet or too dry.
8. The plant should be planted at a proper depth by keeping the bud union 2.5 – 5.0 cm above the soil level.
9. The gap in the hole is to be filled with the soil which was dugout and pressed properly to anchor the plant firmly.
10. Then the soil around the stem should be rammed firmly by treading over with feet. This will press out air pockets in the soil which will help the roots coming in contact with the soil particle and intake of water and nutrients through the rootlets.
11. The beds after planting thoroughly have to be irrigated immediately.
12. The best planting time depends mainly on the climatic conditions of the region. In countries with severe winter, planting may be done either in autumn (or) in the spring when plants are in dormant condition and easy to handle.

13. The best season is rainy & winter for better establishment (June – October)
14. Immediately after planting stake the plants.

7.7. IRRIGATION:

- Adequate soil moisture is very much essential throughout the vegetative and flowering stages of roses,
- Water logging condition is not good for rose cultivation.
- The frequency of irrigation depends on
 - Stage of growth
 - Soil texture/ Media
 - Climate and
 - Type of production-field or pot culture.
- Normally the lighter soil requires more frequent irrigation than heavy soils.
- In general water the rose beds once in a week or 10 days in winter and twice a week during the summer season.
- Different system of irrigation is prevalent in various parts of the world.
- Drip irrigation is deal for roses.
- High concentration of salt in water is harmful to the rose plant which results in chlorosis; tip burning and reduction in flower yield and stem length.

7.8. MANURES AND FERTILIZERS:

- ➡ Rose is a nutrient loving plant and all 16 essential nutrients are known to play an important role for its proper growth and development.
- ➡ In addition to major nutrients like N, P₂O₅, K₂O, Ca, Mg & S and micronutrients like Fe, Mn, Cu, B, Mo, Zn, etc.
- ➡ The dosage of nutrients varies from soil types and climate as well.
- ➡ Basic manuring with bulky organic matter has to be done before planting.
- ➡ After establishment as well as immediately after pruning both organic and inorganic manures have to be applied.
- ➡ Supplementary manuring should be done after the first flush of blooming is over and there is a pause for the next flush.

- It was reported that monthly application is better for healthy growth and flowering.
- The recommended fertilizers dose for rose is 10: 10 : 15 g of NPK / plant after each pruning. Along with this 100 g of rose mixture (complex) has to be given normally twice a year i.e. after each pruning.
 - First dose – 15 days after pruning (when the new growth has started)
 - Second dose – After the first flush is over.
 - Third dose – After second flush is over, before the spring blooming.
 - FYM – 05-10 kg / bush
 - The fertilizers should be applied 20 – 25 cm away from the stem.

Liquid fertilizers

- Are also been practices through fertilizers for spray hardening the limp stem and getting good blooms for exhibition purpose.
- Dissolve Potassium nitrate @ 680 g, ammonium sulphate @ 340 g and potassium phosphate @ 170 g in 96 gallon of water & applied @ 0.5 gallon / plant .
- Micronutrients like Rose mixture / multiplex, etc. are given through foliar spray
 - 7.09 g – pot. Sulphate
 - 14.17 g – Amm. Sulphate
 - 28.35 g – pot. Nitrate in 8 gallon of water and be applied @ 1.36 g / liter of water

7.9. MULCHING:

- ◆ Mulches are used for a number of purposes on rose beds or in green houses.They conserve;
 - Soil moisture
 - Supply humus
 - Suppress the weeds
 - Keep the soil somewhat cooler in summer months
 - Results in improvement of growth and flowering of roses.
 - For mulching well decomposed garden compost, FYM, peat straw, saw dust, ground or whole corn cobs, Black polythene sheets (0-18 mm thickness).

7.10. WEED CONTROL:

- Weeds pose very serious problems in rose cultivation.
- The weeds not only consume water and nutrients but also act as hosts for a number of diseases and pests.
- Manual method is effective, if it is done properly and frequently.

- However, chemical method is economical, convenient and efficient in eradicating weeds by one or two applications.
- Eg: 2, 4-D @ 2 kg 1600 liter per hectare (before flowering) controls broad leaved weeds.
- Nitrofan @ 9 lb ai / acre gave 95% control



LECTURE - 8

ROSE

TOPICS

- 8.1. Pruning in rose
 - 8.1.1. Objectives of pruning
 - 8.1.2. Time of pruning
 - 8.1.3. Where and how to prune?
 - 8.1.4. Types of pruning
- 8.2. Special cultural practices to improve the quality
- 8.3. Harvesting
 - 8.3.1. Time of harvesting
- 8.4. Post harvest technology
- 8.5. Yield
- 8.6. Pests & Diseases of roses
- 8.7. Protected cultivation

8.1. PRUNING IN ROSES:

- Pruning refers to the removal of certain portion of the plant.
- It is an important operation for maintenance of floriferousness and
- To improve the quality of flowers along with vigor of roses.

- **The pruning consists of two operations thinning and shortening of stem.**
 - 1) **Thinning:** Thinning comprises removal of old, weak, dry, twiggy and diseased stems and branches from the point of start.
 - 2) **Shortening:** Means shortening of the remaining shoots, aims to cutting down the last year's growth to a desirable height.

8.1.1. OBJECTIVES OF PRUNING:

- i. To remove the unproductive growth, because rose plant bears flowers on a new shoot.
- ii. To ensure production of large number of strong and healthy shoots.
- iii. To improve the flower production with quality.
- iv. Pruning will force the eye bud to produce the strongest shoot.

- v. It keeps the rose bush in proper shape and size.
- vi. To allow light and air to reach the centre of the rose bush.
- vii. To facilitate various cultural operations like hoeing, weeding, soil scraping, sterilization, manuring so also harvesting the long and straight stems.
- viii. To rejuvenate the old plants. Cut off the old plants from the base to get strong shoots.

8.1.2 TIME OF PRUNING:

- The purpose of pruning will not serve, if it is done at the wrong time.
- Sufficient time must be allowed for the new shoots to mature and flower.
- Late pruning delays flowering as well as reduce the production considerably.
- The best time for pruning in rose is the period when the activity of the rose plant is least and the plant is at dormant to near dormant stage.
- Pruning time will depends entirely on the climate condition of the region.
- In temperate climate it is normally done in spring.
- Over a large area in India (Indo-Gangetic plains) pruning is done only once in a year.
- The most usual time for pruning is during October-November – after rains are well over and the cold season is approaching.
- The staggering of pruning at weekly interval from September end to October end will provide a regular supply of flowers throughout the Winter.
- In some regions pruning is practiced twice a year, i.e. in May and October for monsoon and winter flowering, respectively.

8.1.3. WHERE AND HOW TO PRUNE?

- Every rose stems has eyes (buds) alternating on opposite sides in the leaf axils (usually outward and inward).
- The basic rule in pruning is always to make the cut about half a centimeter above a vigorous bud that finds in the direction one desires the new shoot to grow.
- Since the rose bush has to be kept open in the centre.
- The cut is made at an outward growing bud in standard roses as well as in floribundas.
- Where as in climbing roses the pruning is done at a bud pointing more or less upward.
- Always encourage outward bud to expose the center open.
- Whichever the bud is selected the cut should be slightly slant. As the horizontal cut retains moisture / sap and therefore, is liable to cause fungal growth,

- While making the cut care should be taken not to make it too high above the eye (bud) as there may be chance of die back of shoot.
- On the other hand if the cut is very nearer to the bud, it may die due to sap flow. So cut one inch above the bud.
- It is absolutely necessary to cut the sharp end clean because the broken tissues, bruises or hanging shreds of bark will invite for infestation of pests & diseases.
- All the cut ends should be pasted with cane sealer (copper fungicide) against the attack of fungus and cane boring insects.
- Within a fortnight after pruning new flush of growth will start and within 45 days of pruning new flowers are ready for harvesting.

8.1.4. TYPES OF PRUNING:

The intensity of pruning markedly influences the growth and flowering of roses depending upon the extent and level of shortening. There are three types of pruning practiced in rose *viz.*

1. **Light pruning :**
2. **Moderate pruning :**
3. **Hard pruning :**

1. Light pruning:

- Dried and dead branches are trimmed off.
- Cut either at the 2nd or 3rd eye bud immediately below the flower bearing stalk.
- Removing of tips upto 2-3 buds and is practiced in standard roses, climbers and ramblers.

2. Moderate pruning:

- Healthy shoots are pruned back to 45-60cm from the base.
- Commonly practiced in floribundas and HT roses.

3. Hard pruning:

- Here keeping only three or four shoots of the last year growth and heading back at about three or four eyes from the base.
- Practiced for rejuvenation of old bushes and weak plants
- Pruning is done by leaving 10-30cm from the bud joint.

8.2. SPECIAL CULTURAL PRACTICES TO IMPROVE THE QUALITY OF ROSES:

1. Thinning:

- * Removal of the undesirable growth like inward growth, weak stems, blind shoots, crowded growth.

2. De-suckering:

- * The operation of removal of suckers from root stock i.e. the shoots produced below the bud union on rootstocks is called de-suckering.

3. Pinching:

- * Removal of a part of terminal growing portion of stem is called pinching.
- * It is done to reduce the plant height and to promote auxiliary branching.
- * Pinching of blind shoot is beneficial to increase flowering.

4. Disbudding:

- * Removal of undesirable buds is known as disbudding.
- * Keeping only the central bud and removal of others cause development of a quality bloom.
- * It is done in standard/HT roses to reduce number of flowers.

5. Removal of young vegetative shoots:

- This practice is also known as **de-shooting**.
- It is generally followed in HT roses.

Young vegetative shoots developing from the axils of leaves of basal and lateral shoots are removed to allow only one terminal shoots.

It is important from the point of stalk length.

6. Defoliation:

- * Under special conditions it is followed, but it has reported that removal of leaves from rose plants will increase number of blind shoots,
- * It will force the plants to produce growth and flowering during desired period.

7. Use of growth substances:

- * To some extent some growth regulators like GA₃ and retardants like CCC are used to get more number of flowers with good quality.

- * GA₃ @ 250ppm has been found to increase the stalk length, flower size and reduce number of blind shoots.

8. Removal of faded flowers:

- * If the opened blooms are not removed in time, there is chance of developing fruits bearing seeds.
- * Once the hips are formed and reach the advanced stage of development, growth and flowering are severely reduced during the season;
- * Cutting of faded flowers will force to produce strong lateral shoots which will produce good quality flowers.

8.3. HARVESTING:

- ✓ The stage at which flowers should be cut, either for decoration or for cut flower dispatch is the tight bud stage.
- ✓ When the bud shows full color but the petals have not yet started unfolding.
- ✓ Harvesting at this stage will help the flower to last longer in vases or during transportation for better retention of colour and freshness.
- ✓ The optimum stage may vary slightly depending on cultivar and one has to experience to judge the right stage for cutting.
- ✓ Because a flower bud of a red cultivar when cut at a little early stage may fail to open later.
- ✓ Most pink and red cultivars should be allowed to develop a stage where one of the two outer petals begins to unfurl at the upper point.
- ✓ Loose flowers used for preparing perfumes and various other products also for worshipping are harvested only when they are fully opened.

8.8. TIME OF HARVESTING:

- ✱ The flowers should be cut before sunrise i.e. early morning or late in the afternoon when the sun is about to set so as to avoid damage of buds due to high temperature during the day.
- ✱ Late harvest result in short vase life of cut flower and low oil content.
- ✱ In greenhouses for every two hours flowers can be harvested. The stem cut should always be given above a healthy outward pointing bud with clean and sharp secateurs.
- ✱ It has to be cut above two five leaflet leaves. The cutting of the stem just above the 'Knuckle' (i.e., the point at which the shoot originate is called 'Knuckle') significantly

reduces the flower yield per plant compared to the cutting made above the 1st or 2nd five leaflet leaf stage.

8.9. POST HARVEST TECHNOLOGY:

- Immediately after cutting the stem should be dipped in clean water up to the neck or base of the flower bud. The delay in keeping the cut flowers in water will lead to air entry and results in vascular blockage.

1. Pre-cooling:

- ✦ In a cold storage at the temperature of 4.4-7.2°C the flowers have to be kept immediately after harvesting to remove latent heat which enhances the keeping quality of flowers
- ✦ Then they have to be dispatched to market with maintaining cold chain
- ✦ It should be transported to Airport by 'Refrigerated Van' and store them in cold storage at airport and directly shifted to refrigerated cargo flights.
- ✦ Usually pre-cooling is done for 6-8 hours in winter and 8-12 hours in summer.

2. Pulsing:

- ✦ Treating of cut flowers with 2-4% sucrose solution for 3-4 hours. This treatment makes the cut flower very hardy and turgid to improve the quality of cut flowers, also have less neck bending.

3. Grades:

- ✦ The flowers which are in uniform stem length and developing flower buds should be grouped together at the time of cutting and kept them in separate container.
- ✦ For easy handling the basal foliage and thorns may be removed up to 20 cm at the time of cutting of the flowers.
- ✦ It is necessary to dispatch the flowers within 24-30 hours after harvesting.

4. Packing:

- The graded cut blooms have to be packed in corrugated cardboard boxes (CCB).
- The size of the boxes varies with the quality and quantity of roses to be packed.
- A box of 100cm length x 32.5cm width and 6.5cm height will accommodate 80 roses of 65-70cm long stem.

- The inside area of the box is lined with thin polythene film and very fine newspaper. Moist tissue papers are spread out end to end of the box to provide a cushion to blooms.
- The blooms are generally packed in bundles of 20 each and bundles are tied with string or rubber band
- The upper portion of the each bundle having flower buds and are wrapped in a corrugated paper which is fixed with an adhesive tape or rubber sheet.
- The labeling of cultivars is made on the paper. The lower half of the bundle is wrapped with tissue paper.
- Two bundles are placed opposite to one another all along the length of the boxes in such a way that their flower buds will face the side of the box and their stem end towards the center of the boxes and at the sides there will be cushioning have to be provided.
- After this the stem ends of two bundles on either side are secured firmly with a wooden stick fixed along the width of the box.
- This wooden stick is placed over a strip of foam rubber to avoid damage of stem.
- The inside of the box is finally covered with a sheet of tissue paper before putting the cover of the box.
- Labeling is done with all details includes cultivars, colour, stem length, number of flower/bundle, total quantity of flowers in a box and the firm etc.
- All along the outer edges of the boxes either adhesive tapes or plastic tying strips with tying machine
- The final box will weighs about 5-6 kg.

8.10. YIELD:

- ❖ The yield depends as several factors *viz.*, cultivars, plant density/unit area, flowering duration, pruning method, nutrition, other cultural operations adopted from time to time.
- ❖ On an average the outdoor rose cultivation produces about 60-80 flowers/m²/year
- ❖ Plant density has much influence on total yield. Normally closure spacing yields more number of flowers than wider spacing.

INTERNATIONAL QUALITY STANDARDS OF ROSE CUT FLOWERS FOR EXPORT

General requirements

- Straight, strong stem capable of holding the flowers in upright position.
- Uniform stem length
- Tight bud and open slowly
- Size of the flower should be representative of the cultivars
- Flower Should be free from blemishes, bruising, injuries from diseases and pests
- Flower should have more number of petals arranged capacity

Table . ROSE – *Rosa hybrida* the Society of American Florist standards (SAF)

8.11. Vase life:

- ✦ Senescence in cut roses is characterized by decrease in concentration of anthocyanin, protein and tannic acid and an increase in most amino acids, glutamine, Maleic acid and free ammonia in the petal tissue.
- ✦ The advances in senescence are due to increase in ethylene production and membrane permeability.
- ✦ Pre-cooled and pulsed flowers stored better in general. However some of the preservatives like 8HQC @ 300ppm, 8HQS @ 150ppm, AgNO₃ @20-30ppm, citric acid @ 200ppm have been found to be good for prolonging the vase life of cut roses.

8.11. PESTS & DISEASES OF ROSES:

Important pests like White Flies, Red Scales, Aphids, Thrips, Chafer Beetles, Red Spider Mites, Mealy Bugs White Flies, Jassids (Leaf Hoppers), Digger Wasps, Nematodes (Root knot & lesion nematodes) etc. and diseases like,

DISEASE: Die back (*Diplodia rosarum* + *Collectotrichum* sp), Powdery mildew: (*Sphaerotheca pannosa* var. Rose), Black spot: (*Diplocarpon rosae*), Leaf spot (*Alternaria alternata*) ,Stem blight,Botrytis blight (*Botrytis cineria*),Root fungus – (*Trichoderma viridae*), Rose wilt and Rose mosaic virus.

PROTECTED CULTIVATION OF ROSES

Roses are the most beautiful flowers tops among the cut flowers grown under protected cover and marketed in the world. Excellent shape and size, bewitching colours and good keeping quality attracts people worldwide.

TYPES OF GREENHOUSE REQUIRED:

- Under mild climatic conditions (Bangalore and Pune) roses can be successfully cultivated under naturally ventilated polyhouses.
- However, under warm and high temperatures (Hyderabad and Delhi) it needs forced ventilation system (cool-cell pad) to get quality flowers.

ENVIRONMENTAL REQUIREMENTS:

- Rose is a sun loving plant requires high light intensity,
- Optimum day and night temperature requirement is 24 – 26° C and 15 – 17°c, respectively,
- 75 per cent relative humidity and
- CO₂ level up to 1000 ppm.

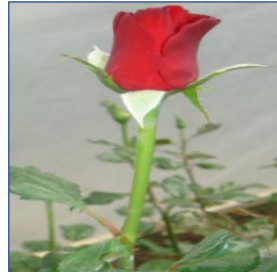
IMPORTANT VARIETIES:

First Red	Lambada	Ambassidor
Noblesse	Sasha	Papillon
Grand Gala	Skyline	Polo
Confetti	Ravel	Lovely Red
Osiana	Golden gate	Tunike

CULTIVARS OF ROSE



Grand Gala



First Red



Golden Gate



Konfetti



Grand Prix



Cream Propytha

CULTIVATION PRACTICES:

BED SIZE:

- 1-1.6 m wide,
- 30-40m long and
- 15-20cm/ 30-40cm height
- 0.5-0.75m between two beds.

SPACING:

- 30-40cm between rows,
- 14-18cm or 15-20cm between plants,
- 6-9 plants/m², However, 7 plants/m² is optimum,

MEDIA:

- Both soil and soil-less substrates (rockwool, peat, sphagnum moss, vermiculites, perlite, leaf mould, coco peat, rice husk etc.,)
- pH 5.5-6.8
- 30-40cm deep well drained, porous, rich in organic content.
- Pasteurize with steam at 70-100°C for 30 minutes or use methyl Bromide @ 25-30g/ M²/ 10ml/cuft for 24-48 hr or Formalin @ 7.5-10.0 l /100 M² or Basamid (Dazomet) @ 30-40g/ M²

PLANTING:

- 6-18 month old budded plants may be planted during May-June.
- The soil should be loose and humid but not too wet nor muddy.

- Planting may be in 2-row system.
- Per compartment of 6.40 metre 6 rows of plants can be planned.
- The distance between the plants in one row varies around 15-20 cm.
- This results at 7 to 8 plants per metre square (depending on cultivar and cultivation system).

GROWTH REGULATION:

- **Primary bending** : Have to be taken up 5-6 weeks after planting to build a strong frame work.
- **Secondary bending** : 4-5 weeks after first bending to get more number of strong shoots.
- **Gradual pruning** : Harvesting of flower shoot will take care of this operation.
- **Direct pruning**
- **De-shooting,**
- **Disbudding** etc.

MANURING:

- Depends on variety, type of medium used, growth stage, irrigation system etc.
- Well decomposed FYM have to be incorporated into the bed @ 100 t/ha.
- Nutrient composition of rose plant based on leaf analysis is 3.0 per cent N, 0.2 per cent P, 1.8 per cent K, 1.0 per cent Ca and 0.25 per cent Mg.
- Nutrient requirement @ 1:0.2:1.2:0.3 NPK & Mg
- Fertigation requirement 170ppm N, 34ppm P, 160ppm K, 120ppm Mg per every watering.

IRRIGATION:

- The first week watering has to be done with sprinklers or hose pipe 5-8 times a day.
- 3-4 weeks after planting drip irrigation may be employed for uniform watering.
- Each plant has to be watered @ one liter/plant/day.

DRIP IRRIGATION.

- A drip irrigation system is recommended; as each plant receives the equal amount of water.
- By supplying the water directly on the potting mix, the plant itself does not become wet (so preventing diseases).
- The dripper line of the irrigation system are placed on the ground between the two rows, this prevent the dripper line becoming empty and keep the water temperature low and the dripper line out the reach of direct sunlight.
- A capacity of 2 liters per hour is preferred as the chance of congestion is smaller.

- By using a drip system, a wet (water) column is created through which the roots grow.
- Place the drippers by planting in the jiffy pot, after 2-3 weeks when the roots are growing out of the jiffy pot into the potting soil replace them approximately 1 - 5 cm from the jiffy pot.

CROP MAINTENANCE AFTER PLANTING:

BENDING IN ROSES:

- After planting, shoots will develop quickly.
- Only after the flower bud becomes clearly visible the shoots are bend-out towards the path and the flowers are removed, this process is known as '**bending**'.
- Since the plants grow about 40 cm above the ground, it is possible to bend down the stems deeply.
- Be careful not to break the shoots, the plant should remain capable of transporting sugars from these areas to the new developing shoots.
- The shoots should be bending down so the grafting place or, if a cutting is used, the old top of the cutting will become the top of the plant.
- The flower buds on these bend-out shoots have to be removed. This system allows the leaves to continue their production of energy.
- When the dominating primary shoots (apical dominance) is removed, causing the plant to respond by developing more basal buds.
- In the plant hormonal changes take place, which promote shoot development (balance cytokinins/auxins).
- After cutting or bending out results in an increased cytokine level, causing buds to break. The shoots formed are producing auxins, so restoring the hormonal balance in the plant.

BASAL SHOOTS

- Depending upon the growth and potentiality of a cultivar the number of basal shoots are formed.
- Per plant 2 to 3 well-formed shoots are allowed to continue growing, if more shoots were formed it is recommended for bending out of these shoots.
- This way a plant has got the use of more active leaf canopy to supply enough energy for development of a heavy crop with first quality flowers.

SPECIAL OPERATION:

1. **Bud Capping:** The flower buds are inserted with nylon a cap which helps for increasing bud size, avoids damage in transportation and maintains the microclimate in package.

HARVESTING AND YIELD:

- Yield starts 4-5 months after planting.
- Harvest the flower buds at **tight bud stage** for longer distance.
- Stem length vary from 40-90cm.
- At harvest it often was practice to cut back to the first 5-leaf stage.
- Hence, it is recommended for cutting back to just above the original cutting.
- The length of the remaining stem decides the number of shoots (flower stems) which will grow back.
- If too much (4-6 cm) stem is left, many shoots are formed of a poor quality. Therefore it is advised to cut back to 1 cm.
- After 1 to 1.5 year the rose bush is cut back to approximately 10 cm above the original cutting, so creating a new top. Now again only 1-cm stem is left after harvest.
- Flower yield ranges from 100-150 stems, 200-225 and 250-350 stems per m² in large hybrid tea, medium types and small and sprays, respectively.

QUIZ:

- 1) Rose is commercially propagated by
 A) Seeds B) Budding C) Tissue Culture D) Cuttings
- 2) Explants used in micro propagation of roses
 A) Shoot Apices B) Auxiliary Buds C) Leaf Blade D) All of These
- 3) ideal light requirement of rose
 A) 6000-8000 ft Candles B) 5500-6000 ft Candles C) 5000-5500 ft Candles D) 6000-7000 ft candles
- 4) Normal spacing followed for rose cultivation outdoor
 A) 75x75cm B) 60x60cm C) Both A & B D) 45x45
- 5) Mulching is done in rose
 A) Suppress The Weeds B) Soil Moisture C) Supply Humus D) All of These
- 6) Pruning in Roses is done to
 A) Develop Frame Work B) To Remove Dead And Diseased Branches C) Both A& B D) None of these
- 7) Removal of certain portion of the plant is referred as
 a) Pruning b) Thinning c) Shortening d) both a & b
- 8) In moderate pruning healthy shoots are pruned back to _____centimeters from the base.
 a) 45-60 b) 20-25 c) 30-45 d) 60-65
- 9) Pruning done for rejuvenation of plants
 a) Light pruning b) Moderate pruning c) Hard pruning d) Thinning
- 10) The correct stage of harvesting of rose
 a) Tight bud stage b) full bloom stage c) colour break up stage d) none
- 11) Pre-cooling temperature for rose
 a) 4.4-7.2°C b) 3.5- 3.8°C c) 2-3°C d) 2.5 - 4°C
- 12) Most serious disease in rose after pruning
 a) Canker b) die back c) stem rot d) rose wilt

(Key answers: 1)b, 2)d, 3)a, 4)c, 5)d, 6)c, 7)d, 8)a, 9) c, 10)a, 11)a, 12) b)



LECTURE - 9

CHRYSANTHEMUM (*Asteraceae*)

(*Chrysanthemum morifolium* /*Dendranthema grandiflora*)

TOPICS

9.1. INTRODUCTION:

9.2. ORIGIN

9.3. IMPORTANCE AND USES

9.4. CLASSIFICATION

9.5. CULTIVARS

INTRODUCTION:

- Chrysanthemum is a popular commercial flower crop of the many countries.
- It is next only to rose in value of flower trade in the world market.
- The word **Chryso** means ‘golden’ and **anthos** means ‘flower’.
- It is commonly known as ‘Queen of East/ autumn queen/ guldaudi.
- Japanese National Flower.

10.1 ORIGIN:

- ◆ Native to Europe and Asia
- ◆ It originated in Europe and Asia (China).
- ◆ Species involved in the development are *C. sinense*, *C. indicum*, *C. japonicum*, *C. ornatum*.

10.2. IMPORTANCE AND USES

- ❖ In India too, chrysanthemum occupies a place of pride both as a commercial crop and as a popular exhibition flower.
- ❖ It has a wide range of type, size and colour and also ‘forms’.
- ❖ Short day plant – ‘Photo sensitive’ (10 hours day light)
- ❖ The erect and tall growing cultivars are suitable for background planting in borders or for cut flowers.

- ❖ The cultivars with the dwarf and compact growing habit, on the other hand, are suitable for front row plantation or pot culture.
- ❖ The decorative and fluffy bloomed small-flowered cultivars are ideal for garland making and hair decoration.
- ❖ The extra large-bloomed cultivars for their exhibition value.
- ❖ Tall growing type suitable for background planting in borders.
- ❖ Dwarf growing for flower beds and pot culture (pot mums)
- ❖ Loose flowers – garland, veni, worship etc.
- ❖ Long stem flowers – cut flowers for Bouquet, Vase etc.
- ❖ *Chrysanthemum morifolium* is also an important source of essential oil and sesquiterpenoid alcohol.
- ❖ The species like *Chrysanthemum cinerariifolium* and *C. coccineum* are also being cultivated as sources of pyrethrum and an important insecticide.
- ❖ Chrysanthemums are the most popular cut flower sold in the United States.
- ❖ The chrysanthemum is one of the most beautiful and perhaps the oldest flowering plants, commercially grown in different parts of the world.
- ❖ It is important both as cut flower and as potted plant in the international market.
- ❖ In Dutch cut flower auction, chrysanthemum ranks 2nd after rose.

10.3. CLASSIFICATION

- ◇ The species of the genus *Chrysanthemum* are annual, perennial herbs, sometimes partly woody.
- ◇ The genus *Chrysanthemum* belongs to the family Compositae / Asteraceae.

Class 1. Single

- ◇ Ray florets in a single row at right angles to the stem.
- ◇ Disc is flat to slightly round and may be of contrasting colours, e.g., Potomac.

Class 2. Semi-double

- ◆ Ray florets in more than one row at right angles to the stem but may curve downward at the tips.
- ◆ Disc as in class 1.

Class 3. Anemone

- ◆ Ray florets variable, from flattened, broad and equal in length to reflexing, pointed at tip and unequal in length.
- ◆ Disc florets are numerous tube-like and elongated so as to form a prominent disc which may range from flat to hemispherical in form.

Class 4. Pompon

- ◆ Bloom globular, somewhat flat in young stage or small button type.
- ◆ Ray florets broad, incurved, smooth and firm with good substance.

Class 5. Incurve

- ◆ Breadth and depth should be equal to produce a globular bloom.
- ◆ Ray florets narrow to broad, smooth and incurve in a regular to an irregular manner without producing an open centre, e.g., Snow Ball, Mountaineer, Nob Hill.
- ◆ An Irregular Incurve chrysanthemum, or 大菊 *Ōgiku* in Japanese, meaning "big chrysanthemum". The size of this flower is around 20cm (about 8 inches).

Class 6. Reflexing incurve

- ◆ Ray florets usually broad and smooth. Breadth and depth nearly equal to form a globular bloom, sometimes flattened, may be less compact than incurve.
- ◆ All mature florets not completely incurving and not all completely reflexed.

- ◆ The lower florets sometimes reflexing to give a skirted effect, e.g., Dream Castle, Indianapolis.

Class 7. Decorative

- ◆ Ray florets from short and broad to narrow, long and pointed, they generally reflex, although upper florets may tend to incurve.
- ◆ Blooms more flattened than globular,
- ◆ e.g., Otome Pink, Princess Anne.

Class 8. Reflex

- ◆ Bloom globular with equal depth and breadth and a full centre, or somewhat flattened.
- ◆ Ray florets narrow to broad, gracefully overlapping in either a regular or in an irregular manner and reflexed.
e.g., Coronation Pink.

Based on the size, shape of flower, arrangements of florets and purpose used, the chrysanthemums are classified into several groups.

- i) Small flowered types.
- ii) Large flowered types
- iii) Classification based on plant growth
- iv) Based on usage.

I. SMALL FLOWERED

1. **Singles** – The petals are arranged in one or not more than five rows with prominent central disc.
2. **Anemones** – Prominent centrally raised hemispherical cushiony disc florets surrounded by short rounded or flat or twisted or quilled ray florets. Ex: Golden sands, White sands.
3. **Korean single** – Small flowers with a prominent central disc, ray florets are flat, number of whorls or ray florets are five and less than five. Ex: Cardinal, Gul-e-Sahir, Chairman.
4. **Korean double** – The number of whorls of ray florets are more than five and the central disc is open. Ex: Flirt, Man Bhawan.
5. **Spoon** – The outer ray florets are tubular with a spatula or spoon like opening at the tips. Ex: Anokha.
6. **Decorative** – Fully double flowers with flat petals and central disc is generally absent or not seen, ray florets are longer. Ex: Aretic, Elegance, Blue chip, Dolly.
7. **Quilled** – Small flowers, ray florets are tubular. Ex: Golden crystal, Snow crystal.
8. **Button** – Very compact, small flowers, produce numerous flowers. Ex: Golden dust.
9. **Pompon** – The flowers small, freely opened, compact, hemispherical or ball shape, the central disc is concealed or absent, florets neatly arranged. Ex: Apasara, Jayanthi, Lameo, Dandy, Eve.

II. LARGE FLOWERED TYPES

1. **Incurved regular** – The outer ray florets curve upwards and inwards towards the disc florets to form a globular shape. Ex: Snow ball, Sonar Bangla, Chandrama.
2. **Incurve irregular** – The outer ray florets incurve loosely and irregularly and do not form a ball as in case of regular.
3. **Refluxed** – The outer ray florets curved outwards and downward away from the centre so that only their upper surface is seen. Ex: Cresta, City Beauty, Golden Rule, Day dream, Peach blossom, Sweet Heart.
4. **Intermediate** – The inner florets incurved and outer florets are reflexed, they are intermediate in shape to incurved and reflexed. Ex: John Reid, Lady Hope town.
5. **Spider** – The outer ray florets are large, elongated, tubular and curved to form a hook or coil like structure at the tip of the petals. Ex: Rupasi Bangla, Mahatma Ganthi.
6. **Quill** – The outer ray florets are elongated, straight and tubular like a quill with tips open but not flattened.
7. **Exhibition** - The outer florets are reflexed and inner florets incurved, the ray florets are generally twisted, irregularly overlapped each other and looks attractive.
8. **Ball type** – Ray florets are straight and radiated in all directions to give a complete ball shape.

III. CLASSIFICATION BASED ON PLANT GROWTH

1. **Standards** – plants with single flower, other buds are removed if arise from the laterals and produce big flower.
2. **Spray** – The main apex bud is removed and lateral buds are allowed.
3. **Pot mums** – Small flowered mums with 6-9” height are beautiful in decorating the places.

IV. BASED ON USAGE.

- Cut flowers –
 - i) Disbudded inflorescence
 - ii) Spray inflorescence
- Loose flowers
- Potted/bed plants

SPECIES AND CULTIVARS

- The number of species under the genus *Chrysanthemum* varied from 100-200.
- Some important species are:
- $n=9$ ($2n=18$ to 90)

1. *Chrysanthemum boreale* : Abura – Giku
2. *C. carinatum* : Tricolor chrysanthemum
3. *C. coronarium* : Garland chrysanthemum
4. *C. cinerariifolium* : Dalmatian pyrethrum
5. *C. rubellum* – sturdy species used for breeding of hardy cultivars.
6. *C. satsumense* : Satsuma-nogiku
7. *C. sinensis*- One of the sources of today's florists' mums.
8. *C. sibiricum* is one of the parents for Korean hybrids.
9. *C. coccineum* : Painted daisy
10. *C. indicum* : Chinese/ Japanese mums
11. *C. morifolium* : *Florists' chrysanthemum*

- *C. morifolium* is a hybrid species and is the result of repeated cycles of inter-specific crossing among elemental species extending over a period of 2500 years.

- Plants are perennial.

C. carinatum : Tricolor mums

C. coronarium

C. frutescens

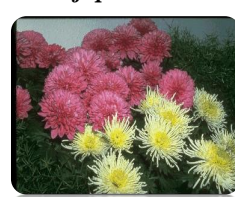
Florists' chrysanthemum (*C. morifolium*):



***C. indicum*:**



***C. japonicum*:**



10.4. CULTIVARS

- More than 15000 cultivars are listed in Japan alone.
- The National Chrysanthemum Society of Britain lists over 6000 cultivars.
- In India also more than 500 cultivars.

PROMISING CULTIVARS OF CHRYSANTHEMUM



Birbal Sahni



Fiji



Baggi



Mountaineer



Snowball



Sonar Bangla



Tata Century



Thai Ching Queen



Nanako



Fiji Yellow



Surf



Ajay

SPRAY TYPES

White	:	Super white, White spider
Yellow	:	Sunbeam, Super yellow
Pink	:	Blue Marble, Blue Winner
Pale pink	:	Pink Marble, Snapper
Red	:	Red Fandango, Red Nero, Red,
Bronze	:	Bronze Nero, Tuneful
Light bronze	:	Apricot Marble, Orange Aglow
Purple	:	Fandango, Flamenco
Salmon	:	Coral Marble

STANDARD TYPES

White	:	Giant Indianapolis White, Snow Ball
Yellow	:	Bright Golden Anne, Chandrama
Pink	:	Cassandra, Deep Champagne
Red	:	Red Anne
Bronze	:	Resilient, Alfred Wilson
Light bronze	:	Gay Anne
Purple	:	Purple Anne

SMALL-FLOWERED FOR POT CULTURE

White : Mercury, Honeycomb
Yellow : Aparajita,
Maive : Megami

SMALL-FLOWERED FOR CUT-CULTURE

Yellow : Sujata
Maive : Nilima

SMALL-FLOWERED FOR GARLAND

White : Birbal Sahni, Sharad Shobha
Yellow : Basanti

VARIETIES DEVELOPED AT NBRI, LUCKNOW

1. Ajina Purple:

- It is a regular incurve type of chrysanthemum with very large flowers.
- Ray florets are narrow to broad.
- Florets are very smoothly incurved in a pattern to form a perfect ball.
- Disc is not visible.

2. Snowball:

- It is a regular incurve type of chrysanthemum with very large flowers.
- Ray florets of this variety are narrow to broad.
- Florets are very smoothly incurved in a pattern to form a perfect ball.
- Disc is not visible.

3. Potomac :

- It is a single large flowered type of variety.
- Ray florets of this variety are long, elongated and strap like.
- Number of whorl of florets restricted up to four.
- The disc is conspicuously visible.

4. M-24 :

- It is a large flowering variety of spoon type.
- Ray florets of this variety are tubular with spatula like open tips.

- The size of open portion varies.
- Disc visible.

5. Agnishikha :

- It is a gamma ray induced new mutant.
- It is a small flowering variety of decorative type producing erythrite red flowers.
- Ray florets are strap-like.
- Number of whorls of ray florets is more than five.
- Disc is not visible due to developed ray florets.

6. Batik :

- It is a gamma ray induced new mutant, which unique colour combination of yellow stripes on red background

7. Harvest Home:

- It is a small flowered variety of stellate type.
- Ray florets of this variety are strap-like but both the side of ray florets are reflexed downward.
- Florets may not be twisted.
- Disc flat with short florets.

8. Gypsy Queen :

- It is a large flowering variety of spider type.
- The ray florets are tubular and elongated with tips open or closed.
- Tips may be open or closed but in either case they are coiled or hooked.
- The rays may either fall or spread.

9. Navneet Yellow :

- It is a gamma ray induced new mutant, which produces yellow flower heads.

10. NBRI Indiana:

- It is a small flowered, yellow, pompon type, suitable for mini and pot culture.
- It is also a very good cut flower and garland variety.
- It has been developed by crossing 'Little Darling' (orange) as female and 'Nanako' (yellow) as male parents

11. Gamit :

- It is a large flowering variety of reflexed type.
- Ray florets of this variety are narrow to broad.
- Ray florets bent backward and downward.

- Inner florets remain incurved at the early stage concealing the disc florets of the bloom.
- Outer florets turn outward from the central tuft.
- Blooms look globular but may be somewhat flattened.
- Average bloom size 15-20cm.

12. Nanako :

- It is a small flowered variety of pompon type.
- Ray florets of this variety are short, broad and very systematically and uniformly arranged .
- Width and breath almost equal.
- Ray give florets may be incurved or reflexed.
- Disc is normally covered or inconspicuously open.

13. Gauri :

- It is small flowered variety producing white flower yellow heads in the centre.
- A gamma ray induced new mutant of this variety has also been developed which produces yellow colour flowers.

14. Rosa :

- It is a small flowering variety of anemone type.
- Disc florets of the flowers are well developed and prominent.
- Ray florets may be flat, twisted and quilled.

15. Shabnam :

- It is a small flowering variety of decorative type.
- The disc is not visible due to developed ray florets.
- Ray florets regular or irregularly reflexed .

16. Taruni :

- It is a large flowered variety of reflex incurve.
- Ray florets of the flowers are narrow to broad.
- Ray florets bent backward and downward.
- Inner florets remain incurved at the early stage concealing the disc florets of the bloom.
- Outer florets turn outward away from the central tuft.
- Blooms look globular but may be somewhat flattened.
- Average bloom size 15-20cm.

17. Pournima :

- It is a large flower pompon type producing white flowers.
- Ray florets of the flowers are short, broad and very systematically and uniformly arranged to give bloom a compact hemispherical shape.
- Width and breath almost equal.
- Ray give florets may be incurved or reflexed.
- Disc normally covered or inconspicuously open.

The Floriculture Division of NBRI has recently developed four new varieties of chrysanthemum through selective crossing and seedling collection.

These varieties, are being released as **`NBRI Golden Jubilee Year Varieties**

1. NBRI KUSUM

- It is a small flowered, yellow open disc, single Korean type chrysanthemum good for pot culture.
- It is a bushy compact with profuse blooming habit in late November. The plant habit and shape is most attractive for exhibition.
- Plant height – 45 to 50 cm, 255 flower heads/plant, 22 flowers/stem, 42 florets/flower head, floret length 2.1 cm, floret width 0.40 cm, flower head diameter 4.2 cm, floret colour bright yellow [09/A (Fan1)].
- It has been developed by crossing `Haldighati' (yellow) as female and `Sharad Kanti' (yellow) as male parents.

2. NBRI LITTLE DARLING

- It is a small flowered, terracotta pompon type mini chrysanthemum.
- It requires neither `Pinching' nor `Staking'.
- It is a unique genetic strain with dwarf, bushy, compact round shape, profuse blooming habit in early December.
- The plant habit and shape is most attractive for `mini culture'.
- It has been developed by crossing `White Charm' (white) as female and `Jubilee' (bronze) as male parents

3. NBRI MINI JESSIE

- ❖ It is a small flowered, cineraria type mini chrysanthemum.
- ❖ It requires neither `Pinching' nor `Staking'. It is a unique genetic strain with dwarf, bushy, compact round shape, profuse blooming habit in early December.
- ❖ The plant habit and shape is most attractive for `mini culture'.
- ❖ It has been developed by crossing `Cameo' (pink) as female and `Jessie' (purple) as male parents.

IIHR VARIETIES:

1. Indira:

- Is a hybrid developed from crosses between ID14 and Fxv-1.

2. Neelima:

- It is also a hybrid, developed from crosses between Flirt & Valentine.

- | | |
|-----------------|--|
| 3. Chandrakant | : It yields about 150 flowers/plant |
| 4. Chandrika | : Hybrid between angela and gp-1. |
| 5. Keerthi | : Hybrid between angela and gp-1. |
| 6. Pankaj | : Early variety. |
| 7. Rakhee | : Seedling progeny of lord doonex. |
| 8. Ravikiran | : Hybrid between flirt & valentine. |
| 9. Red gold | : It is hybrid between flirt & valentine. |
| 10. Yellow gold | : Mutant induced from flirt. |
| 11. Yellow star | : It produces yellow flowers, 150 flowers/plant. |

PUNJAB GOLD:

- It is a hybrid between Flirt & Gel-e-sahir ,
- Released from PAU in 1999.
- Ray florets are coppery red which turn to golden at full bloom.
- Good for pot culture and resistant against septoria leaf spot.

Quiz

I. Chose the correct from the following

1. Important species of chrysanthemum.

- a) *C. carinatum* b) *C. rubellum* c) *C. sibiricum* d) all of these

2. Spray cultivars of chrysanthemum.

- a) Snow Ball b) Super white c) Megami d) Alfred Wilson

- 3) Standard cultivars of chrysanthemum.
- a) Snow Ball b) Chandrama c) Aparajita d) both a & b
- 4) Small-flowered chrysanthemum for garland
- a) Sujata b) Nilima c) Birbal Sahni d) Chandrama
- 5) Stem Length of Export standard chrysanthemum
- a) 88-100 cm b) 68-80 cm c) 75-88 cm d) 98-110 cm
- 6) Chrysanthemum requires a well drained loamy soil with soil pH ranging between
- a) 5.0-6.0 b) 6.0-7.0 c) 5.5-6.5 d) 6-7.5
- 7) The suckers or slips of chrysanthemum are planted at spacing
- a) 30 x 20 cm b) 30 x 15 cm c) 30 x 30 cm d) 30 x 45 cm
- 8) Planting of chrysanthemum is done during
- a) May-June b) April-May c) June d) Sept- Oct
- 9) Propagation of chrysanthemum is done by
- a) Sucker b) Cuttings c) Micro propagation d) all of these
- 10) Chrysanthemum is a
- a) Short day plant b) Long day plant c) day neutral plant d) short long day plant

(Key answers: 1)d, 2)b, 3)d, 4)c, 5)a, 6)b, 7)a , 8)b 9)d, 10) a)

II. Match the following

A

- 1) Chrysanthemum
- 2) Short day plant
- 3) *C. carinatum*
- 4) *C. coronarium*
- 5) *C. satsumense*
- 6) Spray cultivar
- 7) Standard cultivars Garland
- 8) Small-flowered for pot culture
- 9) Small-flowered for cut-culture
- 10) Small-flowered for garland

B

- Basanti
- Sujata
- Mercury
- Alfred Wilson
- Coral Marble
- Satsuma-nogiku
- Chrysanthemum
- Tricolour chrysanthemum
- Photo sensitive
- Queen of the East

(Key answers: 1) Queen of the East, 2) Photo sensitive, 3) Tricolour chrysanthemum, 4) Garland chrysanthemum, 5) Satsuma-nogiku, 6) Coral Marble, 7) Alfred Wilson , 8) Mercury, 9) Sujata, 10) Basanti)



Contd...

LECTURE - 10

CHRYSANTHEMUM (*Asteraceae*)

TOPICS

- 10.1. Propagation
- 10.2. Culture -soil requirement
- 10.3. Climatic requirement
- 10.4. Planting density
- 10.5. Planting:
- 10.6. After care -irrigation
- 10.7. Manuring and fertilization
- 10.8. Pinching
- 10.9. Disbudding and Dis-shooting
- 10.10. De-suckering
- 10.11. Staking of plants
- 10.12. The art of training
- 10.13. Green house cultivation
- 10.14. Environmental Factors
- 10.15. Growth regulators
- 10.16. Harvest and Yield**

10.1. PROPAGATION

- Chrysanthemum can be propagated both by vegetative and sexual methods.
- Maintain the purity of cultivar seeds are used to develop hybrids.

VEGETATIVE PROPAGATION

1. SUCKERS :

- Suckers arise from the underground stem and these are separated and planted in prepared nursery beds during January for stock plants.
- Regular pinching is performed in these plants for vigorous and profuse branching.
- Some of these stock plants are used for preparation of cuttings.
- The first pinching is performed in April, followed by monthly pinching up to June.
- After 3rd pinching in June, cuttings are taken from these mother plants.

2. CUTTINGS

Terminal Cuttings:

- Cuttings of 5-7 cm in length are taken from healthy stock plants in June.
- The cuttings are prepared removing basal leaves and reducing the leaf area of remaining leaves to half.
- The basal portions (less than half inch) of cuttings are dipped in rooting hormone (1000 ppm solution of IBA) for better rooting.
- Sometimes the lower portion of cuttings is treated with some copper fungicide to avoid fungal growth.
- These rooted cuttings are ready for planting in the field.

3. Micro propagation

4. Grafting

Among these, propagation through cutting is the most common and popular method.

10.2. CULTURE

10.2.1. SOIL REQUIREMENT

- ◆ Chrysanthemum with a shallow but fibrous root system is sensitive to water-logging and prone to attack by diseases, such as root rot and wilt due to lack of aeration.
- ◆ Clay and clay loam soils retain too much of moisture and thereby hinder proper aeration, resulting in rotting of roots.
- ◆ Sandy soils drain too quickly and require frequent irrigation and also suffer from loss of nutrients due to leaching.
- ◆ Sandy loam soils are ideal for chrysanthemum growing.
- ◆ pH ranging between 6.2 and 6.7

10.2.2. LAND PREPARATION:

- Chrysanthemum requires well prepared soil for proper growth and development.
- The field should be ploughed 2 to 3 times before preparing the beds and leveled well.
- A basal dose of well decomposed FYM should be applied @ 5kg/meter square.
- Addition of peat or organic matter improves the soil structure & helps in the development of the plant.
- Proper soil sterilization with carbendazim should be done before planting to avoid soil borne diseases.

10.2.3. CLIMATIC REQUIREMENT

- ◆ Light and temperature are the two important environmental factors influencing the growth and flowering.
- ◆ As far as light is concerned, both photoperiod and the intensity have profound effects on growth and flowering of chrysanthemum.
- ◆ It is a short-day plant normally initiates and flowers during September to December under South Indian conditions. Hence, planting during April-May is recommended.

10.2.4. PLANTING DENSITY

- ✓ The best plant population was 32 cuttings/m².
- ✓ For cv. Chandrama, a large flowered cultivar, spacing of 30 x 30 cm.
- ✓ The suckers or slips are planted at a spacing of 30 x 20 cm on one side of the ridges.

10.2.5. PLANTING:

- ◆ May-June planting resulted in well developed plants with good flowers.
- ◆ Cut flower production was the highest from May plantings.
- ◆ 90,000 to 1, 10,000 suckers or slips obtained from 15 cents of the previous crops are required to plant one hectare.
- ◆ Before planting, the roots of the suckers or slips are dipped in wet Cerasan or Agallol 0.1% to protect against wilt.
- ◆ The field has to be ploughed thrice during March and beds or ridges and furrows are formed.

10.3. AFTER CARE

10.3.1. IRRIGATION

- ❖ The plants need adequate water during active vegetative growth when new leaves are being formed.
- ❖ After the formation of flower buds no further leaf is formed and less amount of water is needed.
- ❖ Hence, chrysanthemum are to be irrigated twice a week in the first two weeks and subsequent by at weekly intervals.
- ❖ Chrysanthemum roots are very sensitive to water logging but tolerate water stress appreciable.
- ❖ Different systems of irrigation are prevalent in various part of the world.

- ❖ These include overhead mist spray lines.
- ❖ Sprinkler and self-travelling sprayers.

10.3.2. MANURING AND FERTILIZATION

- Chrysanthemum is a heavy feeder and requires large amount of both Nitrogen and Potassium.
- Nitrogen is required at early stage and the plants need P throughout the growth period.
- As the buds appear, the proportion of K should be increased and N should be reduced.

Chrysanthemums are heavy feeders and hence they are to be adequately manured. They are applied with 25 t of FYM along with 250,120, 25 kg NPK/ha.

Half of the N and the entire quantity of P and K are to be applied basal by just before planting.

The other half of N is to be applied 30 days after planting the suckers.

The same dose can be repeated if a ratoon crop is raised and hoeing should be done once in a month.

Micronutrient application

- Coated fertilizers
- Liquid feeding
- Foliar feeding

Recommend doses for various centers

centers	N	P	K
Karnataka	200	200	200
Ludhiana	400	400	200

10.3.3. PINCHING

- ◆ Pinching is one of most important operations in chrysanthemum culture.
- ◆ The operation of removal of terminal growing portion of stem pinching reduces plant height and promotes axillary branches.

- ◆ Time and severity of pinching depend on the type of chrysanthemum and the desired objectives.
- ◆ After planting, the growth is mostly upward with very little branching.
- ◆ To arrest such tall growth, a simple procedure called 'pinching' is used. It is also called 'stopping'.
- ◆ Only soft vegetative shoot tips 1.5 to 3 cm long are removed.
- ◆ Pinching is most essential for small flowered chrysanthemum.
- ◆ First pinching is done when the plants reach a height of 15-20 cm with 3-4 pairs of leaves.
- ◆ A second pinching may be necessary if the plants make straggly and lean growth.
- ◆ Pinching increases the number of flowering stems in each plant; it can indirectly control flowering date and bloom quality; and the number of stems to a plant can easily be controlled.
- ◆ Two types of pinching are performed:
 - (a) **Soft pinching:** By this pinching the top soft tips of the shoot along with 2-3 open leaves are removed;
 - (b) **Hard pinching:** It means removing a longer portion upto hard shoot.
- ◆ Single pinching is done, if two flowers are desired, whereas double pinching is done for four flowers.
- ◆ In **spray** chrysanthemum numerous small to medium sized flowers are produced, therefore, two pinchings are required to encourage lateral growth.
- ◆ As a general rule rooted cuttings are pinched two weeks after planting or approximately 100 days before full bloom.

10.3.4. DISBUDDING AND DE-SHOOTING

- ◆ These operations are mostly performed for large flowering of decorative type chrysanthemums.
- ◆ Many of the standard type varieties are disbudded in which the largest terminal bud is reserved and all auxiliary buds are removed.
- ◆ Disbudding of spray varieties is very easy because in this case only the large apical bud is removed and the auxiliary buds are allowed to develop
- ◆ For taking three blooms per plant, three lateral strong shoots are allowed to grow and others are removed.
- ◆ Lateral buds and side shoots are removed at their early stage of growth from time to time.
- ◆ For taking one bloom per plant no pinching is done.
- ◆ Only the main stem is allowed to grow.
- ◆ Removal of undesirable lateral buds and shoots are done.
- ◆ Dis-shooting is practiced to reduce the number of branches for improving the size and form of the flower.

10.3.5. DE-SUCKERING

- ◆ During the vegetative growth phase, plants grow upward.
- ◆ New suckers continue to develop from base of plants.
- ◆ For proper and vigorous growth of plants, suckers are removed from time to time.
- ◆ It is practiced to allow single stem to develop up to a certain height.
- ◆ Without de-suckering the main plant will lose vigour and becomes weak.

10.3.6. STAKING OF PLANTS

- ◆ Staking is necessary to keep plants erect and to maintain proper shape of plants and bloom.
- ◆ Stakes are prepared mostly from bamboo sticks.
- ◆ Staking of plants is required for vertical support of the plants.

10.3.7. THE ART OF TRAINING

11.3.7.1. Standard : For better shape of the plants and attractive extra large flower, large flowered chrysanthemums are trained as standard to produce 1-3 blooms per plant.

11.3.7.2. Sen Rin Tsukuri : In this style, the plant is designed to a geometrical shape (6-10 concentric circles in steeped manner) and it is trained in such a way that about 200-300 blooms are formed per plant having an approximate height of 153-183 cm and a diameter of 183-244 cm.

11.3.7.3. Bush Form : Small flowered chrysanthemum blooms are arranged compactly to give an effect of a floral carpet. The most important is the use of soft pinching to outer or lower branches and hard pinching to central or higher branches.

11.3.7.4. Cascade Form : the plants trained in Cascade form give the effect of a water fall in blooming stage. The stem is made to bend down above the rim of the container.

11.3.7.5. Coniform : The shape of the plant is made conical by special training. For giving a perfect coniform shape staking and pinching are most important.

11.3.7.6. Fan Form : A type of training form of small flowered chrysanthemum. In final form it looks like a hand fan.

WEED CONTROL:

- Weeding and hoeing are generally done manually as and when required, normally 8-10 times yearly.
- Crop suffers heavily if timely weeding is not given.
- Besides, control of weeds the soil is made loose porous to provide aeration.

10.4. GREEN HOUSE CULTIVATION

10.4.1 ENVIRONMENTAL FACTORS

1. Light: Chrysanthemum flowering is very much influenced by the quantum and quality of light. Most of the cultivars require shorter days for flower bud initiation and development. Under long days they tend to remain vegetative.

2. Temperature: Based on temperature requirements chrysanthemum cultivars are classified into three.

- i) **Thermo-zero cultivars** which flower at any temperature between 10-27°C but most constantly at 16°C night temperature.

- ii) **Thermo-positive cultivars** in which continuous low temperature between 10-13°C inhibit or delay flower bud initiation and at 27°C there will be rapid initiation but delayed flowering.
- iii) **Thermo-negative cultivars** in which bud initiation occurs at low temperature delay bud development.
 - ◆ The effect of night temperature is more pronounced than day temperature and night temperature of 16-20° C was found optimum for most of the cultivars.
 - ◆ High temperature may cause floral distortion and low temperature may some time cause discoloration of the flower.

3. Relative humidity: The chrysanthemum requires a moderate humid condition of 70 to 90 per cent and hence it should be preferably grown in places there will not be any rains during flowering time.

10.5. GROWTH REGULATORS:

- Crop growth regulation and flowering can be modified or controlled by use of growth regulators.
- Flower quality and yield can be improved by the use of regulators.
- The plant starts flowering from 3rd months onwards. GA₃ 50 ppm can be sprayed at 30, 45 and 60 days after planting to increase the yield.

10.6. PESTS AND DISEASES

- Aphids, thrips, leaf miners and mites are the common insects attacking chrysanthemum.

DISEASES

- Cercospora leaf spot, Alternaria leaf spot, Fusarium stem rot and Powdery mildew are the common diseases attacking chrysanthemums.

10.7. HARVEST AND YIELD:

- ◆ Decorative types are harvested when the petals in the centre of the topmost flower is almost fully developed.
- ◆ In standards, harvesting is generally done when outer ray florets ceases to further develop.
- ◆ Pot-mums are sent to the market with half to fully opened flowers.
- ◆ Spray mums are generally harvested at the two thirds to three-fourths open stage; standard mums at the three-fourths to full open stage of development.

- ◆ Yield start from 3-4 months after planting.
- ◆ Main crop duration 6 months.
- ◆ Ratoon crop 4 months. Total duration (6+4) 10 months.

YIELD

1. Main crop : 9-10t/ha.
2. Ratoon crop : 4-5 t/ha.
3. Sprays- 1, 00,000 stems can be obtained from one ha.

10.8. POSTHARVEST TECHNOLOGY

GRADING

- Chrysanthemums are graded based on the stem length, flower appearance, number of flowers, stem straightness, colour and freshness of flowers.
- **Standard** chrysanthemum is graded into Blue, Red, Green and Yellow, whereas **spray** types are graded into Gold, Silver and Bronze based on the quality parameters.
- In Dutch market, **spray** chrysanthemums are graded into extra grade and shorter grade.
- The lower leaves are stripped off up to 15-20 cm and bundled in units of 5 stems and secured with a rubber band.

PACKING

- Most often standard chrysanthemum are placed in sleeves and packed in display boxes measuring 91 x 43 x 15cm.
- They are placed in the boxes according to the grades.
- For bulk packing of the **spray** chrysanthemums, 10, 15 or 20 stems are placed in sleeves according to the grades.
- Six sleeves, three at each end, are generally packed in each box, measuring 80 x 50 x 23cm.

STORAGE

- Chrysanthemum cut flowers can be wrapped in plastics and stored dry for 6 to 8 weeks at a temperature of 0.5°C.
- Temperature for truck shipments across the country ranged between 2° and 4°C.
- The stems in the buckets (after grading) are given a cut using sharp blade and pre cooled at 1°C minimum of 2 hours before packing.

- Chrysanthemum can be stored for 3-6 weeks period at 0-3°C.

10.9. VASE LIFE

- ❖ The use of proper preservative solution throughout the period of post-harvest handling is very important to prolong the life of cut flowers.
- ❖ Dipping of the stem for a very short period (5 seconds) in 1200-4800 ppm silver nitrate or soaking the stems in 1000 ppm silver nitrate for 10 minutes.
- ❖ Addition of 2 % sucrose to silver nitrate was found beneficial.
- ❖ It increased the vase-life from 12 days to 20 days.

10.10. EXPORT STANDARDS FOR CHRYSANTHEMUM:

Parameter	Standard	Spray	Dwarf
Stem Length	88-100 cm	75-88 cm	25-38 cm
Weight	30g/stem of 90 cm	30g/stem of 85 cm	15g/stem of 30 cm
Number of flowers	Only 1 flower With 5 buds	10 flowers with 5-8 buds	10-12 flowers

Quiz

Match the following

A		B
1) Pinching	___	Proper shape
2) Soft pinching	___	200-300 blooms
3) Disbudding	___	Water fall
4) De-suckering	___	Hand fan
5) Staking	___	Stopping
6) Standard	___	Soft tips
7) Sen Rin Tsukuri	___	Terminal bud
8) Cascade Form	___	Vigour
9) Fan Form	___	

(Key answers: 1) stopping 2) soft tips 4) terminal bud 5) vigour 6) proper shape 7) 1-3 blooms per plant 8) 200-300 blooms 9) water fall) 10) hand fan)



LECTURE- 11

CARNATION

(**Caryophyllaceae**; *Dianthus caryophyllus* L.)

TOPICS

- 15.1 Introduction:
- 15.2 Importance and uses
 - Species
 - Types of carnation
 - Varieties
- 15.3 Soil
- 15.4 Climate
- 15.5 Propagation

15.1. INTRODUCTION:

- Carnation (*Dianthus caryophyllus* L.) belonging to the family Caryophyllaceae.
- It is one of the important cut flower crops in the International flower market.
- It is more preferred to other cut flowers due to its
 - ✓ Large array of colours,
 - ✓ Excellent keeping quality,
 - ✓ Wide range of forms
 - ✓ Ability to with stand long distance of transportation,
 - ✓ As well as remarkable ability to rehydrate after continuous shipping.
- Carnations in general are grown only under protected cultivation of carnation.
- It is commonly called as Carnation, Divine flower, Clove pink, Gilly Flower.

IMPORTANCE AND USES

- ❖ One of the top ten cut flower crops in the International flower market.
- ❖ Apart from cut flower it is being used for bedding, pots, rock gardens, window boxes and edging.
- ❖ It gives a unique softness in the rock gardens.
- ❖ Popular in flower arrangements for decorating homes.

- ❖ Cultivated in Italy, Spain, Colombia, Kenya, Sri Lanka, Canary Islands, France, Holland, Germany and USA.
- ❖ They are in large demand in Valentine's Day, Easter and Mother's day and during Christmas.
- ❖ In India the major carnation producing centers are located in and around Bengaluru, Pune, Delhi, Trivandrum, Andhra Pradesh and HP.
- ❖ Flowers also have medicinal properties. Used as cardio tonic, diaphoretic and alexiteric.
- ❖ It is also used for perfume extraction in France.

ORIGIN AND HISTORY:

ETYMOLOGY:

- ♣ Some scholars believe that the name "Carnation" comes from "Coronation" or "Corone" (flower garlands), as it was one of the flowers used in Greek ceremonial crowns.
- ♣ Others say in Latin 'Carnation', from 'Caro' (genitive "Carnis") (flesh), which refers to the original colour of the flower, or incarnation, which refers to the 'incarnation of God made flesh'.
- ♣

ORIGIN:

- ♣ Native of the Eurasia
- ♣ It is native to the Mediterranean region but its exact range is unknown due to extensive cultivation for the last 2000 years.
- ♣ Dianthus in Greek 'dios,' **divine**; 'anthos', **flower** which means 'Flower of Zeus' or Divine flower.
- ♣ The cultivar 'William Sim' produced in 1938 by William Sim of USA.
- ♣ From the red flowering 'William Sim' there have been mutations to all the possible colours and several variegated forms.

BOTANY:

- It is an herbaceous perennial plant growing to 80 cm tall.
- The leaves are glaucous grayish green to blue-green, slender, up to 15 cm long.
- The Flowers are produced singly or up to five together in a cyme;
 - 3–5 cm diameter and sweetly scented;
 - colour is bright pinkish-purple, red, white, yellow and green.
- Carnations will grow from 2" to 3 feet high, most garden varieties grow 10 to 20 inches tall.
- They bloom mainly during cool times of the year, especially early winter.

SPECIES:

There are about 250 species of *Dianthus* of which only a few are under commercial cultivation. They are as follows,

Major species

- *D. caryophyllus*
- *D. barbatus*
- *D. chinensis*

Other species

- *D. alpinus*
- *D. grandiflorus*
- *D. giganteus*
- *D. hybridus*
- *D. nobilis*

TYPES OF CARNATION

1. Chabaud or marguerite:

- Developed by crossing *D. chinensis* x *D. caryaophyllus*,
- They are annuals produces single or double flowers.
- Reproducing by seeds
- Flowers are large with fringed petals. Moderate vase life.

2. Border and picotee:

- Easy to grow and has symmetrical flowers
- Flower colour varies from single to blend with irregular markings.
- They produce single stem in first year and form bushy in subsequent years

3. Malmaison:

- Malmaison has stiff and massive habit with broad leaves
- Flowers are large and fully double mainly pink with well frilled centers.
- Flowers have rich fragrance.
- Suitable for pot purpose due to its dwarf in habit.

4. Perpetuals:

- They are hybrids involving many *Dianthus* species.
- Plants are not hardy and flower all round the year.
- Flower stalks are long and hence suitable for cut flowers.
- They produce better quality flowers and withstand long transportation.
- They are grouped into standards or Sim and sprays.

4.1. Standard types:

- Produces single large blooms with longer flower stalks.

4.2 Spray types:

- The miniature or spray type produces many flowers of smaller size.
- Better adapted to warm climate than standard types.

15.3. SOIL/GROWING MEDIA AND PREPARATION OF BEDS

- Soil should be ploughed upto 80-100 cm deep.
- Addition of calcium carbonate or dolomite limestone to corrects severe acid condition and also supplies calcium and magnesium for plant nutrition.
- ✓ Addition of sulphur or use of acid forming fertilizers will inturn reduces the soil pH if it is on the higher side.
- ✓ A rich sandy loam or loamy soil is considered to be the most ideal for successful production of carnation.
- ✓ The ideal soil pH is between 6.0 to 7.0
- ✓ EC of 1.2 at the start of the crop and 1.5 at the generative period is ideal.
- ✓ Plants can be grown in a perlite / rock wool mixture at 3:1 or 1:1.
- ✓ Soil mixture : 50 % sand, 30% loam and 20% clay
- ✓ Media have to be sterilized with methyl bromide@ 25-30g / formaldehyde @ 3-7% (7.5 to 10.0 l/100/sq.mt or Basamid (Dazomet) @30-40g/m²
- ✓ Bed size : 30 cm height ; 1.05 m wide ; length varies as per the length of the protected structure.
- ✓ Spacing between beds : 30 cm

15.4. CLIMATE:

- Light is the most important factor, which influences growth of the plant. About 21.51 lux is considered to be the minimum natural light intensity required for adequate photosynthesis of carnations.
- Mild climate with a temperature ranging from 5-18⁰C is considered to be the ideal for the crop.
- Day temperature : 28⁰C (20 -25 ⁰C)
- Night temperature : 16-18⁰C (10 -15 ⁰C)
- Quantitative Long Day plant (long days promote flowering)
- Critical photoperiod : 13 hours and light intensity is 10 – 15 foot candle.
- Co₂ enrichment in greenhouse upto 500-1000 ppm improves the flower quality.
- RH : 50 -60 %
 - Beginning : 80-85%
 - At full growth : 60-65 %
- High day & night temperature during flowering leads to
 - abnormal flower opening
 - calyx splitting

15.2. VARIETIES:

1. Standard Carnation

Red : Scania, Tanga, Killer

Pink : Nora, Pink Sim, Candy, Calypso

Yellow: Pallas, Murcia, Tahiti

White : Sim, Roma, Candy white

Others: Charmeur, Santiago, Vanessa, Monaco, Regina, Trendy, Papaya, Gold Rush, Internet, Monopole, Cobra, Shocking pink and White Sim,

CULTIVARS OF CARNATION



Dona



Farida



Firato



Hildelgo



Lavender Lace



Lady Green



Master



Sunrise



Baltico



Cherry Solar



Farida



Frivole



Malga



Dover



Pink Dover



Liberty



Parasio



Red Corso



White Wedding



Pax

2. SPRAY CARNATION

Red : Rony, Karma, Etna

Pink : Annelies, Barbara, Silvery Pink

Yellow: Odeon, Alicetta, Lior

White: Royalette, Tibet, Excel

Others: Exquisite, Scarlet Elegance, Kissi : Kristal, Celins, Furore, Star dust, White Barbara and Red Barbara

3. Micro Carnation : Eolo, Pink Eolo, Wiko

4. Mini Spray Carnation : Lima, Onia, Roland

Cultivars resistant to diseases

❖ Fusarium - Resistant	:	Angela, Regina
-Tolerant	:	Salome, Vanya
- Highly susceptible	:	Pajee.
❖ Bight - Highly susceptible	:	Yellow Dusty
- Tolerant	:	Scania
❖ Rust - Resistant	:	Nibbo, Desio
- Moderately	:	Calypso, Astor
- Susceptible	:	White Sim, Irene

15.5. PROPAGATION:

- Carnation may be propagated by both sexual and asexual methods.

SEED :

- ♣ July or August to October
- ♣ In the hills, sowing should be done during August to October and March to April depending upon temperature.
- ♣ At four-leaf stage, the seedlings are pricked or transplanted.
- ♣ Sowing at 20°C gives the maximum germination.

VEGETATIVE PROPAGATION

CUTTING

- Using soft terminal cuttings is the common method of multiplication used by commercial growers throughout the world.
- Cuttings of 10-15 cm with 3-4 nodes weighing around 10g are ideal for multiplication.
- Rooting hormone such as IBA at 500ppm is used prior to planting of cuttings for rooting.
- Terminal cuttings give rise to good plants. Cuttings can be stored at 0°C before planting for several weeks.
- Cuttings are spaced at 5 cm apart and intermittent misting should be used for good rooting.
- Cuttings normally develop good root system within 21 days.
- The rooting medium should be sterilized before planting.
- Drenching with fungicide is ideal to control fungal problem during rooting.

LAYERING

- ♥ Layering is done in pots or directly in the ground.
- ♥ The layering generally roots earlier than the cuttings.
- ♥ Ground layering was found to be most suitable method.

GRAFTING

- ♥ 65 to 70 % success
- ♥ Union was completed in 15 days.

MICRO-PROPAGATION

- ♥ Almost all parts of the plant may be used as explants in carnation except the root.

Vitrification in carnation

- A problem will encounter during the *In-vitro* culture of carnation due to the formation of abnormal leaves and stem with thickened and translucent structures.
- Shoots with such abnormal leaves usually turn brown and failed to root in the rooting medium.
- Vitrification in carnation tissues, by transfer from solid to liquid medium was accompanied by decreased lignin content.

Quiz

1. *Dianthus caryophyllus* belongs to the family
a) Caryophyllaceae b) Asteraceae c) Araceae d) Oleaceae
- 2) Variety of standard Carnation
a) Excel b) Rony c) Candy white d) Silvery Pink
- 3) Example of Mini Spray Carnation
a) Lima b) Onia c) Roland d) all of these
- 4) Optimum EC level required by carnation
a) 1.2 – 1.5 b) 1.0 -1.2 c) 1.0 -1.5 d) none of these
- 5) Addition of sulphur _____ the soil pH
a) Neutralizes b) Increases c) Decreases d) none of these
- 6) Light requirement for growth and development of carnation is
a) 30 lux b) 50.50 lux c) 21.51 lux d) 10.10 lux
- 7) Ideal temperature requirement for growth and development of carnation is
a) 5-18⁰C b) 15-20⁰C c) 20-25⁰C d) 10-15⁰C
- 8) Concentration of IBA used for rooting in cutting of carnation is
a) 100 ppm b) 500 ppm c) 700 ppm d) 1000 ppm
- 9) Carnation cuttings are spaced at
a) 5 cm b) 10 cm c) 15 cm d) 7.5 cm
- 10) Cuttings normally develop good root system within
a) 15 days b) 10 days c) 30 days d) 21 days.

(Key answers: 1) a, 2) c, 3) d, 4) a, 5)c, 6)c, 7)a , 8)b, 9)a, 10) d)



Contd...

LECTURE 12

CARNATION (*Dianthus caryophyllus*)

TOPICS

- 16.1. Planting and Aftercare
- 16.2. Support Material
- 16.3. Pinching
- 16.4. Disbudding
- 16.5. Manuring
- 16.7. Calyx Splitting
- 16.8. Harvest and Post harvest
- 16.9. Plant Protection

16.1. PLANTING AND AFTERCARE:

- Carnation plants are planted in different spacing normally, 30-45 plants per sqm is considered to be ideal.
- Different spacings 15x8cm, 15x15cm, 15x20cm and 15x10cm, are followed. Alternate normal method of transplanting wherein the plants are planted firmly to soil, carnation,
- Shallow planting is followed. Deep planting should be avoided.
- Shading should be given in the beginning of the crop for few days.
- Care should be taken to maintain the humidity to prevent plants from drying.

SPECIAL CULTURAL PRACTICES:

16.2. SUPPORT MATERIAL:

- Carnation crop has the tendency to bend unless supported properly. Hence the crop needs support while growing.
- Good support material is metallic wire woven with nylon mesh.
- At every two meters the wire should be supported with poles.
- The poles at both the ends of bed should be strong.
- Metallic wire is tied around the bed along the length with the support from supporting poles.
- Across the bed, nylon wires are woven like net.
- For an optimum support, an increasing width of the meshes can be used bottom net can be of 7.5x7.5cm /10x10cm, then two nets of 12.5x12.5cm and the upper most can be 15x15cm.
- 4 – 5 layers of nets are to be laid before planting.
- For every 2.5 to 3.0 m wires to be supported with poles.
- First net should be fixed at 12 cm above soil.
- Place remaining nets over first net 15 cm apart.

16.3. PINCHING:

- Pinching refers to breaking out tip of budding and encouraging growth of side shoots.
- Essential for Standards.
- 4-6 well grown laterals are allowed.
- At six pairs of leaf first pinching has to be done.
- First pinching done 3 -4 weeks after planting.
- Depending upon the need of crop spread it is classified into,
 - Single,
 - One and half and
 - Double pinches.

□ SINGLE PINCH

- Ideal time for pinching is morning.
- When the plant attains 6 nodes, the first pinch is given.

- 5 -7 cm of apical portion has to be pinched off.

- This would give rise to 4-6 lateral shoots.

ONE AND HALF PINCH

- After single pinched shoots flower, half of side shoots are pinched off.

- 2-3 of these lateral shoots are pinched again.

DOUBLE PINCH

- All the lateral shoots are pinched off. i.e., 3 - 4 weeks after first pinch

- Pinching is done at 4 well developed pairs of leaves

16.4. DISBUDDING:

Disbudding refers to removal of side buds so that the central/terminal bud receives maximum food for the full development.

1. **FOR STANDARDS**

- Removal of lateral buds.

- Main flower bud alone left.

2. **FOR SPRAYS**

- Terminal or main buds are removed to encourage more number of side shoots.

Best time for disbudding – when apical bud is 15 mm in diameter.

16.5. MANURING:

No inorganic fertilizers in first 3 weeks after planting

Fertilizer application of 40g N, 20g P and 10g K, in addition to 5kg of well decomposed FYM /m² will increase the yield of flowers. OR

250 : 80 : 200 : 125 : 400 g / m² / yr N, P₂O₅, K₂O, Ca, Mg application in 24 splits once in 15 days.

16.6. IRRIGATION:

♣ Over watering and poor drainage causes root death and stunted growth.

♣ Water logging would cause deprival of oxygen to plants.

♣ The growing medium should be evenly moist.

♣ For proper establishing of the cuttings misting is require

♣ Drip irrigation can be followed after 3-4 weeks of planting

♣ Water requirement : 4 -5 l / m² / day

- ♣ Optimum moisture : 300 -500 tension

PHYSIOLOGICAL DISORDER

16.7. CALYX SPLITTING:

- Cultivars with too many petals are susceptible to calyx splitting.
- Due to fluctuation in temperature and environmental conditions also influences calyx splitting.

MEASURES

- Selection of cultivars that are less prone to splitting,
- Regulation of temperature and maintenance of optimal fertilizer level can minimize this disorder.
- This can also be reduced by placing a rubber band or 6mm wide clear plastic tape is used around the calyx of the flowers which have just start opening. This operation is referred as '**Calyx banding**'.

16.9. PLANT PROTECTION:

PEST AND DISEASES

Aphids: Aphids suck the sap from leaves of growing plants and can be most serious insect pest of carnation. They also transmit carnation rings spot and carnation mosaic virus diseases. They are controlled by spraying of metathios (2 ml/l), malathion (2ml/l), endosulfan (2ml/l) or rogor (2ml/l).

Thrips: They suck sap from leaves causing distortion. Spraying of rogor (1ml/l) or sumithion (3.5ml/l) or malathion (2ml/l) controls thrips.

Red Spider Mite Spraying with Kelthane (2.5ml/l) or Wettable sulphur 3g/lit controls mite effectively.

Nematodes - can be eliminated by growing plants in fumigated soil. Application of furadan, aldicarb or nemaphox controls nematode infestation.

16.8. HARVEST AND POST HARVEST:

- After planting normally it takes 110-120 days to come to peak flowering.

STANDARDS:

- Carnation flowers mature in 4-5 months period.
- Standard cultivars are harvested at "Paint Brush" stage with half-open flowers, or almost fully open flowers.
- At large bud / tight bud / cross bud stage
- Petals are visible at this stage

SPRAYS:

- When at least 2-3 top flowers have opened & other buds show colour

TIME OF HARVEST:

- 15 – 20 weeks after single pinching

YIELD:

- On an average 10-20 flowers / plant/year or 150-300 flowers / m²/ year
- Yearly production of 300-400 flower/m² is ideal and economical.
- After planting normally it takes 110-120 days to come to peak flowering.

POST HARVEST OPERATIONS:

- Harvested flowers are bunched together based on their physical measurements like length of stem, diameter of flower etc.
- For a good post harvest life, flower stems have to be trimmed at the base and should be immediately placed in a bucket of preservative solution (Acidic pH 4.5) with 2-5 % sucrose and biocides for 2 to 4 hours.
- Carnation flowers can be stored for 2-4 weeks before marketing.
- Flowers have to be packed in cartons lined with polyethylene be pre-cooled without lid.
- The plastic is then loosely folded on top of the stems and the lid is closed.
- These cartons are stored in cool chambers designed to maintain 0⁰C with good air circulation and a constant RH of 90-95 %.
- Floral preservatives like, 8-HQS or 8-HQC @ 200-600 ppm; STS (Silver Thio-sulphate) @ 0.2- 4mM; Cytokinin @ 10-100 ppm; Sugar @ 0.5-2% and Citric acid @50-100 ppm.



Grading



Packing



Packing comprises three stages :

- **Bunching,**
- **Wrapping and**
- **Packing.**



Quiz

I. Match the following

A		B
1) Aphids	___	Aldicarb
2) Thrips	___	Kelthane
3) Red Spider Mite	___	Distortion
4) Nematodes	___	Temperature
5) Calyx splitting	___	Rings spot

(Key answers: 1) Rings spot, 2) Distortion , 3) Kelthane , 4) Aldicarb , 5) Temperature

II. Chose the correct answer from the following

- 1) Spacing of nylon wires for bottom net
 - a) 7.5x7.5cm
 - b) 10x10cm
 - c) 15x15cm
 - d) both a & b
- 2) Single pinch is given when the plant attains
 - a) 6 nodes
 - b) 10 nodes
 - c) 5 nodes
 - d) none of these
- 3) After planting normally carnation takes _____ days to peak flowering
 - a) 100 -105
 - b) 110-120
 - c) 120-130
 - d) both a & b
- 4) Relative humidity required for growth and development of carnation is
 - a) 90-95 per cent
 - b) 80-85 per cent
 - c) 85-90 per cent
 - d) 75-80 per cent
- 5) Most serious insect pest of carnation
 - a) Red Spider mite
 - b) Thrips
 - c) Aphids
 - d) Nematodes

(Key answers: 1) d, 2) a, 3) b, 4) a, 5)c)



ORCHIDS

LECTURE-13

Topics

- 12.1. Introduction:
- 12.2. Habit and habitats
- 12.3. Climatic zones
- 12.4. Tropical zone
- 12.5. Subtropical zone
- 12.6. Temperate zone
- 12.7. Alpine zone
- 12.8. Selection of orchids
- 12.9. Where to grow
- 12.10. Factors affecting orchid growth
 - 12.10.1. Light
 - 12.10.2. Photoperiodic control of flowering
 - 12.10.3. Temperature
 - 12.10.4. Humidity
 - 12.10.5. Air relations
 - 12.10.6. Water quality and watering

12.1. INTRODUCTION:

- Orchidaceae is a large family of monocotyledons comprising about 800 genera and 25,000 species around the world.
- Orchids are accepted to be the world's most exotic and fascinating flowers, with their extraordinary variety of form, sizes, shapes, colours, texture and markings.
- These features make them highly priced among the ornamentals.
- Majority of the cultivated orchids are natives of tropical countries.
- In India, they are mainly found in North eastern hills, Kerala and Western Ghats and few in Kashmir.
- They grow in the humid tropical forests.

- Orchid growing has become a great hobby all over the world in addition to its commercial value for cut flower industry.
- Cultivation of orchids has become a very profitable occupation.
- The secret of successful cultivation of orchids is to provide them with conditions as identical as possible with the environment under which they were growing in the wild.
- Due to their peculiar nutritional habits, Orchids require special techniques of cultivation, if they are to grow healthy and put out a good crop of flowers.

BOTANY

- Orchidaceae is the largest family of angiosperms.
- The family contains more than 80,000 hybrids.
- Sub Kingdom : Phanerogams
- Division : Angiosperms
- Class : Monocotyledons
- Order : Orchidales
- Family : Orchidaceae (Bentham & Hooker)

ORIGIN : Tropical Forests of Amazon & Indo - Malayan region.

DISTRIBUTION IN INDIA: India is blessed with a wealth of orchids flora and about 1300 species are estimated to occur in the country.

- North western Himalayas – 200 spp
- North eastern India - 800 spp
- Western Ghats - 200 spp
- Others - 100 spp

IMPORTANT GENERA OF COMMERCIAL IMPORTANCE:

Cymbidium, Dendrobium, Phalaenopsis (Moth Orchids), Aerides, Cattleya, Paphiopedilum, and Vanda etc.,

12.2. HABIT AND HABITATS

- There are many orchids which are very beautiful belonging to different climatic zones and these cannot grow under the same climatic conditions.

- India with a vast geographic expanse and climatic zones ranging from tropical to temperate supports a rich diversity of flora.
- A vast majority of Indian orchids are confined to mountains where they are distributed from the base of hill to an elevation of 4,300m in climates ranging from tropical to temperate.

ORCHID FLOWER AND PARTS;

-
-
-
-
-
-
-
-
-
- Flowers of orchids are perfect, terminal, solitary or in a spike or raceme or panicle
- All orchids are made up of seven parts;
 - Three sepals, two petals, a lip or labellum, which is actually another petal, but showier than the rest; and a column enclosed in the trumpet like part of the lip.
- The sepals and petals are typically coloured.
- The sepals may be free from one another or sometimes united on occasion forming a definite tube, which is called sepaline tube.

CLASSIFICATION OF ORCHIDS

I. BASED ON GROWTH HABIT

1. Monopodials:

- The orchids which do not make separate new growths in each season.
- The growth of the axis is stops at the end of each flowering season and continues in the next season by a newly grown axis.

- Abundant in humid tropical rain forests of India. - Elevation upto 3000m.
- Example : *Vanda*, *Vanilla*, *Dendrobium*, *Cymbidium*, *Cattleya*, *Oncidium* etc.

(iii) Saprophytic Orchids

- Live on dead and decaying organic matter, - Found on the moist forest floors.
- Example : *Neottia*, *Galeola*, *Listera* etc.

(iv) Lithophytic Orchids

- Rarely found and they grow in moist, shaded rocks and crevices of walls.
- Example : *Cymbidium munronianum*, *Diplomeris birsuta*

(v) Subterranean Orchids

- Underground orchids, - Found in Australia
- Example : *Rhizanthetta* and *Cryptanthemis*

III. Classification based on Temperature requirement

For growing purposes, orchids are usually divided into three temperature groups.

1. **Warm orchids** : 15.5°C

Eg. *Phalaenopsis*, *Vanda*, *Rhynchostylis* and some *Dendrobium* species.

2. **Intermediate Orchids** : 13°C to 18°C

Eg. *Cattleya*, *Laelia*, *Brassavola*, *Oncidium*, *Miltonia*, etc.)

3. **Cool Orchids** : 10°C to 13°C

Eg. *Cymbidium*, plain leaf *Paphiopedilum*, some species of *Miltonia*, *Odontoglossum* and *Dendrobium*.

Spider Orchid -*Arachnis flosaeris*



12.3. CLIMATIC ZONES

Orchids are broadly classified depending on the climatic zones which they choose to grow; accordingly, three different types of orchids with different climatic zones have been recognized.

12.4. TROPICAL ZONE (300-900M):

- This zone is characterized by dense, humid tropical forests with high amount of rainfall and humidity (90-100%).
- The temperature ranges from 22 to 27°C.

- This warm and humid belt is the home of epiphytic orchids, like *Aerides*, *Arundina*, *Ascocentrum*, *Dendrobium*, *Vanda teres* etc. (Kerala, Chennai and other Coastal places).

12.5. SUB TROPICAL ZONE (1800-3500M)

- ◆ This zone has mixed forests and receives less rain. Moss covered tree branches and rocks form a congenial habitat for orchids.
- ◆ The temperature ranges from 25-30°C and humidity almost 100% during monsoon. The most beautiful orchids occur in this zone.
- ◆ The **epiphytic species** of *Bulbophyllum*, *Coelogyne*, *Cymbidium*, *Dendrobium*, *Eria* and *Liparis* are found growing here.
- ◆ The **terrestrial** spp. Like *Calanthe*, *Hebenaria*, *Phaius* spp.
- ◆ Some of the rare orchids like *C. gigantium*, *P. fairieanum* have also been reported from this zone (Western Ghats, South Karnataka).

12.6. TEMPERATE ZONE (1800-3500M)

- ✨ The temperate zone remains covered with snow for 3-5 months a year.
- ✨ The temperature during summer varies from 10-14°C with Relative humidity between 80-100%.
- ✨ The trees of Rhododendron magnolia and Pinus are moss covered providing habitats for many **epiphytic orchids** like *Aerides maculosum*, *Arachnis clarkei*, *Bulbophyllum* spp. *Paphiopedilum* spp., *Vanda Coreulea* and over and above the excellent *Cymbidium* spp and hybrids.

12.7. ALPINE ZONE (3500-5000M)

- This zone is situated in the Himalayan range, is snow covered for about 4-6 months and mostly some **terrestrial orchids** are found to grow at lower ridges.
- Some of the orchids recorded from this zone are *Bulbophyllum retusiusculu*, *Habenaria cumminsiana*, *Herminium longilobautm*, *Nervilla macroglossa*, *Pleione maculate*, etc.

12.8. SELECTION OF ORCHIDS

Orchids should be selected carefully keeping in view their growing conditions. Certain essential requirements must be met.

- ✨ Suitable temperature
- ✨ An adequate supply of water
- ✨ Plenty of fresh moving air
- ✨ Suitable light
- ✨ A suitable and adequate supply of essential mineral salts.

When we buy orchid hybrids, we should ask for the ones which will suit our climatic conditions. Another point to be taken into account is to buy orchids according to the type of space you have.

It is all about choosing the right type of plant for the particular conditions and facilities available.

- ✨ The only available space you have at house are window sill, then you can go for shade loving orchids like *Vanda*
- ✨ For drawing rooms, orchids with foliage should be selected. *Paphiopedilum*, *Phaius*, *Calanthe*.
- ✨ For Varandhas, partial shade loving orchids such as *Cymbidium*, *Dendrobium*, *Rhyncostylis*, *Aerides* which can be hung in wooden baskets can be selected.
- ✨ If there is a large space outside, sun loving orchids like *Arudiana graminifolia* and some *Dendrobium*, *Vanda*, *Aranda*, *Arachins*, *Oncidium* plants can be grown.

The choice of orchids should be made in such a way that you get flowers round the year.

IMPORTANT DENDROBIUM VARIETIES

Purple and white	: Sonia 17 , Sonia 28 , Sonia Bom Jo , Earsakul
Purple	: Renappa , New Wanee , Sabine Red , Jurie Red
White	: Emma White , Fairy White , Kasem White, Snow White
Pink	: Sakura Pink ,New pink
Yellow	: Sherifa Fatimah , Kasem Gold , Tongchai Gold

Important *Dendrobium* varieties



Aranda Nora Orange



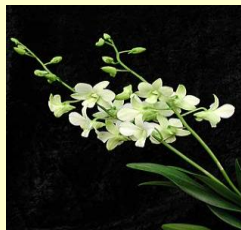
Aranda Nora Red



Aranda Nora Purple



Dark Sonia



Emma White



Sonia Bom Jo

12.9. WHERE TO GROW



- Orchids should be grown in suitable containers according to their habitat.
- If it is grown indoor needs some additional heat, this can be most conveniently supplied by heat boards or propagating beds.
- Provided the root area is kept warm, heating the whole growing area is not required; quite often there is enough radiant heat for the remainder of the plant.
- Inside most houses, the humidity is lower than most orchids appreciate.
- This can be increased by growing the plants on a tray of gravel with water kept to a level just below the surface of the gravel.
- Plants in pots standing on the gravel will benefit from the rising humidity.

- In warmer regions, if the plants grow outside, an area below the outer branches of a tree will often be satisfactory. Place the pots on a small bench or bricks to allow free circulation of air, yet prevent insects entering the pots.
- Most of the terrestrial orchids can be grown in soil or pots but most of the erect and epiphytic ones can be hung in baskets down the roof.
- They can also be arranged on the wooden logs or green fern and tied to the tree trunks if you have them in your compound.
- Trees in the garden form a natural Orchidarum.

12.10. FACTORS AFFECTING ORCHID GROWTH

12.10.1. LIGHT

- Light, like many other cultural factors, will vary from orchid genus to genus under cultivation.
- The optimum which orchids generally require is between 3000-6000 foot candles.
- *Cypripedium* and *Phalenopsis* need only between 200-300 foot candles and hence are to be kept in comparatively more shaded regions of the orchid house.
- *Cymbidium* will grow under full sun.
- Therefore, it becomes necessary to shade some orchid green houses to ensure that the proper amount of light will be available for good plant growth.
- An intimate knowledge of the light requirements of orchids has led to the development of the fascinating procedure called '**light gardening**' which now quite popular among orchid growers.
- There are particular regions in the spectrum of sunlight which aids particular processes in the physiology of plants.
- Thus the blue and orange-red regions of the spectrum aid in photosynthesis, while absorption in the far-red regions of the spectrum stimulates flowering.
- Based on this knowledge, extra amount of illumination is now being supplied to orchids either to supplement sunlight or to replace it entirely, with the result that more vigorous growth and greater output of flowers are achieved.
- Light gardening has made it possible to grow orchids even in cellars where no sunlight penetrates.

12.10.2. PHOTOPERIODIC CONTROL OF FLOWERING

- Even though the majority of orchids are day-neutral, there are a few species which are controllable.
- In these plants, the hormone phytochrome is produced only then the day and night are able to control the time of flowering in such species.
- The correct ratio between the light and dark periods and in some cases, the correct temperature also initiate the production of phytochrome, which is a protein acting as an enzyme.
- In general, orchids grow best in diffused light but there are certain orchids which grow well in high light.
- We should give our plants as much light as possible provided the roots stay moist and cool.

12.10.3. TEMPERATURE

- ✚ The temperature regimes used will be governed by the genera grown.
- ✚ Even though various species of orchids vary in their individual requirements of optimum temperature.
- ✚ Generally orchids thrive in a day temperature varying between 16 to 21° C and a night temperature of 13 to 16°C.
- ✚ If plants are grown outside the tolerance limits, poor growth or even death will result.
- ✚ A widely held misconception is that, all tropical orchids need really high temperatures, this is not altogether true and to subject them to such treatment can be disastrous.
- ✚ Three basic temperature regimes enable the enthusiast to grow nearly all cultivable orchids. They are
 1. The cold or cool
 2. The intermediate (temperate)
 3. The warm or hot.

COOL SPECIES	SEASON	Summer: Day	16-21° C	<i>Cymbidiums, Odontoglossums,</i>
		Night	13° C	<i>Paphiopedilums,</i>
		Winter: Day	13-16° C	<i>Zygopetalums.</i>
		Night	10° C	

INTERMEDIATE SPECIES	Summer: Day	18-24° C	<i>Cattleyas, Laelias,</i>
	Night	16-18° C	<i>Oncidium</i> s,
	Winter: Day	16-21° C	<i>Stanhopeas</i> and
	Night	13-16° C	
WARM/HOT SPECIES	Summer: Day	21-29° C	<i>Phalaenopsis,</i>
	Night	18-21° C	<i>Phaphiopedilums</i> and evergreen
	Winter: Day	21-29° C	<i>Dendrobium</i> s.
	Night	18-21° C	

- ✚ Temperature influences not only proper vegetative growth, but also production of flowers in quite a good number of species.
- ✚ It should be noted that for optimum growth and flowering, the night temperature should be lower than day temperature.
- ✚ *Cattleya labiata* does not flower when the night temperature is higher than 21°C.
- ✚ Most *Cymbidium* species need a temperature of 13-16°C, during nights and plenty of sunlight during day time for proper flowering.
- ✚ The *Dendrobium crumenaum*, flower only in response to a sudden drop in temperature of 10°C. However, in all cases, temperature changes must not be too sudden and too often. Very low temperatures common at the foot hills kills plant tissues just as burning does.

12.10.4. HUMIDITY:

- ✓ Humidity is very important for the good growth of all plants especially tropical ones and particularly epiphytes, which is much more difficult to control than either heat or light.
- ✓ It has been proved that about 50% humidity is suitable for most orchids.
- ✓ As a rule, they do not thrive in places where the relative humidity is less than 50%.
- ✓ Since they are not regular soil plants, with a proper root system to absorb and supply them with enough moisture from the soil,
- ✓ Eepiphytic orchids do best in an atmosphere as saturated with water vapour as possible.
- ✓ Excessive humidity is dangerous, as it brings about susceptibility to certain diseases. Plant parts may be attacked by various bacteria and fungi.
- ✓ Excessive high relative humidity (above 70%) contributes to succulent growth which is more susceptible to infection than hard growth.

- ✓ The danger of infection during the high relative humidity maintained for the purpose of cooling the plants in the day time is lessened by good air movement.
- ✓ A humidity level varies greatly from area to area and from country to country and it would be unwise to generalize.
- ✓ The most popularly used device for creating humidity is the evaporative water coolers.
- ✓ Spraying the benches, walls and floor of the orchid house or misting with very fine nozzles are also effective in this respect.
- ✓ In stagnant air of a greenhouse, it is wise to reduce humidity at night.
- ✓ As a general rule, any form of watering, clamping down or spraying should not be performed in the late afternoon or evening.
- ✓ In orchid houses we should run oscillating fans continuously. During the warmer months, an evaporate cooler keeps the orchids house day time temperature around 10°C and increases further air movement.

12.10.5. AIR RELATIONS

- ✱ Industrial regions offer hazards to orchid growing, both by the production of smoke and haze which reduce the light available to the plants, and by the production of noxious fumes.
- ✱ When soot and grime collect on the plants, wash them off with a forceful spray of water at frequent intervals.
- ✱ Dirt collecting on the leaves may plug up the stomata and cut down the working power of the leaves.

12.10.6. WATER QUALITY AND WATERING:

- ✱ Good quality water is very important requirement to grow orchids successfully.
- ✱ Acceptable water sources include de-ionized distilled water and rain water.
- ✱ Watering needs depend on the potting media and the growing conditions.
- ✱ Correct watering has a direct relationship between atmospheric humidity and compost mixture.
- ✱ Fundamentally the lower the atmospheric humidity, the damper should be the compost, and the higher the humidity the lower the moisture content of the potting mixture.
- ✱ A potting media should never be wet but just evenly moist.

- ✱ Occasionally short term drying out is beneficial as this closely imitates natural conditions whereby epiphytes are subject to very dry spells.
- ✱ Although it is not advisable to water pots daily, they should all be examined frequently and if too dry, well watering or even submerging by total dipping is suggested.
- ✱ Terrestrial orchids require more water than epiphytes.
- ✱ Some orchids have heavy thick leaves with large pseudo-bulbs, these are storage devices for water, adapted by the plant to suit quite dry environments.
- ✱ These plants must be allowed to partially dry out in between watering to have a wet/dry cycle of five to seven days.
- ✱ Other varieties have thin, soft leaves, requiring more frequent watering.
- ✱ Some like *Paphiopedilums* do not have any pseudo bulbs at all, these therefore must be kept moist but not at all times wet.
- ✱ Generally speaking, watering twice or thrice a week would be best. When drawing up such a schedule the following factors should be kept in mind.
- ✱ Actively growing plants need more water than resting plants.
- ✱ Large plants need more water than smaller ones or seedlings.
- ✱ Plants grown in larger pots retain moisture for longer periods than those in smaller pots and hence need less frequent watering.
- ✱ Plants require more water on a sunny day than on a cloudy day.
- ✱ Plants growing in full sun utilize water more than those in shade.
- ✱ Osmunda and coconut fiber retain moisture longer than either tree fern or bark, hence watered less frequently.
- ✱ Plants which are freshly potted should be watered very sparingly till new roots appear.
- ✱ As the number of roots appears there should be a gradual increase in the amount of watering.
- ✱ After plant maturation, watering should be completely stopped or withheld for a while to induce flowering.
- ✱ For orchids, which are collected from the wild, where they survive on a minimal supply of water obtained through rains and absorbed through the velamen roots, over watering is a hazard always to be reckoned with under cultural conditions.
- ✱ Wrinkling of the pseudo bulbs and yellowing of the leaves are due to excessive watering. Then stop watering immediately and confine to spraying only aerial parts till new root appear.

- ✱ The quality of water used, whether it is for spraying, damping down or watering direct, is of great importance. Since tap water has usually been chemically treated it should be used with caution.
- ✱ For best results, orchids need a slightly acidic water of about pH-5.
- ✱ The best water is undoubtedly rainwater except in areas with a high degree of atmospheric pollution which is common in industrial areas and in older style high density housing.
- ✱ As it is not possible to store sufficiently large quantity of freshly aerated rain water, it can be revitalized by pumping air into it with an aquarium aerator.
- ✱ The temperature of the water is important.
- ✱ If the water temperature and surrounding air temperature are equal no harm will result and slight differences either way can be tolerated by healthy plants.
- ✱ Fatal, or long term damage not easily discernible at first, can result from watering with too cold water.
- ✱ Under watering will cause shriveling of the leaves and pseudobulbs and new growth will be small.
- ✱ The roots may be thin and starved. If the medium is in good condition, simply step up the frequency of watering.
- ✱ Ideally, plants should remain moist and should never be dry.
- ✱ More plants may be lost to over watering than to under watering.
- ✱ For most orchids, especially those with pseudobulbs, a good rule is that "If in doubt, do not water."

Quiz

- 1) Orchidaceae family comprising
 - a) 800 genera
 - b) 600 genera
 - c) 100 genera
 - d) 500 genera
- 2) In India, orchids are mainly found in
 - a) North eastern hills
 - b) Kerala
 - c) Western Ghats
 - d) all of these
- 3) Epiphytic orchids
 - a) Dendrobium
 - b) Vanda
 - c) Calanthe
 - d) both a & b
- 4) Terrestrial orchids
 - a) *Bulbophyllum*
 - b) *Coelogyne*
 - c) *Cymbidium*
 - d) none of these
- 5) Orchids found in temperate zone
 - a) *Bulbophyllum retusiusculu*
 - b) *Habenaria cumminsiana*
 - c) *Nervilla macroglossa*
 - d) *Pleione maculate*
- 6) Orchids selected for drawing rooms
 - a) *Paphiopedilum*
 - b) *Phaius*
 - c) *Calanthe*
 - d) all of these
- 7) Orchids selected for varandhas
 - a) *Paphiopedilum*
 - b) *Rhyncostylis*
 - c) *Calanthe*
 - d) *Phaius*
- 8) Sun loving orchids
 - a) *Arudiana graminifolia*
 - b) *Calanthe*
 - c) *Paphiopedilum*
 - d) *Phaius*
- 9) Cool species of orchid
 - a) *Phalaenopsis*
 - b) *Phaphiopedilums*
 - c) *Cymbidiums*
 - d) both b & c
- 10) Intermediate Species of orchid
 - a) *Cattleyas*
 - b) *Phalaenopsis*
 - c) *Cymbidium*
 - d) *Phaphiopedilums*

(Key answers: 1) a, 2)d, 3)d, 4)d, 5)a, 6)d, 7)b , 8)a, 9)d, 10) a)

II. State true or False

1. Orchids are accepted to be the world's most exotic and fascinating flowers.
2. Majority of the cultivated orchids are native of temperate countries.
3. In sub tropical zone temperature ranges from 25-40°C.
4. The temperate zone remains covered with snow for 3-5 months a year.
5. Sunlight has several 'Photo morphogenetic influences upon plants.
6. The optimum light which orchids generally require is between 3000-10,000 foot candles.
7. Generally orchids thrive day temperature varying between 20 to 35° C.

8. *Zygopetalums* thrive well 16-21° C day temperature in winter.

9. *Cattleya labiata* does not flower when night temperature is higher than 21°C.

10. *Dendrobium crumentaum*, flower only when temperature is 10° C.

(Key answers: 1)True, 2) False, 3) False, 4) True, 5) True, 6) False, 7) False , 8) False, 9) True, 10) True)



ORCHIDS

LECTURE-14

Topics:

- 13.1. Floral biology
- 13.2. Propagation of orchids
- 13.3. Feeding/nutrition
- 13.4. Organic feeding
- 13.5. Inorganic feeding
- 13.6. Containers and composts
- 13.7. Potting materials
- 13.8. Potting
- 13.9. Annual repotting

13.1. FLORAL BIOLOGY

- ✿ The three inner floral segments are very irregular called the petals.
- ✿ One of them termed the lip or labellum is typically very much modified and enlarged.
- ✿ It is often the most prominent and distinctive part of the flower.
- ✿ In the bud, the lip is the uppermost petal
- ✿ It becomes the lower most one through a remarkable twisting of pedicellate ovary, a process known as resupination.
- ✿ The column is the reproductive part of the orchid blossom.
- ✿ Stamens are united to the styles and stigma forming a column.
- ✿ The orchid flowers are irregular extremely variable in size and shape with sparkling texture, they may be solitary or in spike emitting the fragrance of lemon cloves or fresh lavender oil. A few are, however highly malodorous.

- ✿ The flower as its parts in three sepals and three petals (collectively called as tepals due to their resemblances in texture and color)
- ✿ Similar to each other and sub-similar to sepals. It is, however, the third petals, which is different and distinctive and is called labellum or the lip.

- ✱ The lip that highly polymorphous is responsible orchid, ladies sleeper orchid.
- ✱ The reproductive organs of the orchids, the stamens and the pistil are condensed and form a consolidated complex body, the column (Gynostemium),
- ✱ The male and female part being separated by a flap or projection of a tissue, called restellum.
- ✱ Orchids are cross-pollinated by insects, birds, etc. and to achieve this they have adopted many contrivances like mimicry and twisting of the flower on its stalk to almost 180° to face its pollinating agent (Resupination).
- ✱ A Mediterranean orchid 'Ophyrus' shows a fine example of mimicry. It resembles a female wasp to the death of all parts.
- ✱ Long stemmed monopodials such as species of *Vanda*, *Angraecum*, *Renanthera* and *Aerides* are perhaps among the most difficult to divide. Only older healthy plants that have developed aerial roots 20cm or more from their bases should be dealt with by cutting them into pieces below each root.
- ✱ The severed piece, along with its roots, forms a new plant and the original plant, rid of most of its aerial roots, soon develops more roots and will flower probably within three years.

PROPAGATION OF ORCHIDS:

SYMBIOSIS:

- There is a peculiar interdependency between orchids and fungi.
- A brief knowledge of this 'mycorrhizal relationship' is very necessary to understand the procedures of orchid seed germination.
- There have been developed two distinct and basic methods of germination based on this knowledge.
- In the first it is assumed that the presence of the fungus is necessary for successful germination. The fungus is isolated, grown in sterilized culture sand then, when fully developed in the medium, orchids are sown. This is a time consuming method which is hardly ever used today.
- Generally the second, the asymbiotic method is applied. Here the growing medium is enriched by mineral nutrients which provide the plant with basically the same substances as the fungus.
- A high degree of sterility, both of the sowing media and the seed is necessary. There are many new recipes for suitable germinating media. To mention a few are Burgeff, Knudson C. Vacin and Went, Nitsch, Murashige and Skoog, etc.
- Recently another vegetative reproduction method, meristem culture, has gained importance.
- The process is technically very complicated and demanding and since it requires a laboratory to be carried out successfully.

- However, meristem propagation has only been achieved, to a commercially acceptable standard for *Cattleya*, *Cymbidium*, *Calanthe*, *Dendrobium*, *Miltonia*, *Odontoglossum*, *Oncidium*, *Zygopetalum* and Hybrids.
- Plants produced by this method, when young are known as mericlones. Here the meristems are transferred to a culture medium where they can be subdivided and an unlimited number of new plants raised.

METHODS OF PROPAGATION

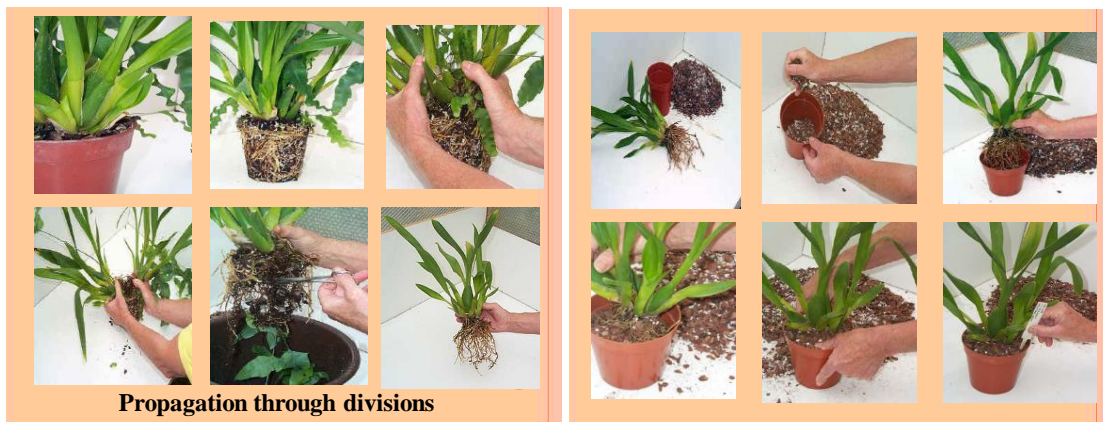
CONVENTIONAL METHODS

I. Monopodial orchids

- A . Stem cuttings
- B . Flower stalk cuttings
- C . Layering

II .Sympodial orchids

- A . Divisions
- B. Offshoots
- C . Back bulbs



13.2. MICROPROPAGATION OF ORCHIDS

The modern methods of propagation have brought orchid cultivation on par with other commercial crops.

In-vitro seed culture:

- Orchid seeds are extremely small (80-130 Mm wide and 410-560 Mm long) and usually undifferentiated.
- They produced in large numbers ranging from 1300 to 5 lakh/capsule.
- Each seed contains an undifferentiated embryo composed of 80-100 cells without any functional endosperm.
- Under natural conditions the orchid seeds germinate in association with fungus (Mycorrhiza).

FERTILIZER APPLICATION

According to some workers Ammonium nitrate is the best nitrogen source for early germination and protocorm formation. After the roots and leaves are formed the protocorms prefer nitrate for their continued growth.

- In their natural habitats, orchids grow on no special nutrients, depending only on what they could absorb from decaying tree bark and the atmosphere.
- A synthetic inorganic fertilizer, equally balanced in,
 - ❑ NPK 17:17:17 or 20:20:20, dissolved in water @1-5g per litre applied once or twice a week gives satisfactory results.
 - ❑ To promote flowering, a higher proportion of phosphorus and potassium such as 10:20:20 is helpful.

13.3. FEEDING/NUTRITION

- Three basic principles have to be applied to orchid feeding:
 1. Only well rooted plants should be fed;
 2. The feed is preferable in small but frequent doses;
 3. It should only be applied during the period of maximum active growth.
- The actual feed can be organic or inorganic.

13.4. ORGANIC FEEDING

- Organic fertilizers like
 - Cow dung,
 - Chicken manure,
 - Groundnut cake,
 - Neem cake etc. can be moderately used.
 - These must be soaked in water at 1:10 or 1:20 for 2 to 3 days to allow decomposition of the fertilizer.
 - The supernatant solution is used for spraying once or twice a month.
- The use of organic fertilizers seems obvious since they are the natural food of orchids. Unfortunately, however, the precise chemical formulae of organic feeds are not usually known and it is therefore impossible to control accurately a plant's intake.
- The application of organic feeds has a great disadvantage in that it decomposes the potting compost very quickly.
- There are several commercial organic feeds on the market and many of these are good for orchids, especially those prepared from fish or seaweed bases.

13.5. INORGANIC FEEDING

- With inorganic feeding the exact proportions of the different chemicals can be accurately ascertained and the plants fed according to their requirements.
- The essential elements are Nitrogen (N), Phosphorous (P), and Potassium (K).
- The NPK mixture fertilizer 2 % N, 0.2 % to 0.5% of P and K is mainly responsible for the control of flower and fruit development.
- Growth regulators like GA₃ enhance flowering and also the yield of flowers when sprayed @ 1.5ppm/l once in 15 days before flowering. IBA @ 1ppm/l promotes the growth of new shoots.
- Orchids growing in nature do not need much of manuring but those grown in the orchidariums need spraying in the liquid forms.

- Fertilizer doses should be dilute. The plants will burn by over fertilizer which can be seen as burnt leaf tips. One of the liquid spray's which gives healthy growth is the Ohio spray.

Composition of Ohio solution made up for 1 gallon / 4.5 lt. of water.

* Potassium nitrate	2.63g
* Ammonium sulphate	0.44g
* Magnesium sulphate	2.04g
* Monocalcium phosphate	1.00g
* Calcium sulphate	4.86g
* Iron sulphate	0.50g
* Manganese sulphate	0.25ml.

13.6. CONTAINERS AND COMPOSTS



- For the naturally growing orchids the tree trunks, ground, damp broken walls and rocks are the containers.
- But when we grow orchids domestically and commercially we need special types of containers well suited for their habitat.
- Some of the most suitable containers used are (1) Pots, (2) Baskets, (3) Wooden logs, (4) Tree ferns, (5) Coconut husks, etc.
- Clay pots are generally used for orchids. They may have few to many holes for good drainage and aeration.
- The pot size may vary from thumb size to 20 inch pots.
- Plastic pots can also be used.
- Wooden baskets are made up of high quality wood which can withstand frequent watering.
- These may also differ in size and shape generally square baskets are used.

- Similarly tree fern blocks can also be cut into different sizes and shapes and the plants can be tied to these with thin copper wires.

POTTING MEDIA:

- In the above containers (Pots and baskets) compost mixture is added in different proportions.
- Care should be taken while preparing the above compost mixtures so that it provides, (1) Aeration, (2) Drainage (3) Rich mineral nutrition etc.
- The potting mixture which is generally used consists of the following material:
- Brick pieces, charcoal pieces, peat moss, stone pieces or jelly, tree fern fiber, farm yard manure, rock wool plugs, peat moss and vermiculite.
- Pots which have side drainage holes the compost used is brick pieces, stones pieces, coke which are mixed in equal proportions 1:1:1.
- At the bottom of the pots slightly bigger pieces of charcoal are put.
- Pots with bottom drainage holes are filled up with very small pieces of charcoal and tree fern fiber powdered in equal proportions of 1:1. This compost mixture is used for epiphytic orchids.
- In choosing suitable types of container, may be pot, basket or raft the needs of the plant must be considered along with one's own preferences.
- The bark of cork oak is extremely amenable to plant growth as well as being very durable.
- Ordinary oak or pine bark is not so durable but even so will last for several years. Because of their porosity and durability the stems of tree ferns are also extremely good.
- In larger collections, the traditional clay pots are still used, mainly because of their cheapness.
- They are also useful for the beginner as indiscretions of over watering are offset by the porous nature of the pot which, incidentally, also helps to maintain atmospheric humidity.
- Expanded polystyrene is very good, especially since its fantastic insulating properties protect the roots and favor their growth but it's one great disadvantage is that it is so light that plants are likely to be knocked over more readily.
- The advantage of baskets is that air can enter from all directions, but this can lead to a more rapid drying out of the compost, especially in hot summer spells, and therefore watering is more of a chore with them.
- The best way of watering baskets is by dipping. Wire baskets, either of galvanized iron or aluminum or plastic-covered copper-wire, can be used and shaped to fashion.

- Terrestrials present no problems, being grown exclusively in clay or plastic pots or pans.
- For terrestrial or ground orchids, we can use sand, mud and farm yard manure in equal proportions and earthen pots.
- In Florida a new coconut basket has been introduced called the COCONEST.
- This is unique spun coconut fiber NEST treated with organic substances, creating a strong flexible shell, allowing air to circulate and retain humidity in the natural way, allowing constant moist compost for growing.
- The NEST provides an even distribution of water to the fine growing roots.

13.7. POTTING MATERIALS

OSMUNDA:

- This is the root fibers of the Royal fern, *Osmunda regalis*.
- It is hard, durable, sufficiently springy but rigid enough for good anchorage and contains very little mineral matter.
- Its great disadvantage is its high price and today good quality osmunda is almost unobtainable.

POLYPODIUM FIBER

- This is the root fibres of the common polypody fern, *Polypodium vulgare*.
- It is softer and finer than Osmunda fiber and neither so durable nor so good for anchorage and aeration.
- A little soil should be added to it and this obviously also increases its mineral nutrition.

SPHAGNUM

- This bog moss is cheap,
- Has excellent water retention property and is inert chemically.
- It is usually mixed with some other media but can be used by itself for the establishing of seedlings and newly imported plants that need special attention.

TREE FERN

- This is usually obtainable as the ground-down trunks of tree ferns.
- It is hard, fairly durable, without mineral content and not very expensive but the fibers are not always long and spongy enough to provide good anchorage.
- Broken brick, pumice granules, gravel and broken coke, fir bark, peat, synthetic materials can either be used by themselves in a form of hydroponic orchid culture or mixed with sphagnum.

- Generally medium should be porous and well aerated for the roots to freely grow and respire easily.
- Easily available and cheap medium should be used either individually or in combinations.
- A mixture of brick and charcoal or peat moss which is degradable and holds moisture for a long time can be used.

13.8. POTTING

- After the selection of plants proper potting with proper compost mixture has to be done.
- While potting the epiphytic orchids like *Vanda* and *Dendrobium* care should be taken that **aerial offshoots** or **Keikis** should not break.
- *Vanda* plants are staked.
- Proper labeling should be done after the potting is over.
- The pots should be filled to about 1/3 of their height with the compost material chosen.
- The bottoms of baskets should be covered with large flat crocks.
- The bases of the pots are generally being prepared.
- The oldest pseudobulb should be against the edge of the pot and the youngest ones towards the center so that there will be ample space for new shoots and pseudobulbs to grow.
- More potting material is gradually added, being temped down firmly with a potting stick working from the outside towards the center.
- With a coarse potting medium the top level should be 1-2 cm below pot level.
- Monopodial orchids, such as *Vanda*, *Renanthera* and *Phalaenopsis*, should be potted similarly but, since they do not have pseudobulbs, they should all be planted in the center of the pots.
- In *Paphiopedilum* the potting material is topped up with sphagnum, which, with correct watering, will continue to grow and be beneficial to the plants as well as act as an indicator of the condition of the compost.
- Without compelling reasons orchids should not be repotted.
- If, however, aeration of the potting material is poor because of decomposition it must be replaced.
- If in doubt, put it off for another year. Basically care must be taken that new growth and shoots are not overlapping the rim of the pot,
- For large neglected plants which have been potted for a long time are notoriously difficult to handle and it is very easy to break off new shoots and roots.

The frequency and time of repotting has certain rules:

13.9. Annual repotting

- *Calanthe, Dendrobium, Phalaenopsis* and its hybrids, *Paphipedilum* and *Phalaenopsis*.
- Every alternate year- *Cattleya, Dendrobium, Oncidium* and *Odontoglossum*
- Every third year- *Vanda* and its allies, *Cymbidium*
- Less frequently -all 'tussock' orchids
- It must be stressed again that repotting can seriously disturb a plant and therefore should not be undertaken more than necessary.
- Repotting times do not vary very much but should usually be at the beginning of the active growing season or at least when the new roots appear.
- The techniques of repotting may be difficult both for amateurs and professionals
- Certain points must be considered, especially regarding the treatment of the roots.
- To remove the root-ball from the pot it is advisable to use a knife.
- All old potting material, dead roots and shriveled pseudobulbs have to be removed.
- With sympodial orchids such as *Cattleya, Dendrobium, Odotoglossum*, etc., not more than 5 or less than 3 pseudobulbs should remain.
- When the older pseudobulbs, the backbulbs are removed from many orchids it will be noted that they often have 'eyes'.
- These backbulbs can be planted in small pots and within 2-3 years will be like ordinary plants.
- The containers, pots, pans, baskets or rafts, should be large enough to carry two shoots or developing growths.
- Too large pots are to be avoided because they can actually retard growth and inhibit flowering.
- While repotting, the plant is held at the base and loosened along the pot inside. The old roots and leaves are removed. Then the plant is potted again.



Quiz

I. Chose the correct answer from the following

1. Long stemmed monopodials sps.

- a) *Vanda Angraecum* b) *Renanthera* c) *Aerides* d) all of these

2. Sympodial orchids such as

- a) *Cattleya* b) *Dendrobium* c) both a & b d) *Vanda*

3. The stamens and the pistil are condensed and form a consolidated complex body

- a) gynostemium b) rostellum c) resupination d) tepals

4. Example of mimicry

- a) *Vanda Angraecum* b) *Renanthera* c) *Aerides* d) *Ophyrus*

5. Recent vegetative reproduction method followed in orchid

- a) meristem culture b) cuttings c) anther culture d) protoplast culture

(Key answers: 1) a, 2) c, 3) a, 4) d, 5) a)

II. True and false

1. Orchid is also called as ladies sweeper orchid.

2. The male and female part of orchid being separated by a flap or projection of a tissue called rostellum.

3. A American orchid 'Ophyrus' shows a fine example of mimicry.

4. There is a peculiar interdependency between orchids and virus.

5. Orchids seeds are extremely small and usually undifferentiated.

6. At IARI a new technique was developed for viability testing of orchid.

7. Most of the orchids seeds utilize monossacharides such as sucrose, which is most commonly used carbon source.

8. Ammonium nitrate is the best nitrogen source for early germination and protocorm formation.

9. Orchids growing in nature need much of manure compared to those grown in the orchidariums.

10. Clay pots of thumb size to 20 inch are generally used to grow orchids.

(Key answers: 1)False, 2) True, 3) False, 4) False, 5) True, 6) False, 7) False , 8) True, 9) False, 10) True)

Match the following

A

B

1) coloumn

Phalaenopsis

2) projection of a tissue

Resupination

3) pollinating agent

Polypodium vulgare

4) polypody fern

Rostellum

5) Monopodial orchids

Gynostemium

(Key answers: 1)gynostemium, 2)rostellum., 3) resupination, 4) *Polypodium vulgare*, 5) *Phalaenopsis*)



LECTURE-15

ORCHIDS

Topics:

- 14.1. Harvesting
- 14.2. Post-harvest handling
 - 14.2.1. Grading:
 - 14.2.2. Storage:
 - 14.2.3. Packaging
- 14.3. Vase-life.
- 14.4. Pests and diseases
- 14.5. Orchids in trade and economy

14.1. HARVESTING:

HARVESTING STAGE ,STORAGE AND VASE LIFE OF DIFFERENT ORCHIDS

Genus	Harvesting stage	Storage temperature	Vase life (days)
Cattleya	3-4 days after full opening of flowers	8 –10 ⁰ c for 10 to 14 days	14
Cymbidiums	When all florets open	1 to 4 ⁰ c for two weeks	15-21
Dendrobiums		5 to 7 ⁰ c in water for 10 to 14 days	14 –21
Paphiopedilum		-0.5 to 3 ⁰ c for days	25-30
Phalaenopsis		7 to 10 ⁰ c for 14 days	14 - 21

- This is a very important operation and the growers should have thorough knowledge about the flowering behavior of the orchids used for cut-flower production.
- Proper time, stage and method of harvest determine the quality of the produce. In general, orchid flowers do not mature until 3 to 4 days after they open.
- Flowers cut prior to their maturity may wilt before reaching the wholesaler.
- Harvesting should preferably be done in the evening.
- All the tools should be sterilized.
- Flowers harvested in the heat of the day can be stressed because of high temperature.
- Dark coloured flowers may be as much as 5.5° C warmer than white flowers during mid afternoon.
- When individual *Cattleya* and *Cymbidium* flowers are cut, the peduncle should immediately be inserted in a tube of water.
- In Hawaii and Singapore, some *Dendrobium* and *Aranda* growers immerse the entire sprays of flowers in water for 15 minutes before packing and shipping.

14.2. POST-HARVEST HANDLING

Typical view of the post harvest room where flowers are neatly stacked after cleaning

14.2.1. GRADING:

- There are no standard grades for orchid flowers and their prices are fixed according to the size.
- In case of *Cattleya* flowers both colour and size are considered while pricing.
- Grading is done mainly on length of the flower spike, flower number and size and arrangement of flowers on the spike.
- Sometimes the number of lateral branches on the inflorescence is also taken into consideration.

14.2.2. STORAGE:

- Since most orchid flowers are long-lived on the plants, they should not be harvested until needed.
- If these are to be cut they should be stored at 5-7° C. At this temperature most orchid flowers can be stored for 10 to 14 days.
- Plastic film storage is attractive and can be utilized.

14.2.3. PACKAGING

Typical view of packing systems:

- Packaging is another important aspect in the flower trade.
- If it is not done properly, the flowers may wither or suffer mechanical injury during transit.
- An ideal package should be air tight, water proof, strong enough to withstand handling and small in volume.
- Many ways are followed to pack orchid flowers.
- *Cymbidium* spikes are often packed 100 flowers to a box.
- Standard florist boxes are used for the packing of *Cattleya* flowers.
- Hawaiian *Dendrobium* is packed in 4 dozen sprays per box.
- Keeping of a wet cotton at the cut end of the flower stem which is wrapped with a polythene wrapper helps to maintain humidity.

14.3. VASE-LIFE

- Orchid flowers, though long-lasting, should properly be handled to ensure minimum shelf life.
- Immediately after arrival, the lower 0.75 cm of the peduncle is cut off, and the flower is inserted into a fresh tube of water containing preservative.
- In case of spray-type of orchids, the basal 2.5cm of the stem is cut upon arrival, placed in warm water at 38° C with a preservative and hardened off at 5° C.
- In cut-flower industry the major chemical environmental pollutant affecting senescence is ethylene.
- Orchid flowers are very sensitive ethylene and proper management and control of ethylene and ethylene like pollutants are important for the success of the industry.
- Foliar application of aluminum chloride at 500ppm, ammonium molybdate at 100ppm or boric acid at 1000ppm extends the vase-life of *Oncidium foldiana*.

- Hydroxyquinoline resulted in additional bloom opening of the flowers and also increased the vase-life.

14.4. PESTS AND DISEASES

Orchids are prone to a number of pests and diseases caused by various agents like viruses, fungi, bacteria, insect pests, etc.

The chart below identifies and illustrates types of damage to orchids and the various causes.

PEST	CAUSE/SYMPTOM	REMEDY
APHIDS	<ul style="list-style-type: none"> ▪ Leaves and stems appear stunted; ▪ Flowers may be malformed or fail to open. ▪ Aphids are visible, particularly on new growth. ▪ Most vulnerable pest: <i>Cattleya</i>, <i>Oncidium</i>, <i>Phalaenopsis</i> 	<ul style="list-style-type: none"> ▪ Wash off black fungus with water and mild kitchen detergent. ▪ Use an insecticide containing Malathion, Desis, Nicotine or pyrethrum.
MEALY BUGS	<ul style="list-style-type: none"> ▪ Cottony masses especially infest points of juncture such as the crook between two leaves. ▪ Plants may appear stunted or shriveled. <p>Most vulnerable: <i>Cattleya</i>, <i>Dendrobium</i>, <i>Phalaenopsis</i></p>	<ul style="list-style-type: none"> ▪ Remove small infestations with a cotton swab dipped in methylated spirits. ▪ On heavy infestations, use an insecticide containing malathion or nicotine.
SCALES	<ul style="list-style-type: none"> ▪ Causes sooty mould ▪ The plant may be stunted, with leaves yellowing and falling off. <p>Most vulnerable: <i>Cymbidium</i>, <i>Pahipedilum</i>, <i>Miltonia</i>, <i>Zygopetalum</i>, <i>Cattleya</i>,</p>	<ul style="list-style-type: none"> ▪ Pick off small infestations with tweezers or a knife, or swab with methylated spirits. ▪ Spray adult scales with an insecticide containing malathion or nicotine.
SLUGS AND SNAILS	<ul style="list-style-type: none"> ▪ The plant is punctured with ragged holes and a slimy trail is visible where pests have passed. <p>Vulnerable: All orchids, especially seedlings.</p>	<ul style="list-style-type: none"> ▪ A tuft of cotton wool around the stem will protect flowers. ▪ Trap snails and slugs with pesticide bait containing metaldehyde or methiocarb.
SPIDER MITES	<ul style="list-style-type: none"> ▪ Leaves appear pitted or stippled with white. ▪ White webbing may show on the underside 	<ul style="list-style-type: none"> ▪ Scrub and rinse foliage with warm water to break up webs. ▪ Spray heavy infestations

	of the leaves. Most vulnerable; <i>Cymbidium</i> , <i>Dendrobiu</i> , <i>Phalaenopsis</i> .	with pesticide containing malathion or derris.
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DISEASES

PEST/SYMPTOM	CAUSE	REMEDY
<p>BLACK ROT: Purplish blotches edged with yellow appear on leaves and new shoots. Rotting may work downwards from leaves or upwards from roots and rhizomes. Most vulnerable: <i>Cattleya Orchids</i>, <i>Phalaenopsis</i>.</p>	<p>Black rot is caused by several types of fungi that favour high humidity, cool temperatures and standing water. Damping off, which affects seedlings, is also caused by these fungi and occurs most readily in community pots.</p>	<p>Drench infected plants with a fungicide such as captan or zineb. Remove infected parts cut 2.5cm into healthy tissue and seal cuts with fungicide. Destroy badly the diseased plants.</p>
<p>LEAF SPOT: Raised or sunken spots in yellow, brown or purplish shades spread quickly over leaves. In advanced stages, leaves turn yellow or brown and die. Most vulnerable: <i>Oncidium</i>, <i>Dendrobium</i></p>	<p>Leaf spot is usually caused by those species of fungi that thrive in high humidity. IT is especially destructive to seedlings but rarely fatal to mature plants.</p>	<p>Reduce humidity and increase air circulation. Cut off diseased leaves; spray cuts with fungicide. Apply captan or a systemic fungicide containing binomial or thiphanate-methyl weekly.</p>
<p>PEATAL BLIGHT: Small brown circles, often with pink edges, appear on sepals and petals. Most Vulnerable: <i>Cattleya</i>, <i>Orchids</i>, <i>Dendrobium</i>, <i>Oncidium</i>. <i>Phalaenopsis</i>, <i>Vanda</i></p>	<p>Petal blight, also known by the name of the fungus that causes botrytis, generally appears in cool, damp weather when there is inadequate air circulation. Microscopic spores are carried by insects, water or human hands. Fungus tends to attach</p>	<p>Cut off and destroy infected blossoms. Spray plants with a fungicide containing benomyl, captan, thiophanate-methyl, thiram or zineb.</p>

	old and fading flowers.	
<p>VIRUS: Leaves may show yellow, black or brown pitting, mottling, mottling and streaking. Flowers too may be streaked or mottled. Vulnerable: All Orchids</p>	<p>Two main types of viral diseases, cymbidium mosaic and Cattleya mosaic, spread through the vascular systems of plants. Highly infectious, viruses may be transmitted by infected plants. Highly infectious, viruses may be transmitted by infected plants, hands, tools, aphids.</p>	<p>There is no cure. Destroy infected plants. When dividing, flame sterilizes the knife between cuts, dip potting sticks in a 10 percent household bleach solution.</p>

As a general rule:

- 1) Apply fungicides and insecticides early in the morning or late in the evening.
- 2) Use a fine nozzle for spraying.
- 3) Heavily infected plants should be discarded and burnt, and should not be used as propagating material.

14.5. ORCHIDS TRADE AND ECONOMY

- At present Orchid cut flower trade is a multi-million dollar business.
- The cut flowers of species like Cymbidium, Paphipedium, Phalaenopsis, *Cattleyas* and *Dendrobiums* have a tremendous market in USA and Europe.
- It is estimated that two hundred million *Cattleya* flowers are sold annually in American market.
- Some of the developing countries like Malaysia, Singapore, Thailand and Sri Lanka are fast catching up the international market and run the cut flower industry on co-operative basis they pool the collections and export them to Europe, Japan and USA a few orchids figure prominently as State or National flowers. E.g. *Cypripedium reginae* by Minnesota and *Cattleya skinneri* by Cost Rica.
- Through commercial orchid cut flower nurseries provide under 3% of the world cut flowers they earn considerable foreign exchange profit for many countries.

- The Netherlands is the only European country with a sizeable orchid export industry.
- In 1993, the Netherlands exported 51.8 million stems of orchids valued at 77.4 million.
- *Phalaenopsis* orchids were the 14th most popular cut flowers sold in Dutch auctions in 1993 with sales exceeding 12.8 millions.
- More than 3,600 tons of *Dendrobiums* were sent to Europe in 1993 from Thailand and more from Singapore.
- *Dendrobium* orchids accounted for 3.2 million dollars of sales in Dutch auction market; but most were imported directly whole sale distributions in France, Germany, England and Italy.
- The largest importer of tropical cut orchids in Europe in Italy, importing about 21,43,425 kg in 1993 and 30,00,725 kg in 1996.
- Germany is the second largest importer of tropical orchids in Europe with 4,78,446 kg.
- The growth and popularity of orchids is gaining lot of importance in our country due to the high rate of return.

Quiz

State True or False

1. Orchid flowers do not mature until 3 to 4 days after they open.
2. There are standard grades for orchid flowers and their prices are fixed according to the size.
3. At 5-7° C temperature most of the orchid flowers can be stored for 10 to 14 days.
4. Packaging is not an important aspect in the flower trade.
5. Hydroxy quinoline resulted in additional bloom opening of the flowers and also increased the vase-life of orchid flower.
6. No major pest and disease attack on orchid.
7. The international trade on floriculture is estimated at about ten billion dollars per annum.
8. The largest importer of tropical cut orchids in Europe is Italy.
9. The growth and popularity of orchids is gaining lot of importance in our country due to the high rate of return.
10. Germany is the first largest importer of tropical orchids in Europe.

(Key answers: 1) True, 2) False, 3) True, 4) False, 5) True, 6) False, 7) False , 8)True, 9) True, 10)False)

Match the Following

A	B
1. Black rot	Plants appear stunted
2. Aphids	Zineb
3. Mealy bugs	Metaldehyde
4. Slugs	Leaves appear pitted
5. Spider mites	Malathion

(Key answers: 1) Zineb 2) Malathion 3) Plants appear stunted 4) Metaldehyde 5) Leaves appear pitted)



LECTURE 16

GERBERA

TOPICS

- 26.1. Introduction**
- 26.2. Soil structure**
- 26.3. General disinfection of soil**
- 26.4. Bed preparation**
- 26.5. Greenhouse/shade house for commercial cultivation**
- 26.6. Planting**
- 26.7. Irrigation**
- 26.8. Fertilization**

26.1. INTRODUCTION:

- Gerbera (*Gerbera jamesonii*) is commonly known as Transvaal Daisy, Barberton Daisy or African Daisy.
- It is an important commercial flower crop grown throughout the world in a wide range of climatic conditions.
- It is ideal for beds, borders, pots and rock gardens.
- The flowers available in a wide range of colors and lend themselves beautifully to different floral arrangements.
- Used as cut flowers and the cut blooms have long vase life.

MORPHOLOGY:

- A plant is stemless and tender perennial herbs, leaves radical, petiole, lanceolate, deeply lobed, sometimes leathery, narrower at the base and wider at the tip and are arranged in a rosette at the base. The foliage in some species has a light underside.
- The daisy-like flowers grow in a wide range of colors including yellow, orange, cream-white, pink, brick red, scarlet, maroon, terracotta and various other intermediate shades.
- The double cultivars sometimes have bicolor flowers, which are very attractive.

- The flower stalks are long, thin and leafless.
- Flower heads solitary, many flowered.

ORIGIN AND HISTORY:

- The genus *Gerbera* was named in honor of a German naturalist, Traugott Gerber.
- This is native to South Africa and Asiatic regions.
- In India they are distributed in the temperate Himalayas from Kashmir to Nepal at an altitude of 1300 to 3200 meters.
- *Gerbera jamesonii* is native to Natal and Transvaal and *Gerbera viridifolia* from Cape.
- *Gerbera* species of Indian origin are *Gerbera anandria*, *G. kunzeana*, *G. languinosa*, *G. macrophylla*, *G. nivea*, *G. ovalifolia* and *G. piloselloides*.
- Gerbera belongs to the family “Compositae”.
- 45 species, native to tropical Asia and Africa.

SPECIES AND CULTIVARS:

- The genus *Gerbera* consists of about 40 species.
- *Gerbera jamesonii* is the only cultivated species.
- *Gerbera asplenifolia*
- *Gerbera aurantiaca*
- *Gerbera kunzeana*
- *Gerbera viridifolia*

IMPORTANT CULTIVARS:

Dusty, Flemingo, Fradaisy, Fredeking, Fredorella, Maron Clementine, Nadja, Terraqueen, Uranus, Valentine, Vesta, Alexis, Amber, Anke, Apple blossom, Belitis, Caprice, Hildegard, Ibiza, Joyee, Kabada, Marleen, Pascal, Romilda, Rozamunde, Salmorosa, Sympathic, Easter Star, Eastelle, Nena, Terra Parade, Terra Son, Aruba, Asheley, Flora, Goldspot, Nevada. Rosabella, White Sun. Vino, Venturi, Sunset, Sundance, Sangriana, Siby, Sissy, North Star Ornella, Tropical, Cocktail, Panorama, Mirage, Pink Sensation, Tara, Thallasa, Diablo, Lyonella, Twiggy, etc.,

CLASSIFICATION

- There are ‘single’ and ‘double’ types of gerbera.

- One or two rows of ray florets on the periphery of the disc and the rest are disc florets in the 'single' types.
- In the 'double' type, more than two rows of florets are present
- They are further divided into
 - Standard,
 - Spider and
 - Mini depending on the size and shape of the flowers.

PROPAGATION

SEEDS;

- Gerbera is propagated by seed, by cuttings of side shoots and suckers.
- Seed is set if cross-pollinated.
- Sowing of seed may be done in almost any season.
- Seeds germinate in 15 to 20°C within two weeks; otherwise it may take up to 30 days.
- Plants from seeds will bloom in the second year and produce good flowers from the third year onwards.

VEGETATIVE PROPAGATION:

- Side shoots, with some amount of heel, is utilized for.
- Divisions/ suckers, cuttings are also used.

MICRO-PROPAGATION:

– Following are the plant parts used as explants for micro propagation.

- Shoot tips,
- Leaf mid-rib,
- Capitulum,
- Flower heads,
- Inflorescence and
- Buds
- Murashige and Skoog (MS) media with modification is successfully used as culture media.

SOIL AND CLIMATE

CLIMATE:

- The optimum day and night temperature is 27°C and 14°C respectively
- For flower initiation is 23°C and for leaf unfolding it is 25 - 27°C
- Sunny or semi-shady locations are good for gerbera cultivation.

16.2. SOIL:

To be successful in Gerbera cultivation, the soil selection is very important. The main factors to be considered are as follows;

- Soil pH should be between 5.5 to 6.5 or it should be maintained at this level to get maximum efficiency in absorption of nutrients.
- The salinity level of soil should not be more than 1 ms/cm. Therefore, as soon as you select the site, get the soil analyzed to decide its further reclamation.
- Gerbera are deep rooted plants and the roots go as deep as 50 to 70cm.
- The soil should be highly porous and well drained to have better root growth and better penetration of roots.

26.3. DISINFECTION OF SOIL:

- Before plantation of Gerbera, soil disinfection is absolutely necessary. In particular, the fungus *Phytophthora* is a menace to Gerbera. The various methods of sterilization are;
 1. **Steam:** Not economically feasible for Indian conditions.
 2. **Sun:** Cover the soil with plastic for 6-8 weeks. Sunrays will heat up the soil, which will kill most fungi.
 3. **Chemical sterilization:**
 - Use of formalin @ 7.5-10 lit/100sqm.
 - This pure chemical should be diluted 10 times in water and then sprayed/drenched on beds.
 - Cover the beds with plastic sheets for 7 days.
 - Then flush the soil approximately with 100 liters of water per sqm to drain the traces.

- After sterilizing, subsequent washing out of the soil.
- It is advised to wait for 2 weeks before plantation.
- Other chemicals that can be used are,
 - Methyl Bromide : @ 25 – 30g/sqm
 - Basamid (Dazomet) : @ 30 – 40g/sqm

26.4. BED PREPARATION:

- In general, Gerberas are grown on raised beds to assist in easier movement and better drainage. The dimensions of the bed should be as follows:
 - Bed height : 1.5 ft (45cm)
 - Bed Width : 2 ft (60 cm)
 - Pathways between beds : 1 ft (30 cm)
 - The beds for planting should be highly porous, well drained and airy.
 - Gravel/sand can be added at the bottom for better drainage.
 - Organic manure is recommended to improve soil texture and to provide nutrition gradually.
 - The soil should be loose all the time. Organic manure and soil should be mixed thoroughly for optimum results.
 - The soil should not be very compact after watering.
 - The upper layer of soil and FYM should be properly mixed.
 - While bed preparation, add Single Super Phosphate (0:16:0) @ 2.5 kg per 100 sqft for better root establishment and
 - Magnesium Sulphate @ 0.5 kg per 100 sqft to take care of deficiency of Mg.

26.5. GREENHOUSE/SHADE HOUSE FOR COMMERCIAL CULTIVATION:

1. The height of the greenhouse/shade house should be minimum 5-6.5 m; so there is proper air circulation.
2. Sufficient ventilation space is required on top and sides.
3. To protect the plants in the monsoons provision for covering the top with polythene or plastic sheet is advised.
4. To control light intensity and solar radiation, while shade net (50-70%) is used. Approximately 400w/m² light intensity is required on the plant level.
5. The ideal temperature for Gerbera flower bud initiation is 23°C and for leaf unfolding is 25-27°C. The flowering of Gerbera is harmed at below 12°C and above 35°C.

12°C

Bud initiation will stop

35°C

Frequency of flowers will be very low & absorption of buds will take place

6. The optimum humidity inside the greenhouse/shade house should be 70-75%, which will maintain the health of the plants.

26.6. PLANTING:

- While planting Gerbera plants, the crown of plants should be 1-2 cm above soil level.
- As the root system establishes the plants are pulled down.
- Therefore, the crown must be above the ground level at planting and also throughout the life cycle.
- Plant the seedlings without disturbing the root-ball.
- Generally, two- three rows may be planted on one bed at 37.5 to 40cm distance between the rows and 30cm distance between the plants in one row.
Row – Row = 37.5- 40 cm
Plant – Plant = 30.0cm
- 6 to 7 plants can be accommodated per sq m.
- Rake the soil surrounding the plant every fortnight for aeration.
- After plantation, maintain the humidity at 80 – 90% for 4 -6 weeks to avoid desiccation of plants.
- Gerbera can also be cultivated in pots as bench system of planting.

26.7. IRRIGATION:

- Water quality should be as follows
 - pH – 6.5 – 7.0
 - EC – 0.5 – 1 ms/cm
- Avoid excessive watering to gerbera”
- To lower the pH of water, add acids in the water tank and then irrigate the plants.

- Immediately after plantation, irrigate the plant with overhead irrigation for four weeks to enable uniform root development. Thereafter gradually change to drip irrigation. Drip irrigation is mainly for correct doses and fertilizer application.
- Generally, one dripper per plant is required. The aim is to provide sufficient irrigation in the 2nd year for extra foliage.
- The water requirement of Gerbera plant may be approximately 700 ml per plant per day. In hot summer foggers can be utilized to maintain the humidity of the air.
- Before irrigation observe the soil column and visually check the soil moisture content. Then decide on the quantity of irrigation required. It varies with seasons; however the frequency is the same.
- Always water the plants before 12 noon.
- Until the first flowers are produced, watering can be done as overhead irrigation. Thereafter irrigation is through drippers.
- The R.H. of air should not exceed 90 – 92%, as it will lead to deformity of flowers.
- As a thumb rule, the soil should be moderately moist-however never having excessive water.

26.8. FERTILIZATION:

- Irrigate and fertilize frequently in small quantities for optimum results. However, always take care to fulfill the crop requirement.
- Micronutrients should be given weekly or fortnightly as per the deficiency symptoms (preferably chelated source).
- Always analyze the soil once in 2-3 months to decide specific nutrient schedule.
- As a layman, whenever you enter the greenhouse the plants should look very healthy and glossy.
- 25-75 t/ha of well decomposed organic manure is required.
- 150:137:190 g NPK/m² (40:40:40 g, three months at monthly interval)
- For the first three months after planting, application of 20:20:20:N:P:K @ 1.5 g/l of water every two days during the vegetative stage encourages better foliage.
- Once flowering commences.
 - N:P:K 15:8:35 at the rate of 1.5 g/l water/day.
 - Boron deficiency causes base of young leaves to turn black coloured.

- Zinc deficiency symptoms can be identified with the C-shaped leaf structure caused by chlorosis on one half of the leaf blade which ceases to expand, while the other half of the leaf is normal.

QUIZ

1. Choose the correct answers:

1. The roots of Gerbera go as deep as
 - a. 20-30 cm
 - b. 30-40 cm
 - c. 40-50 cm
 - d. 50 – 70 cm
2. While planting Gerbera plants, the crown of plants should be
 - a. 1-2 cm above the soil level
 - b. 1-2 cm below the soil level
 - c. Ground level
 - d. None
3. Gerbera is a ----- months crop
 - a. 24-30
 - b. 12-18
 - c. 10-12
 - d. 6
4. Gerbera flowers after
 - a. 3-4 weeks
 - b. 7-8 weeks
 - c. 9-10 weeks
 - d. 5-6 weeks
5. Average yield of Gerbera flowers per sq.mt.
 - a. 120
 - b. 200
 - c. 220
 - d. 240
6. Gerbera belongs to the family
 - a. Compositae
 - b. Iridaceae
 - c. Oleaceae
 - d. Clusaceae
7. Soil pH should be between
 - a. 6-7
 - b. 3.5-4
 - c. 5.5 – 6
 - d. 8.5-9
8. Recommended spacing adopted for Gerbera

a. 37.5x30 cm b. 30x30 cm c. 45x45 cm d. 60x45 cm

9. The ideal temperature for Gerbera flower initiation is

a. 20°C b. 23°C c. 14°C d. 30°C

10. The ideal temperature for leaf unfolding of Gerbera is

a. 17-20°C b. 25-27°C c. 20-22°C d. 30-32°C

I. Key Answer

1(d) , 2(a), 3(a), 4(b), 5(d), 6(a), 7(c), 8(a), 9(b), 10(b)

II. State true or false

1. Iron deficiency causes Interveinal chlorosis on older leaves.
2. The water requirement of Gerbera plant can be approximately 200 ml per plant per day
3. Gerbera plant is stem less herb.
4. Gerbera flower should be plucked from the plant rather than cutting them.
5. Double-faced Gerbera flower – A physiological disorder caused by imbalance of nutrients.

II. Key for State true or false

1(F), 2(F), 3(T), 4(T), 5(T)

III. Match the following:

- | | |
|----------------------|---------------------------|
| 1. Whitefly | a) <12°C and > 35°C |
| 2. Botrytis | b) Hot and dry climate |
| 3. Flower initiation | c) 25-27°C |
| 4. Leaf unfolding | d) 23°C |
| 5. Flowering affects | e) High relative humidity |

III. Key

1(b), 2(e), 3(d), 4(c), 5(a) ● ● ● ● ● ● ●

LECTURE 17

GERBERA

TOPICS

- 17.1 Cropping pattern and harvesting of flowers
- 17.2 Diseases/ pests
- 17.3 Disease control in gerbera
- 17.4 Never apply following chemicals on gerbera
- 17.5 Deficiency symptoms

17.1. CROPPING PATTERN AND HARVESTING OF FLOWERS:

- Gerbera is a 24-30 months crop.
- The first flowers are produced 7-8 weeks after plantation.
- Harvesting is done when the two outer rows of the disc florets are fully expanded and perpendicular to the stalk.
- The average yield is 240 flowers per sqm (6-7 plants/sqm).
- The flowers are harvested when 2 – 3 whorls of stamens have entirely been developed; this will decide the vase life of flowers.
- Pluck the flowers in the morning or late in the evening or during the day when temperature is low.
- Pluck the flower from the plant rather than cutting them.

POST HARVEST HANDLING OF FLOWERS

- Cut the heel of the stem by giving an angular cut.
- Pack the flowers in a box with following dimensions.
- Immediately after harvesting, flowers put in water and kept for four hours at 7 to 8°C
- The cut flowers can be stored dry at 2°C in moisture – proof retentive boxes for two days
- If stored wet at 4 to 5°C, the flowers can be kept for 5 to 7 days.
- Always add 7 – 10 ml commercial bleach/Sodium Hypochlorite solutions in one litre water i.e. 1% solution.
- It has a maximum vase life of 7 to 8 days.
- Frequent re-cutting of stem ends is suggested.
- The flowers are relatively insensitive to ethylene.

- A good flower has stalk length of 45 – 55cm, and diameter of flower is 10 – 12cm.
- **Gerbera Cups - The packaging solution to protect the gerbera flower**

17.2. DISEASES/ PESTS:

- Aphids: Causes deformed leaves, excrete some substance on which fungus develops.
- Greenhouse Whitefly: Occurs when climate is hot and dry, cause damage to leaves.
- Leaf Miner: White specks on leaves caused by files. White tunnels in leaves caused by larvae, which stays in soil.
- Mites: Older leaves are curled up. Younger ones being deformed and leathery, deformed flowers or if petals are missing.
- Thrips: Cause white specks or stripes on ray florets; flower heads may be deformed. Silvery, grayish spots on the leaves; Brown spots on leaf petioles/midvein.
- Crown Rot: Caused by *Phytophthora cryptogea* results in wilting disease of Gerbera, Crown of the plant becomes black.
- Root knot Nematode: Yellowing of leaves; nodules on roots.
- Botrytis: Occurs especially when the relative humidity of the air is more than 92% for two hours in the morning – gray spots on the flower petals – rot in the heart of flower.

Pests	Suggested control	Concentration per litre
Whitefly	Astra, Lanate (Methomyl)	0.4 g
	Rogor (Dimethoate)	2 ml
	Endosulphon	2 ml
	Neemazol	2 ml
	Malathion	2 ml
	Confidor (Imidacloprid)	0.5 ml
	Pride (Acetamiprid)	0.4 g
Leaf Miner	Chlorpyriphos	1 ml
	Nuvan (Dichlorovos)	1 ml
	Vertimec (Abamectin)	0.4 ml
	Acephate (Acephate)	1.5 g
	Metacid (Methyl Parathion)	1 ml

Thrips	Regent (Fipronil)	1.5 ml
	Confidor (Imidacloprid)	0.5 ml
	Nuvan (Dichlorvos)	1.5 ml
	Nuvacvon (Monocrotophos)	2 ml
	Rogor (Dimethoate)	2 ml
	Pride (Acetamiprid)	0.4 g
	Vertimec Abamectin)	0.4 ml
Red mites	Pure Water Spray	
	Wettable Sulphur	1.5 g
	Karathane (Dinocap)	0.4 ml
	Kelthane (Dicofol)	1.5 ml
	Vertimec (Abamectin)	0.4 ml
	Magister (Fenazaquin)	1 ml
Cyclamen Mites	Wettable Sulphur	1.5 g
	Karathane (Dinocap)	0.4 ml
	Vertimec (Abamectin)	0.4 ml
Catterpillar	Lanate (Methomyl)	1.5 g
	Thimet (Phorate) (S)	2g/plant
	Decis (Deltamethrin)	0.5 ml

17.3. DISEASE CONTROL IN GERBERA:

Pests	Suggested control	Concentration per litre
Root rot	Aliette (Fosetyl Aluminium) (D)	2 g
	Topsin-M (Thiophanate-Methyl) (D)	2 g
	Benlate (Benomyl) (D)	3 g
	Bavistin (Carbendazim) (D)	2 g
	Captaf (Captan)	2 g
Crown rot	Aliette (Fosetyl Aluminium) (D)	1.5 g
	Topsin-M (Thiophanate-Methyl) (D)	2 g
	Trichoderma (D)	3 – 5 g
Fusarium	Topsin-M (Thiophanate-Methyl) (D)	2 g
	Trichoderma herzenium (D)	3 – 5 g
Alternaria Leaf Spot	Dithane M-45 (Mancozeb)	1.5 g
Powdary Mildew	Wettable Sulphur	.5 g
	Karathane (Dinocap)	0.4 ml
	Topsin-M (Thiophanate-Methyl) (D)	2 g
	Quintol (Iprodion+Carbendazim) (D)	0.5 g

Nematodes	Neemcake	30 – 50g/plant
	Suzon (Diazinon) (D)	1.5 ml
	Carbofuran (Furadan)	10g/sqm

NOTE: (D) : Drench @ 30 – 40ml/plant
(S) : Soil application around plant

17.4. NEVER APPLY FOLLOWING CHEMICALS ON GERBERA:

Sl.No.	Trade Name	Consistent
1	Hostathion	Triazophos
2	Tilt	Propiconazole
3	Topaz	Penconazole
4	Contaf	Hexconazole
5	Spark	Cypermethrin + Triazophos
6	Polytrin	Profenophos
7	Ridomil	Metalaxyl 8% + Mancozeb 64%

- Flower bent – Loss of cell turgidity and under nutrition (lack of Calcium)
- Pre-harvest stem break – High root pressure and high humidity in the air.
- Premature wilting of Gerbera flower – Cloudy weather followed by bright sun or carbohydrate depletion.
- Double-faced Gerbera flower – A physiological disorder caused by imbalance of nutrients.
Too much growth too little flower buds.
- Non-uniform flower blooming – Physical injury to flower stem/pest damage/phytotoxicity.
- Short stem length – High salinity level, moisture stress, low soil temp.

17.5. DEFICIENCY SYMPTOMS:

1. Nitrogen: General yellowing starts on older leaves and then moves gradually upward because nitrogen is translocated out of older leaves to the new growth under deficiency.
2. Phosphorus: Brownish discoloration along the vein on underside of old leaves.
3. Potassium: Marginal necrosis of old leaves.
4. Calcium: Extreme yellowing of young leaves
5. Magnesium: Interveinal chlorosis on older leaves, leaves get thick and crispy.

6. Iron: Interveinal chlorosis on young leaves. Serious deficiency results in a yellowish-white coloring.
7. Zinc: Chlorosis, one half of leaf blade ceases to expand and develop while other half is normal i.e., C shaped leaf structure.
8. Manganese: Leaves turn yellowish, starting with younger ones; veins remain green, heavy chlorosis
9. Copper: Chlorosis in younger leaves; flower develops bad.
10. Molybdenum: Chlorosis on the edges of leaves.
11. Boron: Bases of younger leaves are black colored.

Control measure

Chelated sources (like Microsole, Tracel, Micnef) of these microelements as a foliar spray.



LECTURE 18

JASMINE (*Jasminum* spp.)

TOPICS

- 18.1. Introduction
- 18.2. Uses and Importance
- 18.3. Cultural requirements
 - 18.3.1. Soil and Climate
- 18.4. Varieties
- 18.5. Propagation and Planting Material
- 18.6. Plant Spacing, density and season
- 18.7. Planting
- 18.8. Nutrition
- 18.9. Nutritional requirement
- 18.10. Foliar Nutrition
- 18.11. Irrigation
- 18.12. Pruning
 - 18.12.1. Need for Pruning
 - 18.12.2. Pruning period
- 18.13. Weeding
- 18.14. Harvesting
- 18.15. Grading
- 18.16. Packing
- 18.17. Yield

18.1. INTRODUCTION:

- ◆ Jasmine (*Jasminum* spp.) is one of the oldest fragrant flowers.
- ◆ Jasmine being one of the important commercial flower crops is cultivated in India.
- ◆ It belongs to the family Oleaceae.
- ◆ As many as forty species of their genus are known to be in India.
- ◆ Important Species are
 1. *Jasminum auriculatum* : Vasantha Mallige
 2. *Jasminum grandiflorum* : Jajimallige/Jathimalli (or) Pitchi (or) Spanish Jasmine
 3. *Jasminum sambac* : Gundu mallige /Malligai / Arabian jasmine / Tuscan jasmine
 4. *Jasminum pubescens (multiflorum)* - Kakada

18.2. USES AND IMPORTANCE:

- They are mainly grown as climbers, shrubs and rarely as pot plants.
- Jasmine flowers, known for their fragrance are used for making garland.
- Garlands are being used for personal adorning by women and in religious offerings.
- Flowers and buds used, bouquets, vent/veni preparation.
- Production of perfumed oils and *attars*.
- The world famous jasmine oil is extracted from Spanish jasmine (*J. grandiflorum*).
- The essential oil extracted from the flowers is of high value as starting material for the perfume industry.
- There is tremendous scope for the development of jasmine essential oil industry for export.
- Some portions of the flowers are also used for the production of perfumed hair oil and 'attar'.
- The world famous jasmine oil is extracted from the flowers of the Spanish jasmine (*J. grandiflorum*). Nearly 50% of world's famous jasmine oil is produced from France and the rest is contributed by Belgium, Netherlands, Italy, Turkey, Morocco and Tunisia.
- The jasmine oil is considered unique as it blends well with other floral extracts to make high grade perfumes and cosmetics.

ORIGIN N HISTORY

- Among the large number of species existing only three species have attained importance in commercial cultivation.
- The Arabian or Tuscan jasmine (*J. sambac*) -native of the East Indies.
- The Royal jasmine or common white jasmine or Poet's jasmine (*J. officinale*) - Persian origin.
- The Spanish jasmine or Catalonion jasmine (*J. grandiflorum*)
- Cooke (1905) stated that *J. officinale* is a native of Kashmir.
- Adorn in central Asia, Afghanistan, Iran, Nepal etc.
- In India it is being grown in 8000 hectare area.
- India exports – to Sri Lanka, Singapore, Malaysia and Gulf countries
- Historic evidences show that even 200-500 years ago, the jasmines were extensively used for hair ornamentation by the women in China.

DISTRIBUTION

- Though jasmines are distributed in tropical and subtropical countries of the world,
- No. of species are centered around India, China and Malaysia
- Among these, about 40 species are reported to occur in India. Some of the important are as follows,
- *J. auriculatum* India
- *J. calophyllum* India
- *J. flexile* India
- *J. grandiflorum* Subtropical Himalayan region
- *J. humile* Tropical Asia
- *J. officinale* Iran, India, China
- *J. parkeri* India
- *J. sambac* India
- *J. multiflorum*

Commercially important species are;

1. *Jasminum auriculatum* (Vasantha mallige)

- Shrubby
- Leaves are shiny, with auricles
- Flowers white, sweet scented
- Corolla lobes elliptic, carpels solitary and globose
- Fruits black. Flowers -perfumes.
- Cultivars- Parimullai, CO 1 and CO 2

2. *Jasminum grandiflorum* (Spanish jasmine)

- Woody bush
- Leaves : Pinnate with 3-5 leaflets of equal size
- Flower : White, pinkish at the base, very much fragrant and commercially
- Used for essential oil extraction.
- Cultivars- CO 1, CO 2 and Arka surabhi.

3. *Jasminum sambac* (*Gundu mallige*)

- Evergreen twine. Leaves cordate to oblong, acute or obtuse, wavy, almost sessile, rather thin;
- Flowers white, fragrant usually in small, 3-forked cymes.
- Almost continuous.
- Variety *florepleno*: shows a double-flowered form.
- Cvs : Ramanathapuram, Gundumalli, Khoya and Arka Aradhana, Ramabanam madanban, Single mogra, Double mogra, Soojimalli, Kasthurimalli

4. *J. multiflorum*

- Straggly, downy shrub, leaves-cordate, mucronate, hairy beneath;
- Flowers white, large, fragrant, petal 6-9, lanceolate.
- Round the year flowering

18.3. CULTURAL REQUIREMENTS:

18.3.1. SOIL AND CLIMATE:

- Jasmine prefers mild tropical climate.
- Loamy (or) Red loamy and well drained garden soil is the best suited.
- Since jasmine is commercially grown in India under open field conditions, the ideal requirements for successful cultivation of these plants are mild winter, warm summer, moderate rainfall and sunny days.

18.4. VARIETIES:

J. auriculatum

- | | |
|------------|---|
| Parimullai | - Selection from a local type.
Medium round bud. Resistant to gall mite. Yield 8 t/ha with flowering duration about 9 months/year. |
| CO 1 | - Selection from a Long Round type.
Flowers have long corolla tube; easy for harvesting and marketing. Yield 8.8 t/ha. |
| CO2 | - Induced mutant from a Long point type.
- Longer corolla tube; flower buds bolder; field tolerant to phyllody; Yield 11.1 t/ha. |

- Others - Long Point, Long Round, Medium Point, Short Point and Short Round

J. grandiflorum

- CO 1 - Clonal selection from germplasm
 - Suitable for both loose flower production and oil extraction. Pink streaks are found on external surface of petal. Average yield 10 t/ha
 - The concrete recovery is 0.29 per cent.
- CO2 - Induced mutant from CO1 Pitchi.
 - Bolder pink buds with long corolla tube yield 11.68 t/ha.

J. sambac

- Ramanathapuram
- Gundumalli - Round flowers with good fragrance; yields 7 to 8 t/ha.
- Khoya - Flowers familiar to *J. sambac*, but bolder buds with less fragrance.
- Others - Ramabanam, Madanbanam, Single Mogra, Double Mogra, Iruvatchi, Kasthurimalli, Oosimalli, Soojimalli.

'Madurai Malli'

18.5. PROPAGATION AND PLANTING MATERIAL:

- ◆ Jasmines are commercially propagated by cuttings and layering.
 - *J. auriculatum* - Semi-hard wood
 - *J. grandiflorum* - Terminal cutting
 - *J. sambac* - Terminal and Semi-hardwood cuttings.
- ◆ Growth regulators. IAA (or) IBA treated at 1000 ppm for terminal cuttings and 2500 ppm for semi-hard wood cuttings.
- ◆ The treatment is quick dip method of the basal cut end before planting in the medium.
- ◆ Best rooting medium is sand: Vermiculate: moss at 1:1:1 ratio.

18.6. PLANT SPACING, DENSITY AND SEASON:

Species	Spacing	Density(Plants/ha)	Season
<i>J.auriculatum</i>	1.5 x 1.5 m	4400	June to November

<i>J.grandiflorum</i>	2.0 x 1.5 m	3350	- do -
<i>J.sambac</i>	1.25 x 1.25 m	6400	- do -

18.7. PLANTING:

- ◆ Land with proper drainage, irrigation facilities and sunny location are essential.
- ◆ Pits of 45 cm³ are dug at least one month before planting and exposed to sunlight.
- ◆ A few days before planting, pits are filled with 2 parts of FYM and one part each of fresh earth and coarse sand.
- ◆ Pits are to be watered to settle the mixture.
- ◆ Well rooted, healthy and strong plants are planted one in each pit.

18.8. NUTRITION:

- ◆ Jasmine responds to intensive manuring.
- ◆ Too much of manuring encourages vegetative growth and hampers quality and quantity of blooms.

18.9. NUTRITIONAL REQUIREMENT:

Species	Quantity(g/plant)			Method
	N	P ₂ O ₅	K ₂ O	
<i>J. auriculatum</i>	60	120	120	Six split doses at bimonthly interval
<i>J. grandiflorum</i>	10 0	150	100	In two split doses first June-July and second dose at December after pruning
<i>J. sambac</i>	60	120	120	Two split doses first at June-July and second at November after pruning

18.10. FOLIAR NUTRITION:

- ◆ Spraying of zinc 0.25% and magnesium 0.5% before flowering increases the yield of flowers.
- ◆ Spray Feso₄ at 5g/lit. at monthly intervals until the chlorotic symptoms disappear.

18.11. IRRIGATION:

- ◆ Plants are irrigated by flooding once in a week.

- ◆ Sufficient amount of moisture in the soil is necessary for proper growth and flowering.
- ◆ Jasmines can be irrigated once in ten days depending on the soil and climatic conditions.

18.12. PRUNING:

18.12.1. NEED FOR PRUNING:

- ◆ In jasmine, flowering habit is terminal and axillary.
- ◆ So increasing the number of shoots is the main criterion to increase the yield, for this pruning is an essential operation.
- ◆ It also influences growth, flower bud initiation, differentiation and ultimately the flower production.

18.12.2 .PRUNING PERIOD:

- ◆ *J. sambac* - Last week of November
- ◆ *J. grandiflorum* - Last week of December
- ◆ *J. auriculatum* - Last week of January
- ◆ Pruning is done at a height of 45-50 cm from the ground level.

18.13. WEEDING:

- Commonly done manually but is expensive.
- Chemical weed control is effective and economical.
- Spraying with Oryzalin 1 or 2 application is effective.
- Mulching also reduce weed population.

18.14. HARVESTING:

- ◆ Jasmine gives economic yield only from the third year and upto 12-15 years and then starts declining in their yield.
- ◆ The stage of harvest depends on the purpose of flowers to be harvested.
- ◆ For fresh flowers, fully developed unopened flower buds are picked in the early morning, while for extraction of concrete only fully opened fresh picked flowers are required.
- ◆ Picking of flowers after 11am will considerably reduce the yield and quality of the concrete.
- ◆ Pluckers collect the flowers in a bag.

- ◆ Care should be taken to see that the flowers are not badly handled.
- ◆ Wrinkled and damaged during harvest and transit will affect fresh flowers and concrete recovery will be affected and the entire product may be unmarketable.

18.15. GRADING:

- ◆ There are no standard grades available for jasmine.
- ◆ The flowers may be graded according to the corolla tube length, bud size, shape and freshness.

18.16. PACKING:

- ◆ Packing should be functional, economical and attractive besides being acceptable in markets.
- ◆ Harvested flower should be given cold treatment before packing.
- ◆ Corrugated cardboard boxes are the proper packing materials for distant market.
- ◆ The growers also use small bags made out of fertilizer bag material to bring flowers of jasmine to the market.
- ◆ Wholesalers pack flowers in bamboo baskets.
- ◆ They are packed so as to maintain some moisture and air circulation in the baskets.
- ◆ Water is sprinkled on the newspapers covering the inside of the basket.
- ◆ The top is covered with paper again and closed with a bamboo basket cover or gunny sack which is stitched at the edges.

18.17. YIELD:

- ◆ Flower and concrete yield in jasmines vary considerably according to the species and cultivars and management practices.
- ◆ The flower yield and concrete recovery in three important species of jasmine are:

Species	Flower yield (kg/ha)	Concrete recovery (%)	Shelf life of flowers
<i>J.auriculatum</i>	4636 – 9022	0.28 – 0.36 (13.44 – 28.24 kg/ha)	28-30 hrs
<i>J.grandiflorum</i>	4329 – 10144	0.25 – 0.32 (13.85 – 29.42 kg/ha)	24 hrs
<i>J. sambac</i>	739 – 8129	0.14 – 0.19 (1.18 – 15.44 kg/ha)	28-30 hrs

Quiz

I. Choose the correct answers:

1. Jasmine belongs to the family
 - a. Oleaceae b. Asteraceae c. Iridaceae d. Caryophyllaceae
2. Jasmine being one of the important commercial flower crops is cultivated in
 - a. Malaysia b. Singapore c. India d. Bangladesh
3. The world famous jasmine oil is extracted from the flowers of
 - a. *J. grandiflorum* b. *J. auriculatum* c. *J. sambac* d. *J. pubescens*
4. Parimullai is resistant to
 - a. Gall mite b. Nematodes c. Thrips d. White flies
5. CO 1 of *J. auriculatum* is selection from
 - a. Long Round type b. Long Point type c. CO2 d. None
6. CO 2 *J. grandiflorum* of is induced mutant from
 - a. Short Point b. Parimullai c. CO1 Pitchi d. Long Point
7. *J. grandiflorum* is propagated by
 - a. Semi-hard wood b. Terminal cutting c. Hard-wood cutting d. None
8. Spacing followed for *J. auriculatum* is
 - a. 1.25x1.25 b. 1.5x1.5 c. 1.75x1.75 d. 2.0x1.5
9. Pruning period for *J. sambac*
 - a. Last week of January b. Last week of December c. Last week of November d. None
10. Jasmine gives economic yield only from
 - a. Third year onwards b. Second year onwards c. First year onwards d. None

II, Match the following:

- | | | |
|---------------------------------|------|---------------|
| 1. <i>Jasminum auriculatum</i> | – a. | IBA-1000ppm |
| 2. <i>Jasminum sambac</i> | - b. | Parimullai |
| 3. <i>Jasminum grandiflorum</i> | - c. | Gundu mallige |
| 4. <i>Jasminum pubescens</i> | - d. | Kakada |
| 5. Terminal cuttings | - e. | CO-1 Pitchi |

III. State true or false:

1. Jasmine is mainly grown as pot plants rarely as climbers and shrubs.
2. The essential oil extracted from the flowers is of low value as starting material for the perfume industry.
3. Jasmine prefers mild tropical climate.
4. CO₂ is induced mutant from CO₁ Pitchi.
5. In jasmine, flowering habit is terminal and axillary.
6. The natural perfume is available in very large quantity in jasmine flowers in the form of volatile oil.
7. Processing of jasmine flowers involves three steps.
8. Jathimalli flowers open in the evening between 5-7 p.m.
9. Picking after 11.00 a.m. will increase the yield and quality of concrete.
10. The flowers may be graded according to the corolla tube length, bud size, shape and freshness.

Answers:

I. Choose the correct answers:

1(a) , 2(c), 3(a), 4(a), 5(a), 6(c), 7(b), 8(b), 9(c), 10(a)

II. Match the following:

1(b), 2(c), 3(e), 4(d), 5(a)

III.State true or false:

1(F), 2(F), 3(T), 4(T), 5(T), 6(F), 7(F), 8(T), 9(F), 10(T)



LECTURE 19

JASMINE (*Jasminum* spp.)

TOPICS

- 19.1. Extraction of jasmine concrete
 - 19.1.1. Flowers
- 19.2. Processing
- 19.3. Treating the flowers with the solvent
- 19.4. Evaporation
- 19.5. Extractor
- 19.6. Evaporator
- 19.7. Condenser
- 19.8. Concrete

19.1. EXTRACTION OF JASMINE CONCRETE:

- Jasmine concrete obtained from *Jasminum grandiflorum* (Jathi Malli/Pitchi) – is a wax like substance containing the natural flower perfume together with some plant waxes, albumin and colouring matter.
- The natural perfume is available in very small quantity (0.25%) in jasmine flowers in the form of volatile oil.
- The usual and simple method of steam distillation for the extraction of the volatile oil could not be adopted in this case as jasmines do not yield the perfume oil on steam distillation.
- Hence, the solvent extraction method is practiced in which the principle is that the odoriferous substances of the flower are allowed to be absorbed by a highly volatile solvent and then the solvent is evaporated leaving the odoriferous principles.

19.1.1. FLOWERS:

- For extraction of concrete, only freshly picked fully opened flowers are required.
- Jathimalli flowers open in the evening between 5-7 p.m.
- The fully opened flowers have to be picked in the early morning preferably before 9.30 a.m.,
- Delay in picking flowers after 9.30 a.m. results in gradual reduction of concrete yield.

- Picking the flowers after 11.00 a.m. will considerably reduce the yield and quality of concrete especially in the hot climate.
- Therefore, it is essential to pick the fully opened flowers in the morning before it becomes hot.
- The flowers should be harvested and transported in clean baskets or cloth bags.
- The flowers should be picked in such a way that at the time of picking, the sweat, dirt etc., of the picking personal do not contaminate them. The contamination will reflect in the quality of the concrete.
- While picking and transporting care should be taken not to damage the flowers.
- The damaged flowers yield concrete with more percentage of unwanted wax and other plant materials.
- The flowers harvested should be stored in a cool atmosphere and processed within a maximum period of two hours.

19.2. PROCESSING:

- Processing of jasmine flowers involves two steps.
 1. Dissolving the perfume material by treating the flowers with the solvent.
 2. Removal of the solvent from the perfume material by evaporation.

19.3. TREATING THE FLOWERS WITH THE SOLVENT:

- The fully opened flowers are treated with the solvent so that all the odoriferous material in the flowers gets dissolved in the solvent.
- In this process, the solvent penetrates the flowers and dissolves the waxes, albumin and colouring matter also, which have to be removed later to get pure perfume oil.
- In solvent extraction process, the most important factor is the quality of solvent used.
- Though there is no solvent possessing all the qualities, the commercial food grade hexane has found to satisfy many of the requirements of good solvent and hence used in large scale for the extraction of floral concrete throughout the world.
- Food grade hexane available in the market has to be purified before using it as solvent.
- Food grade hexane is treated with liquid paraffin at 5% and distilled at 70⁰C. The residue which is not evaporating at 70⁰C is rejected as impurities.

- The purified hexane is a colourless liquid with a boiling point ranging from 60⁰C to 80⁰C.
- The flowers are treated with purified hexane at 2 liters per kg of flower for about 30 minutes.
- The complete extraction of the perfume from the flowers can also be ensured by slowly rotating the container having the flowers and solvent for about 20 minutes in the rotary type of extractor.

19.4. EVAPORATION:

- After the complete extraction of the perfume from the flowers, the solvent is filtered and concentrated by evaporation at a constant temperature of 75⁰C.
- At this temperature, the solvent evaporates leaving the perfume and other plant waxes.
- The vapour of the solvent is condensed into liquid again for recycling.
- The concentrated liquid containing perfume, wax, pigments and the solvent is distilled in a vacuum distillation unit where the complete removal of the solvent takes place, leaving the floral concrete in the form of molten wax.
- Based on the above principle, Tamil Nadu Agricultural University, Coimbatore has designed a pilot plant for extraction of floral concrete.
- It has essentially four steps viz.,
 - (1) Extractor
 - (2) Evaporator
 - (3) Condenser And
 - (4) Vacuum Distillation Unit.

19.5. EXTRACTOR:

- The extractor used is a rotary type.
- It has a capacity to treat 3 kg of flowers at a time.
- For every kg of flowers, 2 liters of solvent is added and the extractor is closed tightly and rotated slowly for 25 minutes at the rate of 3 rotations per minute.
- After five minutes, the flowers are allowed to stand in the solvent for another 20 minutes.
- During the process, the solvent absorbs the perfume of the flower.
- After mixing, the solvent is drawn through the drain cock at the bottom of the extractor, and filtered through a fine filter to remove the dust, dirt etc.

- By opening the drain cock all the free solvent may come out but still a small quantity of perfume laden solvent may be sticking to the spent flowers in the extractor.
- To draw this small quantity of solvent the spent flowers are gently pressed. It must be noted that the flowers should never be squeezed to remove the solvent completely.

19.6. EVAPORATOR:

- The perfume laden solvent is led into the evaporator.
- The evaporator is a wide mouthed circular bowl made in stainless steel with a capacity to hold 25 litres of solvent.
- It has an air tight lid with a hole at the centre for the outlet of the solvent vapour.
- The evaporator is heated over a water bath at a constant temperature of 75⁰C.
- The water bath is heated electrically by 2000 watt heating elements and the temperature is kept 75⁰C by thermostatic control.
- Temperature control is essential as high temperature and prolonged heating at atmospheric pressure will spoil the quality and appearance of the concrete.
- The evaporator should never be directly heated. It should be heated either over a water bath or by steam circulation.
- As the temperature rises in the evaporator, the hexane evaporates and the vapour escapes through the hole in the lid which is led into the condenser through a stainless steel pipe.

19.7. CONDENSER:

- The condenser also is made of stainless steel and it contains several (12) small pipes fitted parallelly through which solvent vapour is passed.
- By circulating cold water in the condenser continuously the solvent vapour is condensed and it is collected for recycling.
- The heating of the evaporator is continued till about 90% of the solvent is recovered by condensation which may take about 30 hours.
- The remaining 10% of the solvent containing all the aromatic oil and waxy material is transferred to vacuum distillation unit where the complete removal of the solvent is effected, and the concrete is left in the still in the form of molten wax.
- Here also the still should not be heated directly.
- The heating should be done on a water bath.

- Since vacuum has been created into the still, the solvent evaporates quickly at lower temperature which is condensed in the condenser and collected for recycling.
- The heating should be continued till the last traces of hexane are removed.
- The operation can be stopped when there is no condensation of hexane vapour in the condenser.
- After the complete removal of the solvent, a semi-solid wax like brown substance is left in the still which is the jasmine concrete of commerce.
- The material when it is hot is transferred to the container in which it has to be stored, when cooled it solidifies and transfer to other containers may be difficult.
- The concrete can be stored in glass or aluminium containers.

19.8. CONCRETE:

- It is a wax like substance containing the natural flower perfume together with some plant waxes, albumin and colouring matter.
- The natural perfume is available in very small quantity (0.25%) in jasmine flowers in the form of volatile oil.

20.2. PROCESSING PROTOCOL:

Two steps

- Dissolving the perfume material by treating the flowers with solvent.
- Removal of the solvent from the perfume material by evaporation.

20.3. EQUIPMENTS REQUIRED:

1. Extractor (Rotary type of 3 kg capacity)
2. Evaporator (wide mouthed circular stainless steel bowl of 25 litre capacity with air tight lid + hole at the center for the outlet of solvent vapour)
3. Condenser (Stainless steel with 12 small pipes fitted parallelly for solvent vapour passing and circulating cold water to condense the solvent).
4. Vacuum distillation unit.

20.4. STEP I – SOLVENT TREATMENT:

Flowers are soaked in Food Grade Hexane (Having Boiling point of 70°C).



Mixing Hexane 2 litres / kg of flowers for 30 minutes



Rotate the container slowly for 20 minutes in the rotary type of extractor.



Perfume substance along with wax and pigments dissolved in Hexane.

29.5. STEP II – EVAPORATION:

Perfume laden solvent is led into the evaporator



Evaporation at a constant temperature of 75°C



Vapour of the solvent condensed into liquid for recycling



Liquid (Perfume, wax & pigments) is distilled in a vacuum distillation unit for complete removal of solvent in the still



Floral concrete settled in the still in the form of molten wax



Cooled and Stored in glass (or) aluminum containers

@@@@@

KNOWLEDGE ASSESSMENT:

I. Choose the correct answers:

1. Jasmine belongs to the family

- a. Oleaceae b. Asteraceae c. Iridaceae d. Caryophyllaceae
2. Jasmine being one of the important commercial flower crops is cultivated in
a. Malaysia b. Singapore c. India d. Bangladesh
3. The world famous jasmine oil is extracted from the flowers of
a. *J. grandiflorum* b. *J. auriculatum* c. *J. sambac* d. *J. pubescens*
4. Parimullai is resistant to
a. Gall mite b. Nematodes c. Thrips d. White flies
5. CO 1 of *J. auriculatum* is selection from
a. Long Round type b. Long Point type c. CO2 d. None
6. CO 2 *J. grandiflorum* of is induced mutant from
a. Short Point b. Parimullai c. CO1 Pitchi d. Long Point
7. *J. grandiflorum* is propagated by
a. Semi-hard wood b. Terminal cutting c. Hard-wood cutting d. None
8. Spacing followed for *J. auriculatum* is
a. 1.25x1.25 b. 1.5x1.5 c. 1.75x1.75 d. 2.0x1.5
9. Pruning period for *J. sambac* is last week of
a. January b. December c. November d. None
10. Jasmine gives economic yield only from
a. Third year onwards b. Second year onwards c. First year onwards d. None

II. Match the following:

1. *Jasminum auriculatum* - a. IBA-1000ppm
2. *Jasminum sambac* - b. Parimullai
3. *Jasminum grandiflorum* - c. Gundu mallige
4. *Jasminum pubescens* - d. Kakada
5. Terminal cuttings - e. CO-1 Pitchi

III. State true or false:

1. Jasmine is mainly grown as pot plants rarely as climbers and shrubs.

2. The essential oil extracted from the flowers is of low value as starting material for the perfume industry.
3. Jasmine prefers mild tropical climate.
4. CO₂ is induced mutant from CO₁ Pitchi.
5. In jasmine, flowering habit is terminal and axillary.
6. The natural perfume is available in very large quantity in jasmine flowers in the form of volatile oil.
7. Processing of jasmine flowers involves three steps.
8. Jathimalli flowers open in the evening between 5-7 p.m.
9. Picking after 11.00 a.m. will increase the yield and quality of concrete.
10. The flowers may be graded according to the corolla tube length, bud size, shape and freshness.

Key Answers:

Choose the correct answers:

1(a) , 2(c), 3(a), 4(a), 5(a), 6(c), 7(b), 8(b), 9(c), 10(a)

Match the following:

1(b), 2(c), 3(e), 4(d), 5(a)

State true or false:

1(F), 2(F), 3(T), 4(T), 5(T), 6(F), 7(F), 8(T), 9(F), 10(T)



LECTURE - 20

GLADIOLI (*Gladiolus* spp. Iridaceae)

TOPICS

- 20.1. Introduction
- 20.2. Classes of gladiolus
- 20.3. Varieties
- 20.4. CULTURE
 - 20.4.1. Climate
 - 20.4.2. Soil
 - 20.4.3. Land preparation
- 20.5. After care
- 20.6. Propagation
- 20.7. CULTIVATION
 - 20.7.1. Time of planting of corms
 - 20.7.2. Method of Planting of Corms
- 20.8. Irrigation
- 20.9. Staking
- 20.10. Weed control
- 20.11. Flower Production
- 20.12. Nutrition
- 20.13. Harvesting of spikes and post harvest operations.
- 20.14. HARVESTING AND STORAGE OF CORMS
 - 20.14.1. Harvesting of Corms:
 - 20.14.5. Storage of corms

INTRODUCTION:

- ◆ It is said to be the 'Queen of bulbous flower crops' and commonly known as 'Sword Lily' or 'Corn flag.'
- ◆ The name gladiolus was originally coined by Pliny the Elder.
- ◆ *Gladiolus* (Tournefort.) L. takes its name from the Latin word '*Gladius*' meaning a sword,' because of sword- like shape of its foliage.

IMPORTANCE AND USES:

- ◆ Gladiolus is an important florist crop, most popular as cut flower in the domestic and International market.
- ◆ In Netherlands, it ranks next only to tulip in commercial importance
- ◆ It is relatively easy to grow and also suitable for bedding and exhibition.
- ◆ The fascinating spikes bear a large number of florets which exhibit varying sizes and forms; with smooth, ruffled, deeply crinkled or lacinated tepals.
- ◆ The flower spikes are used in flower arrangements, in bouquets and for indoor decoration.
- ◆ *Grandiflorus* and *Primulinus* types look very attractive in mixed flower borders.
- ◆ Spikes of gladiolus have good keeping quality and can be transported to long distances.
- ◆ Its flowers open in acropetal succession, one by one and spike lasts for 1 to 3 weeks in ordinary vase water, depending upon the season and variety.
- ◆ *Gladiolus natalensis*, *G. cardinalis*, *G. communis*, *G. callianthus*, *G. arneus*, *recurvus*, *G. tristis*

ORIGIN AND DISTRIBUTION:

- There are around 200 species scattered throughout Tropical and South Africa and Mediterranean region.
- It is said to be in cultivation since 1578. It was first introduced into France & soon after, it spread to England, Germany, Holland & North America.
- No species is known to be native of India.
- In India it was introduced during British period.

TAXONOMY:

- *Gladiolus L.* belongs to the family Iridaceae. Basic chromosome number is $n=15$.
- Ploidy in the genus ranges from diploid ($2n=30$) to dodecaploid ($2n=180$)
- The modern garden gladiolus is a complex of at least 12 species and most of the cvr's are tetraploids ($2n=60$) & highly heterozygous, they will not breed true to the type if grown from seeds.

FLORAL BIOLOGY:

- Inflorescence is simple spike consisting of 10-25 florets all facing one side arranged in rows.
- The florets are protandrous in nature, the anther dehiscing before the stigma of same flower becomes receptive.
- 2-3 flower open in the morning hours & later the anthers dehisce along the longitudinal sutures. After about 24 hours of flower opening, the stigma becomes receptive.
- Ray Choudary reported that the gladiolus flower bud takes 16 days to reach the full bloom stage. The unfurling of the petals starts early in the morning & complete opening of florets takes 22-24 hours.
- The dehiscence of anthers occurs between 8.00 and 9.30 a.m. following anthesis. And stigma receptivity stays for 24 hours.
- Gladiolus is cross pollinated crop.

SPECIES:

- ◆ There are about 226 recorded species scattered in Republic of South Africa.
- ◆ The genus *Gladiolus* has further been divided into four sections.
- ◆ Section I: *Euglandiolus* which includes 100 species.
- ◆ Section II: *Habea* includes 12 spp.
- ◆ Section III: *Schweiggeria*, includes only two species.
- ◆ Section IV: *Homoglossum*, includes 5-6 species.

CLASSES OF GLADOIOLUS:

On the basis of floret size, gladiolus has been put into 5 classes, the description of which is as follows:

Class	Designation	Floret size (cm)
100	Miniature	< 6.4
200	Small or miniature	≥ 6.4 to < 8.9
300	Decorative	≥ 8.9 to < 11.4
400	Standard or Large	≥ 11.4 to 14.0
500	Giant	> 14.0

CLASSIFICATION:

- **Grandiflorus or large flowered hybrids:** exhibition types, 90-150 cm long spikes
- **Primulinus hybrids:** less vigorous, 40-45 cm long spike.
- **Butterfly hybrids:** spikes shorter than 45 cm.
- **Miniature hybrids:** recent origin. 40 cm long spike, ruffled tepals
- **Face ups:** dwarf stem, florets are 5-6 cm wide & face upward.
- **Colvillei hybrids: (G.tristis X G cardinalis.)** early flowering, more suitable for green house condition.
- **Ochideola:** new group developed in Israel, produce smaller florets on shorter stems

VARIETIES:

<u>Colour</u>	<u>Variety</u>
Pink	America, Applause, Dawn pink, Deciso, Friendship, My love
Orange	Autumn Gold, Coral Seas, Fiesta, Setting sun
Red	Black Prince, Hunting Song, Oscar, Victoria
Yellow	Anglia, Aurora, Folk Song, Golden Harvest, Golden Peach
White	Amsterdam, Classic, Cotton Blossom, White Friendship
Purple, Violets	Blue Moon, Her Majesty, High Style, Mayur, Pusa Sarang, Pusa Shingarika

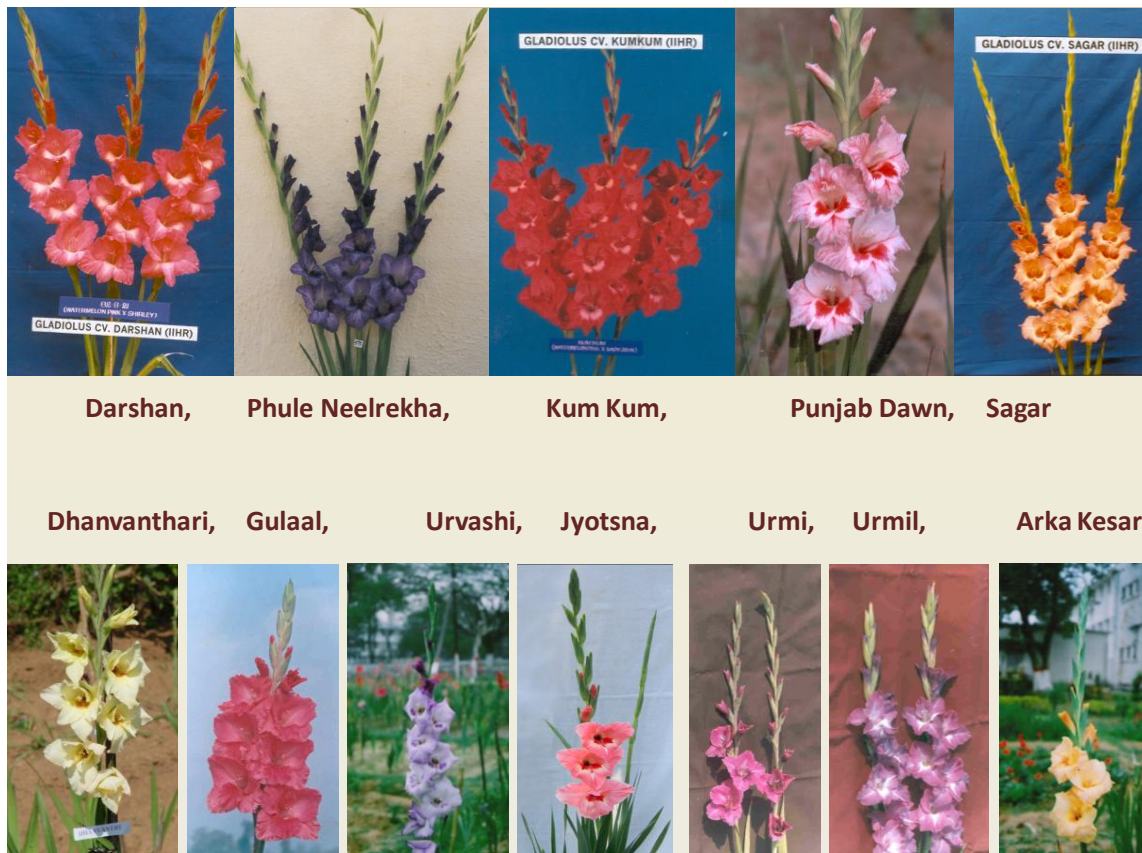
IIHR Varieties

Amar

Arka Naveen

Arka Kesar

Shobha



CLIMATIC REQUIREMENT:

- ◆ Gladioli require full exposure to sunlight for better crop, otherwise blasting may occur or plants may remain blind.
- ◆ The long day conditions of 12 to 14 h photoperiod increase number of florets, spike length and percentage of flowering.
- ◆ Low light intensity causes failure in flowering.
- ◆ High light intensity without proper temperature also affects growth adversely.
- ◆ Corm storage at 3 to 7°C is good for better growth and flower production.

SOIL REQUIREMENT:

- ◆ Gladioli can be grown in a wide range of soils.
- ◆ The soil should have proper drainage facilities.
- ◆ It should also contain sufficient organic matter.
- ◆ The soil should be sandy-loam and slightly acidic with pH 5 to 8.

LAND PREPARATION:

- ◆ Preferably, the bed size should be 6 x 2 meters.
- ◆ The first ploughing is done to a depth of 30cm two month before planting and left as such for another 2-3 weeks.
- ◆ Second ploughing is done followed by rolling for a fine tilt hand remove weeds and stubbles thoroughly before planting.

PROPAGATION:

Seeds:

Gladiolus can be propagated through

- (i) Corms
- (ii) Cormels
- (iii) Seeds and
- (iv) Tissue culture

(i) Through Corms

- Propagation of gladiolus through corms is a commercially used method.
- A single corm produces on an average of 1 to 3 flowers along with daughter corms in a season depending upon its size and the variety.
- 10-50 cormels can be obtained from a single corm.

(ii) Through Cormels

- ◆ Cormels from corms are used as planting material.
- ◆ The multiplication of gladiolus through cormels is an inexpensive and rapid method which enables build up of large stocks with minimum cost.
- ◆ The cormels also tend to escape diseases of viruses even if the parent corm is infected.

TIME OF PLANTING OF CORMS:

- North Western Plains – October (first fortnight)
- Staggered planting can, however, be done at 10-15 day intervals from mid-August to mid-December to get continued supply of spikes over a longer period and to match the market demand.
- In temperate climates, the corms are planted after the winter, i.e. in March and April when frosts are over and climate becomes warm.

PLANTING OF CORMS:

- ◆ Only the non-dormant corms should be planted.
- ◆ The emergence of root buds at the base of the corms shows that the corms are ready for planting.
- ◆ The corms should be suitably treated with fungicides before planting.
- ◆ When planting, the lower portion of the corm should be placed on the soil such that the bud at the top lies straight above.
- ◆ It is done to make sure that the stem grows erect and does not show crooked growth.
- ◆ At planting time, the soil should contain sufficient moisture to facilitate uniform sprouting of corms.
- ◆ The depth of planting depends more on the size of the planting materials. The medium and smaller sized corms are generally planted upto 7 cm deep while large or jumbo corms to a depth up to 15 cm.
- ◆ Planting is carried out during October in plains and March-April in hills.
- ◆ The row to row distance is normally 40 cm while plant-to-plant is 15 cm.
- ◆ The requirement of the corms per hectare is roughly 1, 50,000-2, 00,000.

IRRIGATION:

- ◆ Gladiolus requires water in plenty but does not grow well under water-logged conditions.
- ◆ Frequency of irrigation depends upon the soil type, weather conditions and rainfall.
- ◆ Normally in sandy soils, the crop should be irrigated at 7-10 day intervals, whereas in heavy soils, at less frequent intervals.
- ◆ Irrigation should be withheld at least 4-6 weeks before lifting of corms.

STAKING:

- ◆ Especially large-flowered varieties of gladioli grown outdoors are susceptible to lodging, hence need staking.
- ◆ The stems should be tied with strings to thin but strong supports

WEED CONTROL:

- ◆ Pro-emergence herbicides reported for gladiolus are diuron (0.9 kg/ha) (or) linuron (3.0 kg/ha)
- ◆ Post-emergence herbicides, 2, 4-D @ 1.5-3.0 kg/ha has been found to reduce weed population.

NUTRITION:

- ◆ Commonly a 12:12:18 N:P:K compound fertilizer is applied prior to planting at 1 ton per hectare.
- ◆ Gladiolus can be damaged by fluorine and phosphatic fertilizers containing fluorine should not be used.
- ◆ The crop can be top dressed as required with calcium nitrate at an application rate of 200-300 kg per hectare.

HARVESTING OF SPIKES AND POST HARVEST OPERATIONS:

Harvesting of Spikes:

- ◆ Gladiolus takes 60-120 days to produce spikes.
- ◆ The spikes of gladiolus generally exhibit vase life of about 7-15 days.
- ◆ The spikes should be harvested in the morning or evening hours when temperatures are mild.
- ◆ Spikes should preferably be cut with sharp knives or secateurs.
- ◆ While harvesting, at least four basal leaves should be retained on the plant to ensure proper development of corms and cormels.
- ◆ The stage at which the spike is to be cut should depend upon the transportation distance, consumer requirement and prevailing temperature conditions.

HARVESTING AND STORAGE OF CORMS:

- ◆ It generally takes 6-8 weeks after harvesting of spikes from the corms to become mature and ready for lifting.
- ◆ Plant growth stops at this stage.
- ◆ Irrigations should normally be withheld at least 2-3 weeks before harvesting of corms.
- ◆ In India, lifting of corms is carried out manually with small garden forks or 'khurpas'.
- ◆ After lifting the corms from the soil, the upper leafy portions should be removed by twisting and breaking the stalk.
- ◆ The old withering mother corms attached to the bottom of the newly-formed corms should also be removed similarly with the thumb.
- ◆ The cormels should also be separated simultaneously and handled separately.
- ◆ The corms usually get damaged or bruised during harvesting and cleaning operations.
- ◆ The corms should be cleaned, dipped for 30 min in 0.3% Captan 50 WP and shade-dried at an aerated place for about 15 days.
- ◆ Corms are then packed in crates or in net bags and cold-stored at 3-7°C.
- ◆ From cold storage, these corms should be taken out one month prior to planting and kept at ambient conditions at an aerated place.
- ◆ The corms or cormels of different cultivars must be handled separately and labeling properly so that they do not get mixed up.
- ◆ Before planting, these are once again dipped for one hour in 0.3% Captan solution

STORAGE OF CORMS:

- ◆ Storage of corms at low temperature (4-5°C) is an established commercial practice.
- ◆ It serves three main purposes:
 - It helps to break dormancy of corms raised under warmer climates,
 - It helps to overcome warm and dry conditions of summer months that intervene between lifting of corms and their planting in the subsequent season, and
 - It prevents premature sprouting of corms.

KNOWLEDGE ASSESSMENT:

I. CHOOSE THE CORRECT ANSWERS:

1. The word Gladiolus is derived from
a. Latin b. French c. Greek d. English.
2. Floret size of giant Gladiolus is
a. >14 b. ≥ 11.4 to 14.0 c. ≥ 6.4 to < 8.9 d. ≥ 8.9 to < 11.4
3. Red colour variety of gladiolus
a. America b. Pusa Sarang c. Black Prince d. My Love
4. Gladiolus flower opens in ----- succession
a. Acropetal b. Basipetal c. Middle d. None
5. Gladiolus is a
a. Short day plant b. Long day plant c. Day neutral d. None
6. Number of cormels can be obtained from a single corm
a. 10-20 b. 10-100 c. 10-50 d. 50-100
7. Corms should be harvested ----- weeks after harvesting of spikes
a. 4-8 b. 6-8 c. 2-4 d. 4-6
8. Corms are cold stored at a temperature of
a. 4-5°C b. 3-7°C c. 4-8°C d. 6-8°C
9. Gladiolus are classified into five classes based on
a. Flower colour b. Spike length c. Leaf length d. Floret size
10. Gladiolus prefers a pH range of
a. 5-8 b. 4-8 c. 6-7 d. 8.5-9

KEY WORDS:

I. CHOOSE THE CORRECT ANSWERS:

1(a), 2(a), 3(c), 4(a), 5(b), 6(c), 7(b), 8(a), 9(d), 10(a)

II. STATE TRUE OR FALSE:

1. Gladiolus belongs to Iridaceae family.
2. Gladiolus (Tourn.) L. takes its name from the Greek word *Gladius*.
3. Gladiolus is a short day plant.
4. Commercial method of Gladiolus propagation is through cormels.
5. Large flowered variety of Gladiolus is not susceptible to lodging.
6. Gladiolus takes 60-120 days to produce spikes.
7. Stage of harvesting of Gladioli depends on transport distance & consumer requirement.
8. Low temperature storage will prevent pre mature sprouting of corms.
9. Only dormant corms should be planted.
10. Cormels are free from viruses.

II. STATE TRUE OR FALSE:

1(T), 2(F), 3(F), 4(F), 5(F), 6(T), 7(T), 8(T), 9(F), 10(T)



LECTURE - 20

GLADIOLI (*Gladiolus* spp. Iridaceae)

TOPICS

- 20.1. Introduction
- 20.2. Classes of gladiolus
- 20.3. Varieties
- 20.4. CULTURE
 - 20.4.1. Climate
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- Inflorescence is simple spike consisting of 10-25 florets all facing one side arranged in rows.
- The florets are protandrous in nature, the anther dehiscing before the stigma of same flower becomes receptive.
- 2-3 flower open in the morning hours & later the anthers dehisce along the longitudinal sutures. After about 24 hours of flower opening, the stigma becomes receptive.
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- Gladiolus is cross pollinated crop.

SPECIES:

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- ◆ The genus *Gladiolus* has further been divided into four sections.
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- ◆ Section IV: *Homoglossum*, includes 5-6 species.

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- **Ochideola:** new group developed in Israel, produce smaller florets on shorter stems

VARIETIES:

<u>Colour</u>	<u>Variety</u>
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Red	Black Prince, Hunting Song, Oscar, Victoria
Yellow	Anglia, Aurora, Folk Song, Golden Harvest, Golden Peach
White	Amsterdam, Classic, Cotton Blossom, White Friendship
Purple, Violets	Blue Moon, Her Majesty, High Style, Mayur, Pusa Sarang, Pusa Shingarika

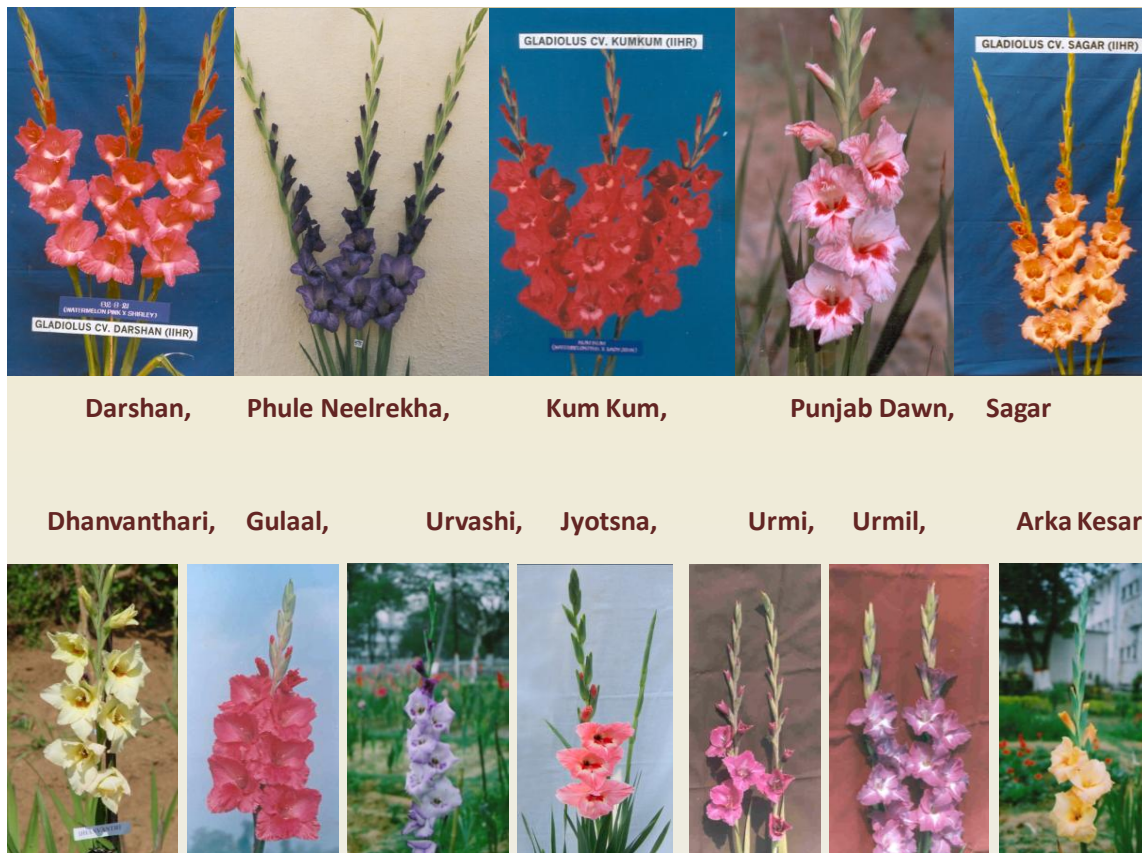
IIHR Varieties

Amar

Arka Naveen

Arka Kesar

Shobha



CLIMATIC REQUIREMENT:

- ◆ Gladioli require full exposure to sunlight for better crop, otherwise blasting may occur or plants may remain blind.
- ◆ The long day conditions of 12 to 14 h photoperiod increase number of florets, spike length and percentage of flowering.
- ◆ Low light intensity causes failure in flowering.
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SOIL REQUIREMENT:

- ◆ Gladioli can be grown in a wide range of soils.
- ◆ The soil should have proper drainage facilities.
- ◆ It should also contain sufficient organic matter.
- ◆ The soil should be sandy-loam and slightly acidic with pH 5 to 8.

LAND PREPARATION:

- ◆ Preferably, the bed size should be 6 x 2 meters.
- ◆ The first ploughing is done to a depth of 30cm two month before planting and left as such for another 2-3 weeks.
- ◆ Second ploughing is done followed by rolling for a fine tilt hand remove weeds and stubbles thoroughly before planting.

PROPAGATION:

Seeds:

Gladiolus can be propagated through

- (i) Corms
- (ii) Cormels
- (iii) Seeds and
- (iv) Tissue culture

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- Propagation of gladiolus through corms is a commercially used method.
- A single corm produces on an average of 1 to 3 flowers along with daughter corms in a season depending upon its size and the variety.
- 10-50 cormels can be obtained from a single corm.

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- ◆ Cormels from corms are used as planting material.
- ◆ The multiplication of gladiolus through cormels is an inexpensive and rapid method which enables build up of large stocks with minimum cost.
- ◆ The cormels also tend to escape diseases of viruses even if the parent corm is infected.

TIME OF PLANTING OF CORMS:

- North Western Plains – October (first fortnight)
- Staggered planting can, however, be done at 10-15 day intervals from mid-August to mid-December to get continued supply of spikes over a longer period and to match the market demand.
- In temperate climates, the corms are planted after the winter, i.e. in March and April when frosts are over and climate becomes warm.

PLANTING OF CORMS:

- ◆ Only the non-dormant corms should be planted.
- ◆ The emergence of root buds at the base of the corms shows that the corms are ready for planting.
- ◆ The corms should be suitably treated with fungicides before planting.
- ◆ When planting, the lower portion of the corm should be placed on the soil such that the bud at the top lies straight above.
- ◆ It is done to make sure that the stem grows erect and does not show crooked growth.
- ◆ At planting time, the soil should contain sufficient moisture to facilitate uniform sprouting of corms.
- ◆ The depth of planting depends more on the size of the planting materials. The medium and smaller sized corms are generally planted upto 7 cm deep while large or jumbo corms to a depth up to 15 cm.
- ◆ Planting is carried out during October in plains and March-April in hills.
- ◆ The row to row distance is normally 40 cm while plant-to-plant is 15 cm.
- ◆ The requirement of the corms per hectare is roughly 1, 50,000-2, 00,000.

IRRIGATION:

- ◆ Gladiolus requires water in plenty but does not grow well under water-logged conditions.
- ◆ Frequency of irrigation depends upon the soil type, weather conditions and rainfall.
- ◆ Normally in sandy soils, the crop should be irrigated at 7-10 day intervals, whereas in heavy soils, at less frequent intervals.
- ◆ Irrigation should be withheld at least 4-6 weeks before lifting of corms.

STAKING:

- ◆ Especially large-flowered varieties of gladioli grown outdoors are susceptible to lodging, hence need staking.
- ◆ The stems should be tied with strings to thin but strong supports

WEED CONTROL:

- ◆ Pro-emergence herbicides reported for gladiolus are diuron (0.9 kg/ha) (or) linuron (3.0 kg/ha)
- ◆ Post-emergence herbicides, 2, 4-D @ 1.5-3.0 kg/ha has been found to reduce weed population.

NUTRITION:

- ◆ Commonly a 12:12:18 N:P:K compound fertilizer is applied prior to planting at 1 ton per hectare.
- ◆ Gladiolus can be damaged by fluorine and phosphatic fertilizers containing fluorine should not be used.
- ◆ The crop can be top dressed as required with calcium nitrate at an application rate of 200-300 kg per hectare.

HARVESTING OF SPIKES AND POST HARVEST OPERATIONS:

Harvesting of Spikes:

- ◆ Gladiolus takes 60-120 days to produce spikes.
- ◆ The spikes of gladiolus generally exhibit vase life of about 7-15 days.
- ◆ The spikes should be harvested in the morning or evening hours when temperatures are mild.
- ◆ Spikes should preferably be cut with sharp knives or secateurs.
- ◆ While harvesting, at least four basal leaves should be retained on the plant to ensure proper development of corms and cormels.
- ◆ The stage at which the spike is to be cut should depend upon the transportation distance, consumer requirement and prevailing temperature conditions.

HARVESTING AND STORAGE OF CORMS:

- ◆ It generally takes 6-8 weeks after harvesting of spikes from the corms to become mature and ready for lifting.
- ◆ Plant growth stops at this stage.
- ◆ Irrigations should normally be withheld at least 2-3 weeks before harvesting of corms.
- ◆ In India, lifting of corms is carried out manually with small garden forks or 'khurpas'.
- ◆ After lifting the corms from the soil, the upper leafy portions should be removed by twisting and breaking the stalk.
- ◆ The old withering mother corms attached to the bottom of the newly-formed corms should also be removed similarly with the thumb.
- ◆ The cormels should also be separated simultaneously and handled separately.
- ◆ The corms usually get damaged or bruised during harvesting and cleaning operations.
- ◆ The corms should be cleaned, dipped for 30 min in 0.3% Captan 50 WP and shade-dried at an aerated place for about 15 days.
- ◆ Corms are then packed in crates or in net bags and cold-stored at 3-7°C.
- ◆ From cold storage, these corms should be taken out one month prior to planting and kept at ambient conditions at an aerated place.
- ◆ The corms or cormels of different cultivars must be handled separately and labeling properly so that they do not get mixed up.
- ◆ Before planting, these are once again dipped for one hour in 0.3% Captan solution

STORAGE OF CORMS:

- ◆ Storage of corms at low temperature (4-5°C) is an established commercial practice.
- ◆ It serves three main purposes:
 - It helps to break dormancy of corms raised under warmer climates,
 - It helps to overcome warm and dry conditions of summer months that intervene between lifting of corms and their planting in the subsequent season, and
 - It prevents premature sprouting of corms.

KNOWLEDGE ASSESSMENT:

I. CHOOSE THE CORRECT ANSWERS:

1. The word Gladiolus is derived from
a. Latin b. French c. Greek d. English.
2. Floret size of giant Gladiolus is
a. >14 b. ≥ 11.4 to 14.0 c. ≥ 6.4 to < 8.9 d. ≥ 8.9 to < 11.4
3. Red colour variety of gladiolus
a. America b. Pusa Sarang c. Black Prince d. My Love
4. Gladiolus flower opens in ----- succession
a. Acropetal b. Basipetal c. Middle d. None
5. Gladiolus is a
a. Short day plant b. Long day plant c. Day neutral d. None
6. Number of cormels can be obtained from a single corm
a. 10-20 b. 10-100 c. 10-50 d. 50-100
7. Corms should be harvested ----- weeks after harvesting of spikes
a. 4-8 b. 6-8 c. 2-4 d. 4-6
8. Corms are cold stored at a temperature of
a. $4-5^{\circ}\text{C}$ b. $3-7^{\circ}\text{C}$ c. $4-8^{\circ}\text{C}$ d. $6-8^{\circ}\text{C}$
9. Gladiolus are classified into five classes based on
a. Flower colour b. Spike length c. Leaf length d. Floret size
10. Gladiolus prefers a pH range of
a. 5-8 b. 4-8 c. 6-7 d. 8.5-9

KEY WORDS:

I. CHOOSE THE CORRECT ANSWERS:

1(a), 2(a), 3(c), 4(a), 5(b), 6(c), 7(b), 8(a), 9(d), 10(a)

II. STATE TRUE OR FALSE:

1. Gladiolus belongs to Iridaceae family.
2. Gladiolus (Tourn.) L. takes its name from the Greek word *Gladius*.
3. Gladiolus is a short day plant.
4. Commercial method of Gladiolus propagation is through cormels.
5. Large flowered variety of Gladiolus is not susceptible to lodging.
6. Gladiolus takes 60-120 days to produce spikes.
7. Stage of harvesting of Gladioli depends on transport distance & consumer requirement.
8. Low temperature storage will prevent pre mature sprouting of corms.
9. Only dormant corms should be planted.
10. Cormels are free from viruses.

II. STATE TRUE OR FALSE:

1(T), 2(F), 3(F), 4(F), 5(F), 6(T), 7(T), 8(T), 9(F), 10(T)



LECTURE - 21

MARIGOLD (*Tagetes* spp., Asteraceae)

TOPICS

- 21.1. Importance
- 21.2. Uses
- 21.3. Origin and History
- 21.4. Species
- 21.5. Types
- 21.6. Varieties
- 21.7. CULTURE
 - 21.6.1. Climate
 - 21.6.2. Soil
 - 21.6.3. Preparation of soil
- 21.8. PROPAGATION
 - 21.7.1. Seeds
 - 21.7.2. Cuttings
 - 21.7.3. Transplanting of seedlings
 - 21.7.4. Spacing
- 21.9. Manures and Fertilizers
- 21.10. Weeding
- 21.11. Irrigation
- 21.12. Pinching of Marigold plants
- 21.13. Harvesting and Yield

21.1. IMPORTANCE:

- ◆ Marigold has gained popularity amongst gardeners and flower dealers on account of its easy culture and wide adaptability.
- ◆ Free flowering and short duration.
- ◆ Wide spectrum of colour, shape, size and good keeping quality.
- ◆ Marigold is also known as 'Friendship Flower' in the United States.
- ◆ In language of flowers, marigold, in general, means anxiety but despair or grief, in particular.
- ◆ African marigold represents vulgar minds whereas,
- ◆ French marigold is a symbol of jealousy.

21.2. USES:

- ◆ Used for garland, veni and other decorations.
- ◆ The long stemmed flowers used for vase arrangements.
- ◆ It is highly suitable as bedding plant, in an herbaceous border, also as shrubbery in landscaping.
- ◆ French marigold is ideal for rockery, edging, hanging baskets and window boxes.
- ◆ Have medicinal properties to cure boils and carbuncles.
- ◆ Floral extract is used as a blood purifier and cure for bleeding piles.
- ◆ Good remedy for eye diseases and ulcers.
- ◆ Some species of *Tagetes* are used for essential oil extraction.
- ◆ The Pigments (Xanthophylls) are used as a natural colour to intensify yellow colour of egg yolk and broiler skin, flesh and also for fish.
- ◆ Xanthophylls are the major carotenoid fraction in the flower petals.
- ◆ Lutein accounts for 80 – 90% of total xanthophylls content.
- ◆ Used for colouring the food stuffs, textile industries and pharmaceuticals.
- ◆ *Tagetes patula* contain essential oil which can readily be extracted by steam distillation.
- ◆ The oil has a pronounced odour and acts as a repellent to flies.
- ◆ Trap crop -It is highly effective in reducing the population of nematodes under control and also attracts the fruit borers in many vegetables, fruits and ornamental plants.

21.3. ORIGIN AND HISTORY

- The name 'Tagetes' was given after 'Tages', a demigod, known for his beauty.
- African marigold was first introduced into 'Spain' early in the 16th century and became popular in Southern Europe under the name, 'Rose of the Indies'. This plant was reintroduced into Europe in 1535 under the name, '*Flos Africonus*' by Emperor Charles V.
- It continued to be so called until well upto the 18th century, although it was correctly figured as *Plantas tagetes indica* in Fuch's Herbal of 1547 (Genders, 1971).
- It is native of central and Southern America, especially Mexico.

21.4. SPECIES

There are about 33 species of the genus *Tagetes*. Some of the important are as follows

1. *Tagetes erecta* (African marigold):

- ◆ Plant is hardy, annual, upto 90 cm tall, erect and branched.
- ◆ Flowers are single to fully double and large sized with globular heads.
- ◆ Flower varies from lemon yellow to yellow, golden yellow or orange.

2. *Tagetes patula* (French marigold):

- A hardy annual, about 30 cm tall, bushy type.
- Foliage is dark green with reddish stem.
- Flowers are small, either single or double
- The flower colour varies from yellow to mahogany red.

Other important species

3. *T. tenuifolia* (Syn. *T. signata*) – Bushy type (less than 30 cm)
4. *T. lucida* – Sweet scented marigold, perennial
5. *T. lacera* – Californian marigold, grow upto 120-150 cm in height
6. *T. lemmonii* – Shrubby marigold, grow upto 60-70 cm height bears small flowers.

In India the cultivation of *T. erecta* and *T. patula* are dominant.

21.5. TYPES

I. AFRICAN MARIGOLD (*Tagetes erecta*):–

1. **Carnation flowered (Carnation flowered tall):**

- The plants grow up to a height of 75cm, flowers up to 10cm across.
- Color orange, golden yellow, deep orange or lemon yellow

i. **Carnation flowered dwarf:** It grows up to 40cm and large flowering.

2. **Chrysanthemum flowered:**
 - i. **Tall double chrysanthemum flowered:** plants are tall (60-80cm), flowers are large and are available in various shades of yellow and orange.
 - ii. **Dwarf double chrysanthemum flowered** – grow up to 20-30cm.it has several strain viz.,
 - **Lexur Series** – Improved cupid type
 - **Rexor Series** - improved spun type
3. **Tall F₁ hybrids:**
 - Plants grow up to 3 m high, large, fully double flowers up to 12cm across. It has two series
 - **F₁ Gold Coin Series**
 - **F₁ Climax series**
4. **Semi tall F₁ Hybrids:** This is also popular as hedge type because of its uniform and compact growth. Grows upto 50 cm height. Double flowers and 10cm across.
5. **Dwarf F₁ Hybrids:** plants grow up to 15- 40 cm high with compact. Many flowers appear at one time i.e., uniform flowering.
 1. **Inca Series:** Flowers are large, fully double and compact.
 2. **Space Age Series:** Early flowering, dwarf and uniform.
 3. **Galore Series:** long flowering duration with uniform.
6. **F₁ Triploids:** early type and vary free flowering. Large and golden yellow flowers

II. FRENCH MARIGOLD (*Tagetes patula*):

1. **DWARF DOUBLE:**
 - Plant 20-30cm high, yellow, orange, reddish brown, mahogany red, golden yellow, sometimes bi-colour.
2. **DWARF DOUBLE – SCABIOUS FLOWERED:**
 - Flowers with crested centre,
 - Wide range of colours are available – golden yellow, golden orange with red marking, golden yellow with red, brownish red with orange centre, golden yellow with spotted red, etc.
3. **DWARF DOUBLE PETITE:**
 - A plant are very dwarf, 15-20cm high, and bears large number of attractive flowers with golden yellow, orange, yellow and maroon colour.

4. FRENCH DWARF SINGLE:

- Plants grow up to 20-35cm high, compact flowers, single,
- Golden yellow, yellow, golden yellow with maroon eye, mahogany red with yellow centre, yellow with brown.

5. DWARF TRIPLOID F₁ HYBRID:

- Plants grow up to 25-40 cm high, extremely early, profuse flowering; colour – yellow, golden yellow, orange and brownish red.

6. DWARF DOUBLE:

- **Dwarf All Saints:** grows upto about 20cm high, good for bedding and wide range of colours are available.
- **Dwarf chrysanthemum type:** Plants will grow upto 20cm high, compact and bushy, chrysanthemum flowered with rose and crimson coloured.

7. TETRAPLOID HYBRIDS:

- Early flowering, brilliant orange, fully double, carnation type flowers up to 6-7cm across.

8. SINGLE SIGNET (*Tagetes tenuifolia*):

- One of the dwarf types of marigold, grow up to 30-35cm tall, bushy with fine lacy foliage and covered with small single flowers of lemon yellow and orange colours.
- These are suitable for pot culture, edging or rock garden in landscaping.

INTERSPECIFIC HYBRIDS:

- The interspecific hybrids between African marigold and French marigold have been produced in the USA which is intermediate in characters.
- These hybrids are early flowering, medium in height, grow about 60 cm tall.
- Plants are bushy and produce double flowers with delightful colour combination of red and gold and hence they are called 'Red and Gold Hybrids'.

GENETICS AND BREEDING

Genetics:

Towner 1961 compiled the species of *Tagetes* based on their chromosome number is as follows

<u>Diploid species- 2n</u>	<u>Tetraploid species- 4n</u>
1. <i>Tagetes erecta</i> - 24 (Eyster, 1939)	1. <i>T. patula</i> - 48 (Eyster, 1939)
2. <i>T. tenuifolia</i> -24 (Eyster, 1939)	2. <i>T. minuta</i> - 48
3. <i>T. elongate</i> -24	3. <i>T. remotiflora</i> - 48
4. <i>T. lemminii</i> -24	4. <i>T. biflora</i> - 48
5. <i>T. lucida</i> -22	5. <i>T. mendocina</i> - 48
6. <i>T. jaliscensis</i> - 24 (Townwe, 1962)	

MALE STERILITY:

There are two types of male sterility is observed by Goldsmith during 1968 in marigold viz.,

1. Apetalous

2. Double flowered.

- Apetalous male sterility is more preferred to full double flowers.
- Because the second one is prone to break down and it gives few disc florets at later stages which, may be due to the age of the plant or environmental factors.
- Apetalous flowers are less attractive to pollinating insects.
- Male sterility is governed by recessive gene and is incorporated into seed parent.
- It is maintained by crossing the heterozygous plants with the sterile ones.

BREEDING:

- Self incompatible and cross pollinated crop.
- The ratio of CP to SP is 35:65

FLORAL BIOLOGY

OBJECTIVES

- High yielding, better quality of genotypes.
- Pest and disease tolerance
- Flower color-bicolors

METHODS

- Introduction and Selection
- Hybridization
- Pedigree breeding
- Heterosis breeding
- Male sterility
- Polyploidy

21.5. VARIETIES

1. *Tagetes erecta* (African marigold)

- Produces either 50 flowers or 800g of flowers by weight/plant for commercial growing.

Eg:

Alaska, Fire Glow, Golden Jubilee, Golden age, Yellow Fluffy, Giant Double African Orange, Climax (F₁), Golden Climax and Tant Bangalore selection, Pusa Narangi Gainda, Pusa Basanti Gainda, Orange Lady, Orange Double, Sun Giant, Texas, Yellow stones or GoldSumith, Golden Mammoth mum, Guinea Gold, Happiness, Hawaii, Honey comb, Man of the moon, Mr. Moon light, Giant sunset, Orange Fluffy, Orange mums, Prime rose, River side, MDU-1, Giant Double African Orange, Giant Double African Yellow, Cracker Jack, Climax, Dusloom, Golden Age, Chrysanthemum Charm, Crown and Gold, Spun Gold

2. *Tagetes patula* (French marigold)

- Cultivars which produces either 100 flowers or 200g flowers per plant.

Eg:

Brownie Scout , Burpees Nugget, Cupid Yellow, Orange flame, Petite (W), (Y), Petite spray, Petite Gold, Yellow pygmy, Valencia, Sussana, Bolero, Bonita, Burpee's Gold Nugget, Burpee's red and gold, Caronea, Cupid Yellow, Fiesta, Goldie, Harmony, Lemon drop, Melody. Red Brocade, Rusty Red, Butter Scotch, etc.

3. *Tagetes tenuifolia*

Golden Gem, Lulu, Pumila, Ursula, etc.

21.6. MARIGOLD CULTURE

21.6.1. CLIMATIC REQUIREMENT:

- ◆ Marigold requires mild climate for luxuriant growth and profuse flowering.
- ◆ It ceases to grow at high temperature thereby flower quantity and quality is adversely affected.
- ◆ During severe winter including frost plants and flowers are killed and blackened.
- ◆ Sowing and planting is carried out during rainy season, winter and summer season.
- ◆ Hence, flowers of marigold can be had almost throughout the year.

21.6.2. SOIL REQUIREMENT:

- ◆ Marigold can be successfully cultivated on a wide variety of soils.
- ◆ However, a soil that is deep fertile and sandy loam, friable having well water holding capacity, well drained and near to neutral in reaction
- ◆ pH of 7.0-7.5 is most desirable.

21.6.3. PREPARATION OF SOIL:

- ◆ Land should be well prepared by ploughing 2-3 times and 50 tones of well decomposed farmyard manure should be well mixed.
- ◆ Beds of convenient size are made to facilitate irrigation and other cultural operations.

21.7. PROPAGATION:

- ◆ Marigold is propagated by both methods *i.e.*,
 1. Seeds
 2. Cuttings.

21.7.1. BY SEEDS:

- ◆ Crop raised from seeds is taller than the vegetatively propagated one and vigorous and heavy bloomer; thus, it is preferred over cuttings.
- ◆ For better seed germination, optimum temperature range between 18 to 30°C is required.
- ◆ Seed rate of 1.5 kg is required for one hectare area.
- ◆ Seeds of marigold can be sown in pots, seed boxes or on flat or raised nursery beds.
- ◆ Nursery beds of 3 x 1 m size are thoroughly prepared and mixed with 10 kg of well decomposed farmyard manure per sq m

21.7.2. BY CUTTINGS:

- ◆ This method is commonly followed for maintaining the purity of varieties.
- ◆ Normally, the presence of adventitious roots along the stem helps in the establishment of cuttings.
- ◆ About 10 cm long cuttings are made and treated with seradix No.1.
- ◆ The cuttings are planted in the sand to strike roots easily and plants thus raised are used for bedding and pot planting.

21.7.3. TRANSPLANTING OF SEEDLINGS:

- ◆ Marigold seedlings will be easily established after transplanting in the field without much mortality.
- ◆ At the time of transplanting, seedlings of one month old with 3-4 true leaves have to be selected for proper establishment and higher yield.
- ◆ Aged seedling should not be selected.
- ◆ Transplant should be done early in the morning or late in the evening. One side of the ridges formed.
- ◆ After transplanting, a light irrigation has to be given.

21.7.4. SPACING:

- ♥ In general *Tagetes erecta* requires wider spacing than *T. patula*. However a wide range is practiced all over the country for higher yield. They are as follows,

<u><i>Tagetes erecta</i></u>	<u><i>Tagetes patula</i></u>
1) 40 x 40cm	1) 20 x 20cm
2) 40 x 30cm	2) 20 x 10cm
3) 45 x 30cm	3) 30 x 30cm
4) 60 x 45cm	4) 30 x 30cm

21.8. MANURES AND FERTILIZERS:

- ◆ To get highest flower yield, 100 kg N, 100 kg P₂O₅ and 100 kg K₂O should be mixed at the time of preparation of land.
- ◆ Remaining 100 kg N per ha should be applied in 2 splits @ 30 and 40 days after transplanted.

21.9. WEEDING:

- ◆ 3-4 manual weeding are required during the entire growth period.

21.10. IRRIGATION:

- ◆ It takes about 55-60 days to complete vegetative growth and to enter into reproductive phase.
- ◆ Season of planting determines the frequency of irrigation.
- ◆ If rainfall is normal and well distributed, irrigation is not frequently required, but if the rain is scanty irrigation is needed frequently.
- ◆ From April to June, frequent irrigation at the interval of 4-5 days is required.

21.11. PINCHING:

- ◆ In tall varieties of *Tagetes erecta*, emergence of side branches and their flowering is influenced by the presence of apical dominance.
- ◆ Due to which the plants of marigold grow straight upwards to their final height and develop into terminal flower bud.
- ◆ However the apical portion of the shoot is removed at the early stage to get more number of axillaries which in turn produces more flowers.
- ◆ Pinching the plants at 40 days after transplanting enabled the plants to yield more flowers.

FLOWERING

- In summer season crop, - commences by the middle of May with maximum intensity in the month of June and continues till the onset of rains.
- Rainy season crop - by the middle of September and the flowering will continue till December.
- Flowering in winter crop - by the middle of January and will continue till March.

PESTS AND DISEASES:

Diseases (Fungal):	<u>Causal organism</u>	<u>Measures</u>
1) Damping off	<i>Rhizoctonia solani</i>	Seed treatment with captan @ 0.5%
2) Collor rot	<i>Rhizoctonia solani</i> <i>Phytophthora sp.</i> <i>Pythium sp.</i> <i>Sclerotium rolfsi</i>	Seed treatment with captan @ 0.5%
3) Leaf spot	<i>Alternaria tagetica</i> <i>Cercospora spp.</i> <i>Septoria tageticola</i>	Spray with Blitox @ 0.4% or Bavistin @ 0.1%
4) Blight	<i>Colletotrichum capsia</i>	DM 45 @ 0.2%
5) Inflorescence blight	<i>Alternaria zinnac</i>	DM 45 @ 0.2% or Bavistin @ 0.1%
6) Powdery mildew	<i>Oidium sp.</i>	Spray with calixin, sulfex @ 0.2% (WS) @ 0.2%

Viral diseases: Marigold is infected by Cmv, Aster yellow virus

PESTS

1. Red spider mite : Spray Kelthane @ 2ml/l
2. Hairy caterpillar: Spray Endosulfan or Ekolux @ 2ml/l
3. Leaf hopper : Spray wits Melathian or Rogar @ 2ml/l
4. Japanese Beetle
5. Tarnished plant bug,
6. Slugs

21.12. HARVESTING AND YIELD:

- ◆ Marigold flower should be plucked when they attain the full size depending upon the variety.
- ◆ Plucking of flowers should be done in cool hours of the day *i.e.*, either in the morning or evening.
- ◆ Field should be irrigated before harvesting so that, flowers keep well for longer period after plucking.
- ◆ Plucked flowers should be covered with moist gunny bags if kept overnight before taking to market.
- ◆ Productivity of plants increases considerably by regular plucking of flowers.

Yield	No. of flowers/ha (Million)	Fresh flower (t/ha)
1) African marigold	1.5 – 2.5	11 – 18
2) French marigold	6.0 – 8.0	8 – 12

Marigold Flower Polysaccharide (MFP):

- MFP can be extracted from the meal with warm (50-55°C) water.
- Petals were separated from the rest of the flower and extracted in a soxhlet apparatus with methanol.

Quiz

I. Chose the correct answer from the following

1. In USA marigold is also known as
a) Friendship flower b) National flower c) Blanket flower d) none of these
- 2) The Pigments present in marigold is
a) Xanthophylls b) Carotenoids c) pelargonidins d) both a& b
- 3) Marigold spread to different part of the world during the early part of
a) 17th century b) 16th century c) 20th century d) none of these
- 4) Marigold is native of
a) Asia b) Africa c) Mexico d) India
- 5) Botanical name of French marigold are
a) *T. tenuifolia* b) *T. lucida* c) *T. erecta* d) none of these
- 6) Chrysanthemum flowered Marigold can be grown up to height of
a) 30-60cm b) 20-30 cm c) 60-75 cm d) 10-15 cm
- 7) chromosome number of *T. patula* (4n) is
a) 48 b) 24 c) 32 d) none of these
- 8) Varieties of African marigold
a) Alaska b) Fire Glow c) MDU-1 d) all of these
- 9) Varieties of French marigold
a) Yellow pygmy b) Cupid Yellow c) both a& b d) Happiness
- 10) Varieties of *Tagetes tenuifolia*
a) Red Brocade b) Rusty Red c) Butter Scotch d) none of these

(Key answers: 1) a, 2) a, 3) b, 4) c, 5) c, 6) a, 7) a, 8) d, 9) c, 10) d)

II. Match the Following

- | A | B |
|-------------------------|--------------------------|
| 1) African marigold | ___ 40 x 30 cm |
| 2) Soxhlet apparatus | ___ Ursula |
| 3) French marigold | ___ Californian marigold |
| 4) <i>T. erecta</i> | ___ 20 x 20 cm |
| 5) <i>T. patula</i> | ___ Shrubby marigold |
| 6) <i>T. tenuifolia</i> | ___ Blood purifier |
| 7) <i>T. lacera</i> | ___ 12 t/ha |
| 8) <i>T. lemmonii</i> | ___ Methanol |
| 9) Floral extract | ___ Egg yolk |
| 10) Xanthophyll | ___ 18 t/ha |

(Key answers: 1) 18 t/ha , 2) methanol, 3) 12 t/ha, 4) 40 x 30 cm , 5) 20 x 20 cm, 6) Ursula, 7) Californian marigold , 8) Shrubby marigold , 9) blood purifier, 10) egg yolk)



LECTURE – 22

TUBEROSE (*Polianthes tuberosa* L.; Amaryllidaceae)

TOPICS

- 22.1. Introduction
- 22.2. Origin and Distribution
- 22.3. Description of the Plant
- 22.4. Species and Varieties
- 22.5. Cultivars Description
- 22.6. Hybrids
- 22.7. Soil
- 22.8. Climate
- 22.9. Season
- 22.10. Land Preparation
- 22.11. CULTIVATION
 - 22.11.1. Propagation
 - 22.11.2. Planting
 - 22.11.3. Fertilizer Application
 - 22.11.4. Irrigation
 - 22.11.5. Interculture
- 22.12. Pests of tuberose
- 22.13. Diseases of tuberose
- 22.14. Harvesting and Yield
- 22.15. Ratoon Cropping
- 22.16. Lifting, Curing, and Storage of Bulbs

22.1. INTRODUCTION:

- Tuberose (*Polianthes tuberosa* L.), belonging to the family, *Amaryllidaceae*,
- It is essentially a florist's flower and one of the leading commercial crops because of its multifarious uses.
- The predominant characteristics of this crop are its lingering, delightful fragrance and excellent keeping quality.
- It has a great economic potential for cut flowers trade and essential oil industry.
- Due to their great demand it is being cultivated in most part of the tropical and subtropical countries.

IMPORTANT AND USES

- The flowers remain fresh for pretty long time and stands long distance transport.
- They are used for making artistic garlands, floral ornaments, bouquets and buttonholes.
- The long flower spikes are excellent cut flowers for table decoration.
- The variegated ones with beautiful golden stripes on foliage margins are very attractive and suitable for garden display.
- The fleshy, white, tubular flowers emit a strong odour and hence are cultivated on a large scale in some parts of the world for the extraction of highly valued natural flower oil, the tuberose oil.
- The tuberose oil contains methyl benzoate, methyl anthranilate, benzyl alcohol, benzyl benzoate, butyric acid, phenyl acetic acid, methyl salicylate, eugenol, geraniol, nerol both free and as acetates, farnesol, methyl vanillin and piperomel.
- The leaves, flowers, bulbs and roots are reported to contain sterols, triterpenes, carbohydrates, saponins and traces of alkaloids.
- The tuberose flower oil of commerce is one of the most sought after and expensive raw materials in perfumery.
- The fresh flowers give a concrete yield of 0.08 to 0.11 %, of which nearly 18 to 23% constitutes the alcohol-soluble 'absolute'.
- The essential oil is used in only the highest grade perfumes. Sometimes, the oil is used in flavouring candy, beverages and baked food.

22.2. ORIGIN AND DISTRIBUTION:

- The tuberose is a native of Mexico.
- It is grown largely in the southern states of America, Italy, France, Morocco, South Africa, Taiwan, Egypt and many other tropical and subtropical areas in the world.
- The word tuberose is derived from tuberose. This plant is being the tuberous hyacinth and distinguishes from the bulbous hyacinth.
- In India, tuberose is cultivated on a commercial scale in Ranaghat, Kolaghat and Panskura in West Bengal,
- Devanahalli, Tumkur and Mysore in Karnataka;
- East Godavari, Guntur, Chittoor and Krishna districts of Andhra Pradesh;
- Coimbatore in Tamil Nadu and
- Pune and Thane in Maharashtra.

22.3. PLANT MORPHOLOGY:

- *Polianthes tuberosa* is a half hardy, bulbous perennial.
- It has a tuberous root-stock has adventitious and shallow with a mass of basal foliage.
- The leaves are light-green, long, narrow and very dense /rosette, grass- like. The leaves sometimes reddish near the base.
- The flowering stems are long and can reach a height of up to 100 cm, although 60 to 75 cm is normal.
- It is approximately the top third of the stem which bears the pure, white, waxy-textured raceme of blooms.
- The flowers have funnel shaped perianth, measures 3 to 6 cm in length, fragrant and are borne in pairs on a long spike.
- The segments are 1 to 2 cm long; the tube is long, narrow and funnel-shaped, slightly bent near the base.
- The filaments are attached to the upper part of the corolla.
- The ovary is 3-celled; there are 3 stigmas which are ovate-falcate.
- The fruit is crowned by a persistent perianth and the seeds are flat.

22.4. SPECIES AND VARIETIES:

- There are about fifteen species under the genus *Polianthes*, of which twelve species have been reported from Mexico and Central America.
- Of these, nine species have white flowers, one is white and red and two are red.
- Except *Polianthes tuberosa* L., all the others are found growing wild.

***Polianthes tuberosa* L.:**

- ✚ An erect herb, 60-120 cm high with stout and short bulbs
- ✚ Leaves basal, 6-9 in number, 30-45 cm long, about 1.3 cm wide, linear, bright green, reddish near the base,
- ✚ Flowers funnel shaped, waxy white, the tube bent only near the base, filaments attached on upper part of corolla,
- ✚ Fragrant, in long terminal racemes.
- ✚ There are three types of tuberose named on the basis of the number of rows of petals they bear. They are,
 - Single,
 - Semi-double,

- Double and variegated,
- The **single type** has the most fragrance.
- The flowers are pure white and are popular among the growers for the production of essential oil.
- Calcutta Single and Single Mexican the single varieties, are being grown in Tamil Nadu.
- Suvasini a single type variety has been released by the IIHR, Bangalore.
- Rajat Rekha – single flowered mutant has been released by the National Botanical Research Institute (NBRI), Lucknow.
- The '**Semi-double**' type bears white flowers with two to three rows of corolla segments.
- The '**Double**' type has more than three rows of corolla segments and is white in colour. The flowers tinged with red in the 'Double' type are known as 'Pearl'.
 - Pearl Double is high flower yielder with quality.
 - Swarna Rekha is another double mutant, has been released by the NBRI, Lucknow. The leaf-margin is streaked with golden-yellow.
 - There are some streaked leaf-forms, known as 'variegated',
 - In others the flowers have little tinge of red in the bud-stage, which turns to white when fully open.
 - Other varieties include 'Albinos' and 'Excelsior'

22.5. DESCRIPTION OF COMMERCIAL CULTIVARS:

- Tuberose cultivars are classified into three types, based on the number of rows of petals.

(i) Single flowered tuberose:

Ex., Rajat Rekha, Calcutta Single, Shringar, Single Mexican etc.,

- Cultivars having flowers with one row of corolla segments.
- Flowers are extensively used for essential oil extraction and also for loose flowers.
- Single types are more fragrant than double.
- Also the per cent seed setting is high in single.
- Its floral buds are greenish white.
- Flowers are pure white with only one row of corolla segment.

- Concrete content has been observed to be 0.08 to 0.11 per cent.
- Loose flowers are used for making floral ornaments.

(ii) Semi double flowered tuberose:

- Flowers with 2-3 rows of corolla segments on straight spikes used for cut flowers also
- E.g. Cv. Semi Double bears white flowers with two to three rows of corolla.

(iii) Double flowered tuberose:

Varieties: Swarna Rekha, Suvasini

- Flowers with more than three rows of corolla segments on long and sturdy spikes used as cut flower as well as loose flower and for extraction of essential oil.
- Concrete recovery has been found to be 0.06%.
- Flower colour white and also tinged with pinkish red.
- The double type of tuberose is previously known as pearl.
- It does not open well and is not commercially viable as the single cultivar.

22.6. HYBRIDS:

1. Rajat Rekha:

- **Single** type with silvery white streak all along the middle of the leaf blade.
- It is a mutant evolved by irradiating bulbs of single flowered cultivar.
- Released by NBRI, Lucknow.
- Concrete content has been found to be 0.089 per cent.

2. Swarna Rekha:

- **Double type** with golden yellow streaks along the margins of leaf.
- It is a gamma ray induced mutant, in which mutation occurred in chlorophyll synthesis resulting in change in leaf colour.
- Released by NBRI, Lucknow.
- Concrete content has been found to be 0.062 per cent.

3. Shringar:

- It is released by IIHR, Bangalore.
- This variety has been developed from a cross between 'Single x Double'.
- It bears **single type of flowers** on sturdy spikes.
- The flower bud is slightly pinkish tinged.
- Florets are bigger and appealing than 'Calcutta Single'.
- Resistant to *Meloidogyne incognita* nematode.
- Loose flowers are ideal for making garland, while spikes can be used as cut flower.
- Yield of loose flowers is about 15,00 kg/ha per year, which is 40% higher than 'Calcutta or Mexican Single' and the concrete content of the Hybrid is at par with Mexican Single.
- Shringar is preferred by farmers and perfumery industries.

4. Suvasini:

- A **multi whorled variety** developed from the cross between 'Single' x 'Double'.
- Pure white flowers are bold and big, borne on a long spike.
- Spikes are best suited as cut flower.
- Suvasini recorded 25% more yield than cv. Double.
- IIHR, Bangalore has also evolved two more new varieties of tuberose namely Prajwal and Vaibhav recently.

5. Prajwal:

- This hybrid which **bears single type flowers** on tall stiff spikes is from the cross 'Shringar' x 'Mexican Single'.
- The flower buds are slightly pinkish in colour while the flowers are white.
- The individual flowers are large in size, compared to 'Local Single'.
- It yields twenty per cent more loose flowers than 'Shringar'.
- Recommended both for loose flower and cut flower purpose.

6. Vaibhav:

- The hybrid which bears **semi-double flowers** on medium spikes is from the cross 'Mexican Single' x IIHR – 2.

- The flower buds are greenish in colour in contrast to pinkish buds in 'Suvasini' and 'Local Double'.
- Flowers are white.
- Spike yield is 50 per cent higher compared to 'Suvasini'.
- Good for cut flower purpose.

SOIL AND CLIMATIC REQUIREMENT:

22.7. SOIL:

- Tuberose can be grown on wide variety of soils from light, sandy loam to a clay loam.
- The soil should be at least 45 cm deep, well drained, friable, rich in organic matter and nutrients with plenty of moisture in it.
- The soil should have a pH range from 6.5 to 7.5 with good aeration.
- The crop can be grown even in high saline-alkaline soils with better agronomical practices.
- It is observed that the vegetative growth and flowering are affected by increasing the levels of NaCl and very a low concentration of CaCl₂.

22.8. CLIMATE:

- The crop is best suited for cultivation in tropical to subtropical and temperate climates.
- The crop is reported to flower profusely throughout the year, if the climate is mild and free from extremes of high and low temperature.
- A temperature range from 20-30°C is considered ideal for this crop.
- If the temperature is above 40°C, the spike length and quality of the flowers are affected.
- Very low temperature and frost will damage the plants and flowers.
- Tuberoses grow well in a sunny situation.
- Although the plant is photosensitive, exposure to a day-length of about 16 hours appreciably promotes vegetative growth and enhances the emergence of the first flower-spike by 10 days.
- The length of the flower-spike also increases under long days.

22.9. SEASON OF PLANTING:

- Tuberoses are generally planted in February-March in the plains and April-May in the hills.
- The bulbs can also be planted during July-August.
- Tuberoses can be planted all year round in Bangalore, but a higher flower-yield is obtained from the April-May planting.
- To obtain flowers almost throughout the year, sequential planting can be practiced.

22.10. LAND PREPARATION:

- The land is ploughed deep, twice, to a depth of 45 cm.
- The first ploughing is done in January and the second about a month before planting.
- At the time of the second ploughing apply FYM @ 20-50 t/ha and incorporate into the soil.
- Then the soil is brought to a fine tilth by breaking the clods and removing the weeds.
- The field is laid out into plots of convenient sizes with irrigation channels, ridges and furrows at the recommended spacing.

22.11. CULTIVATION:

22.11.1. PROPAGATION:

- Tuberoses are propagated by bulbs, bulblets and seeds.
- Multiplication by bulb-segments and *in vitro* micro propagation from scale stem-sections is also possible.
- Propagation by bulbs is the most common method practiced for the commercial multiplication of tuberoses.
- The bulbs remain dormant during the winter months in places where the temperature is low and,
- If early planting is desired, the dormancy can be successfully broken by dipping the bulbs in 4% Thiourea solution for one hour.
- Ethylene chlorohydrins can also be used for breaking the dormancy.
- The bulbs are separated from the clumps by rubbing off the loose scales and the long roots should also be removed.
- Spindle-shaped bulbs with a diameter of 2.6 to 3 cm size are used for planting.
- However, if the bulbs are very large they may be cut into 2-3 vertical sections, each containing a bud and part of the basal plate.
- Each of these sections is treated with copper fungicide and planted vertically with their tips just showing above the surface.
- About 8 to 9 tons of bulbs are required to plant an area of one hectare.

22.11.2. PLANTING:

- The density of planting markedly influences the yield and quality of the flowers.
- The planting distance varies with the soil and climatic conditions.
- About 1, 00,000 to 2, 00,000 bulbs are required for planting one hectare of land.
- A spacing of 15 x 20 cm (Maharashtra), 25 x 25 cm (West Bengal), 30 x 30 cm (Lucknow), 30 x 22.5 cm (Bangalore) and 20 x 20 cm (for other part of South India) have been recommended for this crop.
- While planting, the bulbs are planted at the recommended plant-spacing, 3.5 cm deep on the sides of the ridges.
- The plots are irrigated immediately after planting.

22.11.3. FERTILIZER APPLICATION:

- 100 kg N, 60 kg P₂O₅ and 40 kg K₂O/ha is recommended for tuberose production.
- For achieving increased essential oil content in flowers and for the maximum recovery of concrete, a fertilizer dose of 80 kg N, 60 kg P₂O₅ and 40 kg K₂O/ha has been recommended.
- Of the full recommended dose of fertilizers, half the N, the full dose of P and K has to be applied at the time of planting and the remaining half of N is given as a top-dressing after 45 days of planting.
- Apart from N, P and K, calcium, magnesium, sulphur, iron, zinc, manganese, aluminium, boron and copper have also been found to influence the growth and flowering in tuberoses.

22.11.4. IRRIGATION:

- Irrigation is given immediately after planting.
- Subsequently, the crop is irrigated at 5-7 days intervals depending upon weather conditions.
- In the summer months, irrigation is recommended twice a week.

22.11.5. INTERCULTURE:

- In order to keep the plots free of weeds and to avoid the exposure of bulbs, the plots are weeded and earthed-up once a month.
- Earthing-up enables the spikes to grow erect, despite strong winds and rains.
- The application of Atrazine (@ 3 kg/ha) as a pre-emergent weedicide keeps the plots weed-free.
- A pre-emergent treatment of Gramaxone (@ 3 kg/ha) followed by three post-emergent sprayings at intervals of 110 days in between the rows also keeps the crop weed free.
- Mulching the plots with strips of black polythene, dried grass and chopped straw is effective in controlling weeds.
- The flower-spikes should be supported by stakes after about 2 1/2 months of planting.

22.12. PESTS OF TUBEROSE:

- Tuberose are hardy crops and are not much affected by attacks of insects, pests and diseases.
- Aphids and grasshoppers are found to feed on flower buds and leaves.

- They can be controlled by a 0.1 % spray of Malathion or Rogor at an interval of 15 days.
- The leaves become yellow or bronze, due to the sucking of sap by red spider mites.
- A spray of Metasystox (0.2%), wettable sulphur (0.3%) or Kelthane (0.5%) is recommended for effective control.
- The flowers also get deformed by thrips attack.
- The control measure suggested is to spray Nuvacron (0.1 %) or the application of Thimet to the soil.
- Root-knot nematode (*Meloidogyne incognita*) and greasy streak nematode (*Aphelencooides besseyi*) are reported to cause damage to the crop, which is characterized by the stunted growth of the plants. The leaf size is reduced and the flowers look sickly and, ultimately, the roots rot. The application of Thimet or Furadan (20 kg/ha) to the soil has been recommended for control.

22.13. DISEASES OF TUBEROSE:

- The fungi, *Scelerotium rolfsii*, deposits prominent, coarse, mycelial masses on the leaf surface or near the soil-level. Later, the infested spots exhibit a light-green colour due to rotting which extend and cover the whole leaf. Drenching the soil around the stem with Brassicol @ 1 % and the soil with 0.3% has been recommended for control.
- The fungi, *Alternaria polyantha*, causes leaf-spot disease, which is characterized by the appearance of brown spots with faint concentric rings on the mid-rib. Bordeaux mixture (0.4%), Zineb (0.5%) or Ziram spray will effectively control the disease.
- The other diseases reported are leaf-spot and blight caused by *Botrytis elliptica*, rust and powdery mildew, which are not serious. Suitable fungicides may be administered to control them when the damage is noticed.

22.14. HARVESTING AND YIELD:

- Flowers are ready for harvest in about 3 to 3 1/2 months of planting.
- August-September is the peak period of flowering.
- Depending on the purpose, harvesting is done by cutting the fully-opened spikes from the base or single flowers are harvested as they open by day; the picking of individual flowers should be completed by 8.00 a.m.

- The flowers have a shelf-life of 3 days.
- Flowers yield up to 17-18 t/ha can be expected from a well-maintained crop.

HANDLING AND PACKING OF FLOWERS

- Loose flowers are transported in poly bags to the nearby whole sale market.
- The flower spikes are graded according to spike length, length of the flowering zone and quality of individual flowers
- Bunched in round bundles each having about 50-100 spikes
- The stem portion of the bundle has to be wrapped with news paper.
- To avoid damage of the flowers and buds, the whole bundle may be wrapped with soft, white tissue paper or polythene.
- Bundles have to be packed in card- board boxes for long distance transportation.

STORAGE OF FLOWERS

- The fresh flowers can be stored at 10°C.

EXTRACTION OF ESSENTIAL OIL

- About 150 kg of flowers are required to produce 1 kg of the brown, semi-solid absolute of Enflourage.
- The extracted flowers will contain some natural perfume and are treated with petroleum ether to obtain the absolute of chassis as a valuable by-product (yield 1.2-1.5%).
- In recent years, the process of Enflourage has been partly replaced by solvent extraction, which requires much less labour though the yield of the absolute reduces considerably.
- The extraction of the tuberose flowers with petroleum ether yields 0.08-0.11 % of concrete, which gives 18-23% of absolute on treatment with alcohol and contains 3% steam distillate.
- The concrete yield is about 17-18 kg/ha which gives 3.5 kg absolute and 0.8 kg distillable oil.

22.15. RATOON CROPPING:

- After harvesting the main crop, the flower stalks are headed back (cut to the base) and the plots are manured and irrigated.
- About 3-4 ratoon crops can be taken from a single planting.

22.16. LIFTING, CURING AND STORAGE OF BULBS:

- Bulbs reach maturity at the cessation of flowering when the leaves become yellow and dry during winter (February-March) in North India.
- At this stage, irrigation is withheld and the soil is allowed to dry.
- The leaves are cut off at the ground level and the bulbs are dug out.
- After digging, the bulbs are lifted out and the adhering earth shaken off neatly and thoroughly.
- The offsets are then separated out by hand, which are used as seed-stock for the next season.
- The bulbs are graded based on the size into mature (> 1.5 cm diameter) and immature (< 1.5 cm diameter).
- Cleaned and graded bulbs are placed on sheaves to dry or cure.
- To hasten curing, artificial heat of 27° to 35° C may be applied.
- The bulbs must be stirred or have their position changed every few days to prevent fungal attack and rotting.
- An ambient air temperature of at least 18°C for four to six weeks or exactly six weeks at 30°C stimulates the yield of commercial sized bulbs.
- Longer storage at 30°C advances flower spike yield but the quality of spike deteriorates and the bulb number decreases.

KNOWLEDGE ASSESSMENT:

I. Choose the correct answers:

1. Tuberose (*Polianthes tuberosa* L.) belonging to the family
a. Amaryllidaceae b. Rosaceae c. Strelitziaceae d. Araceae
2. Tuberose oil contains
a. Methyl benzoate b. Methyl anthranilate c. Benzyl alcohol d. All these
3. Fresh flowers of tuberose give a concrete yield of
a. 0.04-0.5% b. 0.25-0.5% c. 0.08 to 0.11 % d. 0.5-0.75%
4. Native of tuberose is
a. Mexico b. India c. South America d. Indonesia
5. Seeds of Tuberose are
a. Round b. Oblong c. Flat d. None
6. 'Suvasini' is a. Single b. Semi-double c. Double d. None
7. Single-flowered variety, 'Rajat Rekha', a mutant, has been released by
a. IIHR, Bangalore b. NBRI, Lucknow c. IARI, New Delhi d. None
8. Concrete recovery of double flowered varieties
a. 0.0621% b. 0.003% c. 0.041 d. 0.5%
9. Prajwal is a cross between
a. Mexican Single x IIHR – 2 b. Single x Double
c. Shringar x Mexican Single d. None
10. Tuberoses are commercially propagated by
a. Bulbs b. Bulblets c. seeds d. All

II. State true or false:

1. Tuberoses are hardy crops and are not much affected by attacks of insect's pests and diseases.
2. March-May is the peak period of flowering.
3. Shelf-life of tuberose flowers is 7 days.
4. In tuberose 3-4 ratoon crops can be taken from a single planting.
5. The bulbs are graded based on the size into mature (> 1.5 cm diameter) and immature (< 1.5 cm diameter).

III. Match the following:

- | A | B |
|-----------------|-----------------------------------|
| 1. Rajat Rekha | a. Golden yellow steaks (b) |
| 2. Swarna Rekha | b. <i>Silvery white streak(a)</i> |
| 3. Shringar | c. Shringar' x 'Mexican Single() |
| 4. Suvasini | d. Single type |
| 5. Prajwal | e. Double type |
| 6. Vaibhav | f. Semi-double |

Key

I. Choose the correct answers:

1(a), 2(d), 3(c), 4(a), 5(c), 6(c), 7(b), 8(a), 9(c), 10(a).

II. State true or false:

1(T), 2(F), 3(F), 4(T), 5(T)

III. Match the following:

1(b), 2(a), 3(d), 4(e), 5(c), 6(f)



LECTURE 23

CHINA ASTER

TOPICS

- 23.1. Introduction
- 23.2. Uses
- 23.3. Importance of growing China aster
- 23.4. Climate and Growing Seasons
- 23.5. Location and Soil
- 23.6. Cultivation
- 23.7. Propagation
- 23.8. Seed bed Preparation
- 23.9. Method of Sowing
- 23.10. Field preparation and spacing
- 23.11. Fertilizer requirements
- 23.12. Irrigation
- 23.13. Pinching
- 23.14. Use of growth regulators
- 23.15. Harvesting, post harvest handling and yield
- 23.16. Yield of flowers

23.1. INTRODUCTION:

- China aster [*Callistephus chinensis* (L.) Nees] belongs to the family Asteraceae
- Native to China.
- The genus *Callistephus* has only a single species known as *chinensis*.

23.2. USES:

- ◆ China aster is one of the most popular of all the garden annuals grown throughout the world.
- ◆ Used for flower arrangement and religious offerings.
- ◆ Used commercially as cut flowers for interior decorations.
- ◆ It is best flower in bouquets and other flower arrangements.
- ◆ Popular as pot plant. It is also used in garden decoration as an herbaceous border.
- ◆ The dwarf Pompon and Lilliput types can be grown in window boxes and herbaceous borders

23.3. IMPORTANCE

- ◆ Popularity is increasing in and around cities due to its short duration and bewitching colors.
- ◆ In India it is widely grown in Karnataka, Tamil Nadu, West Bengal and Maharashtra.
- ◆ It's accounting for 6 % of the total area and 8.8 % of the total flower production in Karnataka state.
- ◆ It can be grown in various agro climate zones.
- ◆ It is also suitable for growing as intercrop in coconut gardens and orchards also.
- ◆ Cheaply available cut flower.
- ◆ It can be mixed with other cut flowers for making bouquets.
- ◆ It can be grown by small and marginal farmers.
- ◆ Good seed setting and no dormancy.

MORPHOLOGY

- ◆ It is a half hardy annual, plants are erect with branching habit.
- ◆ Plants are erect bearing alternate, broadly ovate or triangular-ovate, irregularly toothed leaves.
- ◆ Flowers are solitary. Blooms contain two kinds of florets: ray florets and disc florets. The discs are short and ray florets are long.
- ◆ Semi-double or double.
- ◆ It has a wide array of varieties and the height ranges from 6 inches to 3 feet.
- ◆ They have daisy-like or star-like flower heads (4-6" in diameter) with a yellow center often tall stems.
- ◆ Their colors vary from white to creamy yellow, pink, blue, red and purple.

FLORAL BIOLOGY:

- China aster is a self-pollinated crop, approximately 10% of natural crossing
- Flower head consists of both pistillate ray florets and perfect disc florets.
- Normally, the stamens and pistils do not mature simultaneously in the individual flowers.

ORIGIN AND HISTORY:

- The genus *Callistephus* derives its name from two Greek words '*kalistos*' means 'most beautiful' and '*stephos*' means 'a crown' referring to the flowers.
- Cassini described the China aster as *Callistephus hortensis*. Linnaeus as *Aster chinensis* and Nees subsequently changed this name to *Callistephus chinensis*.
- It was introduced in Europe during 1731 and then spread to different part of the world.
- The first change in the flower type was the development of the central florets, which led to quelled flowers.
- The German developed the German aster or double cultivar.
- Comet types introduced in 1886 replaced the quelled types.
- Introduction of new branching types in 1893 in the USA.

23.4. CLIMATE AND GROWING SEASONS:

- ◆ China aster is normally a winter season flowering annual.
- ◆ The day temperature of 10-12°C is favorable to develop large size flowers.
- ◆ The colour is well developed in the temperature range of 20-30°C during day and 15-17°C during night with relative humidity 50-60%.
- ◆ It needs sufficient sun light for both better growth and flowering.
- ◆ It needs limited rains, 500-700mm spread over from June to September, followed by provision of frequent but light irrigations.
- ◆ Heavy and torrential rains cause fungal disease like leaf spot and wilt.

23.5. LOCATION AND SOIL:

- ◆ China aster prefers to grow in an open sunny location.

- ◆ The crop is susceptible to more water logging; hence well drained red loamy soils are required.
- ◆ The pH should be around 6.8-7.5.
- ◆ Heavy soils with high calcium content are not suitable.

GROWING SEASON:

Area	Growing season
1. Bengaluru (KNK)	Through out the year May – June September- October (with irrigation facility)
2. Pune (MHR)	June – July October- November
3. West Bengal	First week of October
4. Delhi (like places)	August, September

23.6. CLASSIFICATION OF ASTERS

There are several types of annual asters varying in their growth habits, flower shape, size, appearance of florets, colour of flowers etc. The three main types classified based on growth habit are

- I. **Tall:** The plant height varies from 60-80cm. Based on flower type and colour. Tall types are further grouped into
 1. **American branching** – Flowers with long stalk, available in different colours – dark blue, light blue, rose, salmon, scarlet, violet, white and pink.
 2. **Bouquet powder puffs** – Flowers medium sized, rigid stem, available in different colours.
 3. **Princess and giant princess** – Flowers large, extra double, long woody stems, much branched, ideal for cut flower, available in different colours.
 4. **Giant of California** – Flowers large, late bearing good colour range.
 5. **Chikuma strain** – Fully double, ball shaped pompon type flowers with varied colour shades, ideal for cut flower production.

- II. **Medium Tall:** The plants are 40-60 cm in height, under this group the important types are
1. **Ostrich feather** – Flowers medium, petals curved with wide range of colours.
 2. **Giant comet** – Flowers large, petals curved, much branched, plants are hardy.
 3. **Giant crego:** Flowers large, curled petals, plants bushy and vigorous growing, available in different colours.
 4. **Early Burpeeana** – Chrysanthemum like flowers, early flowering, large flowers, semi incurved petals in blue, rose, white and scarlet.
 5. **Pompon** – flowers ball shaped, petals quilled with varied colours.
 6. **Rubens** – flowers ball shaped, large, early flowering, branches arise from base, suitable for cut flower production.
 7. **Liliput** – Flowers fully double but small, plants erect, attractive.
 8. **Unicum** – Flowers large sized, petals quilled.
- III. **Dwarf:** The plants are 20-40cm in height, under this group important types are
1. **Pinchio** – Flowers star shaped, produce large numbers of flowers, plants are dwarf, compact, excellent for bedding, edging and window boxes.
 2. **Colour carpet** – Flowers are chrysanthemum like, plants dwarf, uniform, circular canopy.
 3. **Dwarf chrysanthemum** – Flowers medium, varied colour range, plants are bushy and compact.

23.7. VARIETIES

I. Varieties developed outside India

Pot'n Patio Blue, Pot'n Patio Pink, "Bouquet Powder Puff, Bouquet White, Asure Blue, Giants Of California, Ostrich Plume, Crego, Crego Azure, Comet, Totem Ple, Giant Massagno, Benihanabi, Cactus Flower, Blue Wonder, White Kurenai, Ariake Pumpson, Invineible, Early Bird.

Dwarf Types: Dwarf queen, Pinocchio, Dwarf chrysanthemum, Dwarf triumph

Tall Types: American beauty, American branching, Giant of California standard, Super princess, Bouquet powder puff.

II. Varieties developed in India

1. Poornima
2. Violet cushion
3. Kamini
4. Shashank
5. Phule Ganesh White
6. Phule Ganesh Pink
7. Phule Ganesh Purple

III. Salient features of Varieties developed at IIHR, Bangalore

1. Kamini:

- Flowers are deep pink in colour, plants grow upto 60cm.
- Takes 135-140 days to flower
- Flower stalk length is 30cm
- Vase life for 8 days, flower 6 cm in diameter, weigh 2g
- Plant produces about 50 flowers.

2. Poornima:

- Plants are 50cm height, flowers pure white compared to local white cultivar,
- Takes 105 days to flower after sowing, flower diameter 6cm, ray florets 5-6 rows, powdery puff like, disc florets tubular, stalk length 25cm,
- Vase life 7 days, produces 25 flowers per plant, weight 3.5g, yield is double compare to white local.

3. Violet cushion:

- Flowers are violet in colour, are pompon type, ray florets 4-5 rows, disc florets tubular,
- Takes 130 days for flowering, flower 4.5cm in diameter, weight 2g, stalk length of 20cm,
- Vase life 8 days, floriferous type, produces 70 flowers per plant.

4. Shashank:

- Plants are 55cm tall, flowers creamy white, powdery puff type, more attractive than local white cultivar,
- Takes 124 days for flowering, flower size 6cm in diameter, weight 2.5g, bears 45 flowers per plant, stalk length 25cm
- Vase life is 9 days; yield double the yield of local white.

23.8. CULTIVATION:

23.9. PROPAGATION:

- ◆ China aster is propagated through seeds.
- ◆ A seed rate of 625 – 750 g/ha is sufficient.
- ◆ The seeds will not have dormancy and germinate in a week at about 21°C.
- ◆ The seeds loose viability at a faster rate if stored in ordinary containers for a longer time, therefore it is advisable to use only fresh seeds.
- ◆ Normally the seeds germinate at a temperature range of 10-35°C. The optimum being 21°C ± 4°C

23.10. NURSERY:

- ◆ Generally sowing should be staggered by 10 – 15 days, so that one can get flowers for longer time and also can avoid glut in the market.
- ◆ Seeds can be sown in seed pans for obtaining seedlings for garden use and in small quantities.
- ◆ For commercial cultivation, seed is sown in raised beds measuring 120x60x10cms (LxBxH).
- ◆ The seeds are sown thinly to avoid lanky tall seedlings.
- ◆ The seeds are sown at 10 -12cms apart and covered with a mixture of soil and FYM.
- ◆ After sowing, the beds should be watered gently with a rose can.

23.12. TRANSPLANTING:

- ◆ Aster seedlings are usually transplanted when they have developed about three to four leaves.
- ◆ Seedlings at too early or late stages should be avoided and usually seedlings are ready for transplanting within 30 - 45 days.
- ◆ The seedlings are hardened sufficiently before planting.
- ◆ The transplanting should be done preferably during early morning or evenings to avoid bright sunlight.
- ◆ After planting the soil around the seedlings is to be firmed and watered thoroughly.

23.13. FIELD PREPARATION AND SPACING:

- ◆ The field should be ploughed thoroughly and brought to a fine tilth.
- ◆ About 10-15 tones of well-decomposed farmyard manure may be incorporated in the soil at the time of soil preparation.
- ◆ In areas receiving high rainfall the seedlings should be planted on ridges to avoid chances of *Fusarium* wilt.
- ◆ A general spacing of 30 x 30 cm may be optimum for recommendation.

23.14. FERTILIZER REQUIREMENTS:

- ◆ Application of manure and fertilizers in required quantities is important for proper growth, yield and quality of flowers.
- ◆ The deficiency of nitrogen causes dwarfing of the plants resulting in small sized plants and flowers.
- ◆ Phosphorus deficiency causes delayed flowering.
- ◆ The recommended fertilizer dose is 180:120:60 kg NPK/ha.
- ◆ Of which 90 kg nitrogen, full dose of P & K has to be applied at the time of preparation of land.
- ◆ Remaining 90 kg/ha nitrogen has to be applied as top dressing at 40 days after transplanting.

23.15. IRRIGATION:

- ◆ Irrigation requirement depends upon the weather, type of soil and season of the crop grown.
- ◆ Since China aster is a shallow rooted crop, it needs continuous soil moisture throughout the entire period of crop growth.
- ◆ It requires irrigation at intervals of 7 to 10 days.

23.16. PINCHING:

- ◆ Pinching of main shoot at one month after transplanting promotes growth and flowering.
- ◆ Pinching delays first flowering by 8-12 days.

23.17. USE OF GROWTH REGULATORS:

- ◆ In China aster, the number of flowers per plant and the duration of flowering were increased by spraying GA₃ at 200 or 300ppm.
- ◆ Foliar spray with MH delays flowering.

23.18. HARVESTING, POST HARVEST HANDLING AND YIELD:

- ◆ Flowers are ready for harvesting in 10-12 weeks after transplanting.
- ◆ Harvesting plays an important role in determining the flower quality.
- ◆ China aster is harvested in two different ways.
- ◆ Individual flowers are harvested for decoration and worship purpose whereas flowers along with stalk or the whole plant just above the ground are cut for cut flower purpose.

23.19. YIELD:

- ◆ Flower yield depends upon season of planting and cultural practices adopted.
- ◆ On an average a fresh flower yield of 20-22 tons per ha during rainy season, 15.0 to 17.5 t per ha in winter and 10.0-12.0 t/ha in summer can be obtained.

KNOWLEDGE ASSESSMENT:

1. China aster [*Callistephus chinensis* (L.) Nees] belongs to the family
 - a. Asteraceae
 - b. Liliaceae
 - c. Malvaceae
 - d. Rosaceae
2. The genus *Callistephus* has only a -----species
 - a. 1
 - b. 2
 - c. 4
 - d. 6
3. The genus *Callistephus* derives its name from
 - a. Latin
 - b. Greek
 - c. Spanish
 - d. None
4. China aster was introduced in Europe during
 - a. 1931
 - b. 1631
 - c. 1831
 - d. 1731
5. Introduction of new branching types of China aster in 1893 in
 - a. Japan
 - b. Mexico
 - c. UAS
 - d. UK
6. China aster is normally ----- season flowering annual.
 - a. Summer
 - b. Winter
 - c. Rainy
 - d. All these
7. China aster varieties developed at IIHR, Bangalore.
 - a. Kamini
 - b. Violet cushion
 - c. Poornima
 - d. All
8. Seedlings of China aster usually transplanted when they have developed
 - a. 4-5 leaves
 - b. 5-6 leaves
 - c. 3-4 leaves
 - d. 1-2 leaves
9. General spacing followed is
 - a. 30 x 30 cm
 - b. 60 x 60 cm
 - c. 45 x 45 cm
 - d. 45x30cm
10. Pinching delays first flowering by
 - a. 5-6 days
 - b. 8-12 days
 - c. 15 days
 - c. 20 days

II. State true or false:

1. Comet types introduced in 1986 replaced the quelled types.
2. The day temperature of 10-12°C results in small sized flowers.
3. China aster needs sufficient sun light for both better growth and flowering.
4. Heavy and torrential rains causes fungal diseases.
5. The pH should be around 4.5 to 5.5.
6. American branching is a medium tall variety.
7. Cactus flower is developed in India.
8. Kamini flowers are deep pink in colour.

9. Pinching of main shoot at one month after transplanting hinders growth and flowering.

10. MH delays flowering.

I. Choose the correct answers:

1(a) , 2(a), 3(c), 4(d), 5(c), 6(b), 7(d), 8(c), 9(a), 10(b)

II. State true or false:

1(F) , 2(F), 3(T), 4(T), 5(F), 6(F), 7(F), 8(T), 9(F), 10(T)



LECTURE – 24

BIRD OF PARADISE (*Strelitzia reginae*; Strelitziaceae)

TOPICS

- 24.1. Introduction
- 24.2. Morphology
- 24.3. Species
- 24.4. Usage
- 24.5. Feature
- 24.6. Planting and Care
 - 24.6.1. Soil and Climatic requirements
 - 24.6.2. Planting
 - 24.6.3. Care after Planting
- 24.7. Propagation
 - 24.7.1. Seeds
 - 24.7.2. Division
- 24.8. Pest and Disease Problems

24.1. INTRODUCTION:

- **Bird of paradise or crane flower** (*Strelitzia reginae*) is a spectacular blossom.
- Long stemmed flowers emerge from green boat-shaped bracts which are bordered in red or purple.
- The uniquely shaped flower of this exotic tropical perennial resembles a bird's head and due to its brilliant orange and blue colors and unique form, it resembles not just any bird but a bird-of-paradise! Hence it is named as bird-of-paradise flower.
- It is popularly known as BOP and botanically called as *Strelitzia reginae*.

ORIGIN, HISTORY AND DISTRIBUTION

- Bird of paradise is **native** of South Africa. In Los Angeles *Strelitzias* are so extensively planted that it is regarded as the emblem of the city.
- *Strelitzia reginae* (*reginea* in Latin) was named after the King's George III (also a patron of botany) wife Queen Charlotte Sophia, of Mecklenburg-Strelitz (*Strelitzia*).
- In South Africa it is commonly known as a "crane" flower.
- It belongs to the family Musaceae.
- Grown on large scale in Hawaii, Israel, South Africa and California.

24.2. MORPHOLOGY:

- The plant is a trunk less, evergreen clump with leaves arising from a crown.
- The species *S. nicolai* is the largest in the genus, reaching 10 m tall; the other species typically reach 2-6 m tall.
- The leaves are large, 30-200 cm long and 10-80 cm broad, similar to a banana leaf in appearance but with a longer petiole and arranged strictly in two ranks to form a fan-like crown of evergreen foliage.
- The flowers are produced in a horizontal inflorescence emerging from a stout spathe.
- The flower is about 6 inches long with orange sepals and a blue petals looking like a "tongue".
- A variety of *S. reginae* called 'Mandela's Gold' was released by Kirstenbosch National Botanical Garden in Cape Town South Africa, (it was originally called 'Kirstenbosch Gold'. Mandela's Gold has yellow petals and a blue tongue.
- They are pollinated by sunbirds, which use the spathe as a perch when visiting the flowers; the weight of the bird on the spathe opens it to release the pollen on to the bird's feet, which is then deposited on the next flower it visits.
- Dogs like to eat these plants, but the seeds, if eaten, are toxic and can cause abdominal pain and vomiting.

24.3. SPECIES: *Strelitzia* genus has five commercial species of perennial plants.

1. *Strelitzia reginae* (syn. *S. parvifolia*) - Strelitzia, Bird of paradise, or Crane lily
2. *Strelitzia alba* (syn. *S. augusta*) - White bird of paradise

3. *Strelitzia caudata* - Swaziland Strelitzia, African desert banana
4. *Strelitzia nicolai* - White, or Giant bird of paradise; Wild banana
5. *Strelitzia juncea* (Ker Gawl.) - Greatly reduced or non-existent leaves.

24.4. USES:

- Bird of paradise clumps provide bulk and mass and can be used in the landscape like a small shrub.
- They serve well anchoring island beds when surrounded by lower growing annuals or ground cover.
- Used in shrub borders and in planting islands and containers.
- Makes a showy and non-messy plant at poolside.
- This beautiful and adaptable beauty is perfect for home and commercial interiors.

24.5. FEATURES:

- Bird-of-paradise is a real eye catcher, in bloom or not.
- Whether in the landscape or as cut flowers making star appearances in arrangements,
- This plant is recognized by most and enjoyed by all.
- It is an icon of the tropics, its image turning up on fabrics, wallpaper, tasteless resort apparel, and assorted works of art both crappy and sublime.
- As beautiful as some of these may be none can compare to the real thing.
- Find a place in your home or garden so you can enjoy this flamboyant showoff.

VARIETIES:

- Under the species, *S. reginae* three varieties are identified based on variability in growth characters.
 - **Humills:** The plants are compact, medium height with attractive flowers.
 - **Glauca:** The leaves are very attractive, shining, leathery dark green in colour, plants medium to tall with orange flowers.
 - **Rutilans:** The plants are semi tall, very attractive due to presence of purple mid rib in the leaves flowers attar.

24.7. PROPAGATION:

24.7.1. SEEDS:

- A bird-of-paradise grown from seed will take three to five years to bloom.
- The black seeds have orange fuzz on one end and are the size of sweet pea seeds.
- The hard seeds must be scarified (nicked or scratched) before they will germinate.
- To scarify, soak the seeds in lukewarm water for several hours and then nick them with a knife or small file.
- Scarified seeds will germinate in two to three months.
- Another way to decrease germination time is to put un-scarified seeds in a plastic bag and place them in a refrigerator at 4.45-7.2°C for two weeks. Then scarify them.
- Sow seeds in vermiculite, a one-to-one mixture of peat and perlite, or a ready-made mix, to a depth of one-half inch.
- The soil mix must be kept consistently damp until the seeds germinate.
- To ensure a moist, humid environment, cover the seed flat or container with a sheet of glass or clear plastic and place it in indirect light.
- Transplant seedlings individually into pots when they have two true leaves.
- Fertilization can begin at this stage.

24.7.2. DIVISION:

- The bird-of-paradise can also be propagated by division.
- This method will produce mature, flowering plants in one to two years.
- For best results, divide clumps during late spring or early summer.
- Dig up and separate old clumps, dividing those with four to five shoots into single-stem divisions.
- Plant divisions at the same soil depth at which they were previously grown.
- Keep the soil moist until roots are established (at least three months),
- Then begin fertilizing.

24.6. PLANTING AND CARE:

24.6.1. SOIL AND CLIMATIC REQUIREMENTS:

- Bird-of-paradise grows in most soils, but does best in fertile, organic soils with good drainage.
- It is considered to be a slow growing plant.
- For good flower production, grow the plants in sunny or partially shaded locations, it prefers full sun, 4000-8000 ft-candles.
- It is a warm temperate plant preferring 18.3 to 21.2° C during the day and 10-12.8°C at night.
- They prefer moderate humidity, around 60%.
- Plants grown in partial shade will be taller and have somewhat larger flowers.
- In full sun, plants are smaller and flowers are on shorter stems.
- The bird of paradise will tolerate light salt spray but should not be used in exposed locations near the ocean.
- Bird-of-paradise tends to produce more flowers along the outside of the plant.
- Thus, spacing the plants at least 6 feet apart will allow adequate space for flowering.

24.6.2. PLANTING:

- The planting hole/pit should be dug 2 to 3 times the diameter of the root ball.
- Make it as deep as the root ball is tall.
- For planting in ground pits of 90x90cm size are prepared and filled with soil and organic matter.
- Planting density @ 2 plants/m² is ideal.
- Before planting, thoroughly water the plant and remove it from the container.
- Gently place the plant in the hole, making sure the top of the root ball is no deeper than the soil surface.
- Planting too deeply may cause a delay in flowering.
- Fill around the ball with soil and gently firm the soil.
- Water thoroughly while planting to remove air pockets.
- Construct a saucer-like basin around the plant from the extra backfill soil. This will hold water until it drains down to the plant's roots.
- Where the soil is hard, compacted or poorly drained, consider digging a planting hole half as deep.
- Mound the soil to cover the sides of the root ball.

- A plant installed in this manner might require more frequent irrigation during dry periods but is not likely to suffer from drainage problems.
- The offset may usually takes 3-5 years to come to flowering.

24.6.3. CARE AFTER PLANTING:

- ❖ It needs adequate moisture during the establishment period (i.e., the first six months).
- ❖ Dry or soggy conditions will cause leaves to yellow and eventually die.
- ❖ Once established, it prefers frequent watering
- ❖ During the winter, watering may be done only when the soil is fairly dry.
- ❖ Mulch placed - conserve moisture, stabilizes root temperature, and reduces weed infestations.
- ❖ Keep a 2- to 3-inch circular area around the stems of plants free of mulch.
- ❖ Organic mulch materials like leaves, pine needles, bark and wood chips.
- ❖ Inorganic materials like gravel and crushed stone are also suitable.

24.6.4. FERTILIZATION AND PRUNING:

- For best growth and flowering, it requires fertilization.
- Organic fertilizers can also be used.
- Spread the fertilizer around the plants at every three months interval during the growing season.
- Dead leaves and old flower stalks should be removed to increase the aesthetic quality of the plant and to reduce the chances of fungal organisms building up on the dead tissue.
- Liquid nutrient feeding, however improves the growth and flowering of BOP.
- Spray the plants with a solution containing 6g superphosphate and 3g potassium nitrate per liter of water at an interval of 10 days.

IRRIGATION AND INTERCROPPING

- The first watering should be done immediately after planting and afterwards it depends on plants demand and surrounding conditions.
- The beds should be thoroughly be soaked at least once in a week.

- After a day or two the soil should be loosen to conserve the moisture and to check the weeds.

24.8. PEST AND DISEASE:

- The bird-of-paradise is relatively pest free.
- Occasional insects include aphids, caterpillars, grasshoppers, scales and snails.
- A leaf borer will sometimes attack the flower bracts during August and September.
- Fungal leaf spot disease may also occur.
- None of these typically threaten the overall survival of the plant.

ROOT ROT:

- Caused by over watering,
- A combination fungicide of ethazole + thiophanate-methyl gives very broad coverage of the root rot causing organism.
- This fungicide can be found under the trade name of Banrot.
- Thoroughly soak the soil as well as the crown with the fungicide mix.

SCALE:

- Scale insects can be treated with insecticidal soap or removed by hand with a sponge and soapy water. It is recommended that you take a damp sponge and clean the leaves once a month.

NEMATODES:

- Nematodes cause a problem for the roots of *Strelitzia*.
- Use clean potting mix or soil when repotting, top dressing or any other type of soil changing.
- Keep pots off of the ground to prevent nematodes from infecting the potting media from your native soil.

HARVESTING:

- Flowers are usually cut when the first floret opens.

DRYING THE BLOOMS:

- If you desire to use the blooms in floral decorations which needs a preserved flower the Bird of Paradise will fit into your plans.

- Take a flowering stalk from the plant and some leaf stalks if you wish.
- Crush the cut end of the stalk and place it in 4 or 5 inches of a water solution containing 1 part glycerin and 2 parts water.
- After the glycerin has penetrated the entire surface area of the stalk, the stem/leaf color will change and begin to ooze at the edge.
- This should take a week or so.
- When the stalk is saturated remove and hang upside down until thoroughly dry.
- Obviously this can get messy so you need a place to allow dripping of the solution onto a floor or table.

KNOWLEDGE ASSESSMENT:

1. Choose the correct answers:

1. In South Africa *Strelitzia reginae* commonly known as
 - a. BOP
 - b. Bird's head
 - c. Crane flower
 - d. *reginea*
2. Bird of paradise is a native
 - a. South Africa
 - b. India
 - c. Australia
 - d. Bangladesh

3. Bird of paradise is pollinated by
 a. Bees b. Ants c. Sunbirds d. All these
4. White bird of paradise
 a. Strelitzia nicolai b. Strelitzia regina c. Strelitzia caudata d. Strelitzia alba
5. A bird-of-paradise grown from seed will bloom in
 a. 3-5 years b. 1-2 years c. 6 years d. 1 year

I. Match the following:

A

B

- | | |
|--------------------------------|--|
| a) <u>Strelitzia alba</u> | 1. Giant bird of paradise |
| b) <u>Strelitzia caudata</u> | 2. White bird of paradise |
| c) <u>Strelitzia nicolai</u> | 3. Bird of paradise or Crane flower |
| d) <u>Strelitzia reginae</u> - | 4. Swaziland <i>Strelitzia</i> , African desert banana |
| e) <u>Strelitzia juncea</u> | 5. Greatly reduced or non-existent leaves |

II. State true or false:

- Nematodes never cause a problem for the roots of *Strelitzia*.
- The bird-of-paradise is relatively pest free.
- The flower is about 6 inches long with orange sepals and a blue petals looking like a "teeth".
- *Strelitzia* is a genus of four species of perennial plants.
- *Strelitzia*'s are showy and non-messy plant at poolside.

I. Choose the correct answers:

1(c), 2(a), 3(c), 4(d), 5 (a)

II. Match the following:

A (2), b (4), c (1), d (3), e (5)

III. State True or False:

1(F), 2(T), 3(F), 4(F), 5(T)



LECTURE- 25

ANTHURIUM

TOPICS

1. Introduction
2. Anthurium production – world scenario
3. Plant morphology
4. Available germplasm
5. Varieties and classification
6. Growth and development
7. Growing environment
8. Growing structures
9. Physiological problems
10. Growing media

INTRODUCTION

- *Anthurium* is an evergreen, tropical herbaceous plant cultivated for its colourful spathe and unusual attractive foliage.
- Originating in American tropics,
- The genus *Anthurium* has 600 species, which are distributed worldwide.
- Among the number of species available, the most popular and economically important species are *Anthurium andreanum* and *A. Scherzerianum*, which possess attractive long-lasting inflorescence.
- Several other species like *A. Magnificum*, *A. Digitatum*, *A. Crystallinum*, *A. Watermaliense*, *A. Clarinervium* and *A. Hookeri* are grown for their excellent foliage.
- The *Anthurium* belongs to family Araceae.
- Derives its name from Greek language ‘Anthos’ means ‘flower’ and ‘Oura’ means ‘tail’ indicating the flower with a tail.

ANTHURIUM PRODUCTION – WORLD SCENARIO

- *Anthurium* ranked eleventh in the global flower trade is next only to orchids among the tropical flowers.
- Until 1970, Hawaii was the world’s leading producer and exporter of *Anthurium* flowers.
- In the last ten years, the Hawaiian *Anthurium* industry has declined because of bacterial blight.
- This is one of the major problems the *Anthurium* growers face worldwide.

- Presently, the Netherlands is the world's leading producer and exporter.
- The Dutch production is concentrated during May to October because of bright light intensity during these months.
- The preferred colours in Dutch markets are orange and red followed by white and pink.
- Germany is the single largest importer of Dutch *Anthuriums* followed by Italy and France.
- Mauritius is the second largest producer and exporter of *Anthuriums*.
- During the last ten years, the *Anthurium* flowers from Hawaii are exported to the main land United States of America or to Japan.
- *Anthurium* is also produced commercially in Indonesia, Japan, South Korea, Thailand, Sri Lanka, Singapore and Taiwan.
- In India, *Anthurium* cultivation, which was mainly a hobby, is transformed into a commercial business by enterprising coffee and tea planters, who were initially responsible for bringing many exotic varieties into India.
- The coastal belts of south India, Eastern and Western Ghats and North-East hilly regions are potential area where *Anthurium* cultivation can be taken up on a large scale.
- Bestowed with natural wealth, the coffee belt along the Coorg district in Karnataka as many as 100 *Anthurium* growers, who have formed an *Anthurium* club to promote and safeguard the interest of *Anthurium* cultivation.
- The Coorg *Anthuriums* are presently marketed in nearby cities like Bangalore, Mangalore, Mysore, Goa, etc., from where they reach other flower markets in Delhi, Mumbai and Kolkata.
- *Anthurium* cultivation on commercial scale is also concentrated around Pune, Nashik, Mumbai, Trivendrum, Cochin, etc. Sensing the potential of this crop, corporate houses are also enthused to cultivate exotic varieties imported mostly from Hawaii or the Netherlands.
- De Orchids and *Anthura* (Mumbai), Noel Agri-tech (Mangalore), Eden Flora (Bengaluru) are few such enterprises.

PLANT MORPHOLOGY

- *Anthurium andreaanum* a perennial with creeping, climbing or arborescent stem s with lots of aerial roots.
- The stem is highly condensed and is not visible during early growing period. As plants grow the stems become noticeable with distinct node and internodal regions.
- The roots are fleshy, thick and the root biomass is more when compared to the shoot biomass.

- The lamina portion of the leaf is attached to a long petiole from where, the mid rib and lateral veins originate in a radiant fashion. The leaves are coppery green in early stages, which turn to dark green as they mature.
- The attractive colourful plant that is traded is actually a **modification of the leaf**, which is botanically called '**spathe**'.
- The heart shaped spathe appears on a long flower stalk and a number of veins that originate from the junction of the spathe and the flower stalk. The veins are interconnected with secondary and tertiary veins.
- A **cylindrical fleshy 'spadix'** originates from the same junction and produces a number of bisexual flowers (150-250 flowers) which are arranged in concentric whorls.
- The female part of the flower matures first (protogynous), which can be noticed by nectar like secretions in the form of shining droplets on the flowers.
- The anthers dehisce at a later stage forcing the flowers to cross pollinate.
- When the stigmatic surfaces are wet and receptive, pollen from another flower/variety/species can be applied to pollinate the flowers.
- After successful pollination, the spadix enlarges and turns dark green in colour; the spathe also loses its original pigmentation and turns green by producing enough chlorophyll pigments.
- The product of fertilization i.e. the fruit – is a berry which pops out of the spadix on maturity. The seed is covered by juicy, mucilaginous pulp, which needs to be removed, when the seeds are sown.
- Anthurium plants normally grow epiphytically (on trees),
- Some times epileptically (on rocks) or
- Terrestrially (on the ground).
- Epiphytical Anthurium grows on the trunks of the trees or on the rocks, but they are not tree parasites. They use them as a foundation or supporting material.
- They had an aerial root system, which absorbs nutrients & also moisture from the air. Since the Anthurium roots are naturally in contact with the outside air.

TAXONOMY:

- Family : Araceae
- Sub family :Othideae
- Order Alismatales within the Araceae family.

- The common feature of the Araceae family is
 - The typical cup shaped inflorescence,
 - The arum consists of the ‘Spathe’ & the ‘Spadix’.

AVAILABLE GERMPLASM

- The genus *Anthurium* can be categorized into two distinct groups –
 - Flowering types and
 - Foliage types.
- Although some *Anthurium* species flowers are inconspicuous and unattractive, they have unique velvety attractive foliage.
- Such *Anthurium* is grown as foliage potted plants.
- The flowering group products remarkably attractive spathe and colourful spadices, but the foliage may not be so attractive.
- The species that are classified as foliage types and flowering types are;

FLOWERING TYPE

Anthurium andreanum, *A. scherzerianum*, *A. omatum*, etc.

FOLIAGE TYPE

A. Clarinervium, *A. corrugatum*, *A. crystallinum*, *A. digitatum*
A. holtanianum, *A. leuconerum*, *A. magnificum*, *A. pentaphyllum*
A. pedetoradiatum, *A. olfersianum*, *A. hookeri*, *A. veitchii*
A. warocqueanum, *A. watermaliense* etc.

VARIETIES

- The present day flowering *Anthuriums* are mostly hybrids of *A. andreanum* and *A. scherzerianum*.
- Some of the hybrids/varieties evolved during early stages of varietals improvement are listed below.

Variety/Hybrids	Spathe Colour	Variety/ Hybrids	Spathe Colour
Abe	Bright pink	Jamaica	White
Aneunue	Green and coral pink	Marian Seefurth	Rose pink
Avo-Anneke	Pink	Manova mist	White
Avo-Jose	White	Ozaki	Red
Avo-Claudia	Red	Sunburst	Bright Orange
Avo-Chemelion	White	Sariana	White and rose
Favoriet	Orange	Trinidad	Off white
Hage-White	White	Horning orange	Orange

- Besides these coloured varieties there are many varieties that are bicoloured.
- Such bicoloured varieties are known as **Obakes** in trade.
- Examples of obakes include;
 - Madona (Cream obake)
 - Farao (bright orange with green borders)
 - Lamboda (white-green obake) and Fla rose (Peach)

TYPES OF ANTHURIUM

- There are three basic types of *Anthurium* flowers

1. STANDARD:

- They have the most common heart shape, the spathe lobes often overlap.
- Sizes range from 12x11cm to 20x18cm.
- Colour range includes red, orange, pink, Coral, white and green.

2. OBAKE:

- Popular for their two-tone coloration usually a bi-colour pattern of green and a major spathe colour.
- Some varieties will lose their green colour in summer resulting in solid coloured spathe.
- Sizes vary from 8x7cm miniatures 28x23cm large varieties.

3. TULIP:

- They have up right cupped spathes, with a straight and erect spadix.
- The spathe size ranges from 10x6cm.
- Tulip types are mostly hybrids with more than one species as their parents.

CLASSIFICATION OF ANTHURIUM CUT FLOWER VARIETIES

Based on the above categorization, the *Anthurium* cut flower varieties are classified as follows. *Anthurium* varieties that are released by the breeders in the recent years are summarized in Table.

Spathe type	Popular varieties	Spathe colour	Spadix colour
Standard	Ozaki Kozohara Nitta Midori Marian Seefurth	Light Red Dark Red Orange Bright Green Pink	Light red-Purple White Yellow tip White, Yellow tip Yellow, Green tip White, Yellow tip

Obake	Madam pele Anuenu Kalapana Rainbow Mickey Mouse	Dark red, green Coral, Green Red, Green Green, White Dark red, Green	White Red White, Yellow tip White, Yellow tip Red Red-Orange
Tulip	Lavender lady Calypso Lady Jane	Mauve Magenta-Fuchsia Light red	Mauve Darkmagenta, Fuchsia Light red

GROWTH AND DEVELOPMENT

- *Anthurium* passes through two distinctive growth phases,
 - A juvenile phase and
 - A generative phase.
- The juvenile phases where only vegetative growth is observed and characterized by the presence of vegetative buds in the axils of the leaf.
- The juvenile phase is relatively long and the plants remain vegetative for 12-18 months.
- The plants enter the generative phase characterized by the transformation of vegetative buds to floral buds in the leaf axils.
- The sequence of a new leaf and emergence of flower is more or less maintained from then onwards.

GROWING ENVIRONMENT

- Diurnal temperature, light and humidity play a major role in the growth and flowering of *Anthuriums*.

DIURNAL TEMPERATURE

- For a **luxuriant growth** the cultivated *Anthurium* (*A. andreanum* and *A. scherzerianum*) required **18.3°C** during **night** whereas
- A **higher night temperature of 21.2 to 23.9 °C** is essential for **initiation of flowering**.
- *Anthurium* cannot tolerate freezing temperature. At the same time *Anthuriums* do not prefer temperatures above 35 °C.
- If the temperature exceeds 35 degree centigrade coupled with low relative humidity leaf scorching is common.

LIGHT

- *Anthurium* is basically a shade loving plant.
- During summer where the light intensity is more, *Anthurium* plants are provided with 75 to 80% shade allowing only 20-25% of light to reach the plants.
- The range of light intensity that suits *Anthurium* cultivation is 20,000 to 25,000 lux.
- Higher light intensity coupled with low relative humidity and poor shading often results in scorching of young leaves and immature flower buds.
- In places with moderate climate where the light intensity is not so high, the plants can be provided with 65 to 75% shade.

SHADING

- *Anthuriums* are tropical plants, requiring high temperature and relative humidity.
- *Anthuriums* have a moderate to low light requirement and require 75 to 80% shade.
- To ensure the highest possible production during winter the shading should be removed at the onset of winter.
- In commercial practice it is advisable to have 50% shade net on the top and a 25% shade net below it, so that the light levels at the plant growth can be modified depending upon the ambient light conditions.
- *Anthurium* can be shaded with saran or with UV stabilized agro shade nets for providing uniform shading.
- The shade nets can be operated manually by closely watching the external light intensity.

RELATIVE HUMIDITY

- *Anthurium* thrives well in areas having high relative humidity levels, which are common in coastal areas of Kerala, Tamil Nadu, Andhra Pradesh and Maharashtra, high rainfall areas of Western, Eastern Ghats and North Eastern hilly regions.
- The optimum relative humidity levels range from 50 to 85% and at humidity levels less than 50%, the vegetative growth is slower and the flower development is poor.

FLORAL DEVELOPMENT

- ✓ The elongation of the stem bearing the spadix begins about one month after expansion of the subtending leaf.
- ✓ This is subtending by a showy leaf-like structure called a spathe.
- ✓ The cycle of the leaf and flower emergence varies with the season.
- ✓ 3 to 8 flowers per plant per year can be expected.
- ✓ The *Anthurium* flower is a spadix or inflorescence spike, cylindrical in shape, bearing up to 250-300 inconspicuous bisexual flowers arranged in a series of spirals.
- ✓ The spadix and spathe are borne on a leafless stem or peduncle.
- ✓ Commercial flower harvesting takes place when approximately three quarters of the stigmas along the spadix have become receptive.

GROWING STRUCTURES

- Depending upon the area of cultivation, the growing structures can be modified to suit the local climatic conditions.
- Commercial scale *Anthurium* cultivation can be taken up in
 - Low cost polyhouses,
 - Shade houses or
 - Climate controlled green houses.

LOW COST POLY HOUSES

- In areas where the relative humidity levels are low and the temperature levels are high, low cost poly houses are more suitable for commercial cultivation of *Anthuriums*.
- By creating a protected climate by cladding UV stabilized polythene, the relative humidity levels can be easily maintained and by providing top or side ventilation, the hot air can be easily expelled.
- Inside the poly house, the top portion can be provided with layers of two shade nets (50% and 25%).
- If the light intensity is very high a thin film of calcium chloride or lime can be sprayed on the external surface of the poly house to reduce the incoming radiation.

SHADE HOUSES

- In many of the commercial *Anthurium* growing areas, shade houses are the most popular structures because of the simplicity of construction and low cost.
- The shade houses can be constructed by taking the support of existing tree trunks if the *Anthuriums* are grown in multistoried plantation cropping.
- In open areas wooden, granite or pillars can be erected at regular intervals connected by GI wires as a mesh on top.
- Shade net can be covered on the top to provide the required shade 75%, (ie., 50 +25%, shade nets).
- Provision can be made for installing overhead sprinkler/misters/fogging systems by running GI wires from one end to another end.

CLIMATE CONTROLLED GREEN HOUSES

- The capital investment and the level of sophistication is more in climate controlled green houses than the previous two structures.
- Climate controlled green houses can be adopted for growing *Anthuriums* in areas where conditions of growing are not so congenial or
- To produce top quality blooms exclusively for export markets.
- Unless it is warranted it is not advisable to go for such capital intensive structures.

PHYSIOLOGICAL PROBLEMS

1) Excess light

- **Symptoms** – Leaves appear bleached in the centers and may have brown tips.
- **Control** – Increase shade so as to reduce light level to 1800-2500 foot-candles.

2) Over fertilization

- **Symptoms** – Lower leaves become yellow and develop brown tips, which gradually enlarge.
- **Control** – Reduce fertilization and leach soils thoroughly. Check roots for damage and possibility of secondary infection by fungus or bacteria.

3) Lack of flowering

- **Symptoms** –Mature plants produce many leaves but few flowers. No flowers on the lateral shoots.
- **Control** – Increase light level to 1800-2500 foot-candles. Maintain higher light intensity as long as leaves do not develop symptoms mentioned in 1) above.

GROWING MEDIA

- *Anthurium* requires a highly organic, well aerated medium with good water retention.
- However, the secret of success for commercial cultivation is to have good drainage in the medium used.
- An ideal medium for pots or ground potting should have the following properties;
 - Good water holding capacity.
 - High porosity.
 - Good aeration.
 - Low salt concentration (especially Na₂, Cl and Ca₂₊ ions).
 - Must provide good anchorage.
 - Should have optimum pH (5.0) and EC (0.6m mhos/cm²)
 - Good structure and texture.
- Various natural derivatives, which satisfy the above conditions, were tried to grow *Anthuriums* commercially. The range of media that were used so far includes;

Sugarcane bagasse
Coffee leaf mould
Spent ground coffee
Coffee husk
Cured coffee pulp
Coffee parchment
Rock wool

Saw dust
Tree bark
Chicken manure
Ground nut shells
Peat
Wood shavings
Brick, gravel, rubble etc

- In many *Anthurium* growing countries, coconut husk and coco-peat have become the most popular media for *Anthurium* cultivation.
- India has a rich wealth of coconut plantations throughout southern India, the byproducts of which can be exploited for *Anthurium*.
- The coconut waste generated from the industry and in the trade can be collected and washed repeatedly to wash of the excess salts especially sodium chloride.
- The coconut waste is allowed to decompose by using microbial (*Pleurotus* sp.) inoculation to the stock of coconut husk/coco-coir/coir dust.

Knowledge Assessment

Quiz:

I. Choose the correct answers:

- Anthurium* is a native of
 - Malayan region
 - American tropics
 - India
 - Australia
- Anthurium* has -----species
 - 600
 - 800
 - 1200
 - 900
- Anthos**’ means -----and **Oura**’ means ----- respectively
 - Anther and tail
 - Flower and Spathe
 - Flower and tail
 - Spathe and spadix
- ‘Spathe’** is modification of
 - Leaf
 - Candle
 - Suckers
 - Stalk
- Flower of *Anthurium* is a
 - Protogynous
 - Hypogynous
 - Androgynous
 - Epigynous
- Anthurium* fruit is a
 - Capsule
 - Berry
 - Drupe
 - None
- Bicoloured varieties of *Anthurium* is known as ----- in trade.

a. Standards b. Tulip c. Obakes d. Sprays

8. Spathe size Tulip type ranges from

a. 10x6cm b. 20x15cm c. 15x10 cm d. 25x20 cm

9. *Anthuriums* do not prefer temperatures above

a. 25°C b. 30°C c. 20°C d. 35 °C

10. *Anthuriums* require ----- shade

a. 75 to 80% b. 50 to 70% c. 85 to 90% d. 40 to 50%

II. Match the following:

1. Standard : 8x7cm to 28x23cm
2. Obake : 10x6cm
3. Tulip : 12x11cm to 20x18cm
4. *Anthurium* spacing : 3-4 leaf stage
5. Transplanting : 45 x 45cm

III. State true or false:

1. Vegetative propagation by terminal cuttings and stem sections are very vigorous.
2. In Hawaii standard master cartons are 43x23x11 inches.
3. *Anthurium* can be easily stored at 13°C for 5-6 weeks.
4. The flowers, which are harvested when $\frac{3}{4}$ th of the length of the spadix changes colour.
5. *Anthurium* cannot tolerate freezing temperature.

Key Answers:

I. Choose the correct answers:

1(b) , 2(b), 3(c), 4(a), 5(a), 6(b), 7(c), 8(a), 9(d), 10(a)

II. Match the following:

1(c), 2(a), 3(b), 4(e), 5(d)

III. State true or false:

1(False), 2(True), 3(False), 4(True), 5(True)

LECTURE- 26

ANTHURIUM

TOPICS

1. Cultivation
2. Planting
3. Planting density
4. Irrigation
5. Nutrition
6. Propagation
7. Harvesting
8. Post harvest handling
9. Yield and returns
10. Pest and diseases

CULTIVATION:

A). IN POTS

- *Anthurium* especially the miniature type, *A. scherzerianum* and its hybrids have to be grown in pots to use them as potted plants.
- When young the plants can be planted in smaller pots (4") and as they grow they can be shifted to bigger pots (6" to 10" diameter).
- Depending on the plant size, the pots have to be arranged in such a way that the foliage does not overlap with the leaves of adjacent pots.

B). IN BEDS

- When planting is done in soil, the plants have to be grown in 1.00 meter wide raised beds with gentle slope, which facilitates good drainage.
- The beds have to be raised approximately 30cm in height which gets compressed due to frequent irrigation and other cultural practices.
- The beds are prepared by digging about 2 feet deep and filling the pits with the chosen growing medium.
- The dug out soil is thoroughly mixed with chosen growing medium and is used as top layer to create the raised beds.
- The mixing of soil with the medium, which is otherwise loose and friable, prevents runoff of the medium.

PLANTING

- Avoid planting during seasons with high temperature and high rainfall.
- Make sure the bed/medium is evenly moist but not wet.
- Provide an initial fertilizer dose having increased potassium and lower calcium levels.
- Dip the roots in a fungicide solution before planting (@ 0.1% Bavistin).
- Plant them in rows in cross wise pattern.
- Plant at an optimum depth (15cm deep so that new aerial roots appear above the planting surface).
- Do not prune the leaves immediately after planting, allow the plants to establish and cut down to three to four leaves.

PLANTING DENSITY

- Depending upon the varieties, Anthurium is also planted at a distance of ,
- 30 cm x 30 cm (accommodates 6 to 7 plants/m²) /30 cm x 60 cm/45 cm x 60 cm.
- The optimum spacing for commercial cultivation of *Anthurium* is 45 x 45cm, which accommodates 5 plants/m².
- A closer planting of 30cm apart is also recommended to accommodate 7 to 10 plants/m² (61,750 plants/ha).
- At higher plant densities though *Anthuriums* produce more, dense planting restricts air circulation and interferes with spray penetration. Hence, disease and pest management becomes difficult.

IRRIGATION

- *Anthurium* requires generous watering and should be irrigated at least twice a day in summer months.
- In field grown plantations besides ground level irrigation, the plants can also be watered using overhead sprinklers.
- Irrigation can be accomplished by flooding beds or by installing micro-sprinklers at the plant level.

NUTRITION

- *Anthuriums* prefer smaller doses of fertilizers at frequent intervals rather than larger doses in longer intervals.
- For pot cultivation it is advisable to apply 5g of any complex fertilizer in 500ml of water (1%) once in a month.
- *Anthuriums* can also efficiently take up nutrients through foliage.
- Foliar application of 0.1% urea at monthly intervals is found to be beneficial.
- Adequate levels of calcium and magnesium are also necessary for optimum yield.
- Deficiency of calcium often results in color break in the spathes. Application of 5g of CaNO_3 at monthly intervals stabilizes the spathe color.
- On average *Anthuriums* require two liters of water/m. sq. per day when supplied through online drippers.
- One gram of fertilizer per every one liter of water is found to be suitable for good growth of *Anthurium*.
- After fertilizer application thorough watering is essential @ two liters of plain water/m² to prevent accumulation of excess salts in the root zone, which otherwise lead to scorching of roots and leaves.
- In high rainfall areas the nutrients get washed away in the rain water, slow releasing fertilizers like osmocote, neem coated urea etc. are preferred in such areas.
- In commercial plantations, fertilizers are applied to the plants through ground level sprinklers or through the Drip irrigation system.
- Depending on the nutrient status of the medium, the following combinations of nutrients are supplied through irrigation water by many commercial growers.

<u>Major Nutrients</u>	<u>Nutrient</u>	<u>Concentration (ppm)</u>
	Potash	14
	Calcium	176
	Magnesium	60
	Nitrate	91
	Sulphate	48
	Phosphate	31
<u>Minor Nutrients</u>		
	Iron	0.80
	Manganese	0.16
	Boron	0.22
	Zinc	0.20
	Copper	0.03
	Molybdenum	0.05

**PROPAGATION:
BY SEEDS**

- Conventionally *Anthuriums* are propagated by seeds.
- *Anthurium* can be very easily grown by seeds, but it is an extremely slow process.
- The berries (fruit of *Anthurium*) pop out extremely slow process.
- The seed (sometimes two) is enveloped by juicy, mucilaginous pulp which depending needs to be removed completely before sowing.
- The time required from pollination to the maturity of the seeds is about 6-7 months.
- Seeds cannot be stored and this should be sown immediately.
- The flowering starts after two years.
- Seed propagated cultivars are poor in uniformity.
- In fact, there may be a great variation in flower production, colour and shape.
- Depending upon the type of medium used the seeds will germinate in 10 to 40 days.
- The seedlings can be transferred to individual pots when they attain 3-4 leaf stage.

1. THROUGH CUTTINGS

- *Anthurium* can be vegetatively propagated through cuttings obtained from fully grown plants.
- Since, the vegetative growth is slow; the plants require at least 3-4 years to elongate and to produce 5-6 nodes and internodes.
- Cuttings can be made by cutting just below the node, so that each cutting has single eye or bud in it.

- The buds sprout in 20-30 days from the cuttings treated with growth hormones especially, the auxins (IBA & NAA) hastens the sprouting and rooting.
- Vegetative propagation by terminal cuttings and stem sections are very slow.

2. BY SUCKERS

- The highly condensed underground stem often produces shoots at the plant base.
- Such multiple shoots may be with or without roots and they can be separated from mother plant and planted in individual pots.
- The suckering capacity can be improved by exogenous application of growth regulators like BAP (@75 ppm) at monthly interval.
- *Anthurium* starts producing suckers once they attain an age of 12-16 months.

3. TISSUE CULTURE

- *Anthuriums* are highly amenable for in-vitro propagation using different parts as explants.

HARVESTING

- *Anthurium* flowers are harvested when the spathe is completely unfurls and the spadix is well developed.
- Development of true flowers on the spadix is also used as a criterion for harvesting the blooms.
- When one third of the flowers on the spadix mature, change of colour can be observed that moves from base to tip of spadix at that stage the flowers are harvested.
- Harvesting has to be done during cooler parts of the day i.e. early morning or late evening.
- The flowers are cut below leaving 2cm stem on the plant & kept in the bucket containing water.
- Flowers are graded according to the length of the stalk and diameter of the spathe
- The flower stalk length varies from 25 to 50cm.
- Depending upon the cultural practices, planting density and variety, 5 to 10 flowers can be obtained per plant per year.
- An average yield of 2,25, 000 blooms of exportable quality can be obtained per hectares per year.
- Average price of Anthurium in Europe is US \$1.50 per flower.
- In the India cities, prices vary from Rs.15 to Rs.30 per flower in florist shops, while growers get Rs.6 to Rs.10 per flower.
- We can expect 5-7 flowers per year per plant for first one and half year to two years and

- 10 to 12 flowers per plant per year after 2 years of planting.
- Generally, some varieties are high productive & some are low productive.
- 6-8 months after planting we can harvest the flowers.
- Besides flowers, *Anthurium* leaves can be sold in the international market.

POST HARVEST HANDLING

1. PACKING

- Dutch packing puts few *Anthuriums* in a box to make sure that the *Anthurium* spathes do not bruise.
- Within each box flowers are of a uniform grade and generally of the same colour.
- Individual flowers are packed with water vials filled with water with preservative solution.
- Flowers are packed so as not to touch each other or the ends of the box.
- White foam rubber cushions are used to support the spadix.
- If flowers are layered, 4cm thick plastic sheeting is inserted between the layers.
- White cellulose shredding is used around the ends, particularly in the winter, when foam peanuts or other white foam pieces may be included in the box for insulation.

PACKAGING

- *Anthurium* packaging is into boxes of white surfaced corrugated cardboard,
- The lids which have been printed with 3-colour logos and lettering.
- European Carton Sizes-100x20x10cm, 100 x 40 x 12 cm and 100 x 40 x 14.5 cm
- In Hawaii standard master cartons are 43 x 23 x 11 inches and contain smaller boxes inside, called trays.

STORAGE AND VASE LIFE

- *Anthurium* can be easily stored at 13°C for 2-3 weeks.
- The flowers, which are harvested when $\frac{3}{4}$ th of the length of the spadix colour changes, last longer than the other flowers which are harvested either early or late.
- The average vase life depends upon life of flowers ranges between 12-24 days depending upon the cultivars.

POST HARVEST QUALITY REQUIREMENT

- The size, shape, colour and texture of the spathe gets prior consideration.
- A heart-shaped symmetrical spathe with overlapping or fused lobes is desirable.

- The spathe should be free from any kind of damages and infestation.
- Straight and sturdy flower stems with shorter internodes are preferred.

YIELD AND RETURNS (100 m²/year)

ield (After years)	# Flowers/ plant/Year	Flower yield/m ²	Flower yield/100m ²	Selling price/ flower (Rs.)	Returns per year (Rs)
I	5	35	3500	10	35000
II	6	42	4200	10	42000
V	8	56	5600	10	56000

Flower Size & Price

Sr. No	Size of spathe	Stem height	Grade	Rate/flower Rs.
1.	< 5cm	20-25cm	Mini	6-8
2 .	5-7cm	25-30cm	Small	8-10
3 .	7-9cm	30-40cm	Medium	12-15
4 .	9-12cm	40-60cm	Big	18-20
5 .	12-15cm	50-60cm	Large	22-24
6 .	> 15cm	60 & above	Extra large	25-30

PEST AND DISEASES

PEST

- ❖ The plants are occasionally infested by aphids, scale insects, mites, thrips, mole cricket and beetles.
 - ❖ Dimethoate (0.3 per cent) is effective to control aphids.
- ❖ Scale insects attack leaves and stems and weaken the plants by sucking the plant sap.
 - ❖ Malathion (0.1 per cent) spray controls them

DISEASE

Bacterial Diseases

- ❖ Soft rot (*Erwinia carotovora subsp. Carotovora*),
- ❖ *Xanthomonas* blight (*Xanthomonas campestris pv. Dieffenbachiae*),
- ❖ Anthracnose (*Colletotrichum gloeosporioides*),
- ❖ Phytophthora leaf spot,
- ❖ Flower blight, and
- ❖ Root rot (*Phytophthora parasitica*)

Nematode:

Burrowing nematode decline (*Radopholus similis*)

LECTURE - 21

DAHLIA (*Dahlia pinnata*; Compositae)

TOPICS

- 27.1 Introduction
- 27.2 Importance and Uses
- 27.2. Growth and Flowering
- 27.3. Light
- 27.4. Plant growth substances
 - 21.4.1. Effect on flowering
 - 21.4.2 Effect on tuberous root formation
- 27.5. Propagation
- 27.6. Division
- 27.7. Cuttings
- 27.8. Soil preparation
- 27.9. Planting
- 27.10. Staking
- 27.11 Manuring
- 27.12. Watering
- 27.13 Mulching
- 27.14. Pruning and disbudding
- 27.15. Pot cultivation
- 27.16. Growing media
- 27.17. Pots
- 27.18. Manuring
- 27.19. Harvesting and Post harvest handling
- 27.20. Tubers storage

27.1. INTRODUCTION

- Dahlia is one of the most important garden plants.
- Its wide spectrum of colours, variation in size (< 2.5 cm to 40 cm diameter), attractive shapes, many forms, profusion of flowering easy cultivation have made them immense popularity.
- It was Abbe Cavanilles gave the name Dahlia in 1791.

- They grow in size from one to five feet. And flowers range from small pompons to several inches diameter.
- Flowers include single bloom and double bloom.
- These attractive plants produce loads of brilliant blooms in rainbows of orange, salmon, bronze, apricot, yellow, crimson, scarlet and lavender.

27.2. IMPORTANCE AND USES:

- They are extensively used in exhibition, garden display and home decoration
- Dwarf types are suitable for beds, borders and mixed borders shrubbery.
- Large flowering dahlias grow in pots, terraced roof and verandah display.
- Long stemmed one is used for flower arrangement.
- Cut flowers of pompons, small and miniature type are most suitable for vases and
- Also used for making garlands.
- Tubers of dahlia contain some medicines like, insulin, fructose, phytin & benzoic acid etc.,.

27.3. ORIGIN AND HISTORY

- The native land of dahlia is Mexico. National flower of Mexico.
- The species introduced into the old world are *Dahlia imperialis*, *D. coccinea*, *D. merckii* and *D. juarezii*.
- The later is actually a hybrid of *D. variabilis* from which most of the garden types have been developed and due to continues crosses several present day types are evolved.

27.4. MORPHOLOGY

- Dahlias are half hardy perennials with tuberous roots.
- Stems are mostly erect, branched, glabrous or scabrous.
- Leaves 1-3 pinnate, with slightly serrated margin, are produced opposite at each node on the stem.
- Bears flower on the long, stiff stem well above the foliage.
- Ray florets are neutral or pistillate and disc florets perfect.

27.5. CLASSIFICATION

- Dahlias are classified according to flower shape and arrangement of petals by National Dahlia Society of England.

I. SINGLE-FLOWERED:

- These have one row of petals, generally grow to 3 feet or less, and have flowers 4 inches (10 cm across) or less in diameter.

II. ANEMONE- FLOWERED:

- Flowers have one or more rows of petals surrounded by a dense group of long tubular disc florets.
- Fully double flowers and good for flower arrangement.

III. COLLERETTE:

- Flowers have one row of normal petals and one or more rows of small petals (the collar).
- Discs are apparent, very good for flower arrangement.

IV. PAEONY FLOWERED:

- Flowers have two or more rows of generally flattened petals.
- Discs are apparent.

V. DECORATIVE:

- Have fully double flowers.
- The petals are broad, more or less flat or slightly twisty and wavy.
- The tips of the petals may either be rounded or pointed.
- It is the largest group among dahlias.
- Decorative group is further divided according to size into five groups.
 1. Giant Decorative
 2. Large Decorative
 3. Medium Decorative
 4. Small Decorative
 5. Miniature Decorative

VI. BALL

- Have fully double flowers.
- They are ball shaped or slightly flattened. They are sub divided into
 1. Small ball (4.0 to 5.9 inch)
 2. Miniature ball (2.0 to 4.0 inch)

VII. POMPON:

- Have fully double blooms.
- Blooms are globular in appearance like table tennis balls.
- The size limit is 50mm.

VIII. CACTUS:

- Have fully double blooms. Outer petals are narrow preferably with revolute edges overlapping from the tips for at least two third of their length.
- This is a large group and is further divided into five sub groups.
 1. Giant cactus
 2. Large cactus
 3. Medium cactus
 4. Small cactus
 5. Miniature cactus

IX. SEMI CACTUS

- Have fully double flowers. Like decorative dahlias the half base of the petal are broad and flat.
- The other half of the outer petal is revolute from the pointed tip for more than one quarter but less than half of the full length.
- This group is also divided into five sub-groups.
 - i.** Giant semi-cactus
 - ii.** Large semi-cactus
 - iii.** Medium semi-cactus
 - iv.** Small semi-cactus
 - v.** Miniature semi-cactus

X. MISCELLANEOUS:

- Cultivars which do not fall under any of the main nine groups are grouped under this category.
- Good for flower arrangement.

XI. FIMBRIATED:

- Fully double flowers.
- Petals are fimbriated from the tips preferably for at least 10 mm.

XII. WATER LILY

- Flowers are fully double.
- Outer petals are broad and slightly cupped with rounded ends. From the side view the bloom are look like a saucer.
- Flowers resembles water lily (nymphaea).

XIII. STAR FLOWERED

- Small cupid shaped flowers having two or three rows of pointed petals which overlap very slightly.



27.6. GROWTH AND FLOWERING:

27.6.1. TEMPERATURE

- Dahlia needs 10-21°C night temperature during winter.
- During summer it requires 15.6-26.7°C night temperature.
- Flower bud accelerated as temperature increases.
- The best quality blooms can be obtained at 25°C day, 16°C night.
- At 24°C day and 12°C night temperature delayed flowering.
- The quality will affect at 28-29°C days, 17-20°C night.

27.6.2. LIGHT:

- Day length regulate flowering.
- 10-14 hours optimal for forcing flowering.
- 16 hours photoperiod or 4 hours night break.
- High light intensity is necessary for forcing.

27.6.3. PLANT GROWTH SUBSTANCES:

27.6.3.1. EFFECT ON FLOWERING:

- Application of growth substances have proved very effective in the regulation of growth and flowering of dahlia by 6-15 days delay flowering.
- SADA @ 1000-5000 ppm, TIBA @ 500-2000 ppm and ethereal @2000 ppm increased flower production
- Ethrel 50-100 ppm, CCC, MH, SADH increased flower size.

27.6.3.2. EFFECT ON TUBEROUS ROOT FORMATION:

- CCC @ 2000-5000 ppm, ethrel 1000-5000 ppm increased number and weight of roots
- SADH application coincide with long day condition – promote roots.
- SADH + GA₃ – inhibit roots.
- Early tuber formation – pre-planting soaking in ethrel 10 ppm

27.7. PROPAGATION:

- Dahlia are propagated from seeds, tuberous roots, and cuttings, grafting and tissue culture also

27.7.1. SEED PROPAGATION:

- Adopted for raising dwarf bedding singles and also for crop improvement.
- Thinly sow the seeds in shallow box or seed pan.
- Container contains porous soil, a layer of fine leaf mould.
- Takes 10 days to germinate at 18-28°C temperature.
- Seedling are ready for transplanting in 3-4 weeks period

27.7.2. DIVISION:

- Tuber division may be used by separating tuber each with a piece of stem.
- Tuberous root required to place in a warm moist place for a short time before dividing the tuberous root.

27.7.3. CUTTINGS:

- Dahlias are commercially propagated by terminal cuttings.
- Cuttings of 7-8 cm with 1-2 pairs of leaves are prepared.

- The cut end is treated with IBA powder facilitate rooting

27.8. SOIL AND CLIMATE

- Dahlias grow well in any type of rich and porous soil.
- They generally preferred well drained, deep fertile and moist soil with pH 6.5.
- An open and sunny place but sheltered from exposure of strong wind is ideal.
- A cool atmosphere free from frost is also necessary.

27.8.1. SOIL PREPARATION:

- ◆ Dahlias are generally cultivated both in pots and in ground.
- ◆ Dig the soil to a depth of 40 cm.
- ◆ Spread the FYM @ 5 kg/m² and pulverized.
- ◆ Mix with fork and make 10 cm fine tilth
- ◆ Prepare before few weeks planting

27.9. PLANTING

- ◆ Generally planted in September – October in the plains and in April in the hills.
- ◆ A spacing of 60 x 75 cm is practiced for tall, 30-45 x 50-95 cm for dwarf.

27.10. STAKING:

- ❖ Need immediately after they started growth.
- ❖ The new growth is soft and liable to affect by strong wind.
- ❖ Stem tied with jute string.
- ❖ Stakes may be painted with green color and the base tarred.
- ❖ Helpful for growing the plants vertically.
- ❖ Bamboo, polyethylene ring can be fixed in pompon around sticks or other small flowering types.

27.11 MANURING:

- 50-80 : 40-60 : 60-100 kg of N, P₂O₅, K₂O/ha
- Half N + full P & K, as basal
- Half N at top dressing
- Omission of any nutrients result as reduces the growth and flowering

27.12. WATERING:

- Dry spell – judicious application – beneficial

- Over watering – soft growth, feeble roots, vegetative buds proportion
- Moistens the full depth of 40 cm and whole bud remains for a few days
- Granular feed application – no shortage of water is needed

27.13. MULCHING:

- Dry grass clipping, old hay and saw dust are used for the purpose.
- Black polythene is very effective mulch.

27.14. PINCHING

- Should be done as soon as 2-3 pairs of leaves appear.
- Pinched off at 15 cm tall – flowering delay 15 days
- Pinching at node 4 gave the best result.
- Pinching at node 2 delayed blooming and produced lowest number of flowers.

27.15. PRUNING:

- Thinning of shoots – keep bushes open
- Large decorative cultivars 4-5 main branches may be retained and small flowering type 8-10 branches.

27.16. DISBUDDING

- To get the large blooms and for regulation of number of flowers it is must.
- All dahlia – excessive buds removed in very early stage

27.17. POT CULTIVATION:

Requirement

- Selection of cv., Pot and potting mixture
- High quality green plant
- Proper potting technique
- Optimum environment
- Judicious feeding, watering, disbudding

27.17.1. GROWING MEDIA:

- Porous soil, well drainage and rich in organic matter
- Potting compost consists of loamy soil: FYM: leaf mould @ 3:3:2
- Add 30 g bone meal, 20 g horn meal, 15 g SSP, 5 g of SOP per 25 – 30 cm pots
- 10 cm garden soil layer, pH 6.5

27.17.2. POTS:

- 20-30 cm diameter, earthen
- Size-no. of flowers
- Larger pots – many flowers on pot
- Pompons, Cactus, others small flowering
- Green plants- thump pots 2.5-3 cm
- Preferred to freshly rooted cuttings
- Plants slightly lower than rooting medium

27.17.3. MANURING:

- Top dressing at 15 days
- 30-40 g powdered mustard cake, 5 g SSP, 2 g SOP
- Single bloom plant apply 30-40 g sterameal, 3 g MgSO₄, 3 g FeSO₄
- Multi bloom plant apply Streameal 10 g more
- Liquid manure after 7 days once in week

27.18. HARVESTING AND POST HARVEST HANDLING

- Flowers are harvest during morning hours.
- Cut the flowers along with long stem.
- Place immediately in a container half filled with water.
- Keep in cool & dark place for conditioning before packing.
- Pretreatment with boiling water for 30 seconds 3-5 days
- Vase life (3-4 days)
- 8.2 days – 10% glucose + 0.2 mM AgNO₃ + 8 HQS 200 PPM
- 8.7 days – 10% glucose + 0.2 mM AgNO₃

27.19. LIFTING AND TUBERS STORAGE:

- When the plants are almost dried and colour of the stems turns to yellow.
- The plants are cut leaving only 15 cm stem from the ground.
- The tuberous roots are taken out with the help of forked hoe
- Allow the tubers to dry for 3-4 days in a shady place.
- Before storage the tubers have to be treated with 0.2% captan for 30 minutes
- Slurry treatment may be done.
- They can be stored on sand floor in a cool place for several months.
- The ideal storage temperature should be between 4° C to 7 ° C
- 40 cm deep screened soil + Dithane M-45+Bavistin (0.1%)

27.20. KNOWLEDGE ASSESSMENT:

I. Choose the correct answers:

1. Flowers of Dahlia is used for
 - a. Exhibition purpose
 - b. Garden display
 - c. Decorations
 - d. All these
2. Best quality of flowers will be obtained at temperature of
 - a. 25°C day, 16°C night
 - b. 28°C day, 19°C night
 - c. 20°C day, 10°C night
 - d. 15°C day, 8°C night
3. Improved tuber growth by soaking in
 - a. Ethrel 50-100 ppm
 - b. SADA 1000-5000 ppm
 - c. SADH 20 ppm
 - d. TIBA 500-2000 ppm
4. Seeds of Dahlia germinate in
 - a. 10 days
 - b. 7 days
 - c. 15 days
 - d. 20 days
5. Dahlia is commercially propagated by
 - a. Seeds
 - b. Divisions
 - c. Cuttings
 - d. None
6. Planting of Dahlia in plains during
 - a. September – October
 - b. March- May
 - c. December- January
 - d. July-August
7. Growing media like loamy soil, FYM, leaf mould in the ratio
 - a. 4:4:3
 - b. 3:3:2
 - c. 1:2:1
 - d. 2:2:2
8. Pinched off at 15 cm tall delay flowering by
 - a. 20 days
 - b. 10 days
 - c. 5 days
 - d. 25 days
9. Pinching at fourth node leads to
 - a. Maximum delay in blooming
 - b. Reduces the flowers
 - c. Best results
 - d. No effect
10. Spacing followed for tall varieties
 - a. 40x45 cm
 - b. 30x30 cm
 - c. 60x45 cm
 - d. 60 x 75 cm

II. State true or false:

1. Long stemmed flowers are preferred especially for floral arrangement.
2. Best quality flowers obtained at 28-29°C day, 17-20°C night temperature.
3. High light intensity is necessary for forcing flowering.

4. SADA @ 1000-5000 ppm results in early flowering.
5. Ethrel 1000-5000 ppm increased no. and weight of roots.
6. 18-28°C temperature is favourable for seed germination
7. Staking is not necessary for Dahlia cultivation.
8. Over watering – soft growth, feeble roots, vegetative buds proportion
9. Mulching with black polythene is not effective.
10. Excessive buds removed in very later stage.

KEY ANSWERS

I. Choose the correct answers:

1(d), 2(a), 3(c), 4(a), 5(c), 6(a), 7(b), 8(b), 9(c), 10(d)

II. State true or false:

1(T), 2(F), 3(T), 4(F), 5(T), 6(T), 7(F), 8(T), 9(F), 10(F),



LECTURE 28 : PACKAGE FOR PRODUCTION OF CUT FLOWERS UNDER PROTECTED CULTIVATION

PARTICULARS	ROSE	CARNATION	ANTHURIUM	GERBERA	ORCHIDS
<i>Scientific Name</i>	<i>Rosa spp.</i> (Rosaceae)	<i>Dianthus caryophyllus</i> (Caryophyllaceae)	<i>A. andreaeanum</i> <i>A. scheyerianum</i> (Araceae)	<i>G. jamesonii</i> (Asteraceae: Compositae)	<i>Dendrobium,</i> <i>Vanda teres</i> <i>Cymbidium, etc.,</i> (Orchidaceae)
Origin	It is said that rose came first and man afterwards.	Mediterranean region	American Tropics	South Africa	Tropical countries
Varieties	First red, Lambada, Ambassador, Grand gala, Noblesse, Lovely red, Golden gate etc.	Standards: Gold rush, internet, master, Monaco, cobra, papaya Sprays: Optima, miolety, Red Barbara, white barbera, stardust etc.	Standards : Osaki, Kozohara, Nitta, Niolori, Marian seefurth Obake: Madam pele, Anuene, Kalpana, Rainbow, Mickey mouse; Tulip: Lavender lady, Lady Jane	Alberino, Red Star, Devil, Souvia, Flavia, Nobelese, Nastensium etc.,	Vanila, Dendrobium, Bulbophyllum, Cymbidium, Calanth, Cypripedium, Aranda, Arachlins.
Climate					
Temperature	Min 15°C/day & Max 28°C	Day – 28°C Night – 16-18°C	Min – 15-17°C Max. -32-35°C Ideal-18-20 °C	> 30°C 23° for flower initiation	Day – 15.5-21°C Night – 10-15.5°C.
Light	Min. 12 hrs/day	If temp high reduce light to 30-40%	15,000-35,000 lux	50% light intensity	2400-3600 ft candles
Relative humidity	60-70%	Beginning 80-85% At full growth 60-65	65-85% day 90-95% night	Initially -80-90% and Later 70-75%	40-75%
Media	Soil or soil less	Porous well drained	Cocopeat, husk, highly	Soil or soil less	Broken bricks, gravel,

	media	light sandy loam soil rich in organic matter	organic good aerated & good water holding capacity sawdust, tree bark		tile bits, charcoal, coconut husk, tree ferns.
CO₂ Concentration	500-3000ppm	800-1000ppm	300-800ppm	1000ppm	2000-2300ppm
Protected structures	Naturally ventilated G.H., Medium to high cost green houses	Naturally ventilated G.H., for south India & High tech green house for N. India.	Shade house & low cost green houses.	Green house & shade house	High tech green houses/orchidarium
Water requirement	For young plants 500 ml/day/pl and for grown up plants 1000ml/day 6-7l/M ²	6-7 l/m ² /day	5.0 l/m ² /day	400-700 ml/day/ plant 2.4-4.5 l/M ² /day	-
Spacing	0.5-0.75m Path: 30-40 x 14-18cm	15-20cm x 15cm. Bed height-45cm Width-60cm between the beds - 30cm	45x45cm or 30x30cm for closer spacing 30cm betn rows 45-55cm betn beds	Row- rows ; 30-40 cm Plant-plant: 30-40cm	-
Plant density/m²	6-7	40-50	8-10	6	100-150
Propagation	Hard wood cuttings & buddlings	Terminal stem tip cuttings of 4-5 nodes.	Cuttings, suckers, seeds & Micro-propagation	Tissue culture plants or suckers	Seeds, Tissue culture, vegetative methods.
Plants/ha	60, 000-70,000	40,000-50,000	80,000-100 000	50, 000-60,000	1,000,000-1,50,000
PH of water	5.3-5.4	5.5-6.5	5.7-6.2	5.5-6.5 soil; 6.5-7.0 irrigation water	5.5
Irrigation Systems	Nozzle & drip irrigation	Over head sprinkler, mist, surface & drip irrigation	Drip irrigation. micro sprinklers, over head sprinklers	Drip irrigation	Mist or fogging system.

EC of Water ms/cm	1.3-1.8	1.2 at vegetative stage and 1.5-1.7 during flowering	1.2-1.3	0.5-1.0 ms/cm	-
Bed Sterilization	Methyl Bromide @ 25-30g/sqmt or Formalin @ 7.5-10.0 l/100 sqmt Basamid (Dazomet) @30-40g/sqmt or Pasteurize with steam at 70-100°C for 30 min	Methyl Bromide @ 25-30g/sqmt or Formalin @ 3-7% (7.5-10.00 l/100 sqmt) Basamid (Dazomet) @30-40g/sqmt	Methyl Bromide @ 25-30g/sqmt or Formalin @ 3-7% (7.5-10.00 l/100 sqmt) Basamid (Dazomet) @30-40g/sqmt	Methyl Bromide @ 25-30g/sqmt or Formalin @ 3-7% (7.5-10.00 l/100 sqmt) Basamid (Dazomet) @30-40g/sqmt	Methyl Bromide @ 25-30g/sqmt or Formalin @ 3-7% (7.5-10.00 l/100 sqmt) Basamid (Dazomet) @30-40g/sqmt
Bed size	1-1.6m wide;3 0-40m long; 15-20cm height;	30cm ht. 1.05 m width with convenient length	Height-30cm Width – 1.0m Deep- 2.0 feet	Bottom width-70cm Top width – 60cm Height- 45 cm	Gown in suitable containers wooden legs etc.
Fertilizers	Before planting apply 2 kg SSP, 1 kg CAN & ½ kg MOP/m2 for better establishment, generally 1.7 kg of lime/m ³ 1:0:2:1:2:0.3NPK mg	1:0.5:1.5 NPK	0.1% urea & 5g CaNO ₃	After planting apply NPK in 1:1:1 ratio 75g, Ca, 0.3g NH ₄ -O ₃	2%N, 0.2% P&K, GA3 1.5ppm/l once in 15 days enhance flowering.
Cultural operations	Primary bending, secondary bending, gradual	First pinch-6 pairing of leaves (3 WAP),	Shading,	Defolting, Scraping the soil Removal of old leaves	Re-potting, Photoperiodic content of per cent

	Pruning, direct de-shooting, disbudding	second double disbudding Netting- 7.5x7.5cm;10x10;12.5x12.5;12.5x15cm				Phytochrome in plant.
Pests & Diseases	Pest- Red spider mite, thrips, orchids, white flies, caterpillars. Disease – Powdery mildew, DM, botrytis, black leaf spot, verticillium wilt.	Pest-Red spider mite, aphids, thrips, moths, nematodes. Diseases- Fusarium wilt & stem rot, Rhizoctonia stem rot, alternaria leaf spot, rust, bacterial wilt & blight , gray mould ,CMV Disorder: Calyx splitting.	Pest: Nematodes: Soft rot, Anthracnose, leaf spot, flower blight, root rots.	Pest-white fly, thrips, red spider mite, Aphids. Diseases: PM, white rust, Botrytes, Rhizoctonia, Fusarium, Phythium Phytophthora	Pest: Aphids, Mealy bugs, scales, slugs & snails, spider mites. Diseases: Block rot, leaf spot, Petal blight, yellowing.	
Harvesting stage	Tight bud stage for distant market or when one or 2 outer petals begin to unfurl from tip & calyx refluxed.	Fight bud stage	When $\frac{3}{4}$ th of flower is developed. (Spathe completely unfurls & spadix is well developed) 50-60% color change	When ray florets completely elongated. Flowers 8-12 weeks after planting.	Fully developed flowers of good quality are harvested.	
Yield/m²	100-350 stems, 4-5 months after planting. Upto 8-10 years	150-300 Flowers 110-120 days after planting 3-4 years	10-12 Flowers/pl/year yields for 6-7 years	200-250 stems depending on varieties, Flowers 8-12 weeks after planting. Up to 3-4 years		

PARTICULA RS	ROSE	CARNATION	ANTHURUM	GERBERA	ORCHIDS
Post harvest aspects	HT Roses: stem length – 60-90cm Bud size – 3-3.5cm Small flowered variety (sweet heart) stem length – 40-50cm Bud size 2-2.5cm	Standards: Stem length -55cm Flower diameter – 7.0cm Sprays: Stem length-43cm Flower diameter 5.7cm	Grades: Tiny – <8cm Small – 8-10cm Medium – 10-13cm Large – over 13cm.	Grade: Flrs dia Stem lnth 1. > 60cm. > 12cm 2. 50-60cm 11-10cm 3. 40-50cm 10-9cm 4. 30-40cm 9-8cm 5. < 30cm 8-7cm	These are no standard grades for orchids, grading done based on stem length of flowers, flower numbers & size and arrangement of flowers on spike.
Packaging	CFB of size 120x45x25cm (80 stems/CFB box)	CFB of size 122x50x30cm (600-800 flrs/CFB (sprays))	CFB of size 24x12x9cm (120 flrs/CFB.) Individual flowers are packed with water vials with preservative at 13°C (2-3 weeks) cold storage	CFB of size 100x30x10cm 50 flrs/CFB	An ideal package should be air girth, water proof, strong enough to withstand handling & small in volume.
Storage	Cold storage	5-8°C	13°C	6-9°C	5-7°C



LECTURE – 29.1

LIATRIS: (*Liatris elegans*; Asteraceae)

TOPICS

- 29.1.1 Introduction
- 29.1.2 Origin
- 29.1.3 Species
- 29.1.4 Climate
- 29.1.5 Propagation:

29.1.1 INTRODUCTION:

- *Liatris* belongs to the family Asteraceae, with each flower head having only fluffy disk flowers and no ray florets.
- The carrot-flavored root of blazing star *Liatris* was once used by American Indians for food. The plants of the *Liatris* genus were also consumed in New England as a treatment for gonorrhea.

29.1.2 ORIGIN:

- Native to North America, Mexico and the Bahamas.
- Commonly it is referred as Gay feather or Blazing Star or Snake Button root,

29.1.3 SPECIES:

- About 40 species of *Liatris* are being grown across North America, from southern Canada to northern Mexico and east of the Rocky Mountains through Florida.

1. Purple or white feathery *Liatris* (*L. spicata*, *L. spicata* 'Alba')

- Is an exceptional garden plant, unique for its unusual blooming pattern.
- In late summer the 1-3 foot spikes of purple or white feathery *Liatris* flowers actually begin to bloom from the top and slowly work downward, unlike most other flowers which bloom the opposite.
- This versatile, easy-to-grow perennial adapts to nearly any type of garden.

- Because of their vertical disposition, *Liatris* species take up minimal space and are suitable for even the smallest garden.

29.1.4 CLIMATE:

- *Liatris* prefers full sun but will adapt well to areas of light shade.
- *Liatris* is also heat and drought tolerant, making it an ideal choice for areas prone to these hot, arid conditions.
- Its tolerance of drought is due to its deep roots.
- *Liatris* plants are great for butterfly.

29.1.5 PROPAGATION AND CULTURE:

1. SEEDS

- *Liatris* can be grown through seeds.
- By collecting the seeds once they have matured, in late summer to early fall and sowing into flats.
- The plots can be left outdoors throughout winter and
- The seeds will germinate once the temperature and soil begins warming in the spring.
- This plant can also be allowed to self sow in open areas of the garden for a pleasant surprise later in the growing season once they begin blooming.

2. TUBEROUS CORMS

- The tuberous corms of older *Liatris* plants can also be dug up and divided in late winter while the plant is dormant.

3. Rough blazing star (*L. aspera*)

- This species is native to much of the eastern, mid-western, and southern states.
- This *Liatris* species are rounded, fluffy, deep rose-purple flower heads that open around the same time, making it a particularly good fresh cut flower for floral arrangements.
- Grows 3-5 feet high and bears lovely lavender flowers in late summer and early autumn.
- Because of its height, the plant may require staking.
- Blooms later than most other *Liatris* species and is distinguished from other species by its rough-looking appearance.

4. Dotted blazing star (*L. punctata*)

- Derived its name from the tiny dots on the leaves of this species.
- This is also known as button snakeroot and some Native Americans called it crow root, because crows were observed eating the roots in the fall.
- This *Liatris* species is native throughout Kansas and produces a tap root reaching a depth of 15 feet, making it extremely drought-resistant.
- The Kiowa Indians bake the roots over a fire and eat them; while the Blackfoot Indians boils the roots and will apply it to swellings or ingest it to alleviate stomach ailments.
- The large purple flower heads of meadow blazing star (*L. ligulistylis*) produce as many as 70 blossoms on its 3-4 foot stems in late summer.
- This species is commonly seen in prairie habitats or along roadsides and emits a specific odor that attracts monarch butterflies.
- *Liatris* is seldom bothered by pests or disease; however, young *liatris* plants are susceptible to rodents, which will eat the buds, seedlings, and tuberous roots.

29.2. ALSTROMERIA

(*Alstromeria* sp; Inca lily/Peruvian lily/Parrot lily)

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- 29.2.1. Importance
 - 29.2.2. Origin
 - 29.2.3. Important Cultivars
 - 29.2.4. Soil
 - 29.2.5. Climate
 - 29.2.6. Propagation
 - 29.2.7. Planting
 - 29.2.8. Fertilizer Application
 - 29.2.9. Harvesting and Storage
 - 29.2.10. Pest and Diseases

29.2.1. Importance

- ❑ Important cut flower in international market
- ❑ Multicolored flowers
- ❑ Large number of varieties
- ❑ Container plants
- ❑ Grown - gardens and pots
- ❑ Area of Nilgris & Bangalore

29.2.2. ORIGIN : South America, Chile

29.2.3. IMPORTANT CULTIVARS:

- ❖ Dr. Salter's hybrids
- ❖ Freedom –flowers are shades of pink
- ❖ Light hybrids-flowers are in shades of yellow orange and red
- ❖ Moreheim orange -orange flowers are marked with dark **red colour**.
- ❖ Alladin
- ❖ Pluto
- ❖ Serena

29.2.4. SOIL:

- Well drained, rich in humus,

29.2.5. CLIMATE:

- Thrive well in cool subtropical climate preferably in 10-20 °C
- Requires partial shade.

29.2.6. PROPAGATION

- By seed
- Division of rhizomes/roots
- Micro propagation is a successful method

29.2.7. PLANTING:

Rhizomes are planted at distance of;

- 50 x 40 cm
- 60 x 50 cm

29.2.8. FERTILIZER APPLICATION:

- It should be frequently fertilized with calcium nitrate and potassium nitrate at 100-200 ppm.

29.2.9. HARVESTING AND STORAGE:

- ❖ It should be harvested when color appears on first flower.
- ❖ Cut flowers are stored at 2 - 4° C.
- ❖ STS solution prolongs the vase life

29.2.10. PEST AND DISEASES:

- Aphid ,whitefly & spider mite
- Botrytis, Pythium and Rhizoctonia

LECTURE – 29.3

LILIES

TOPICS

- 29.3. 1.** Introduction
- 29.3. 2.** Major Growing Countries
- 29.3. 3.** True Lilies:
- 29.3. 4.** Lilies popular as Gift
- 29.3. 5.** Types of Lilies
- 29.3. 6.** Varieties in Lily
- 29.3. 7.** Floral Extracts of Lily
- 29.3. 8.** Different species of Lilies
- 29.3. 9.** Growing Lilies
- 29.3. 10.** Bulking up of bulbs
- 29.3. 11.** Storage of bulbs
- 29.3. 12.** Forcing of bulbs
- 29.3. 13.** Planting Density
- 34.3. 14.** Ideal soil
- 29.3. 15.** Planting Depth
- 29.3. 16.** Feeding
- 29.3. 17.** Irrigation

- 29.3. 18. Lilies Plant care
- 29.3. 19. Common problems
- 29.3. 20. Harvesting/Post-Harvest Handling
- 29.3. 21. Vase life

29.3. 1. INTRODUCTION:

Lilies are one of the most popular flowers in the UK, next only to the Rose. Globally, Lilies rank fourth among the flowers in popularity. Different kinds of lilies are commonly grown in the gardens. Lilies are best suited for growing in flower and shrubbery borders and in pots.

Kingdom	Plantae
Division	Magnoliophyta
Class	Liliopsida
Order	Liliales
Family	Liliaceae
Genus	<i>Lilium</i>

- *Lilium*, the genus, is the Latin form of the Greek word 'Lerion' for the Madonna Lily.
- Red lily was first described by the famous Swedish botanist Carl von Linne (Linnaeus) in 1753.
- Lilies are one of the most beautiful and graceful of all summer-blooming flowers.
- Lilies belong to the *Lilium* genus consisting of less than 100 known species, occurring in all parts of the Northern Hemisphere.
- Lilies are believed to have been under cultivation longer than any other ornamental flower, having existed in gardens 3,000 years ago.
- Floral designs, particularly of Lilies, made their appearance and became very popular in the 18th dynasty of Egypt.

29.3. 2. MAJOR GROWING COUNTRIES:

Lilies are hardy plants (can tolerate up to – 4° C). They are mainly grown in cool moist temperature areas of the world, namely

- Netherlands (Leader), Israel, U.S.A. (Oregon), South Africa, Japan, Chile, Italy, New Zealand, Mexico.

- In India, Ooty/Nilgiris, Himachal Pradesh, Upper Himalayan regions of Uttranchal and Uttrakhand extending upto North- Eastern States has a potential for lily growing.

29.3. 3. TRUE LILIES:

- There are many kinds of flowers, which have been called "Lilies", but many of these so-called Lilies such as the day-lily, water-lily and arum-lily, actually belong to other groups of flowering plants.
- Plants in the Lilies grow from Bulbs or Corms, both of which will store food over the winter or during the dry season.
- Unlike other Lilies, these vines produce their flowers in spherical clusters called Umbels, as in Bomarea.
- True Lilies are composed of fleshy scales without a protective outer coating.
- True Lilies are never dormant.

29.3. 4. LILIES POPULAR AS GIFT:

- Lilies are very popular as gifts in many forms.
- You can gift a lily flower bouquet for your beloved.
- Among the flower bouquets of lilies, Star Gazer and Cassa Blanca lily bouquets are the most sought after floral bouquets.
- Besides bouquets, lily bulbs as well as potted lily plants are also popular gifts.

29.3. 5. TYPES OF LILIES:

In commercial cut flower growing there are three main types of lilies, with following characterization:

Asiatic	Oriental	Longiflorum
Smaller plants with small saucer-shaped flowers and short narrow leaves.	Larger plants with large saucer-shaped flowers and large leaves.	Larger plants with trumpet shaped flowers.
Flowers in 10 – 13 weeks	Flowers in 14 – 19 weeks	Flowers in 14-17 weeks
Generally fetch lower prices	Generally fetch good prices	Generally fetch higher prices
Easy to grow	More difficult and expensive to grow	Easy to grow but more difficult and expensive to

		handle
Popular varieties:		
Dream land (white)	Star Grazer (Pink)	White Europe
Brunello (Orange)	Mero star	Snow Queen
Navona (white)	Siberia	
Connecticut King	Casa Blanca (White)	

29.3. 6. VARIETIES IN LILY:

Cultivars of Lilium



Cv. Detroit



Cv. Brunello



Cv. Pollyanna



Cv. Brindisii(LA)



Cv. Lateya(LA)



Cv. Elite

There are numerous Lily varieties. But, among the Lily varieties, only groups like the Asiatic and Orientals are the most popular flowers and widely grown.

- **Asiatic Lilies** - small flowers, less fragrant, wide colors.
- **Trumpet/Aurelian Lilies**
- **Oriental Lilies** - Have strong fragrances, few colors, larger, flowers
- **The Wild Lilies**
- **Martagon hybrid Lilies** - Edible and Esculent herbs
- **Candidum hybrid Lilies**
- **American hybrids Lilies**
- **Longiflorum hybrid Lilies** - strong, sweet fragrance, large funnel shaped flowers, usually white.

Lilies are really excellent plants for beds and borders. Lilies are suitable for use in a shrub border, as accent plants, a formal or naturalized pool planting.

Even some of the small species would fit perfectly in an alpine rock garden.

29.3. 7. FLORAL EXTRACTS OF LILY:

The oil extracted from lilies has healing and softening properties. Especially, when the lily fragrance oil is mixed with that of calendula works wonderful for very sensitive skin.

We can use this oil for massage, in a bath, after a bath, for babies, dry cuticles, and elbows, as a facial moisturizer, under-eye oil and hot-oil treatment.

Madonna lily (*Lilium candidum*) is the archetypal flower symbolizing purity. The association of Madonna lily with the Virgin Mary dates back to an early Christian legend, in which her tomb was filled with Lilies after her assumption into heaven.

34.3. 8. DIFFERENT SPECIES OF LILIES

Scientific Name	Common Name	Common Uses
<i>Lilium auratum</i>	Japanese golden rayed lily	Lily from Japan, white bowl shaped flowers with a golden ray down the centre of petals and crimson spots. The flowers are fragrant and will make a great cut flower.
<i>Lilium bulbiferum</i>	Orange lily	The bulbs edible. Sweet and mealy, these lilies make very fair eating and can be used as a substitute to potato.
<i>Lilium canadense</i>	Canada lily	Scented use
<i>Lilium candidum</i>	Madonna lily	The bulb is employed for medicinal purposes, having highly demulcent and also astringent properties.
<i>Lilium henryi</i>	Henry's lily	relieve congestion, and the nausea and vomiting of pregnancy
<i>Lilium</i>	Krameri	nourishing and useful in diseases of the chest

japonicum

*Lilium
tigrinum*

Tiger lily

Lily from China with light glowing orange colored flowers with purplish black spots and protruding stamens. They are late flowering, black stem bulbils with stem rooting

*Lilium
lancifolium*

Tiger lily

produce edible bulbs

*Lilium
longiflorum*

Easter lily

Trumpet shaped, white and waxy flowers that are early flowering and stem rooting, mostly used in flower beds

*Lilium
martagon*

Martagon lily,
Turkscap lily

The bulb has diuretic, emmenagogue, emollient and expectorant properties. They are used to relieve heart diseases, pain in the cardiac region and angina pectoris.

*Lilium
pardalinum*

Panther lily

The flowers are 1.5 meters tall, red in color with a yellow centre and maroon spots on it, the bulbs of which are edible.

Lilium regale

Regal lily

Plant in groups integrated in a perennial border.

*Lilium
speciosum*

Japanese lily

The flowers diffuse a powerful sweet honey perfume.

29.3.9. GROWING LILIES:

- Lilies are propagated mainly by means of Bulbs.
- They are also grown from seeds, scales, bulbils and bulblets.
- Although the lilies grown from seeds are more disease resistant, the only disadvantage with growing lilies from seeds is that the lily plants take a longer time to bloom may be, in some cases, even five to six years. Hence, bulbs are very much preferred to grow lilies.
- The ideal location will for Lilies provides direct sun all morning during the summer, with partial shade during hot afternoon hours.

29.3. 10. BULKING UP OF BULBS:

- For the first time, the undersized certified bulbs are needed to be planted in the open field as early as possible in spring.
- The bulbs have to be irrigated, fertilized and grown as any other bulb crop in cool, clean, moist, pest free land.
- The flowers should be removed as they appear. When foliage has died back into the bulb, they are lifted out.
- Bulbs are cleaned, graded and kept in cold storage.

29.3. 11. STORAGE OF BULBS:

- To ensure satisfactory long term storage of lily bulbs they should be packed in plastic film containing slightly moist potting compost.
- Then they are frozen and stored at the following store temperatures:
 - Asiatic - 2° C
 - Oriental - 1.5° C
 - Longiflorum - 1.5° C
 - Other hybrids - 2° C
- Bulbs of Asiatic hybrids can be stored up to a year without showing any deterioration in quality (Bulbs stored for a longer period will develop more rapidly, but plants will be smaller with fewer buds).
- Bulbs of Oriental and Longiflorum cannot be stored for more than 8 months. They start deteriorating. Bulbs of lilies that have not been frozen cannot be stored for long periods (storage duration depends on the storage temperature). On average unfrozen bulbs can be stored at a temperature of approximately 1° C for a maximum of 2 weeks and at 5° C for a maximum of 1 week only.

29.3. 12. FORCING OF BULBS:

- A six to eight week cold storage period of 2° C to 5° C for Asiatics and Longiflorums and
- Eight weeks for Orientals is needed to induce the flowers. This is an essential part of the forcing process.

Ideal green house temperature

- Mean maximum during the day 22° C

- Mean minimum during the night 13 – 17°C
- Soil temperature below 20°C
- Large fluctuation causes leaf scorch

29.3. 13. PLANTING DENSITY:

Planting density depends on bulb size.

Bulb size	Asiatics	Oriental	Longiflorum
10 – 12 cm	63 – 90 cm	-	-
12 – 15	54 – 80	-	-
15 – 17	45 – 72	-	27 – 63
17 – 20	36 – 62	36 – 54	27 – 45
20 – 22	-	36 – 54	27 – 45
23 – 25	-	27 – 36	27 – 36
25+	-	27 – 36	-

- Proper spacing usually is 12 to 18 inches apart, but it varies according to the variety selected.
- Under very high light the lily bulbs could be planted close together to stretch the stems. Under low light, they are planted further apart to reduce competition.

29.3. 14. IDEAL SOIL:

Well – drained sterile medium with pH 5.5 to 7.0 is most ideal for *Lilium* cultivation and the soil should also be fluoride free.

29.3. 15. PLANTING DEPTH:

Bulbs are planted at a depth of 20-25 cm. Stem develops lateral neck roots above the bulb as it grows.

34.3. 16. FEEDING:

Ca (NO₃)₂ and KNO₃ is mixed in the ratio of 2:1 and 3.6 kg mixture per 1000 litres of water is applied once in a week. NPK 19:19:19 or NPK 14:14:14 is applied weekly or as deemed necessary.

29.3. 17. IRRIGATION:

- ❑ Most important requirement of an irrigation system is even water distribution. An overhead irrigation system is preferable.
- ❑ Trickle hoses may be used to prevent tall, top-heavy plants from toppling.
- ❑ Lily is susceptible to salty water. EC of irrigation water should be below 0.5/ms/cm.

29.3. 18. LILIES PLANT CARE:

- Lilies do not require daily watering, but when watering, be sure to water deeply enough to reach the bulb.
- Feed the plants with a balanced fertilizer every few weeks during the growing season. Avoid high-nitrogen fertilizers.
- Remove seedpods when they appear.
- Also, remove stems and foliage when leaves become yellow.
- Mulch should be removed in late fall.
- Keep lilies blooming by removing blossoms as they fade. This prevents the plant from expending all of its energy producing seed.

29.3. 19. COMMON PROBLEMS

1. *Botrytis*
2. Bud drop
3. Leaf scorch
4. Iron deficiency
 - The bulbs should disinfect against root rot complex (Like *Pythium*, *Pencillium*, *Fusarium*, *Rhizoctonia*, *Phytophthora*)

29.3. 20. HARVESTING/POST-HARVEST HANDLING:

- The stems should be cut when the first flower is fully colored, but not yet open.
- They should be stripped of 5 cm of their lower leaves and put into clean water with a preservative and STS.
- The field heat should be taken out in a cooler at 2.5°C.
- Grading is done based on the number of calyx per stem. Minimum requirement is 4 stem per bunch with 20 buds per bunch.

29.3. 21. VASE LIFE:

Asiatic : 7 – 14 days

Oriental : 10 – 15 days



LECTURE – 30

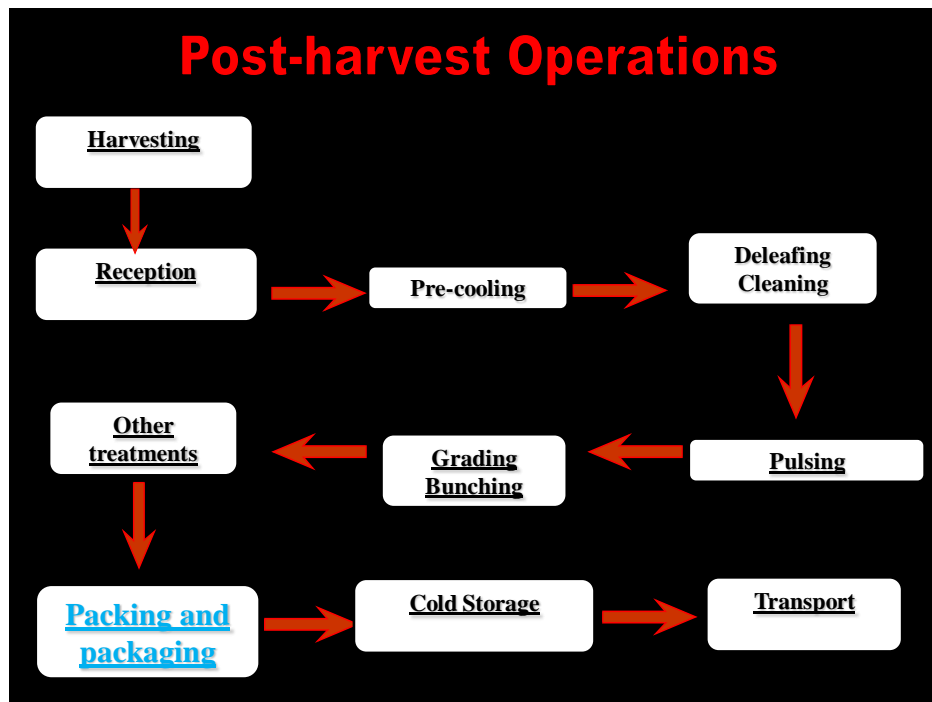
POST HARVEST TECHNIQUES OF CUT FLOWERS

TOPICS

- 30.1. Importance of post harvest handling of flowers
- 30.2. Inherent factors influencing post-harvest life of flowers
- 30.3. Pre-harvest factors influencing post-harvest life of flowers
- 30.4. Right time, method and stage of harvest for different commercial flowers
- 30.5. Optimum stages of harvesting for important flowers
- 30.5. Optimum stages of harvesting for important flowers
- 30.7. Factors affecting storage life of flowers
- 30.8. Conditioning and pre-cooling of cut flowers
- 30.9. Pre-Cooling Temperature For Certain Flowers:
- 30.10. What are the different methods of storage of cutflowers?
- 30.11. Grading and its methods followed for important flowers.
- 30.12. Grading standards for cut flowers in the world market requirements:
- 30.13. Packing methods and Packaging of cut flowers
- 30.14. Box sizes, which are commonly used for packing different flowers
- 30.15. Labeling
- 30.16. Transport
- 30.17. Physiological changes during flower senescence
- 30.18. General points to be considered for improvement of vase life of flowers.
- 30.19. Vase life of cut flowers

30.1. IMPORTANCE OF POST HARVEST HANDLING OF FLOWERS:

- The quality of flowers, which reaches the final consumer, depends on the pre-harvest and post-harvest handling.
- Quality is the pillar for creating value and customer satisfaction
- The flowers are highly perishable need utmost care.
- When flowers are detached from the plant, they deprived of food, water, minerals and hormones.
- It is estimated that about 30% of flowers perish during handling.
- Therefore it is important to study post-harvest handling of flowers to keep flowers in good quality.



30.2. INHERENT FACTORS INFLUENCING POST-HARVEST LIFE:

- Keeping quality of flowers vary from species and cultivars, this may be due to genetic or inherent factors like differences in anatomical, physiological, physical, biochemical and genetic make up.
- Keeping quality of flowers also depends on,
 - ✓ Carbohydrate reserves,
 - ✓ Osmotic concentration,
 - ✓ Pressure potential of petal cells,
 - ✓ Stomatal functioning,
 - ✓ Difference in number of thick walled supporting cells in the xylem element and phloem fibre,
 - ✓ Presence or absence of a complete ring of secondary thickening in flower peduncles,
 - ✓ Differences in the diffusive resistance of leaves in the field.
 - ✓ Lignifications,
 - ✓ Level of plant hormones and
 - ✓ Susceptibility to disease and insects.

30.3. PRE-HARVEST FACTORS INFLUENCING POST-HARVEST LIFE:

- Pre-harvest conditions under which the crop is grown influences on the post-harvest life of flowers.
- Selection of the variety,
- Environmental factors like light, temperature, relative humidity
- Nutrition, irrigation, diseases and pests, pollution, etc

30.4. RIGHT TIME, METHOD AND STAGE OF HARVEST FOR DIFFERENT COMMERCIAL FLOWERS

- Right time, method and stage of harvesting influence the vase life of flowers.
- Harvest early in morning or in the late evening when temperatures are mild to avoid faster respiration rate to excessive water loss.
- Flowers are fully turgid due to low transpiration at night (rose, chrysanthemum, gerbera).
- Evening harvest is advocated because of higher sugar level in the stem due to high rates of photosynthesis during day time.
- Immediately after harvest the flowers should be put in water or preservative solutions.
- Right method of harvest includes cutting flower stem with sharp knives or secateurs;
- Avoid crushing of stem, giving slanting cut to hard wood stems so as to expose maximum surface area to ensure rapid water absorption.
- Cutting stem length at specific lengths depending on crop market, purpose, etc.,
- Harvesting at an optimum maturity stage is important and stage of harvest varies from crop to crop and varieties.

30.5. OPTIMUM STAGES OF HARVESTING FOR IMPORTANT FLOWERS:

Sl. No.	Flowers	Purpose	Stage of Harvest
1	Rose	Cut flower	1-2 petals beginning to unfold. At tight bud stage.
2	Jasmine	Loose flower	Matured, unopened bud stage
		Oil extraction	Fully opened flowers
3	Anthurium	Cut flower	Spadix almost fully developed 1/3 rd of flowers on spadix mature. Change of colour from base to top.
4	Antirrhinum	Cut flower	1/3 rd florets open
5	<i>Cattleya</i> spp.	Cut flower	4-5 days after opening.
6	Chrysanthemum	Standard	When outer florets fully expanded
		Spray	Flowers open but before shedding of pollens
		Pompons and decorative	Centre of the oldest flower fully open
		Anemones	Open but before central disc florets begin to elongate.
7	Dahlia	Cut flower	Fully open flower
8	Carnation	Standard	Paint brush stage when flowers are half open
		Spray	At least two flowers fully open
9	Gerbera	Cut flower	Flowers open but outer two rows show shedding of pollens (fully mature)
10	Gladiolus	Cut flower	1-5 florets show colour
11	Bird of Paradise	Cut flower	First flower open
12	China Aster	Cut flower	Fully opened flower with long stalk
		Loose flower and oil extraction	Fully opened with short or no stem
13	Tuberose	Cut flower	When few flowers open at the base
		Loose flower and oil extraction	When all the flowers are fully opened
14	Tulip	Cut flower	At half coloured buds
15	Lilium (lily)	Cut flower	Coloured buds
16	<i>Cymbidium</i> spp.	Cut flower	3-4 days after opening of all flowers
17	<i>Dendrobium</i> spp.	Cut flower	Fully opened flowers.

30.6. WHY IMMEDIATELY AFTER HARVEST FLOWER STALK ENDS SHOULD BE KEPT IN WATER?

- Cut stem is a living entity, deprived of natural source of water further,
- The flowering buds require water for opening.
- The turgidity of the floral parts and cut stem depends on water absorption by the stem, to meet water loss through transpiration,
- To avoid plugging of xylem vessels caused due to micro organisms and
- To avoid air bubbles block in the xylem vessels.
- The physical blockage of xylem vessels leads to decrease in water uptake by the stem tending towards senescence.

30.7. FACTORS AFFECTING STORAGE LIFE OF FLOWERS:

- Quality of flowers,
- Stage of harvest,
- Temperature, Relative humidity, Light,
- Ethylene
- Pathogens are import factors determine the storage life of flowers.
- Flowers should be of good quality free from injury, pest and diseases otherwise prone to ethylene production and infection with pathogens.
- Harvested at optimum stage,
- Stored at cool temperature (1-4°C)
- High relative humidity (90-95%) and maintenance of storage room in hygienic conditions are important.

30.8. CONDITIONING AND PRE-COOLING OF CUT FLOWERS:

- Conditioning referred to placing of stem cut ends in water immediately after harvest to avoid water stress;
- Generally conditioning is done by placing stem ends immersed in warm water at room temperature for short duration and overnight in the cold room.
- Pre-cooling referred to subjecting flowers under cold storage conditions immediately after harvest to brings down the respiration rate and field heat and ultimately to enhance the vase life and quality of cut flowers.

- The pre-cooling temperature varies with the species and cultivars.

30.9. PRE-COOLING TEMPERATURE FOR CERTAIN FLOWERS:

S. No	Crop	Pre-cooling temp. (° C)	S. No	Crop	Pre-cooling temp. (° C)
1.	Rose	1-3	7.	<i>Cymbidium</i>	0.5-4
2.	Anthurium	13	8.	Gladiolus	4-5
3.	Gerbera	4	9.	Bird of Paradise	7-8
4.	<i>Dendrobium</i>	5-7			
5.	Carnation	0.5-1			
6.	Chrysanthemum	05-4			

30.10. METHODS OF STORAGE OF CUT FLOWERS?

There are 3-4 general methods of storage of flowers, they

1. **Refrigerated storage:** Most widely used method of storage of cut flowers. There are two types (a) Wet storage and (b) dry storage.

✓ **Wet storage :**

- Flowers stored with their bases dipped in water or preservative solution,
- Good for short duration, day to day handling,
- Stored at a temperature at 2-4°C.

✓ **Dry storage :**

- Flowers sealed in plastic bags are stored to prevent loss of moisture.
- More laborious but hold the flowers for longer duration.
- Pre-cooling and pulsing before dry storage is important.
- Stored at 0.5 to 1.0 ° C is ideal for most flowers,
- For tropical flowers like anthurium, cattleya and poinsettia is 10-15° C and
- For sub-tropical flowers like gladiolus, Strelitzia and anemone is 2-8° C.

2. Controlled atmosphere storage (CA):

- ✓ Low temperature storage in gas tight chambers under decreased levels of oxygen (O₂) and increased levels of carbon dioxide (CO₂).
- ✓ CO₂ levels higher than 4% and O₂ level lower than 0.4 per cent causes injury and anaerobic conditions respectively.
- ✓ Different types of flowers cannot be store in the same room at the same time since the O₂ and CO₂ required for storage vary for different flowers and it is the one major limitation in CA storage.

3. Modified Atmosphere storage (MA):

- ✓ Less precise form of CA storage, the dry storage of flowers in sealed bags leads to reduction in O₂ and increase in CO₂ levels due to respiration of the tissue.
- ✓ Build up of very high level of CO₂ may cause damage to flowers.
- ✓ Flowers stored in partially permeable materials are beneficial.

4. Hypobaric or Low pressure storage (LPS):

- ✓ Storage at low atmosphere pressure under refrigerated conditions, continuous ventilation and high relative humidity.
- ✓ Rapid loss of water from tissues is major disadvantage and cost of installation is also high.

The optimum storage temperature and duration of storage varies with flower type. The recommended commercial storage conditions for important flowers at 90-95% RH is as follows.

Storage	Crop	Storage temperature (°C)	Maximum storage period (days)
Dry	Carnation	0-1	16-24
	Chrysanthemum	0.5-1	21
	Gerbera	2.00	2
	Gladiolus	4-5	5-7
	Rose	0.5-2	7
Wet	Anthurium	13	14-28
	Carnation	0.5-1	21-28
	Dendrobium	5-7	10-14
	Gerbera	4	4-7
	Gladiolus	4-5	7
	Tuberose	7-10	3-5
	Rose	2-3	5-7

30.11. GRADING AND ITS METHODS FOLLOWED FOR IMPORTANT

FLOWERS:

- ◆ Grading refers to categorization of flowers on the basis of their quality.
- ◆ Each bunch should be of same size, weight and quality before marketing them.
- ◆ Mostly grading is done on the basis of appearance, harvesting maturity, blemishes or injuries due to disease, attack of insects or pests, colour and size of the bud, straightness, strength and length of the stem.
- ◆ The flowers should look fresh, harvested at right maturity, free from pests and diseases;
- ◆ Stem should be straight, free from side shoots and should be strong enough to hold the flower erect.
- ◆ The foliage should be free from physiological disorders such as bent neck (in roses), tip bending (in gladiolus), stem break (in gerbera) and calyx splitting (in carnation) etc.
- ◆ There are no uniform common standards for flowers in the world; many countries have developed their own grading systems based upon the market requirements.

30.12. GRADING STANDARDS FOR CUT FLOWERS IN THE WORLD MARKET:

Sl. No.	Crop	Grading method/s
1.	ROSE	<ul style="list-style-type: none">◆ Based on stem length,◆ Long stemmed graded from 40-90 cm with difference of 10 cm,◆ Short stemmed from 40-65 with 5 cm difference.◆ Leaves dark green, healthy, free from dust, residue pest and disease.◆ Buds should not be bull head, too opened, too tight, bent neck, and strong stem.

2.	GLADIOLUS	<ul style="list-style-type: none"> ◆ Generally based on stem length, ◆ Number of florets per spike, ◆ Long spikes with more florets fetch better price. ◆ Stem straight, ◆ Colour of florets, ◆ Optimum stage of openness of florets, etc. ◆ <i>According to North American Gladiolus Council (NAGC), USA</i> 			
		Grade	Spike length (cm)	Minimum No. of florets	
		1. Fancy (Grade A)	107 96-107	16 14	
		2. Special (Grade B)	81-96 <81	12 10	
		3. Standard (Grade C)			
4. Utility (Grade D)					
3.	CARNATION	<ul style="list-style-type: none"> ▪ Based on the degree of bud opening ▪ Flower diameter ▪ Stem length, strongest of stem etc. ▪ <i>According to Society of American Florists, USA</i> 			
		Grade	Minimum flower Diameter (mm)	Minimum stem length (cm)	
		Blue (Fancy)	Tight	50	55
			Fairly tight	20	
			Open	75	
			Tight	44	
Red (Standard)	Fairly tight	56	43		
	Open	69			
	Tight	<50			
	Fairy tight	< 50			
Green (short)	Fairy tight	< 50	30		

4.	CHRYSANTHEMUM	<ul style="list-style-type: none"> ▪ Generally based on stem length and flower size, ▪ Long stem and large sized flowers fetch better price. 			
		<ul style="list-style-type: none"> ▪ <i>According to Society of American Florists, USA</i> 			
		Grade	Minimum flower diameter (cm)	Minimum stem length (cm)	
		1. Blue (fancy) 2. Red (special) 3. Green (short)	14.0 12.1 10.2	76 76 61	
5.	GERBERA	<ul style="list-style-type: none"> ▪ Based on straight, strong, length of stem (40cm minimum), ▪ Flowers uniform in size, not less than 7 cm. 			
6.	ANTHURIUM	<ul style="list-style-type: none"> ▪ Generally, based on spathe size, ▪ Straightness of stem, freshness, colour etc. ▪ <i>According to USA and Holland based on</i> 			
		Grade	Size of the spathe		
			Holland (inches)	USA (cm)	
		1. Extra large 2. Large 3. Medium 4. Small 5. Miniature/Tiny	>6 5-6 4-5 3-4 <3	>15 13-15 10-13 8-10 <8	
7.	ORCHIDS	<ul style="list-style-type: none"> ▪ Generally, based on spike size ▪ Straightness of stem, freshness, colour, etc. ▪ <i>According to USA and Holland based on</i> 			
		Grade	No. of flowers/spike		
		A B C D	3-5 6-8 9-11 >11		
8.	TUBEROSE	<ul style="list-style-type: none"> ◆ Based on stalk length, ◆ number of florets per spike, ◆ weight of spike, ◆ Straight and strongness, uniform length and uniform stage of development. 			

GERBERA

BUNCHING / BUNDLING

- ◆ Flowers immediately after harvest, are made into bunches of 5, 10, 12 or 20 stems and loosely tied with rubber band at the base and close to the bunched head.
- ◆ Bunching should be done carefully to avoid bruising.
- ◆ Remove lower leaves, uniform fresh basal cut is given manually or mechanical.
- ◆ Bunching helps for easy packing and handling.
- ◆ Flowers such as gerbera, orchids, anthurium, and standard chrysanthemum are packed individually.
- ◆ Dendrobium and anthurium are kept moist by putting them in specially designed vials filled with water or in moist wool.
- ◆ The bunches are held in polyethylene sleeves or the buds are wrapped in corrugated paper to protect them from mechanical damage.

30.13. PACKING METHODS FOR CUT FLOWERS:

- The method of packing depends on crop, flower, method of transport and market.
- The principle of packing is to keep the flowers for long time and retain quality by lowering the rate of transpiration and cell division during transportation and storage.

- The ideal packing should be air tight, moisture proof and strong enough to withstand handling, transport and staking.
- Corrugated fiber board boxes possessing isothermic properties, light in weight and reusable are generally suitable.
- The dimension of packing boxes depends on stem length, type of flower, efficient utilization of space in the cargo, refrigerated trucks, etc.

30.14. BOX SIZES, WHICH ARE COMMONLY USED FOR PACKING FLOWERS ARE:

Flower	Length (cm)	Width (cm)	Height (cm)	Weight (kg)
Carnation	100	40	20	13
Chrysanthemum	80	50	23	15
Gladiolus	120	50	15	15
Rose	100	40	30	17

- Large size 50 kg returnable boxes holding 1000 to 2000 stems are being increasingly used by large exporters.
- Wet packing for orchids, anthuriums, polyethylene foil cover for gerbera, chrysanthemum and anthuriums, special packing for exotic flowers and orchids are taken up.
- The packed boxes are cooled by forced air cooling method where vents on boxes (4-5%) are provided to pass cool air inside the box on flowers wrapped with polyethylene foil.
- Refrigerated storage and hypobaric storage are also used to store boxes.

PACKAGING:

1. Protection

- ✓ Mechanical Injuries (Cuts, bruises, mechanical, punctures, abrasions)
- ✓ Unfavourable environment.
- ✓ Exposure to harmful gases.
- ✓ Enables transport.

2. Preservation

- ✓ Quality and shelf life

(prevents moisture loss)

3. Presentation

- ✓ Display of Info about the product/ communication & advertizing, trade mark
- ✓ Market penetration & competitiveness
- ✓ Value Addition - silent salesman

TYPES OF PACKAGING

- ✓ **Primary packaging** - container that directly holds the product
Eg., Wrapping materials (paper, polythene), vases, bouquests, carton, crates, etc
- ✓ **Secondary packaging** - any outer wrapping that help to store, transport, inform, display and protect the product
Eg. CFB's, decorated carton, gift boxes, etc
- ✓ **Tertiary packaging** - grouping of products for storage and transportation.
Eg. Pallet Boxes, CFB's, cartons, plastic/wooden boxes



30.15. LABELING:

- The packed boxes should be labeled,
 - Crop,
 - Variety,
 - Colour
 - Grade or standard,
 - Grower identification
 - Date of harvest
 - Quantity etc.

30.16. TRANSPORT:

- The flowers are usually transported by air and by refrigerated vans.
- For short distance and local markets, transport through rail or non-refrigerated insulated trucks can be used.
- The flowers such as gladiolus, snapdragon, antirrhinum and freesia which show bending of tips should be hold vertically during transport.

30.17. PHYSIOLOGICAL CHANGES DURING FLOWER SENESCENCE:

- Loss of dry matter due to hydrolysis of macromolecules such as starch, sugars, proteins and nucleic acid.
- Break down of starch into sugars which are transported to the flowers.
- Release of ammonia due to break down of proteins causes bluing of petals.
- Change in membrane permeability results in leakage of pigments, mineral ions and total electrolytes leading to death of tissues.
- Peak respiration rate at bud opening and during senescence period.
- Changes in vascular system break down of vessel cells and appearance of globular bodies.

30.18. GENERAL POINTS TO BE CONSIDERED FOR IMPROVEMENT OF VASE LIFE OF CUT FLOWERS:

1. Ensure that the flowers are harvested at right stage.
2. Use always clean tools to cut the flowers.
3. Immediately after harvesting and after transport place stem end in water or hydrating solution (citric acid 300ppm).
4. Discard damaged, bruised flowers and leaves from the stem to prevent ethylene production and infection with pathogens.
5. Use always clean vases, change vase water daily.
6. Remove basal leaves submerged in vase solution and give basal re-cut to avoid microbial growth and plugging of xylem.
7. Flowers like dahlia and narcissus release milky fluid and mucilaginous substances which spoil vase solution. Therefore, keep them in water for 24 hours before using along with other flowers.
8. Adding sucrose and biocide to vase solution increases vase life of cut flowers.
9. Keep vases away from source of heat, fan and near windows

MEANS TO EXTEND VASE LIFE OF CUT FLOWERS:

- ✂ Harvest high quality flowers.
- ✂ Cleaning.
- ✂ Pulsing, spray, dipping or gazing treatments.
- ✂ Preservatives, sucrose, surfactants, plant growth regulators, ethylene inhibitors.
- ✂ Cooling chain from packing to consumer.
- ✂ Vase solution (sucrose, preservatives).

30.19. VASE LIFE OF CUT FLOWERS:

1. China Aster : 5 to 10 days.
2. Birds of Paradise : 1 to 2 weeks.
3. Calla Lily : 4 to 8 days.
4. Carnation : 03 weeks.
5. Chrysanthemum : 1 to 2 weeks.
6. Dahlias : 2 to 14 days.
7. Gladiolus : 6-12 days
8. Heliconia : 7 to 21 days.
9. Lily : 4 to 14 days.
10. Orchid : 3 to 4 weeks
11. Rose (HT Rose) : 7 to 10 days.
12. Spray Rose : 7 to 10 days.
13. Statice : 10 to 12 days
14. Tuberose : 7 to 10 days.

Knowledge assessment

Quiz.,

I. Choose the correct answers:

1. Stage of harvest for rose cut flower
 - a. 1-2 petals beginning to unfold
 - b. Fully open flower
 - c. Half open flower
 - d. None

2. Stage of harvest for Carnation cut flower
 - a. Fully open flower
 - b. Paint brush stage
 - c. Half open flower
 - d. 4-5 days after opening

3. For oil extraction Jasmine flowers are harvested at
 - a. Unopened bud stage
 - b. Fully opened stage
 - c. Half opened stage
 - d. None

4. Immediately after harvest flower stalk ends should be kept under water to
 - a. to avoid plugging of xylem vessels caused due to micro organisms
 - b. for opening and the turgidity of the floral parts
 - c. to avoid air bubbles block in the xylem vessels
 - d. All

5. Pre-cooling temperature for Anthurium flowers is
 - a. 1-4°C
 - b. 5-7°C
 - c. 7-8°C
 - d. 13°C

6. Wet storage temperature for most of the flowers ranges between
 - a. 1-4°C
 - b. 2-4°C
 - c. 0.5-1°C
 - d. 5-7°C

7. Dry storage temperature for most of for sub-tropical flowers like gladiolus, Strelitzia and anemone is
 - a. 2-8°C
 - b. 1-2°C**
 - c. 0.5-1°C
 - d. 13°C

8. *According to NAGC, USA* spike length Fancy grade of Gladiolus
 - a. <81
 - b. 81-96
 - c. 107
 - d. 96-107

9. Vase life Anthurium flower
 - a. 3 to 4 weeks
 - b. 1 to 2 weeks
 - c. 1 week
 - d. 5 to 6 weeks

10. Factors which affect storage life of flowers are
 - a. Stage of harvest
 - b. Ethylene
 - c. Pathogens
 - d. All

II. Match the following:

1. Rose : a. 7-8⁰C
2. Gerbera : b. 0.5-1⁰C
3. Chrysanthemum : c. 0.5-4⁰C
4. Carnation : d. 4⁰C
5. Bird of Paradise : e. 1-3⁰C

III. State true or false:

1. Gerbera flower is harvested when the ray florets partially elongated.
2. Standard size of box used for packing of rose flowers is 100 x 40 x 30cm.
3. Release of ammonia due to break down of proteins causes bluing of petals.
4. Adding sucrose and biocide to vase solution decreases vase life of cut flowers.
5. Immediately after harvesting and after transport do not place stem end in water or hydrating solution (citric acid 300ppm).

I. Choose the correct answers:

1(a) , 2(b), 3(b), 4(d), 5(d), 6(b), 7(a), 8(c), 9(a), 10d)

II. Match the following:

1(e), 2(d), 3(c), 4(b), 5(a)

II. State true or false:

1(False) , 2(True), 3(True), 4(False), 5(False)



LECTURE -31

DRY FLOWER TECHNOLOGY

TOPICS

- 31.1. Introduction
- 31.2. Advantages of Dried Flowers
- 31.3. Uses of Dried Flower
- 31.4. Techniques for Production of Dry Flowers
- 31.5. Harvesting
- 31.6. Factors affecting dehydration
 - 31.6.1. Atmospheric humidity
 - 31.6.2. Temperature
 - 31.6.3. Airflow
 - 31.6.4. Embedding Material
 - 31.6.5. Method of drying
 - 31.6.6. Air drying/Drying under shade
- 31.7. Flowers/Foliage suited for Air-drying as reported by different scientists
- 31.8. Polyset drying
- 31.9. Press drying
- 31.10. Plant materials for pressing
 - 31.10.1. Flowers
 - 31.10.2. Grasses and ferns,
 - 31.10.3. Foliages
- 31.11. Embedded drying
- 31.12. Common Embedding Materials
- 31.13. Characteristics of good embedding materials
- 31.14. Taking out the flower
- 31.15. Hot air oven drying
- 31.16. Microwave oven drying
- 31.17. Vacuum drying
- 31.18. Freeze drying/Cryo drying-
- 31.19. Skeletonizing

31.1. INTRODUCTION:

- There is an increasing demand all over the world for decorating living and working places with eco-friendly things like flowers and foliage.
- Fresh flowers and foliage though exquisite in their beauty are highly expensive.
- Also they are perishable and delicate in nature and cannot retain their beauty and fresh look for a long time even with the use of best technology for enhancing vase life.
- Moreover, there is a non-availability of fresh flowers and foliage all round the year in all places.
- In this context, flower can be dried, preserved and processed to retain its beauty as well as everlasting value.
- The beauty and value of the dried flower are that they can be kept and cherished for years, which survive the cold of winter and heat of summer.
- At present dry flower industry is growing very fast with more than 60 per cent share to the floriculture industry in India.
- In dried flower industry, a turn over of more than Rs. 150 crores is projected every year.
- India's share in the export of these items is below 1.5 per cent in Europe and it is below 1 per cent of the world requirement.
- Netherlands ranks first in the export of dried flower followed by Columbia, Mexico, India and Israel.
- In view of expanding clientele, lucrative returns and limited competition, more and more entrepreneurs are expected to enter this blooming business in near future.

31.2. ADVANTAGES OF DRIED FLOWERS:

1. **Eco-friendly:** Dried flower market has grown exponentially as consumers became more "eco-conscious" and choose dry flower as environmentally friendly alternative to fresh flowers. These can be offered in hospitals and pollen allergic people.
2. **Economical and long lasting:** It can be reused several times compared to fresh flowers.

3. Dried flowers are available throughout the year.
4. It can survive the heat of summer and cold of winter.
5. Especially useful in autumn and winter when flowers are scarce and expensive. During this period fresh flower availability is less in temperate countries because of chilling temperature. Cost of production is high due to heating requirement in green houses and non-availability of open field grown flowers.
6. More flexibility than fresh flowers. We can increase the length of flower stalk by using artificial stem. Thus creative possibilities are greater in dried flowers.
7. Less transportation cost. Dry flowers can be transported through sea, whereas fresh flowers need quick transportation through the air, a costly affair. Fresh flowers need cold storage also.
8. Offers wide range of suitable and striking colours.
9. Minimizes losses occurring in fresh flower handling.
10. Requires less maintenance.
11. Biodegradable.
12. A variety of products can be prepared.
13. Tolerant to most temperature.

31.3. USES OF DRIED FLOWER:

Dried flowers can be utilized in the best manner for making.

- a) Decorative floral craft items.
- b) Greeting cards and covers.
- c) Wall hangings/Wall plates.
- d) Floral designs.
- e) Calendars.
- f) Floral balls/Flower balls.
- g) Festive decorations.
- h) Collages.
- i) Pomanders.
- j) Bouquets and wreaths.
- k) Sweet smelling pot pourries.
- l) Topiaries.
- m) Swags (Vertical and horizontal).
- n) Flower arrangements.

- o) Landscapes.
- p) Sheaths.
- q) Floral album-for identification of plants for botanical studies.
- r) Cottage or small scale industry based on floral crafts using dehydrated flowers, leaves, fruits, pods, seeds and other parts is a distinct possibility.
- s) Dry flowers can be sealed in glass containers for interior decorations.
- t) Dry flower industry can be associated with many subsidiary industries like cotton fabrics, terracotta, packaging, cane, basket and glass, jute, iron and brass, ribbons and laces, candles etc. By incorporating one with the other, one can have the benefit of value addition.

31.4. TECHNIQUES FOR PRODUCTION OF DRY FLOWERS:

a. Principles affecting dehydration

There are two important factors responsible for loss of fresh look of flowers and foliage. They are

- a) Microbial activity
- b) Ageing process/senescence

Both the factors are biochemical in nature. Moisture is essential for operation of both factors.

- Preservation by dehydration is based on the principle of reducing moisture content by which chemical changes are brought to a standstill and micro-organism growths are checked.
- After dehydration, dried produce should be stored in a dry atmosphere.
- To achieve strong, natural colour in dried material drying period should be as short as possible.
- Direct sunlight should be avoided to prevent fading of colour. Excess damp conditions also should be avoided as it encourages mould.
- The key to drying flower is to withdraw 50 to 90 per cent water from the flowers without distorting the shape or destroying the appearance of flowers and foliage.
- Selected materials for drying should have less moisture content and fibrous tissue.
- Too matured flowers (opened flowers) are not suited for drying as they generally shed upon drying and will not hold up well in arrangements.

- Dark red colour flowers turns to black while drying due to increase in p^H in the cells that leads to co-pigmentation of flavanoids and anthocyanins. The p^H increase is due to degradation of proteins and release of free ammonia.
- Yellow and orange colours change less while drying while turns to brown or cream colour due to oxidation processes.

31.5. HARVESTING:

- Harvesting should be done early morning or late evening after the dew and surface moisture have evaporated.
- If temperature is high at the time of harvest, biochemical reactions are at faster rate which leads to early senescence and further leads to petal drop while dehydration.
- Summer is the best season for dehydration.
- However, colours are brighter in winter and monsoon produced flowers.
- Use only materials free of insect and disease damage as damage becomes more obvious after drying.
- Place stems in a container of water to prevent wilting while gathering.

31.6. FACTORS AFFECTING DEHYDRATION:

The process of dehydration depends upon:

1. Atmospheric humidity.
2. Airflow.
3. Temperature.
4. Embedding material.
5. Method of drying.
6. Moisture content of the flowers.
7. Type and Shape of the flowers.

31.6.1. ATMOSPHERIC HUMIDITY:

Higher humidity delays the process of drying by reducing the capacity of air to absorb liberated moisture from the product. Less humidity results in brittleness.

Advantage: Cheapest method since no cost on energy is involved.

Disadvantage:

1. Season bound resulting in supply uncertainties.
2. Requires large open space.
3. Time consuming
4. Shrinkage of petals
5. Loss of natural colour induced by over exposure to sun
6. Lack of uniform quality.

31.6.6. AIR DRYING/DRYING UNDER SHADE:

Flowers are hung in an inverted position or kept in an erect manner in a well ventilated, warm and shaded place. Protection from direct sunlight, dry atmosphere and plenty of ventilation are necessary.

Advantage:

- Simple and Cheaper method
- No special equipment involved.

Disadvantage:

- Time consuming
- Weather dependant
- Shrinkage of petals
- Unnatural straight stems

Ex., Helipterum, Helichrysum, Limonium, Strawflower, Statice, Thistles, Yarrow, Golden rod, Baby's breath, Celosia, Globe amaranth, Salvia, Hydrangeas, Xeranthemum, Queen Anne's Lace, Millet, Astilbe, Baptisia, Blackberry-lily, Cat tail, Chinese lantern, Clover, Dusty miller, False-dragonhead, Fennel, Grains Grasses, Lilac, Marigold, Milk weed, Okra, Polygonum, Rose, Smoke tree, Pansy, Bachelor's button, Bells-of- Ireland, Scarlet sage, Blue sage, Sea lavender, Acacia, Acanthus (Bear's breeches) Acer (Sycamore), Love- lies-bleeding, Amaryllis, Anethum (Dill), Artemisia, Arundinaria (Bamboo), Atriplex (Dock), Avena (Blue grass), Birch, Calendula, Callistemon, Safflower (Carthamus tinctorius), Corn flower, Clematis, Artichoke (Cynara scolymus), Dahlia, Larkspur (Delphinium ajacis), Digitalis (Foxglove), Fennel, Kochia (Silver Cypress), Lavender, Liatris, Love-in-a-mist, Poppy, Chinese lantern (Physalis), Mignonette (Reseda lutea), Reed mace, Zea mays, Rose buds, Lavender, Zinnia, Artemesia, Astilbeetc.,

31.8. POLYSET DRYING:

It is a polymer preservation method which is applied to the flower 45 minutes before drying. It is a chemical pre-treatment application which is used before air drying to improve the quality of the dried flower.

Advantages:

- Lessens drying time.
- Improves the intensity of flower colour.
- Minimizes shattering and wrinkling of petals which may occur during air drying.

31.9. PRESS DRYING:

- The flowers and leaves while press drying is placed between the folds of newspaper sheets or blotting papers giving some space among flowers.
- These sheets are kept one above the other and corrugated boards of the same size are placed in between the folded sheets so as to allow the water vapour to escape.
- The whole bundle should be placed in a plant press for 24 hours.
- Then it is kept in electric hot air oven for 24 hours at 40-45⁰ C.
- The press dried flower may be either stored in sheets at a dry place or in desiccators for future use.
- The original shape of the materials cannot be maintained by press drying but original colour is retained.
- The pressed flowers and foliage are used in making floral charts, greeting cards and landscapes.

Ex., FLOWERS

Pansy, Candytuft, *Lantana*, *Verbena*, Aster, *Ixora*, *Chrysanthemum*, Larkspur, Rose, Cosmos, *Mussaenda*, *Euphorbia*, *Pentas*, Violets, Dahlia, English Daisy, Geranium, Marigold, *Zinnia*, *Ageratum*, Bleeding heart, Corn flower, Golden rod, *Alyssum*, Buttercup, Bachelor's button, *Hydrangea Anemone*, Butterfly weed, Daffodil, Lily-of-the-valley, *Azalea*, *Celosia*, *Delphinium*, *Phlox*, Queen Ann's lace, *Salvia*, Sweet pea

GRASSES AND FERNS:

Adiantum, *Nephrolepis*, Golden fern, Silver fern

FOLIAGES:

Thuja, Cassia biflora, Haematoxylon, Marigold, Casuarina, Calliandra, Rose foliage, Grevillea robusta, Taxodium distichum.

31.11. EMBEDDED DRYING:

To overcome the problem of petal shrinkage and other morphological changes in dehydrated materials due to air drying, the flowers are dried in embedding technique. The embedding materials cover flowers in such a way that the original shape of the flower is maintained.

Advantage:

- Retains colour and form.
- Support the petals more rigidly and maintains shape on drying.

Disadvantage:

- Labour intensive.
- Expensive since it involves the cost of embedding materials.

31.12. COMMON EMBEDDING MATERIALS:

Sl. No.	Material	Properties
1.	Silica gel	Very clean material, does not cake, acts very quickly, light in weight, keeps colour well, reusable (Bake in oven at 120 ⁰ C for two hours until turns dark blue), highly hygroscopic, expensive, rapidly absorbs moisture from flowers, it can absorb about 40 per cent of its weight with water, drying within 2-3 days.
2	Corn meal	Light, tends to stick to the petals, hence difficult to handle, less tendency to flatten flowers, makes boxes easier to handle and move after filling.
3	Borax	Hygroscopic, bleaches petals if stored for long time, tends to become lumpy after absorbing moisture, drying will take 2 to 10 days. If flower remain in borax too long, they become brittle and lose their petals.
4	Sand	Cheapest, easy to handle, heavy and does not react with water vapour. It neither forms lumps nor bleaches the plant materials embedded in it. Since heavier, it takes longer time for drying (4 days to 2 weeks)
5	Alum	Double sulphate of Aluminium and Potassium.

31.13. CHARACTERISTICS OF GOOD EMBEDDING MATERIALS

1. **Fineness:** - The material should be very fine (0.02-0.2mm) to fill the crevices and cavities present in flower and completely envelope them leaving no gaps.
2. **Inertness to water vapour:** - It should not react with water vapour released during drying, as well as with floral parts and form lumps.
Eg:- Borax and alum tend to form lumps when damp, sometime they harden and crack.
3. **Optimum weight:-** Very light weight powders are not suitable, since these are difficult to handle and leave gaps during embedding.
4. **Non bleaching:** - Drying material should be free from any type of salt and chemical. Strongly hygroscopic material should be avoided as it bleaches plant material.

5. Embedding and drying in room

- For flowers with weak stems, stems are cut about 2.5 cm from the base of the flower.
- If stem is too soft, a thin but strong wire of 5 cm length is inserted from the back in the center of the flower after removing the flower stalk. Such flower can be easily dried in shallow earthenware or metallic trays.
- About 5 cm layer of the desiccant is made at the bottom of the container and flower stems and wires are pushed into it so that the flower remains upright.
- Desiccant is then gently and gradually poured all around and over so as to fill all the crevices in between the petals without disturbing the shape of flower. Flowers are covered up to a cm on top.
- Flower such as bougainvillea, candytuft, perennial chrysanthemum, pompon dahlia, gerbera, marigold, rose, limonium etc. can be dried with their own stems.
- Embedding in such cases is done in deep containers so as to accommodate the plant material without disturbing its shape and form. These embedded materials are kept at room temperature in a well ventilated room till the plant material gets completely dried.

Advantages :

- ◆ No shrinkage of petals

Disadvantages :

- ◆ Takes longer time for dehydration
- ◆ Weather dependant.

6. Embedding and drying in sun

After embedding, the containers are daily exposed to sun. Containers are shifted under a roof during the evening and again brought to sun in the morning.

Advantage:

- Rapid dehydration as compared to earlier method.

Disadvantage:

- Weather dependant.

Flowers like gerbera, zinnia and chrysanthemum dried well with minimum shrinkage when sun dried after placing them in a box containing sand. This takes 4-5 days for drying.

31.14. TAKING OUT THE FLOWER:

- After dehydration, the containers are tilted for removing the desiccants over and around the flowers.
- The dried flowers are either picked up by hand or by tweezers; cleaned by inverting them and tapping the stems with fingers slowly and gently.
- Remaining desiccants are finally removed with the help of fine hair painting brush.

31.15. HOT AIR OVEN DRYING:

Procedure: The container with the embedded plant material is kept in the hot air oven at a controlled temperature for appropriate time.

Advantages :

- Faster dehydration
- Temperature can be maintained
- Independent from weather conditions
- Superior quality product

Disadvantages :

- Costlier
- Brittle flowers due to lack of humidity.

Accordingly drying period varies from 48 to 72 hours and temperature varies from 30 °C to 50 °C.

31.16. MICROWAVE OVEN DRYING:

- Principle behind microwave oven drying is liberating moisture by agitating water molecules in the organic substances with the help of electronically produced microwaves.

Procedure:-

- Embedded flowers and foliages in silica gel contained in a non-metallic earthenware or glass ware are kept in an oven for few minutes to induce effective drying.
- After the treatment the containers are taken out and kept at ambient temperature for a particular period, so that the moisture of the container gets evaporated and the plant material gets fully dried called as “setting time”.
- Generally, drying period varies from 1 to 4 minutes and setting time 2 to 5 hours.
- Microwave heating is a type of dielectric heating using high frequency waves. When a substance like water is absorbed in its free state and then micro-waved it responds by heating and vaporizing.

Advantage of Microwave oven drying :

- Unbelievably fast
- Quality product

Disadvantages: Costly method.

31.17. VACUUM DRYING:**Principle:**

- The embedded material may be dehydrated under vacuum.
- It employs a thick walled chamber fitted with a heating device, a vacuum pump for maintaining high vacuum and a condenser for condensing the liberated moisture in drying compartment.

Advantages:

- It permits the use of low temperature for drying, thus minimizing oxidative changes resulting in excellent quality of the finished product.
- Energy loss is also minimum as most of the heat is utilized for evaporating moisture.

Disadvantages: High cost of equipment and its sophisticated nature.

31.18. FREEZE DRYING/CRYO DRYING:

- It is a relatively new process.
- Fully opened flowers are cut into a uniform 15cm length and placed in vials so that the basal 5 cm are immersed in solutions of glycerine, clove oil, ethylene glycol, dimethyl sulfoxide and wetting agent.
- Various concentrations and combinations are used for stem uptake.

- After this pretreatment, flower-stems are re-cut to 5 cm in length and placed in a freezing temperature at -80°C for 12 hours.
- Then the flowers are immediately placed in a freeze dryer at 20°C and under a vacuum of less than 100 microns for 7 days.

Two phases in freeze drying

1. Freezing phase.
2. Vacuum drying phase.

Principle :-

- Freeze drying is a dehydration process that causes vaporization of water directly from a solid ice crystal state to a vapour state without passing through normal liquid state.
- Flowers suited for freeze drying include carnation, *Antirrhinum* and roses.

Advantages : Texture, structure, shape, size, colour etc are similar to fresh ones.

Disadvantages :

- High cost of equipment
- Electrical energy consumption.
- Equipment maintenance cost is higher
- Requires precise processing techniques.
- Though expensive, freeze drying is becoming very popular in U.S. to preserve special occasion flowers. Brides often choose freeze drying to preserve their wedding bouquets.
- Vacuum drying temperature had more effect on rose and carnation flowers than freezing temperature. Lower vacuum drying temperature (27°C) resulted in flower with colour closer to fresh and control flowers, while higher vacuum drying temperature (47°C) resulted in lower moisture content and stronger/stiffer petals but more changes in colour.

31.19. SKELETONIZING :

- It is suited for foliages.
- Skeletonizing is a process of removing soft tissue by soaking in water or alkali solution for 7-10 days.
- The decayed tissue is removed by using a paint brush and washed.

E.g.: Peepal leaves



Continued.....

LECTURE -32

DRY FLOWER TECHNOLOGY

TOPICS

- 32.2. Suitable flower for different techniques
- 32.3. Glycerin treatment
- 32.4. Dyeing or Colouring
- 32.5. Moisture tests to know material is dried/not
- 32.6. Care of dried flowers
- 32.7. Value Addition
- 32.8. Description of dried flowers
- 32.9. Export of Indian dried flower materials
- 32.10. Other flowers include
- 32.11. How to make potpourri
- 32.12. Arrangements
- 32.13. Economics
- 32.14. Location of dried flower industry
- 32.15. Major players in Indian Export
- 32.16. Source of raw materials
- 32.17. Employment Potential

32.2. SUITABLE FLOWER FOR DIFFERENT TECHNIQUES:

Methods	Crops
Air drying with silica gel	Anemone, Freesia, <i>Zinnia</i> , Narcissus
Borax/Alum drying	Snapdragon, cosmos, <i>Delphinium</i>
Drying with sand	Dahlia
Air drying with water or immersion in glycerin	Foliage
Air drying preserves fragrance	Lavender
Air drying with glycerin	<i>Mollucella</i>
Air drying with glycerin	Rose
Air drying	<i>Allium</i> , <i>Helipterum</i> , <i>Leucodendron</i> , <i>Mimosa</i> , <i>Gomphrena</i> , <i>Verbena</i>
Microwave oven drying	Spray carnation
Microwave oven drying	<i>Chrysanthemum</i> (small)
Microwave oven drying	Iris, Orchids, Sweet William, Tulip

32.3. GLYCERIN TREATMENT:

It refers to replacing the moisture content in a flower with a mixture of glycerin and water. Here the flower is actually preserved and not dried.

Two types of glycerin treatments

1. Systemic treatment: - It allows the plant to absorb the glycerin through the stems naturally.

2. Immersion treatment: - Here glycerin is forced through the stems under pressure.

Flowers suited: - Caspia, Ming, Tree fern, Salal.

Advantages:

- ★ Retains natural shape and flexibility
- ★ Lasts indefinitely

Disadvantages: Preservation destroys natural colour/ colour changes; Therefore dyes are used to produce a wide array of choices; Dried materials will have greasy feeling.

Leaves:

Maple, Bells- of-Ireland, Mexican, Orange blossom , Oak , Beech, Cherry, Eucalyptus, Magnolia, Japanese Fatsia, Mistletoe, Ferns, Mahonia, Salal, Camellia, Ivy, Rhododendron, Hydrangea

Procedure

- Select a branch about 18 inches or less in length.
- Remove lower leaves and branch or split the stem end of wood materials about 4 to 6 inches to increase absorption.
- Make a mixture of 1 part glycerin and 2 parts warm water.
- Stir well and pour into glass containers.
- Mark the level of mixture on the containers.
- As the branches absorb mixture, add a reserve mixture which contains 1 part glycerin + 4 parts water to the original marked level.
- Soft stem takes 3-6 days for absorption whereas woody stems takes 2 to 6 weeks.
- Foliage colour will gradually change as glycerin is absorbed.

32.4. DYEING OR COLOURING:

- It is essential for good appearance.
- It is a determining factor in the pricing of the product.
- Dyeing also serves as a preservative. It enhances the natural look and texture of the product.

Three methods of dyeing

1. Dyeing by dusting

Chalk powder mixed with dye is applied on flower surface.

2. Colouring of products using dyestuff with water

- 1-4 kg dye and 5-20 liters of water is put in a small bucket to form a paste.
- This paste is added to steam boiling water tank (800 l). About 2 l acetic acid is also added to the tank.
- The product to be coloured is then dipped into the boiling water until the required shade is achieved.
- In case of fragile product, Magnesium chloride is also added.
- After colouring, product is placed in the open to dry.

3. Colouring of product using dyestuffs with methanol

- Methanol is diluted to 50 to 150 liters by adding water.
- Dye paste is added to diluted methanol.
- Products are dipped in methanol solution and immediately taken out and dried for a few minutes.

32.5. Moisture tests to know material is dried/not

1. Test the flower in more than one place, as petals dry before the flower centre.
2. Place sample in airtight jar, leave for a day or two. If condensation appears, need to be dried a little more.
3. Check the sample by keeping upright in a container for 24-48 hours. Head will droop if plants are not completely dried because; neck of flower dries out last.

32.6. CARE OF DRIED FLOWERS:

1. Prevention of moisture absorption- Dry flower absorbs atmospheric moisture and loses their shape. Therefore, they should be stored immediately in moisture proof containers like glass desiccators, tin boxes, cartons, wrapped with plastic sheet or wax paper.
2. Prevention of dust –Storage containers should be dust free as dust particles spoil the beauty of flowers.
3. Prevention of breakage- Pack carefully ensuring that there is not too much pressure on flower heads.
4. Prevention of direct sunlight and light in order to avoid fading of colour.
5. Prevention of damage by insects-Moth balls should be kept in storage containers.

32.7.VALUE ADDITION :

Value added products

Dried flower are exported as assortments of value added items.

32.8. DESCRIPTION OF DRIED FLOWERS

The International Trade centre (ITC) of the United Nations Commission on Trade and Development (UNCTAD) in conjunction with the GATT (General Agreement on Trade and Tariffs) had developed the following product description for dried flowers.

These Categories are

1. Dried, dyed, bleached, impregnated or otherwise prepared cut flowers and flower buds for bouquets or for ornamental purposes

ITC code : HS code-0603.90-00

It includes cut flowers, bouquets, wreaths, floral baskets etc.

2. Dried parts of plants for bouquets or for ornamental purposes

ITC code : HS code –0604.99-10.

3. Dried, dyed, bleached, impregnated or otherwise prepared foliage, branches and other parts of plants (without flowers or buds) and grasses, mosses, lichens suitable for bouquet or for ornamental purpose.

ITC code : HS code 0604.99-90.

It includes decorative fruit and Christmas trees

32.9. EXPORT OF INDIAN DRIED FLOWER MATERIALS:

India has evolved from being a raw material supplier into a manufacturer of finished goods. The Indian dried flower export market is classified into four product segments. These classifications are particular to Indian suppliers and not confirm exactly to Harmonized code ITC (HS) descriptions or to competing product from other origin suppliers.

Product Segmentation

The Indian dried flower export market is classified into three main product segments and one specialized, lower volume segment, each with its own characteristics.

1. Dried flowers and plant parts in bulk
2. Potpourri
3. Arrangements (with dried plant materials and dried flowers) and
4. Floral handicrafts (Specialized/ low volume)

Dried flowers and plant parts in bulk

This is the high volume, well established end of the business. Varieties shipped under this classification include globe amaranth, celosia, marigold, agro waste products as well as 'assembled' flowers, exotics and material for liners and fillers used in flower arrangements. Assembled flowers consist of a number of parts of one or more sorts of flowers.

2. Potpourri

- It is a mixture of dehydrated flowers, berries and leaves which is exported either raw or scented.
- The common method of display is in glass bowls or ceramic jars which are placed in bedrooms and bathrooms.
- This product can be packed in small muslin bags or sachets which are then placed in wardrobes and drawers are 'clothes- fresheners.'
- Use of potpourri as a natural scent as well as decorative feature has gained wide acceptance.
- Potpourri overcomes the harmful effects of ozone depleting aerosols.
- Over 300 products are used in potpourri mixes.
- In India, major products used in potpourri are bachelor's button (globe amaranth), cock's comb (*Celosia argentea*), marigold flower (*Tagetes sp*), rose petals,

bougainvillea petals, green leaves (such as bay leaves), neem leaves (*Azadirachta indica*), stones from plums, peaches, apricot, amaranth etc.

32.10. OTHER FLOWERS INCLUDE:

- Larkspur, *Delphinium*, Cornflower, Peony, Sweet pea, Statice, Strawflower, Honeysuckle
- **Leaves** from herbs like *Artemisia*, thyme, sage, rosemary, basil, yarrow, lavenders scented geraniums, mints, marjoram, *Verbena*, anise, fennel.
- **Fruits** include rose hips, hawthorn berries, juniper berries, grapefruit rind, orange rind and apples.
- Potpourri material should have a strong natural colour or be a light enough shade to absorb non-toxic dyes.
- Material should be dry (maximum moisture content of 7 per cent), resistant to mould, non toxic, free from noxious odours, of a low bulk density and sufficiently robust to withstand mechanical blending.
- U.K. is the biggest potpourri market for Indian raw balm materials.

32.11. HOW TO MAKE POTPOURRI:

- ❑ Basis of a potpourri is the aromatic oils found within the plant.
- ❑ These oils are not confined to flowers, but they are at their peak at flowering time.
- ❑ So harvest leaves and flowers just as the plant begins to flower.
- ❑ After harvesting, dry the plant part in a warm, airy, dry room either by hang drying or flat drying.
- ❑ Drying at high temperature may result in loss of aromatic oils.
- ❑ For making potpourri, a “fixative” is needed which is responsible for absorbing the aromatic oils and slowly releasing them.
- ❑ Common fixatives include finely ground non-iodized salt, Orris root (dried rhizomes of iris plant), sweet flag (calamus root), gum benzoin, and ambergris.
- ❑ Other materials required are finely ground spices (cinnamon, clove and nutmeg). To enhance the scent, add essential oil (Patchouli oil/rose oil/ lavender oil).

32.12. ARRANGEMENTS :

- ❑ Most lucrative segment in dried flower market, in terms of both total gross sales and unit returns.

a. Arrangements with dried plant materials

- ❑ This market is small, specialized and of higher value.
- ❑ Examples are wreaths, topiaries and swags.
- ❑ Indian cottage industries are well developed in handicrafts.

Examples of common products used in India:

Cotton pods, Exotic grasses and leaf material, large pine cones (*Pinus sp*), Unfurling fern fronds, dried capsicums (*C. annum*, *C. frutescens*), Barks and twigs, Ornamental gourds (*Cucurbita pepo*), Seed pods and heads.

b. Dried flower arrangements:

- ❑ High income private hotels and retail uses. Dried items offer the arranger more flexibility than do fresh flowers. As a result creative possibilities are greater.
- ❑ Dried floral designers require products with a natural stalk of 15-40 cm. If stalks are not of an acceptable length, the products have wire stalks attached with hot-glue gums.
- ❑ Products used in dried flower arrangements are classified as Main blooms, Fillers, Liners and Exotics

Main blooms: Plays a key role because of their shape, size and colours in making bouquets or arrangements. They also include assembled everlasting. Most common main blooms used within the market are statice (sea lavender) Strawflower (*Helichrysum*), *Nigella*, larkspur and roses.

Fillers: are a group of products used in making bouquets and arrangements whose function is to add bulk to the flower arrangement. They help to fill any empty space in design.

Liners: Are mostly ornamental grasses, so named because these grasses give a linear accent to an arrangement. Most commonly used grasses are *Avena* (animated oats), *Halaris* (Canary grass), *Triticum* (ornamental wheat) and *Phleum* (Timothy).

In addition, a wide variety of plants such as typha (Cattail or reed mace), maize, sorghum, spiked millet (*Pennisetum*), dried branches and twigs of trees (eg: silver dollar eucalyptus) and shrubs can also be used.

Exotics: Consists of a group of plants and plant materials which originate from various tropical and subtropical regions of the world. Indian Exotics include Lotus heads (Seed head from *Nymphaea* species), palm spears (palm leaf cut into spear shapes) and okra pods.

4. Floral handicraft

Handicraft products have served to generate new demand for dried flower products. This segment includes items such as:

Collages

Flowers pictures

Cards and covers (press-dried flower and foliage)

Innovative items such as :-

- ❑ Candle stands
- ❑ Table lamps
- ❑ Picture frames
- ❑ Floral jewellery
- ❑ Mirror decorations
- ❑ Arrangements in glass containers

32.13. ECONOMICS:

It is possible to start a home-scale establishment with a meager amount of Rs. 15,000/- and one may supplement one's income by employing his family members. A small scale industry can also be started if the market for dry flowers and floral craft items is explored in our country and world. There is quite high margin of profit in this venture.

32.14. LOCATION OF DRIED FLOWER INDUSTRY:

- ❑ The principal export houses /processing units for dried flowers are concentrated in port towns of Tuticorin (Tamil Nadu), Kolkata (West Bengal) and Mumbai.
- ❑ Tuticorin accounts for over 50 per cent of country's export and Kolkata for about 40 per cent. Tuticorin offers certain logistical, political and climatic advantages over Calcutta for this industry.
- ❑ Climate in Tuticorin is dry for best part of the year.

32.15. MAJOR PLAYERS IN INDIAN EXPORT:

1. M/s Ramesh Flowers Limited –based in Tuticorin has emerged as the single largest exporter of dried flowers with a turnover of over Rs 270 million. They have technical and financial collaboration with Schleef of Germany (Schleef holds 51 per cent of the company’s equity). Schleef helps in product design and development for European markets. M/s W. Hogenwoning India, a prominent Dutch company has also started exporting from Tuticorin
2. Singhvi International, Kolkata -having 60 per cent of total dried flower exports from India. The Singhvi family has a stronger export base in Tuticorin
3. M/s Minex Agencies, Kolkata.

Major players export their product to U.S., Holland Germany, Denmark, Czechoslovakia, Italy, France, Spain, UK, Belgium, South Africa, Srilanka, Australia and Mexico.

32.16. SOURCE OF RAW MATERIALS :

- ❑ Kolkata units procure their raw materials locally as well as from Madhya Pradesh, North eastern states, Bihar and South India.
- ❑ Tuticorin units procure some of their raw materials from Pune and Nasik (Maharashtra) and M.P. Bilaspur (M.P.) remains a major source of raw material for both Kolkata and Tuticorin.
- ❑ Most raw materials are collected year round from mountains, hills, valleys and deep sea by villagers and trained rural labour and supplied to the units either directly or through collection agents.
- ❑ Whole process is quite informal and traditional 20 per cent of raw material is cultivated and 80 per cent is collected from the wild.
- ❑ India’s diversity in topography and climatic conditions makes it rich in plant material and hence, India can emerge as the leader supplier of dried plant material

32.17. EMPLOYMENT POTENTIAL:

- ❑ The nature of industry requires an exceptionally large work force at the growing /collecting stages.
- ❑ About 10,000 people are directly employed and about 40,000 people are indirectly employed with this industry.

- ❑ A large number of employed are rural women, who collect the flowers and plant materials, sun dry them and then ready them for dispatch.
- ❑ More than 3,500 women are involved in this industry in Tuticorin alone and many in Kolkata.
- ❑ Thus dried flower industry is critical from the stand point of employment potential.



Continued.....

LECTURE -32

DRY FLOWER TECHNOLOGY

TOPICS

- 32.2. Suitable flower for different techniques
- 32.3. Glycerin treatment
- 32.4. Dyeing or Colouring
- 32.5. Moisture tests to know material is dried/not
- 32.6. Care of dried flowers
- 32.7. Value Addition
- 32.8. Description of dried flowers
- 32.9. Export of Indian dried flower materials
- 32.10. Other flowers include
- 32.11. How to make potpourri
- 32.12. Arrangements
- 32.13. Economics
- 32.14. Location of dried flower industry
- 32.15. Major players in Indian Export
- 32.16. Source of raw materials
- 32.17. Employment Potential

32.2. SUITABLE FLOWER FOR DIFFERENT TECHNIQUES:

Methods	Crops
Air drying with silica gel	Anemone, Freesia, <i>Zinnia</i> , Narcissus
Borax/Alum drying	Snapdragon, cosmea, <i>Delphinium</i>
Drying with sand	Dahlia
Air drying with water or immersion in glycerin	Foliage
Air drying preserves fragrance	Lavender
Air drying with glycerin	<i>Mollucella</i>
Air drying with glycerin	Rose
Air drying	<i>Allium</i> , <i>Helipterum</i> , <i>Leucodendron</i> , <i>Mimosa</i> , <i>Gomphrena</i> , <i>Verbena</i>
Microwave oven drying	Spray carnation
Microwave oven drying	<i>Chrysanthemum</i> (small)
Microwave oven drying	Iris, Orchids, Sweet William, Tulip

32.3. GLYCERIN TREATMENT:

It refers to replacing the moisture content in a flower with a mixture of glycerin and water. Here the flower is actually preserved and not dried.

Two types of glycerin treatments

1. Systemic treatment: - It allows the plant to absorb the glycerin through the stems naturally.

2. Immersion treatment: - Here glycerin is forced through the stems under pressure.

Flowers suited: - Caspia, Ming, Tree fern, Salal.

Advantages:

- ★ Retains natural shape and flexibility
- ★ Lasts indefinitely

Disadvantages: Preservation destroys natural colour/ colour changes; Therefore dyes are used to produce a wide array of choices; Dried materials will have greasy feeling.

Leaves:

Maple, Bells- of-Ireland, Mexican, Orange blossom , Oak , Beech, Cherry, Eucalyptus, Magnolia, Japanese Fatsia, Mistletoe, Ferns, Mahonia, Salal, Camellia, Ivy, Rhododendron, Hydrangea

Procedure

- Select a branch about 18 inches or less in length.
- Remove lower leaves and branch or split the stem end of wood materials about 4 to 6 inches to increase absorption.
- Make a mixture of 1 part glycerin and 2 parts warm water.
- Stir well and pour into glass containers.
- Mark the level of mixture on the containers.
- As the branches absorb mixture, add a reserve mixture which contains 1 part glycerin + 4 parts water to the original marked level.
- Soft stem takes 3-6 days for absorption whereas woody stems takes 2 to 6 weeks.
- Foliage colour will gradually change as glycerin is absorbed.

32.4. DYEING OR COLOURING:

- It is essential for good appearance.
- It is a determining factor in the pricing of the product.
- Dyeing also serves as a preservative. It enhances the natural look and texture of the product.

Three methods of dyeing

1. Dyeing by dusting

Chalk powder mixed with dye is applied on flower surface.

2. Colouring of products using dyestuff with water

- 1-4 kg dye and 5-20 liters of water is put in a small bucket to form a paste.
- This paste is added to steam boiling water tank (800 l). About 2 l acetic acid is also added to the tank.
- The product to be coloured is then dipped into the boiling water until the required shade is achieved.
- In case of fragile product, Magnesium chloride is also added.
- After colouring, product is placed in the open to dry.

3. Colouring of product using dyestuffs with methanol

- Methanol is diluted to 50 to 150 liters by adding water.
- Dye paste is added to diluted methanol.
- Products are dipped in methanol solution and immediately taken out and dried for a few minutes.

32.5. Moisture tests to know material is dried/not

1. Test the flower in more than one place, as petals dry before the flower centre.
2. Place sample in airtight jar, leave for a day or two. If condensation appears, need to be dried a little more.
3. Check the sample by keeping upright in a container for 24-48 hours. Head will droop if plants are not completely dried because; neck of flower dries out last.

32.6. CARE OF DRIED FLOWERS:

1. Prevention of moisture absorption- Dry flower absorbs atmospheric moisture and loses their shape. Therefore, they should be stored immediately in moisture proof containers like glass desiccators, tin boxes, cartons, wrapped with plastic sheet or wax paper.
2. Prevention of dust –Storage containers should be dust free as dust particles spoil the beauty of flowers.
3. Prevention of breakage- Pack carefully ensuring that there is not too much pressure on flower heads.
4. Prevention of direct sunlight and light in order to avoid fading of colour.
5. Prevention of damage by insects-Moth balls should be kept in storage containers.

32.7.VALUE ADDITION :

Value added products

Dried flower are exported as assortments of value added items.

32.8. DESCRIPTION OF DRIED FLOWERS

The International Trade centre (ITC) of the United Nations Commission on Trade and Development (UNCTAD) in conjunction with the GATT (General Agreement on Trade and Tariffs) had developed the following product description for dried flowers.

These Categories are

1. Dried, dyed, bleached, impregnated or otherwise prepared cut flowers and flower buds for bouquets or for ornamental purposes

ITC code : HS code-0603.90-00

It includes cut flowers, bouquets, wreaths, floral baskets etc.

2. Dried parts of plants for bouquets or for ornamental purposes

ITC code : HS code –0604.99-10.

3. Dried, dyed, bleached, impregnated or otherwise prepared foliage, branches and other parts of plants (without flowers or buds) and grasses, mosses, lichens suitable for bouquet or for ornamental purpose.

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It includes decorative fruit and Christmas trees

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