

UNIVERSITY OF AGRICULTURAL & HORTICULTURAL SCIENCES,
SHIMOGA-577225



PRODUCTION TECHNOLOGY OF ORNAMENTAL CROPS

PRODUCTION TECHNOLOGY OF ORNAMENTAL CROPS

LANDSCAPE GARDENING

LANDSCAPE GARDENING

HRT. 202 (1+1)



Prepared by:

Dr. B. Hemla Naik,

M.Sc.(Agri.); Ph.D.(Hort.); P.D.(Israel); eLearning (USA)

Professor & Head (Hort.) cum Coordinator (PPMC)



Name : _____

I.D.No. : _____

Class : II B.Sc.(Agri.) Semester: II Batch : _____

Department of Horticulture
College of Agriculture, SHIMOGA-577225



2013-14

COURSE OUTLINE

THEORY:

1. History of Floriculture and Landscape Gardening in India.
2. Scope and importance of ornamental crops; Industrial importance of Ornamental plants & Commercial flowers in India and abroad.
3. Role of ornamentals in pollution control.
4. Classification of flower crops.
- 5-10. Production technology of flower crops under protected and open cultivation.
 - i. Rose
 - ii. Carnation
 - iii. Gerbera
 - iv. Anthurium
 - v. Gladiolus
 - vi. Tuberose
 - vii. Jasmine
 - viii. Chrysanthemum
 - ix. Crossandra
 - x. Marigold
 - xi. China aster
11. Post harvest handling of cut flowers
12. Principles and planning of landscape gardens.

13. Elements of landscape gardens
14. Types and styles of gardens
15. Garden features
16. Garden Adornments
17. Indoor gardening and
18. Bonsai

REFERENCES:

1. Advanced Commercial Floriculture - S.K. Bhattacharjee & L.C. De
2. Chrysanthemum in India - by M.A. Kher
3. Commercial Floriculture - by S. Prasad/ U. Kumar
4. Commercial Flowers Vol.1& Vol.2- Edited by T.K. Bose, L.P. Yadav, P.Pal, P. Das. & V.A. Parthasarathy
5. Complete Gardening in India - by Gopaldaswami Iyengar
6. Floriculture - Technology, Trades and Trends - by J. Prakash and K.R. Bhandaly
7. Floriculture and Landscaping -by T.K. Bose, R.G. Maiti, R.S. Dhua and P.Das
8. Floriculture -At Glance by Desh Raj
9. Floriculture in India - by Dr. G.S. Randhawa and A. Mukhopadhyay
10. Pests of Floriculture crops and their control - by Pulluri Ramesh
11. Protected cultivation of Roses - by Dr. T. Venkatesh Reddy, & Dr. C.G. Nagaraja
12. Roses - Amitabha Muchopadhyay
13. The Rose in India - by B.P. Pal

SCHEME OF EVALUATION:

Mid Term	Practical Exam	ATT	Assignment	Practical Record	External Examination	Total
20.00	15.00	5.00	5.00	5.00	50.00	100.00

LECTURE-1:

HISTORY OF GARDENING IN INDIA

- The history of gardening in India is as old as its civilization.
- The first evidence of an ornamental plant, the *Pipal (Ficus religiosa)*, comes from a seal **Mohen-jo-daro** of the third millennium B.C.
- Another seal from **Harappa** of the same period depicts a tree similar to that of a **weeping willow (*Salix babylonica*)**.
- The Aryans of the Vedic period were great lovers of trees and flowers.
- The lotus has been mentioned frequently in the Sanskrit scriptures of Vedic times.
- The *Atharva Veda* mentions the *Asvatha (Pipal)* or *Ficus religiosa*.
- The *Rig Veda* also refers to this tree when it describes a tree with fair foliage.
- **The epics of the Aryans- the *Ramayana* and the *Mahabharata***, believed to have been compiled during 500 B.C., mention about gardens, trees and flowers.
- In the *Ramayana* it has been narrated that the palaces had nice gardens with numerous flowers and shady groves. It is frequently mentioned that lakes were full of lotuses.
- Every Indian must be known about the 'Asokavana' where Sita was held in captivity by Ravana, the demon king. This grove was composed mostly of Asoka (*Saraca indica*) trees.
- The *Mahabharata* the Sabhaparva of these epic, detailed descriptions have been given of the pleasure gardens, parks and lakes around the palaces in Indraprastha.
- Both the epics mention the following trees and creepers -
 - *Ficus benghalensis*, *F. religiosa*, *Saraca indica*, *Michelia champaca*, *Terminalia arjuna*, *Butea monosperma*, *Mesua ferrea* (Nagkesara), *Cassia fistula*, *Shorea robusta* (Sal), Palmyra palm (*Botassus flabellifer*), Screw pine (*Pandanus*), *Bignonia* and *Oleander*.
- Special mention can be made of the tree *Kadamba (Anthocephalus cadamba; Syn. A. indicus)* as it was closely associated with the life of Lord Krishna.
- The **lotus** was a popular flower and was **regarded by both the Hindus and the Buddhists** as a symbol of purity. **The flower grows in mud but is free from any 'mud-sticking', as no dirt can stick to it.**
- **In the *Mahabharata*** it is mentioned that, **Bhima brought a lotus for his consort** which had one thousand petals, glowing like sun and with sweet heavenly fragrance which could prolong youth and revive beauty.
- The Aryans developed some **wishful thinking in the form of *Kalpavriksha*, the wish-granting tree and *Kalpalata*, a similar creeper.**
 - The faith goes that anybody, standing under these creepers or trees, wishing anything from jewellery, beautiful clothing, good food, or even beautiful maidens, would get the same.
- One sculpture depicting such a tree dating back to the third century B.C. and now preserved in the Kolkata Museum was identified as the banyan tree.
- Another legend of that time also makes interesting reading. According to the legendary story,
 - ✓ **Once Lord Vishnu was bathing in a lake on earth when a lotus bloomed and from within came out *Pitamaha Brahma***, who claimed that the **lotus was the prettiest flower** one had ever seen.
 - ✓ Although Vishnu agreed that, it was a beautiful flower; he guided Brahma to his own paradise *Vaikuntha* and showed him a **rose bloom** as pale as moonbeam and full of sweet fragrance. **Brahma had to change his view and accept the rose as the prettiest bloom in the universe.**
- The **association of different trees with the life of Lord Buddha** is well known.
 - **The Buddha was born under the Asoka (*Saraca indica*) tree.** The other trees

such as *Sal* (*Shorea robusta*) and *Plaksha* (*Butea monosperma*) were also there.

- **The Buddha attained his enlightenment under a Pipal tree,**
- **Spread his new teachings under shady banyans and mango trees and**
- **Breathed his last in a *Sal* (*Shorea robusta*) grove.**
- The **great Emperor Asoka** adopted **arboriculture** as one of his state policies.
- He encouraged the planting of avenue trees.
- His son Prince Mahendra took a sapling of the great *Bodhi* tree (*Ficus religiosa*) and planted it at Anuradhapur in Sri Lanka.
- The pipal was regarded as a sacred tree even before the birth of the Buddha.
- Vatsayana (about 300-400 A.D.) in his book *Kamasutra* gives a glimpse of the joyful civic life of that period. He narrates four kinds of gardens:
 1. **Pramododyan** - meant for the enjoyment of the royal couples;
 2. **Udyan** - where the kings played chess, enjoyed the dances of the maids and jokes of the court jesters;
 3. **Brikshavatika**- the garden where high-placed persons in the king's court enjoyed life with courtesans; and
 4. **Nandanavana**- which was dedicated to Lord Krishna.
- Vatsayana also described the duties of a virtuous wife.
- It is said that **a loyal and affectionate wife should lay out a garden around the house.**
- Besides, **the garden should be planted with jasmine, *Tabernaemontana coronaria*, China rose, etc.**
- **A good housewife should also construct arbours and seats in the gardens.**
- Before the Mughals came to India there was a long blank in the gardening history of India, with the exception of **Firoz Tughlaq (1351-1388 A.D.)** who **developed about twelve hundred gardens around Delhi and more elsewhere.**
- **Babur** was a great lover of flowers and gardens. He laid out a garden at Agra, now known as '**Rambagh**'.
- **Babur is credited with the introduction of Persian rose in India.**
- **Akbar (1556-1605 A.D.)** built a new capital at **Fatehpur Sikri**, complete with gardens, trees and flowers. He was the first Mughal to enter **Kashmir** and established a garden i.e., **Nasim Bagh, close to the Dal Lake**. The **tomb garden of Akbar at Sikandra** is an example of the gardening art during that period.
- **Jehangir (1605-1627 A.D.)** was also a great admirer of gardens and flowers and so was his famous wife Nur Jahan. **The gardens at Shalimar, Achhabal and Verinag in Kashmir were created by him.** The tomb at Itimad-ud-Daulah in Agra, in memory of his father-in-law, was also his creation.
- **Shah Jahan (1627-1658 A.D.)** also established several beautiful gardens. He built the **Red Fort in Delhi which had a beautiful garden.** The gardens around **Taj Mahal in Agra, in memory of his beloved queen Mumtaz Mahal was also his creation.**
- **The best garden created by Shah Jahan was the Shalimar garden in Lahore (Pakistan).**
- **Sher Shah Suri (1540-1544 A.D.)**, who ruled for a short period after defeating Babur, constructed the famous Grand Trunk Road and planted avenue trees on both sides.
- **The Nawabs of Oudh** also established a number of gardens in their empire, especially in **Lucknow**. One of these was '**Sikandar Bagh**' which was established by the last Nawab **Wajid Ali Shah (1847-1856 A.D.)**, which is now the '**National Botanical Research Institute**'.
- **The Rajput in India** also established several gardens.
 - The garden at Amber Fort near Jaipur was started by Man Singh (1590-1615 A.D.) and completed by Jai Singh II (1699-1743 A.D.). This beautiful garden is laid in three terraces and has a lake.

- The Mandor garden near Jodhpur is a really beautiful garden still today and was built by Raja Abhai Singh (1724-1749 A.D.).
- The city of Jaipur was founded by Jai Singh II (1727 A.D.) who built a palace in the heart of the city with beautiful gardens.
- The garden palace at Deeg was founded by Suraj Mal with fountains, water courses, and other features, it is one of the most beautiful gardens ever created by any Rajput king.
- The gardens and the palaces in Chittor, the Capital of Mewar rulers were also famous. The rulers of Bundi in Rajasthan also were fond of gardening.
- The arrival of **the British in India changed the whole pattern of gardening.**
- The Mughal gardens in India were laid out in symmetrical patterns, but the English changed the style into informal patterns by laying out parks and gardens.
- Until then Indian gardens had only scented trees and shrubs, climbers and bulbs, but had no flowering annuals.
- **The English brought with them beautiful annuals and biennials such as phlox, carnation, verbena, dahlia, larkspur, etc.**
- Before the arrival of the English the Indian knew about how to make garlands and Guldasta (bouquets), but had no **idea of flower arrangements for interior decoration, which was taught by the British.**
- The greatest contribution by the British was the establishment of botanical gardens starting from the one established near Kolkata.
- The present-day garden styles in India are more or less on the pattern of the English style.

IMPORTANCE AND SCOPE OF LANDSCAPE GARDENING IN INDIA

- The role of flowers and gardens in the life of the nation and the people is not properly understood in India.
- Largely, floriculture and gardening are being neglected by the administrators and get last priority in any process of planning or allotment of funds.
- Even whatever meager funds are allocated to floriculture; it is only this branch that is made the first target of any economy drive.
- Though floriculture and gardening have to go a long way to develop to significant level.
- The credit for giving floriculture and gardening- a good start and consequently some status goes largely to the noted administrator-cum -scientist, **Dr. M.S. Randhawa.**
- His work in this field was carried further by another noted scientist and great lover of flowers, particularly roses, **Dr. B.P. Pal.**
- **But** for the encouragement given by these two scientists, floriculture would not have reached the present level of achievement and gained the status that it is having today.
- Of course, the patronization and encouragement given to floriculture and gardening by the late Prime Minister Jawaharlal Nehru and also the late President **Dr. Zakir Hussain** must also be recalled with gratitude.

LANDSCAPE GARDENING

The importance of gardening is also not understood, in India. The people should be educated to realize the importance of gardening, by providing good parks and gardens in cities for a large population to relax and enjoy the beauty of nature.

BIO-AESTHETIC PLANTING

- The term bio-aesthetic planning, a concept of **Prof. Lancelot Hogben,**
- This means the proper utilization of the available flora and fauna in the beautification of the surroundings.
- In India, the theme of bio-aesthetic planning was propagated by **Dr M.S. Randhawa** who

gave a practical shape to it in planning **Chandigarh City** along with the famous architects **Le Corbusier** and **Pierre Jeanneret**.

- The aim behind this concept is to plant ornamental flowering trees all along the roads, in parks, house compounds, public places and also to develop national parks where non-carnivorous animals and beautiful birds will find sanctuary along with beautiful flora. This term also includes landscape gardening though in a wider sense.
- Bio-aesthetic planning should run hand in hand with town planning.
- Our new townships should not be allowed to grow as mushrooms in dung-heaps as our older towns are.
- The roads in town and cities should be broad, planted with flowering and shade trees, and there should be spacious parks along with conservatories for harmless animals and birds.
- The older congested cities and towns also should be retrieved from their present state by bio-aesthetic planning.
 - One way of doing this is to acquire by compulsion the ugly areas of the towns in some centrally located pockets and to convert them into parks.
 - The displaced persons may be accommodated in multi-storey buildings which occupy less land.
 - But many planners are against vertical growth in our towns; a compromise must be found somewhere.
 - In some of the most congested cities such as Kolkata, Kanpur, Mumbai etc., it may be really impossible to get land in the city proper for bio-aesthetic planning.
 - In such cases '**garden suburbs**' should be developed on the outskirts of the city with easily approachable by vehicles or even bicycles.
 - The real estate value of any property goes up if it has a compound properly landscaped and planted with trees.

LANDSCAPE FOR POLLUTION FREE ENVIRONMENT

- Air pollution is one of the most talked problems in the present age, has reached disturbing proportions in some of the largest cities of the world and also in some of the metropolitan cities in residential areas, and proliferation of motor vehicles.
- The smoke from the coal ovens (chulas) of the residential houses, the dust and the smoke from the grinding mills and chimneys of the factories and the exhaust fumes from the motor vehicles all add to the pollution of our cities.
- Pollution is causing an increase in the diseases of the respiratory tract, cancer and many other ailments. Unless something is urgently done the health of our citizens many deteriorate rapidly.
- The role of open spaces such as parks and of living plants in checking air pollution is well known.
- The parks are considered as the lungs of the cities.
- The barrier of trees checks noise pollution, dust pollution and air pollution.
- The role of landscape gardening in human welfare cannot be overlooked.
- Even in an under – developed country as India, people do not live by bread alone.
- They also need some finer things of life. It is a great tragedy that, most of our children in big cities do not have any open space to play and to see colourful flowers, birds and butterflies.
- It is the moral duty of our government, through the municipalities, corporations and such other bodies, to provide the citizens with spacious parks having beautiful trees and flowers where they can relax, find peace of mind and breathe fresh air after a day's hard work.
- The children will also be able to play freely in such parks. It is a common sight in congested cities that groups of youngsters play football, cricket, or hockey in the by-lanes in the absence of playgrounds and parks.

- The wealth of any nation is linked with the health of its people.
- Unless we can ensure the healthy development of our citizens, especially the younger generation, by providing them for open breathing places through bio-aesthetic planning and landscape gardening, we cannot expect to build up a healthy society and prosperous nation.

LANDSCAPE ARCHITECTURE:

“The art and science of analysis, planning, design, management, preservation and rehabilitation of the land. This includes site planning, garden design, environmental restoration, town or urban planning, park and recreation planning, regional planning and historic preservation.”

OR

It is the design of outdoor and public spaces to achieve environmental, socio-behavioral and/or aesthetic outcomes.

It involves the systematic investigation of existing social, ecological and geological conditions and processes in the landscape and the design of interventions that will produce the desired outcome.

The scope of the profession includes:

- Urban design;
- Site planning;
- Town or urban planning;
- Environmental restoration;
- Parks and recreation planning;
- Visual resource management; green infrastructure planning and provision;
- Private estate and residence landscape master planning and design;
- All at varying scales of design, planning and management.
- A practitioner in the profession of landscape architecture is called a **Landscape Architect**.
- A Landscape Architect is a person involved in the planning, design and sometimes direction of a landscape, garden, or distinct space. The professional practice is known as Landscape Architecture.
- Landscape architecture was not commonly recognized in developed nations as a distinct profession until the early twentieth century.

LECTURE-2

FLORICULTURE

- ♦ 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”

OR

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. It includes bedding plants, flowering plants, foliage plants or house plants, cut greens and cutflowers”.

- 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.

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. 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, liliun, 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, Berleria 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.

2. AESTHETIC POINT OF VIEW:

- Lot of scope for landscaping and is considered as billion dollar earning industry in states which ultimately adds the monetary 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 buildup 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.

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.

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 posses 25-30 time more foreign exchange earning ability than cereals or any other agricultural/horticultural products.
- Floriculture is capable of attracting and retaining large number of progressive farmers / entrepreneurs.
- Due to ample sunlight and optimum temperature during winter, it does not require artificial lighting or heating for green house 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 Tuberos
5	North Eastern region including Sikkim	Orchids, Gladiolus, Liliiums, Gerbera, Salvia, Anthurium and other Foliage Plants
6	Area around Kolkata	Lotus, Tuberos, 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, Tuberos, Chrysanthemum, Rose, Carnation and Orchids

PROBLEMS / CONSTRAINTS 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.

AREA AND PRODUCTION OF FLOWERS IN THE STATE AND THE COUNTRY

- ♦ India ranks 2nd next to China with an area of 1, 91,000 hectare and produces 1031 thousand metric tons of loose flowers and 66,671 lakh cutflowers annually (2010-11).
- ♦ 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).

FLOWER FEELINGS:

- Flower meanings and symbolization are the key elements for flower choice since time immemorial as they expresses 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.

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.

@@@@

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

LECTURE-3a

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).

EXPORT MARKET FOR INDIAN PRODUCTS:

- ◆ 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.

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.

CUT FLOWERS EXPORT POTENTIAL:

- The cut flowers generally grown under greenhouse/polyhouses are being exported to The Netherlands, Japan and Germany.
- The international buyers are re-exporting the goods which they import from various developing countries.
- Spain, Kenya and Israel have also started exporting the flowers, accounting 2, 2 and 6%, 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.
- Developing countries have only 6% share in the world market. This help in increasing the export from India which is otherwise negligible.

TOP TEN CUT FLOWERS AND POT PLANTS IN THE WORLD TRADE

<u>Sl. No.</u>	<u>Cut flowers</u>	<u>Sl. No.</u>	<u>Pot plants</u>
1.	Rose	1.	Ficus
2.	Chrysanthemum	2.	Dracaena
3.	Tulip	3.	Kalanchoe
4.	Lily	4.	Chrysanthemum
5.	Carnation	5.	Begonia
6.	Gerbera	6.	Hedera
7.	Freesia	7.	Azalea
8.	Cymbidium	8.	Saintpaulia
9.	Alstroemeria	9.	Hydrangea
10.	Limonium	10.	Spathiphyllum

INDIAN SCENARIO

In India, floriculture industry comprises,

- Flower trade, Production of nursery plants and potted plants,
- Seed and bulb production, Micro propagation and
- Extraction of essential oils and natural pigments.

MAJOR IMPORT MARKETS FOR FLORICULTURE PRODUCT:

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

- Germany is the single largest market accounting for nearly 25 % of the world imports.

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 %.

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.
- ♦ 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.

INSTITUTIONAL ASSISTANCE TO FLORICULTURE HI-TECH PROJECTS:

1. NABARD Soft Loan Assistance:

a. National Bank for Agriculture and Rural Development (NABARD) has evolved a scheme for extending soft loan assistance to prospective entrepreneurs.

b. The entrepreneurs could be individual, proprietary / partnership firm, group of individuals, co-operative societies etc.

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.

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 %.
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.

4. **Nationalized banks viz.,** State Bank of India, Canara Bank etc.,

@@@@

LECTURE-3b

CLASSIFICATION OF FLORICULTURAL PRODUCTS FOR TRADE:

Floricultural products are classified as per the International trade of 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

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, Nemesia, 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, 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, Berleria, 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, Barleria, 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.

INDUSTRIAL IMPORTANCE OF COMMERCIAL FLOWERS IN INDIA & 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.

COMMERCIAL FLOWER INDUSTRIES IN INDIA HAVING 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 Moerheim 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.
8. Laxmi Flori-tech Ltd: Bangalore (Nelamangala) with Flodae BV. Holland.
9. 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.
10. Meghana Flori-tech Ltd, Bangalore.
11. Vasavi Florex Ltd. Bengaluru

LECTURE- 4

ROSE

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.

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.

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. 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.

- 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, Cinderella, 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 **Climber roses** are of most commercial importance and

- 1. Flowers 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.
- 2. Produces singly or in groups of 2 or 3.
- 3. Flowering spreads over the season.
- 4. Medium in vigor.
- 5. Produces bigger flower than ramblers round the year.

10) PERFUME AND ALLIED PRODUCTS:

- ◆ **Rose water:** Important commercial product obtained from rose petals, used as perfume, medicine and confectionary. Its important uses are, cools the body, used in eye lotions, eye drops for its soothing qualities. Drinking water. It is sprinkled on guests at weddings, feasts & other social functions.

- ◆ **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 *Shilagella 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.

- b) **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.
- c) **Pankhuri:** Dried rose petals are known as pankhuri, they are occasionally used for preparing sweetened cold drinks.
- d) **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. davorica, R. pendulina, R. glauca and R. canina.*

- ◆ The hips of *R. roxburghii, R. acicularis, R. rugosa, R. davorica* 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.

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, *Rosa brunonii* (Himalayan Musk rose), *R. eglanteria* (Syn. *R. foetida*, Austrian rose), *R. involucrate* (Syn. *R. sempervirens*), *R. leschenaultiana* (Syn. *R. sempervirens*), *R. longicuspis*, *R. macrophylla*, *R. moschata* (Musk rose), *R. rubiginosa* (Sweet briar/ Eglantine rose), *R. walpoleana*, *R. sericea* (Ladakh rose) and *R. multiflora*

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)

CLASSES OF PRESENT DAY GARDEN ROSES:

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

roses; most popular rose. Bears 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*.

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)

5) **Grandifloras:** Mainly obtained from crosses between 'Hybrid Tea' and 'Floribunda' type. Produces large number of flowers in cluster with fine form. Eg: Montezuma (1955), Queen Elizabeth (1954), Jazor (2000).

6) **Polyanthas:** Dwarf with small flowered polyanthas is the forerunner of Floribundas. Blooms for several months.

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. Used for training on arches, pergolas, etc.

a) Multiflora ramblers from *R. multiflora*,

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

b) Wichuriana ramblers from *R. wichuriana*

Eg: American Pilla (1902)

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.

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 budsports of the *R. centifolias*. 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. 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*. 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*)

LECTURE-5

CULTIVATION:

- 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 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.

▪ 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.

▪ 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.

▪ 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.

▪ 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.

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.

PROPAGATION OF ROSES:

Methods: Seed propagation and vegetative propagation:

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 bellow for rooting.

b. 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 Bangalore, 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.

ROOT STOCKS:

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.

COMMON ROOT STOCKS:

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 and India, very hardy and is an excellent rootstock.
3. *R. indica var. odorata* : Tolerant to powdery mildew & other insects. Resistance to extreme soil conditions.
4. *R. multiflora var. Inermis* good for outdoor roses. Resistant to nematodes.

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.

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 cm³(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 Hybrids
60x60cm for others

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 shoots.
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 ones.
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.

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 crop growth
 - Soil texture/ type of 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.

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 - Potassium sulphate
 - 14.17 g - Ammonium sulphate
 - 28.35 g - Potassium nitrate in 3.79 litres of water and may be applied @ 1.36 ml / liter of water.

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).

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 a.i. / acre

PRUNING:

- 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:

- 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.

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.

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.

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 want of 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.

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.

LECTURE- 6

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 intime, there is chance of developing fruits bearing seeds.
- * Once the hips are formed and reach the advanced stage of development, growth and flowering are severally reduced during the season;
- * Cutting of faded flowers will force to produce strong lateral shoots which will produce good quality flowers.

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 varying 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.

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.

POST HARVEST TECHNOLOGY:

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

1. Pre-cooling:

- ✳ In a cold storage at the temperature of 4.4 to 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 frights.

- ✳ 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 intern makes the cut flower very hardy and turgid to improve the quality of cut flowers, also have lees 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.

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 overage 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:

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

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 @ 150pm, AgNO₃ @20-30ppm, citric acid @ 200ppm have been found to be good for prolonging the vase life of cut roses.

PESTS & DISEASES OF ROSES:

PESTS : 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.

@@@@@

LECTURE- 6b:

PROTECTED CULTIVATION OF ROSES

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.

IMPORTANT VARIETIES:

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

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 months 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.
- Accommodates 7 to 8 plants per metre square (Depending upon 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.

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 @ 0.75 -1.0 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.

@@@@@@

LECTURE - 7

CHRYSANTHEMUM (*Asteraceae*) (*Chrysanthemum morifolium* / *Dendranthema grandiflora*)

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 **Chrysos** means 'golden' and **anthos** means 'flower'.
- It is commonly known as 'Queen of East/ autumn queen/ guldaudi.
- Japanese National Flower.

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*.

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.

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 *ogiku* 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: Arctic, 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: Apsara, 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 refluxed, they are intermediate in shape to incurved and refluxed. 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 Gandhi.
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 refluxed 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.

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.

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.

CULTIVATION:

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

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.

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.

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.

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.

AFTER CARE

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.

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.
- 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

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.

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.

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 loose vigour and becomes weak.

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.

WEED CONTROL:

- Weeding and hoeing are generally done manually as and when required, normally 8-10 times yearly.

GREEN HOUSE CULTIVATION

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.

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.

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.

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.

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.

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.

EXPORT STANDARDS FOR CHRYSANTHEMUM:

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

● ● ● ●

LECTURE- 8

CARNATION

(Caryophyllaceae; *Dianthus caryophyllus* L.)

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.

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*

TYPES OF CARNATION

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.

1. Standard types:

- Produces single large blooms with longer flower stalks.

2. Spray types:

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

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

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 5-18°C is considered to be the ideal for the crop.
- Day temperature : 28°C (20 -25 °C)
- Night temperature : 16-18°C (10 -15 °C)
- 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

PROPAGATION:

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

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.

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:

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.

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.

1. 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.

2. 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.

3. 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

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.

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.

IRRIGATION:

- ♣ Over watering and poor drainage causes root death and stunted growth.
- ♣ Water logging would cause deprivation 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

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'.

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 metasystox (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.

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 0°C 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.

@@@@@@@



LECTURE -9 a

GERBERA (*Gerbera jamesonii*)

INTRODUCTION:

- Gerbera 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.

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 have been identified, native to tropical Asia and Africa.

SPECIES AND CULTIVARS:

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

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.

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.

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

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.

@@@@

LECTURE 9b

PROTECTED CULTIVATION OF GERBERA

- The height of the greenhouse/shade house should be minimum 5-6.5 m; so there is proper air circulation.
- Sufficient ventilation space is required on top and sides.
- To protect the plants in the monsoons provision for covering the top with polythene or plastic sheet is advised.
- 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.

- 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 (Bud initiation will stop) and above 35°C (Frequency of flowers will be very low & absorption of buds will take place).
- The optimum humidity inside the greenhouse/shade house should be 70-75%, which will maintain the health of the plants.

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.

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.

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.

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

DISEASES/ PESTS:

- Aphids, Greenhouse Whitefly, Leaf Miner, Mites, Thrips,
- 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.

NEVER APPLY THE FOLLOWING CHEMICALS ON GERBERA:

Trade Name	Consistent
Hostathion	Triazophos
Tilt	Propiconazole
Topaz	Penconazole
Contaf	Hexconazole
Spark	Cypermethrin +Triazophos
Polytrin	Profenophos
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.

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, Micelf) of these microelements as a foliar spray

@@@

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 and 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

LECTURE- 10

GLADIOLI
(*Gladiolus* spp. Iridaceae)

ORIGIN AND DISTRIBUTION:



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.

- 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.

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*

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.

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 GLADIOIOLUS:

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

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.

LECTURE -11

JASMINE (*Jasminum* spp.)

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

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 jasmynes were extensively used for hair ornamentation by the women in China.

DISTRIBUTION

- Though jasmynes 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,
 1. *J. auriculatum* India
 2. *J. grandiflorm* Subtropical Himalayan region
 3. *J. sambac* India
 4. *J. muliflorum* India

COMMERCIALY IMPORTANT SPECIES:

1. *Jasminum auriculatum* (Vasantha mallige)

- Shrubby in nature
- 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, waved, 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* (Kakada)

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

CULTURAL REQUIREMENTS:

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.

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: Vermiculite: moss at 1:1:1 ratio.

PLANT SPACING, DENSITY AND SEASON:

Species	Spacing	Density(P lants/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 -

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.

NUTRITION:

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

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>	100	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

NUTRITIONAL REQUIREMENT:

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.

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.

PRUNING:

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.

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.

WEEDING:

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

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.

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.

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 stack which is stitched at the edges.

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 to 0.36 (13.44 to 28.24 kg/ha)	28-30 hrs
<i>J. grandiflorum</i>	4329 - 10144	0.25 to 0.32 (13.85 to 29.42 kg/ha)	24 hrs
<i>J. sambac</i>	739 - 8129	0.14 to 0.19 (1.18 to 15.44 kg/ha)	28-30 hrs

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.

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.

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.

TREATMENT OF FLOWERS WITH 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 70°C. The residue which is not evaporating at 70°C is rejected as impurities.
- The purified hexane is a colourless liquid with a boiling point ranging from 60°C to 80°C.
- 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.

EVAPORATION:

- After the complete extraction of the perfume from the flowers, the solvent is filtered and concentrated by evaporation at a constant temperature of 75°C.
- 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.

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.

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 75°C.
- The water bath is heated electrically by 2000 watt heating elements and the temperature is kept 75°C 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.

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.

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.

PROCESSING PROTOCOL:

TWO STEPS

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

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.

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.

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

LECTURE -12

MARIGOLD

(*Tagetes* spp., Asteraceae)

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.

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.

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.

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.

In India the cultivation of *T. erecta* and *T. patula* are dominant.

GENETICS AND BREEDING

Genetics:

Towner 1961 compiled the species of *Tagetes* based on their chromosome number is as follows

Diploid species - 2n	:	
<i>Tagetes erecta</i>	- 24	
Tetraploid species- 4n	:	<i>T. patula</i>
	- 48	

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

CULTIVATION:

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.

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.

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.

PROPAGATION:

- ◆ Marigold is propagated by both methods *i.e.*,
 1. Seeds
 2. Cuttings.

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

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.

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.

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>Tagetes erecta</u>	<u>Tagetes patula</u>
1) 40 x 40cm	1) 20 x 20cm
2) 45 x 30cm	2) 30 x 30cm
3) 60 x 45cm	

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.

WEEDING:

- ◆ 3-4 manual weeding are required during the entire growth period.

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.

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): Causal organism
Measures**

1. Damping off (*Rhizoctonia solani*) Seed treatment with captan @ 0.5%
2. Collor rot: (*Rhizoctonia solani*): Seed treatment with captan @ 0.5%.
Phytophthora sp. Pythium sp. Sclerotium rolfsi
3. Leaf spot (*Alternaria tagetica*) Spray with Blitox @ 0.4% or *Cercospora spp.* Bavistin @ 0.1%
4. Blight (*Colletotrichum capsia*) DM 45 @ 0.2%
5. Inflorescence blight (*Alternaria zinnac*) DM 45 @ 0.2% or Bavistin @ 0.1%
6. Powdery mildew (*Oidium sp.*) 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

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 (Million/ha)	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.

@@@@@

LECTURE-13

TUBEROSE

(*Polianthes tuberosa* L.; Amaryllidaceae)

INTRODUCTION:



- Tuberosa (*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 tuberosa oil.
- The tuberosa 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 tuberosa 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.

ORIGIN AND DISTRIBUTION:

- The tuberosa 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 tuberosa is derived from tuberosa. This plant is being the tuberous hyacinth and distinguishes from the bulbous hyacinth.
- In India, tuberosa 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.

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'

DESCRIPTION OF COMMERCIAL CULTIVARS:

- Tuberose cultivars are classified into three types, based on the number of rows of petals.

(i) SINGLE FLOWERED:

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:

- 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:

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.

SOIL AND CLIMATIC REQUIREMENT:

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.

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.
- Tuberose 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.

SEASON OF PLANTING:

- Tuberose are generally planted in February-March in the plains and April-May in the hills.
- The bulbs can also be planted during July-

August.

- Tuberose 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.

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.

CULTIVATION:

PROPAGATION:

- Tuberose 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 tuberose.
- 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.

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.

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.

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.

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.

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 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.

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.

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 Enfleurage.
- 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 Enfleurage 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 kglha which gives 3.5 kg absolute and 0.8 kg distillable oil.

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.

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.

@@@@@

LECTURE-14

CHINA ASTER

[*Callistephus chinensis* (L.) Nees]

INTRODUCTION:



- China aster belongs to the family Asteraceae
- Native to China.
- The genus *Callistephus* has only a single species known as *chinensis*.

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

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.

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.

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.

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

CULTIVATION:

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

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.

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.

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.

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.

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.

PINCHING:

- ◆ Pinching of main shoot at one month after transplanting promotes growth and flowering.
- ◆ Pinching delays first flowering by 8-12 days.

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.

HARVESTING AND

POST HARVEST HANDLING:

- ◆ 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.

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.

@@@@@@

LECTURE-15

ANTHURIUM

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. Watermalense*, *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.

PLANT MORPHOLOGY

- *Anthurium andreanum* a perennial with creeping, climbing or arborescent stems with lots of aerial roots.
- The attractive colourful plant that is traded is actually a **modification of the leaf**, which is botanically called '**spathe**'.

- 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.

AVAILABLE GERMPLASM

- The genus *Anthurium* can be categorized into two distinct groups –
 - Flowering types and
 - Foliage types.

FLOWERING TYPE

Anthurium andreanum, *A. seherzerianum*, *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.

- 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:



hybrids with more than one species as their parents.

- They have up right cup shaped spathe with a straight and erect spadix.
- The spathe size ranges from 10x6cm.
- Tulip types are mostly

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.	Must provide good anchorage.
High porosity.	Should have optimum pH (5.0) and EC (0.6m mhos/cm ²)
Good aeration.	Good structure and texture.
Low salt concentration (especially Na ₂ , Cl and Ca ₂ ⁺ ions).	

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	Saw dust
Coffee leaf mould	Tree bark
Spent ground coffee	Chicken manure
Coffee husk	Ground nut shells
Cured coffee pulp	Peat
Coffee parchment	Wood shavings
Rock wool	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.

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 CaNo₃ 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.

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.

PEST AND DISEASES

PESTS:

- 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-16

POST HARVEST TECHNIQUES OF CUT FLOWERS

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.

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.

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

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.

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	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.
5	Carnation	Standard	Paint brush stage when flowers are half open
		Spray	At least two flowers fully open
6	Gerbera	Cut flower	Flowers open but outer two rows show shedding of pollens (fully mature)
7	Gladiolus	Cut flower	1-5 florets show colour
8	China Aster	Cut flower	Fully opened flower with long stalk
		Loose flower and oil extraction	Fully opened with short or no stem
9	Tuberose	Cut flower	When few flowers open at the base
		Loose flower and oil extraction	When all the flowers are fully opened

Why immediately after harvesting of flower the 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.

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.

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 bring 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.

PRE-COOLING TEMPERATURE FOR CERTAIN FLOWERS:

Crop	Pre-cooling temp. (° C)	Crop	Pre-cooling temp. (° C)
Rose	1-3	<i>Cymbidium</i>	0.5-4
Anthurium	13	Gladiolus	4-5
Gerbera	4	Bird of Paradise	7-8
<i>Dendrobium</i>	5-7		
Carnation	0.5-1		
Chrysanthemum	0.5-4		

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 stored 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

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.

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.

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.

GERBERA

Grade No.	Stem length (cm)	Flower diameter (cm)	Flower colour	Preference (%)
1.	More than 60 cm	More than 12 cm	Pink	40%
2.	50-60	11-10	Reddish orange	20
3.	40-50	10-9	Orange	20
4.	30-40	9-8	Red	15
5.	Below 30	8-7	Yellow	5
Stage of harvest when ray florets completely elongated				
Number of flowers in bundle –50 flowers in CBF box				
Box size – 100x30x10 cm				
Popular variety – Sangria, Cabana, Thalasa				
Switzerland (Red, violet to soft shades)				

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

- ✓ Primary packaging - container that directly holds the product



Eg.,

Wrapping materials (paper, polythene), vases, bouquets, 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

LABELING:

- The packed boxes should be labeled,
 - Crop,
 - Variety,
 - Colour
 - Grade or standard,
 - Grower identification
 - Date of harvest
 - Quantity etc.

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.

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.

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).

VASE LIFE OF CUT FLOWERS:

- | | |
|----------------------|-----------------|
| 1. China aster | : 5 to 10 days. |
| 2. Birds of Paradise | : 1 to 2 weeks. |
| 3. Carnation | : 03 weeks. |
| 4. Chrysanthemum | : 1 to 2 weeks. |
| 5. Gladiolus | : 6-12 days |
| 6. Lily | : 4 to 14 days. |
| 7. Orchid | : 3 to 4 weeks |
| 8. Rose (HT Rose) | : 7 to 10 days. |
| 9. Spray Rose | : 7 to 10 days. |
| 10. Tuberose | : 7 to 10 days. |

@@@@@@

Crop	Grading method/s			
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. 			
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. ◆ According to North American Gladiolus Council (NAGC), USA 			
	Grade	Spike length (cm)	Minimum No. of florets	
	1. Fancy (Grade A)	107	16	
	2. Special (Grade B)	96-107	14	
3. Standard (Grade C)	81-96	12		
4. Utility (Grade D)	<81	10		
CARNATION	<ul style="list-style-type: none"> ▪ Based on the degree of bud opening ▪ Flower diameter ▪ Stem length, strongest of stem etc. ▪ According to Society of American Florists, USA 			
	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	
CHRYSANTHE MUM	<ul style="list-style-type: none"> ▪ Generally based on stem length and flower size, ▪ Long stem and large sized flowers fetch better price. ▪ According to Society of American Florists, USA 			
	Grade	Minimum flower diameter (cm)	Minimum stem length (cm)	
	1. Blue (fancy)	14.0	76	
	2. Red (special)	12.1	76	
3. Green (short)	10.2	61		
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. 			

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)
	<ol style="list-style-type: none"> 1. Extra large 2. Large 3. Medium 4. Small 5. Miniature/Tiny 	<p>>6</p> <p>5-6</p> <p>4-5</p> <p>3-4</p> <p><3</p>	<p>>15</p> <p>13-15</p> <p>10-13</p> <p>8-10</p> <p><8</p>
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. 		

LECTURE-17

DRY FLOWER TECHNOLOGY

INTRODUCTION:

- There is an increasing demand all over the world for decorating living and working places with eco-friendly things like flowers and foliages.
- Fresh flowers and foliages 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 foliages 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.

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 loses occurring in fresh flower handling.
10. Requires less maintenance.
11. Biodegradable.
12. A variety of products can be prepared.
13. Tolerant to most temperature.

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.

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.

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.

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.

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.

2. TEMPERATURE: Higher temperature leads to rapid moisture loss so the quality of finished product goes down with rise in temperature. Low temperature leads to delayed drying and results in poor quality due to mould growth.

3. AIRFLOW: It is essential for conducting heat from the source to the product through embedding and also for the transfer of moisture liberated from the product to the atmosphere outside.

4. EMBEDDING MATERIAL: Rate of evaporation is different in different embedding material due to different capacities to conduct heat and absorb moisture.

5. METHOD OF DRYING: Rate of moisture loss and quality of produce also depends on method of drying.

Drying methods

1. Sun drying
2. Air drying/Drying under shade
3. Polyset drying
4. Press drying
5. Embedded drying : a) in room
b) in sun
6. Hot air oven drying
7. Microwave oven drying
8. Vacuum drying
9. Freeze drying
10. Skeletonizing
11. Drying through treatment with glycerin
12. Dyeing

1. Sun drying- Most common method

Procedure: After bunching, flowers are hung upside down tied to the thread and dried in sun.

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.

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.,

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

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.

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 in kept is electric hot air oven for 24 hours at 40-45^o 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 foliages 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*,

GRASSES AND FERNS:

Adiantum, *Nephrolepis*, Golden fern, Silver fern

FOLIAGES:

Thuja, *Cassia biflora*, *Haematoxylon*, Marigold, *Casuarina*, *Calliandra*, Rose foliage, *Grevillea robusta*, *Taxodium distichum*.

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.

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 ^o 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.

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.

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

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.

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.

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.

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 foliage 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.

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.

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.

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

SUITABLE FLOWER FOR DIFFERENT TECHNIQUES:

Methods	Crops
Air drying with silica gel	Anemone, Freezia, Zinnia, Narcissus
Borax/ Alum drying	Snapdragon, cosmea, Delphinium
Drying with sand	Dahlia
Air drying with water	Foliage

or immersion in glycerin	
Air drying preserves fragrance	Lavender
Air drying with glycerin	<i>Mollucella</i>
Air drying with glycerin	Rose
Air drying	<i>Allium, Helipterum, Leucodendron, Mimosa, Gomphrena, Verbena</i>
Microwave oven drying	Spray carnation
Microwave oven drying	<i>Chrysanthemum</i> (small)
Microwave oven drying	Iris, Orchids, Sweet William, Tulip

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.

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.

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.

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.

VALUE ADDITION :

Value added products

Dried flower are exported as assortments of value added items.

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

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.

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 balk materials.

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).

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 everlastings. 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

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.

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.

MAJOR COMPANY 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 companies export their product to U.S., Holland Germany, Denmark, Czechoslovakia, Italy, France, Spain, UK, Belgium, South Africa, Srilanka, Australia and Mexico.

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

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 collects 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.

@@@@@@

LECTURE-18

LANDSCAPE GARDENING

1. **Landscape gardening:**

- It is a branch of floriculture which deals with the study of ornamental gardening or garden features.

(OR)

- Bringing an area or piece of land into a garden by utilizing naturally existing features like undulations, terraces and plain surface so as to look to have more naturalistic effect than artificial in order to imitate nature

2. **Ornamental gardening:**

- It may be defined as a place for growing plants exhibits various forms of plant life, which are consciously directed for ornamental or practical use.

3. **Landscape architecture:**

- It is a combination of art and science and it deals with the study of ornamental or landscape gardening.

4. **Landscape architect:**

- Person who plans, designs and executes a work of landscaping is referred as landscape architect.

5. **Arboriculture:**

- It is a branch of science which deals with the cultivation of trees.

6. **Arborist:**

- An arborist is a person who cultivates and conducts research on tree species.

7. **Gardner:**

- Any person who maintains or involved in carrying out day to day operation in the garden or a person who establish and maintains the garden

8. **Conservatory:**

- The glazed structure used for maintaining/growing different plant species or displayed for scientific study or commercial cultivation with or without environmental controlling facility.

9. **Fernery:**

- It is a structure where different types of ferns are grown or maintained for scientific or commercial purpose.

10. **Archidorium:**

- It is a structure where different species of orchids are grown or maintained for scientific or economic purpose.

11. **Archeology:**

- It is a branch of floriculture which deals with different species and varieties of orchids.

12. **Bio-aesthetic planner:**

- He can be described as a master artist who uses the whole country as his canvas and his paints are the rich colours of red, blue, orange and white of the different flowers.

Suggestions for implementing the principles of gardening:

1. The first and the foremost thing are not to imitate another garden which has secured a prize in a competition.
2. One has to develop one's own design giving due consideration to the local conditions.
3. One more mistake which is commonly made is to plant many more specimens than a garden can accommodate causing overcrowding.
4. In a landscape garden any difference in levels has to be taken advantage of, but in a perfectly flat land it will be costly to create artificial undulations.
5. In each garden there should be atleast one feature or if there be a second these two should harmonize with each other.
6. Before planning a design one must be sure for what purpose the garden is - utility or beauty or both.

PRINCIPLES OF GARDENING:

1. INITIAL APPROACH:

- In theory, everyone would like to have a perfect plot of land, but in actual practice the plot available for gardening, in three out of five

cases, either will not be in a good site or the shape and size will not be ideal.

- A good designer is one who will make best use of such a site.
 - As has already been stated, land with natural undulations should never be leveled, but rather the differences in levels should be utilized with advantage.
 - Fencing, should be such that it looks natural as far as practicable and it should not obstruct any natural view. For example, if there is natural forest scenery or a hillock just outside the boundary it should be incorporated in the garden design in a thoughtful manner so that it appears to be a part of the garden.

2. AXIS:

- This is an imaginary line in any garden around which the garden is created striking a balance.
- In a formal garden, the central line is the axis.
- At the end of an axis, generally there will be a focal point, although other architectural features such as bird-bath or sundial can also be erected at about the midpoint.

3. FOCAL POINT:

- In every garden there is a centre of attraction which is generally an architectural feature focused as a point of interest such as **statue, fountain, rockery** etc.
- A focal point is one of the elements of good landscape design.

4. MASS EFFECT:

- The use of one general form of plant material in large numbers in one place is done to have mass effect.
- To see that such mass arrangements do not become monotonous, the sizes of masses should be varied.

5. UNITY:

- Unity in a garden is very important as when this is achieved it will improve the artistic look of the garden.

□ Unity has to be achieved from various angles.

- **First**, the unity of style, feeling and function between the house and the garden has to be achieved.
- **Secondly**, the different components of the gardens should merge harmoniously with each other.
- The aim is to give the visitor an overall impression of the garden rather than blowing up some special features.
- The last point, which is also very important, is to achieve some harmony between the landscape outside and the garden.
- A garden laid out in complete defiance of the local conditions may look exotic, but is not a successful garden. As for example, cacti planted in a seashore garden is completely out of place as these are inhabitants of dry localities.
- To achieve a unity between the house and the garden it is a common practice to train creepers on the front porch which cover the rudeness of the masonry work and also bring the house closer to nature.
- For the same reasons, foundation plantings are also done. A foundation planting broadly means the planting of bushy plants near the foundation of the house.

6. SPACE:

- The aim of every garden design should be such that the garden should appear larger than its actual size.
- One way of achieving this is to keep vast open spaces, preferably center lawn and restrict the plantings in the periphery, normally avoiding any planting in the centre.
- But if any planting has to be done in the centre the choice should be a tree which branches at a higher level on the trunk (or the lower branches are removed) and not a bushy shrub.
- Such planting will not abstract the view or make the garden appear smaller than its size.

- ❑ Another suggestion to create the illusion of more space in a large public garden is to alternate large lawns followed by a group of trees.
- ❑ A large open space planted haphazardly all over with trees looks smaller than its size.
- ❑ **The techniques of creating an illusion of more space are also referred to as 'Forced Perspective'.**

7. DIVISIONAL LINES:

- ❑ In a landscape garden, there should not be any hard and fast divisional lines.
- ❑ But there is the necessity of dividing or rather screening a compost pit or a Mali's quarter or a vegetable garden from the rest of the garden.
- ❑ In fact areas under lawn, gravel, stone or cement path, and shrubbery border have their natural divisional lines from its immediate neighbour though these are not discreet. This is what is exactly needed.
- ❑ The divisional lines should be artistic with gentle curves and these should also be useful.
- ❑ Above all these lines should harmonize with one another.

8. PROPORTION AND SCALE:

- ❑ Proportion in a garden may be defined as a definite relationship between masses.
- ❑ For example, a rectangle having a ratio of 5:8 is considered to be of pleasing proportion.
- ❑ As this ratio comes down the form looks neither a square nor a rectangle and the design becomes undesirable.
- ❑ There is no set rule as regards scale or proportion in a garden.
- ❑ But a simple rule is that a design should look pleasant.
- ❑ It is better to have an adhoc design first and then try it out on the actual spot. If the design looks appealing as well as pleasing, it is implemented.
- ❑ When a shrubbery border has to be planted the outer design is marked by arranging a rubber hose or thick wet rope in different designs on the spot and the one which looks best is adopted.

- ❑ Then sticks of different heights, representing the various shrubs, are planted in various positions and by the method of permutation and combination the most proportionate looking arrangement is adopted.
- ❑ The common practice of laying out a small rockery at the base of a large tree with small rockery at the base of a large tree with small thorny specimens looks not only ugly but is also out of scale and proportion under the large canopy of the tree.
- ❑ A tiny pool in the midst of a large lawn also looks disproportionate.

9. TEXTURE:

- ❑ The surface character of a garden unit is referred to as texture.
- ❑ The texture of the ground, the leaves of a tree or shrub will all determine the overall effect of the garden.
- ❑ The texture of rugged looking ground can be improved to an appreciable extent by laying meticulously chosen small pebbles from the riverbeds, if establishing a lawn is out of the question.
- ❑ A *gulmohar* is a fine textured tree when in full leaf, whereas
- ❑ *Spathodea companulata* is a coarse textured tree. The placement of all these various textures with harmony and contrast has to be achieved to get the ultimate desirable effect.

10. TIME AND LIGHT:

- ❑ In a garden the time factor is very important. There are three different categories of time in a garden.
- ❑ **First** come the **daily time**, which provides different quantities and qualities of light during the course of the day.
- ❑ As the morning sun is vital for all flowers, the designer has to take this into account while planning.
- ❑ In most parts of India the garden design should be planned in such a way that in the afternoon it is possible to sit in a shaded place from where the best part of the garden should be visible.

- ❑ **The second** type of time is the **seasonal changes** in the year.
- ❑ A good planner must roughly take into account the seasonal movement of the sun and where the shade and light are likely to fall during the different parts of the season. As for example, a lawn in Delhi which receives shade during the early parts of the day in the winter will not grow or remain patchy. A good and knowledgeable Gardner is he/she who can visualize such eventualities.
- ❑ **The third time**, which most people overlook or cannot visualize, is the fact as to what shape and proportion the shrubs and trees will attain in the years to come.
- ❑ Often we can see sickly and lanky shrubs growing near the trunk of a large tree, because of lack of light and possibly nutrients also.
- ❑ The shrubs were planted when the tree was a sapling, without visualizing what would happen to them when the tree attained its full size.
- ❑ The right type of tree should be planted at the proper place so that shade is obtained during the hot days, at the appropriate time.

11. TONE AND COLOUR:

- ❑ A tendency on the part of an amateur Gardner is to create a riot of colours by indiscriminately planting flowering annuals of all shades. This practice is not desirable. Moreover, such riot of colours has only temporary effect.
- ❑ In a landscape garden, the permanent backdrop is the green tones of the various trees and shrubs.
- ❑ It is possible to lay out a garden with fine tone of entirely white or yellow flowers, but at the same time making it charming also.
- ❑ Another important point is that it is better to have masses of a single colour against a mixture of colours.
- ❑ A bud of roses containing only a single colour of say red, yellow, or pink has a much softer tone and beauty than a rose bed containing a mixture of colours.

12. MOBILITY:

- ❑ In a temperate country, the garden changes colour very sharply and contrastingly from one season to the other thus symbolizing mobility or movement.
- ❑ As for example, many trees in the temperate regions attire themselves with wonderful hues due to the changes in their leaf colour in the autumn.
- ❑ In most parts of Tropical India, though these contrasting changes cannot be achieved, it is possible to bring in some subtle changes.
 - ❑ For example, to create some symbol of movement trees such as Bengal or Indian almond (*Terminalia catapa*) which changes its leaf colour into striking red twice annually before falling.
 - ❑ *Lagerstroemia flos-reginae* which also changes the colour of the leaves to coppery shade in the autumn before shedding.
 - ❑ *Madhuca indica* and *Ficus religiosa*, the new foliage of these appearing as coppery red in the spring, should be planted in some parts of the garden. This, in addition, improves the landscape.
- ❑ The movement and clattering of birds also bring life and mobility to the garden, though sometimes some birds may become a menace.
- ❑ Large trees and bird-baths attract birds. For the smaller birds, the safety of shrubberies is needed to protect them from large predator birds.
- ❑ Some plants, bearing berries, such as *Ficus infectoria* and *Syzygium cumini* (Syn. *Eugenia jambolana*), can also be planted in some remote corners though they may not look very ornamental.
- ❑ Flowering trees such as *Bombax malabaricum* (silk cotton) or *Erythrina* also attract birds when in bloom.
- ❑ The seasonal flowers will bring in the motion and movement of colourful butterflies.
- ❑ Fountains or even a lawn sprinkler and streams in a garden also serve the objective of movement.

- ❑ The lily pools should be filled with coloured fish, the movement of which will be an added attraction.
- ❑ The frogs will also come and inhabit these pools uninvited and in the process bring in more movement.

13. STYLE:

- ❑ Lastly, one has to decide about the style to be adopted for one's garden.
- ❑ Broadly speaking, every garden lover has to invent his own style of gardening commensurate with his budget, taste and the nature of the site.
- ❑ But a man can develop his own design only when he studies carefully all the great garden styles of the world and grasps the underlying principles in them.
- ❑ There is no doubt that persons not having enough specialized knowledge will commit mistakes; nevertheless, one should not get deterred by this fact.

@@@@

LECTURE-19

STYLES OF GARDENING

Besides the term “landscape gardening” the other two familiar terms in gardening are the **Formal** and **Informal gardens**.

1. FORMAL GARDENS:

- ❑ A formal garden is laid out in a symmetrical or a geometrical pattern.
- ❑ In this garden the design is stiff as everything is done in a straight and narrow way.
- ❑ In such gardens everything is planted in straight lines.
- ❑ Also if there is a plant on the left hand side of a straight road, a similar plant must be planted at the opposite place on the right hand side *i.e., mirror image of each other.*
- ❑ The flower beds, borders, and shrubbery are arranged in geometrically designed beds.
- ❑ Trimmed formal hedges, Cypress, *Ashoka* trees, and topiary are typical features of a formal garden.

2. INFORMAL GARDENS:

- ❑ In an informal garden, the whole design looks informal, as the plans and the features are arranged in a natural way without following any hard and fast rules.
- ❑ But here also the work has to proceed according to a set and well-through-out plan; otherwise the creation will not be artistic and attractive.
- ❑ **The idea behind this design is to imitate nature.**

3. WILD GARDEN:

- ❑ A comparatively recent style of gardening, namely, “**Wild Garden**” was expounded by **William Robinson** in the last decade of the nineteenth century.

- ❑ His idea was revolutionary and found many admirers to follow this.
- ❑ The concept of wild garden is not only against all formalism but it also breaks the rule of landscape styles.
- ❑ His main idea was to naturalize plants in shrubberies.
- ❑ He also preached that grass should remain unmowed, as in nature, and few bulbous plants should be grown scattered in the grass to imitate wild scenery.
- ❑ He also suggested that passages should be opened in the woodland, and trees, shrubs, and bulbous plants should be planted among the forest flora to fulfill his idea of a wild garden.
- ❑ His other idea was to allow the creepers to grow over the trees naturally imitating those of the forests.
- ❑ Before someone starts to venture into designing a garden it will be wise to get an idea about the major gardening styles of the world.
- ❑ This will pen up a window to this knowledge on gardening and help him design his own garden by adapting the best from each or any of these.
- ❑ But this does not mean that one should copy any garden style. For example, when a would-be writer studies Shakespeare, Shaw, or Tagore it does not mean that he will translate their ideas in his work of literature. He only studies the styles of writing and forms his own ideas suiting to the situation and time.
- ❑ Similarly, a garden enthusiast has to study the different styles only to gain knowledge to help him form his own ideas suiting the local condition and limitations such as a available space, funds, etc.,
- ❑ Though in India from history and ancient literature we find that gardening was quite in vogue in olden times, but unfortunately there is no garden style called “Indian garden”, which can claim a place in the major gardening styles of the world.
- ❑ The famous garden style of India the “Mughal Gardens” are nothing but a replica of the ancient Persian Gardens.

The major garden styles are;

1. Mughal Gardens,
2. Persian gardens,
3. Italian gardens,
4. French gardens
5. English gardens and
6. Japanese gardens

□ Out of these, the **Mughal, Persian, Italian and French styles are Formal Gardens**, whereas,

□ **English and Japanese gardens** are classified as **Informal Style of gardening**.

{1} ENGLISH GARDENS:

- Due to favorable climatic conditions such as high annual rainfall, the natural ground cover in the English countryside is grass.
- With this in mind the famous **British garden architects Repton and Capability Brown** advocated the concept that the British gardens should like the countryside.
- Their main idea was that, the gardens should merge with the countryside without any artificial barriers such as fences, hedges, or the like.
- But it is only in the eighteenth century that these two gentlemen along with **Kent** brought the touch of nature in the garden, although the history of gardening in England dates back of fourteenth century.
- They started kitchen gardens to supply vegetables to the inmates of the monasteries and grew herb gardens for medicines.
- But this gradually imbibed the spirit of gardening to the people who realized the goodness of residing in pleasant surroundings.
- By the middle of the sixteenth century the English gardens saw flower beds, topiary, and terrace gardens.
- In the middle of the eighteenth century gardens were laid out with more emphasis on architectural features.
- The main features of gardens during this period were **curved paths, informal groups of**

trees, rivulets or streams, artificial waterfalls and clipped hedges.

- The flowering annuals, the main stay of an English garden, came into prominence during the nineteenth century which subdued the architectural features.
- **The main features of an English garden** are the **lawn, mixed border especially of herbaceous annuals, as well as herbaceous perennials, shrubbery, and rock gardens.**
- The English climate suit admirably well for the growth of herbaceous annuals.
- This prompted them to evolve a large number of hybrids of annuals as well as to collect the best flowering plants from all over the world.
- Most of the flowering annuals that we see today in the Indian gardens, with the few exceptions of amaranthus, balsam, gomphrena, marigold, etc., were brought here by the British.

(2) ITALIAN GARDENS:

- The Italian garden style came into existence at the time of **Renaissance**.
- There is a striking similarity between the Persian and the Mughal styles with the Italian style.
- In all these styles of gardening the similarity was the use of heavy masonry features, through the character of masonry was different in the Italian style.
- The Italian elites conceived their gardens just as an extension of the lavish palaces, as a glamorous outdoor hall for entertainment and for showing off their wealth as well as status.
- **The most prominent features** associated with Italian gardens was,
 - The massive flight of stairs, generally of marble, complete with balustrade to connect the different levels in the garden.
 - Decorative urns, fountains generally in combination with stone sculptures or rather the fountains themselves used to emerge from one part or the other of the statues, are the other equally important features of the Italian gardens.

- The greatest benefit the Italian garden style brought to gardening is that it taught all of Europe that
- Gardening could be a most respectable form of art which demanded through and careful study.

(3) FRENCH GARDENS

- In the sixteenth-century France, the court life was shrouded with stiff formality and exactness. Matching with that the French style of garden designs were also very intricate and artificial. Until this time the French gardens were nothing but copies of Italian style.
- The new style of gardening now known as French style is largely, rather solely, due to the efforts of **Le Notre** who served in the Royal Garden of Louis XIV from 1643 to 1700.
- He elevated the art of garden design to a standard which had never since been reached.
- It was Le Notre who showed to the world the impact in impressiveness of scale, on garden design.
- His main creations, the gardens at Versailles, have avenues which are memorable for their tremendous length and width.
- To design a garden at Vaux-le-Vicomte, his first master piece, Le Notre had removed three villages to create his vista.
- **The moral of French garden style of Le Notre seems to teach the lesson "How to Think Big".**
- The style of Le Notre can be termed as an evolution and mastery of the art of formal garden in its perfection.
- His style dominated the gardens of civilized Europe, for a long time.

(4) PERSIAN GARDENS

- Persian garden style is one of the oldest.
- The Persian garden style and the Japanese style both were based on their respective ideas of heaven.
- Except this similarity the two styles differ widely from one another.

- The Persian styles are strictly formal and symmetrical.
- They used for their gardens all crafted materials such as masonry, carved and pierced marble stones, and highly polished stones.
- The Persian gardens were laid out by cutting terraces on the hill slopes. They also tapped some natural spring to create a straight water-course through the gardens and manipulated the water-course to undertake different movements along its run.
- If there was no natural source of water this was created artificially by diverting some rivulet or a stream.
- So the main stay of a Persian garden design was *nahars* (Flowing canals) of water – the concept of Persian Paradise, "where cooling water flows".
- The selection and placing of trees were very judicious.
- The fruit trees represented the symbol of life while
- Cypress symbolized death and eternity.

(5) MUGHAL GARDENS

- The gardens laid out during the rule of Mughal Emperors in India are known as Mughal gardens.
- The Mughal gardens are similar to the style of gardens of Central Asia and Persia.
- Babar (1494 - 1531) was the first Mughal ruler to introduce this style in India.
- All other Mughal rulers and some of the Mughal Begums starting from Akbar and followed by Jahangir, Nur Jehan, Shah Jehan, and Aurangzeb all laid their hand on developing one or the other Mughal gardens in India.
- The main features of Mughal gardens, which are largely borrowed from the Persian style, are :
- (a) site and style of the design, (b) walls, (c) gates, (d) terrace, (e) nahars or running waters, (f) baradari, (g) often a tomb or a mosque, and (h) trees.

1. Site and Design:

- Mughals were very choosy about the selection of site and always preferred a site on a hill slope with a perennial rivulet or along the bank of a river.
- Mughal gardens are generally rectangular or square in shape and different architectural features are the main stay of the design.

2. Walls and Gates :

- The Mughals created the gardens not only for pleasure and recreation but also as forts and residences surrounded by high walls and with an imposing wooden gate at the entrance which was studded with bold iron nails and pointed iron spikes.
- The purpose of the high walls was security from the enemies and shelter against hot winds.**
- The gardens were a place of peace for the Emperors to enjoy with their wives and concubines.

3. Terrace:

- The Mughals came from the hilly terrains and so they were fond of terraces in the gardens. For this reason they used to select the location of gardens near hill slopes.
- Their fascination for terrace was so intense that even in the plains of Punjab they created artificial terraces.
- According to Islamic faith the Paradise has eight divisions and hence some times the gardens have eight terraces corresponding to the eight divisions or occasionally the gardens may be composed of seven terraces also representing the seven planets.

4. Nahars (Running Water):

- The style for having running water by constructing canals and tanks borrowed from the Persians.

- The water canals were paved with tiles (or marble) of blue colour to create the illusion of depth.
- The course of water used to be manoeuvred in various ways taking advantage of each slope, however small it may be, to break up the flow into artificial falls and ripples.
- The water canals used to have fountains to throw up the water high in the air.
- In the evenings small lamps used to be illuminated to create beautiful reflexions.
- The fascination for water came from the Muslim faith which says that the promised paradise is the place "where cooling waters flow".

5. Baradari:

- This is nothing but an arbour-like structure, but made of stone and masonry with a pucca roof and a raised platform for sitting.
- These were usually provided with twelve or occasionally more doors on all sides for the Emperors to watch the performance of the dancing girls.

6. Tomb or Mosque:

- It was a common practice to have the gardens built around a tomb (e.g., Taj Mahal, Akbhar's Tomb at Sikandra).
- It is often said that the Mughal gardens were at their best when built around a monument.

7. Trees and flowers:

- The trees were selected with careful planning and thought, as to Mughals each tree symbolized something, like life, youth, death, etc.
- Fruit trees were considered symbols of life and youth,
- Cypress represented death and eternity.

- ❑ The Mughals had bias for spring flowering trees and flowers.
- ❑ The seasonal flower beds were of geometrical pattern and constructed along the water canals or near the main buildings.
- ❑ The favourite flowers were rose, jasmine, carnation, hollyhock, delphinium etc.

(6) JAPANESE GARDEN STYLE

- ❑ **Both the Persian and Japanese garden designs were based on their respective ideas of heaven.**
- ❑ **A most important teaching of the Japanese garden is possibly that “unless a garden has an air of peace it’s not worth a place visiting. It should be a place where the mind finds rest and relaxation.”**
- ❑ **Another strong basis of the Japanese garden is its immutability, i.e.,** except some seasonal changes in the deciduous trees the Japanese garden hardly goes through any other strong visible changes during different seasons.
- ❑ Even during the winter the Japanese gardens have their own beauty with snow flakes hanging down the stone pieces or the stone lanterns.
- ❑ The immutability is achieved also because rather than a grand mixture of flowers, shrubs, and trees more emphasis is placed on natural elements such as a simple path, a group of rocks, stepping stones, streams, waterfalls, bridges, stone lanterns, and so on.
- ❑ A Japanese garden tries to capture natural scenery or to imitate a landscape.
- ❑ The three elements most important to achieve these objectives are water, stone, and plants.
- ❑ Low sculptured bushes and trained dwarfed trees look very attractive in a Japanese garden.

Types of Garden: A Japanese garden may either be in the form of a large public park or a small family garden designed for living which is seen usually by members of the family or the family guests.

The Japanese gardens are further classified based on positions, shape and purpose. The important types are;

1. Hill garden,
2. Flat garden,
3. Tea garden,
4. Passage garden, and
5. Sand gardens.

(1) Hill Garden:

- ❑ Out of the various styles, this garden style is considered to be the ideal by many garden enthusiasts.
- ❑ This style is known in Japanese as ‘**Tsukiyama-niwa or Tsukiyama-sansui**’, meaning **hills and water**.
- ❑ The hill garden is made up of one or more hills designed with earth mounds and exposed weathered stones.
- ❑ The other features of this garden are- water in the form of a stream or a pond or waterfalls or all the three with or without islands and also bridges, lantern, stones, and trees.
- ❑ The important points in the garden are decorated with stones and selected trees.
- ❑ But pine trees may be planted to give the effect of being swept by wind.
- ❑ Untrimmed stepping stones are placed over the walks.
- ❑ An island is generally a usual feature in a hill garden.
- ❑ When the island is present it should be decorated with a “Worshipping stone”, called raithai-seki in Japanese, a “Sow-viewing” lantern and a pine tree.

(2) Flat Garden:

- ❑ As the name implies, *Hira-niwa* or flat gardens are laid out in flat ground without hills or ponds.
- ❑ Flat gardens are supposed to represent a mountain valley or a meadowland.
- ❑ A Flat garden is not necessarily as flat as a pancake. Since it stimulates a mountain valley, low rounded hills designed with the help of

stones or earth mounds or both will look quite appropriate in a flat garden.

- ❑ The usual features to break the monotony of a flat garden are a well, a water-basin made of stone in the shape of an urn, stones lying close to the ground.
- ❑ In a flat garden, the principle is to avoid strong vertical lines represented by tall pines.

(3) Tea Garden:

- ❑ The tea garden is laid out based on certain principles and customs of the Japanese tea ceremony and hence needs a considerable space of at least about 200 square metres, for its designing.
- ❑ Since the performance of the tea ceremony needs an atmosphere of intimacy it is essential that the garden be enclosed by a fence.
- ❑ To protect the tea house from the noise of the outer world, the tea gardens are divided into an **outer garden (soto-roji)** and **inner garden (uchi-roji)**.

i. Outer Tea Garden

- ❑ It is comparatively a narrow area, with a waiting place where the guests are supposed to wait until the master of the house appears to welcome them.
- ❑ This waiting place has a water-basin for the convenience of the guests who can wash their hands and a stone lantern for illumination, but in present days this serves more as a decoration piece.
- ❑ A stone path, usually of stepping-stones, leads to the inner garden.
- ❑ The inner garden is also separated from the outer garden by a rustic fence and a gate made of light material.
- ❑ **The outer garden** will have simple plantings and stone groupings.
- ❑ The outer garden should be exposed to sun and hence planting

of **deciduous trees** should **predominate**.

ii. Inner Tea Garden

- ❑ Contains the tea house.
- ❑ The tea house of the classical time was nothing but a small straw hut with an outside waiting place,
- ❑ A small side room for washing the utensils, and the main ceremonial tea house itself having a capacity to accommodate only five persons.
- ❑ The entire path to the tea house is paved with stones or studded with stepping-stone.
- ❑ **The inner garden** is a subdued area and hence **evergreen trees** casting more shadows are used here.
- ❑ The entrance to the tea house is through a low-door so that the guests have to enter in a bending posture, simulating respect and humility.

(4) Passage Garden:

- ❑ The passage gardens, the **Roji-niwa**, are those which are laid in narrow passage, as for example a narrow space between two houses or approaches to buildings.
- ❑ As such areas are generally narrow, the garden lay-out should be simple and not over crowded.
- ❑ In such gardens there should be hardly any ornaments such as **lanterns, basins** or other man-made features.
- ❑ The common features of a passage garden are a **few key rocks, slabs of stones**, and only a **couple of types of plant**.
- ❑ Bushy shrubs and trees are unsuitable in a passage garden; instead, plants with open form and slender shapes are selected.

(5) Sand Garden :

- ❑ It is the simplest style of gardening, though not liked by many as **it is totally devoid of plants.**
- ❑ The most famous sand garden **exists in Kyoto** and is **known as Ryoanji garden.**
- ❑ The garden consists of a rectangular area of about 350 square metres adjoining a Zen Buddhist temple.
- ❑ The main feature of this style of gardening is to arrange few vertical and prostrate stones in groups of 2 or 3 and to fill in gap between the stones with fine white gravel.
- ❑ The gravel is raked in most simple patterns simulating the ripples of flowing water.
- ❑ The raking has to be repeated often to keep the garden in its best shape.
- ❑ This style of garden looks pleasant and effective only when confined to a limited area.

THE FEATURES OF JAPANESE GARDENS

- Ponds ,Streams ,Waterfalls ,Fountains ,Wells ,Islands ,Bridges ,Water ,Stone Lanterns, Stones, Pagodas ,Fences and Gates, Vegetation -
- ❑ It is good practice to use plants which change their leaf colour in the autumn or put forth colourful leaves in the spring.
- ❑ The examples of some such trees and shrubs are: maple, *Cryptomeria japonica*, *Terminalia catappa*, *Lagerstroemia flos reginae*, and *Ficus religiosa*.
- ❑ The deciduous trees are never planted in the front garden except in a tea garden, as the bare branches may not look attractive during the winter.

Some typical trees of Japanese gardens are;

- (a) **Evergreens** : Pines, different species of *Abies*, *Cryptomeria japonica*, *Podocarpus macrophylla*, and *Juniperus chinensis*;
- (b) **Deciduous** : Maples (*Acer* species), Poplars (*Populus* sp.) Mulberry, (*Morus alba*), and *Salix babylonica* (willow); (c)
 - ❑ **Flowering trees:** The most commonly used plants are different *Prunus* species, besides *Magnolia grandiflora* and others.
 - ❑ **Shrubs:** *Aucuba japonica*, *Azaleas*, *Gardenia florida*, *Nandina domestica*, *Camellia*, *Lagerstroemia indica* and *Rhododendrons*.
 - ❑ Bamboos play a special role in the Japanese gardens.
 - ❑ **The flowers** - chrysanthemums, asters (e.g., *Aster fastigiatus*, *A. glehnii*, *A. microcephalus*), carnation, different lilies, irises, lotuses, peonies, and orchids.
 - ❑ **Among the vines-** (*Clematis*, *Lonicera japonica*, *Ipomoea hederacea*, *I. purpurea* (Syn. *Pharbitis purpurea*) *Trachelospermum jasminoides*, and *Wisteria sinensis* are often used.

@@@@@

LECTURE-19

FAMOUS GARDENS OF INDIA

The government, municipalities, city corporations, and some other agencies maintain some sort of gardens and parks in many parts of India. These gardens generally fall into two categories.

1. **Botanical Gardens** - Gardens which are meant for research as well as recreation where all kinds of botanical species are maintained for the benefit of the students of botany and general public.
2. **Pleasure Gardens** - A garden catering to the needs of the ordinary citizens where the common man visits enjoys the grass, plants and flowers and gets relaxed from the otherwise drab city life.

Some of the important Indian parks and gardens and their important features are discussed below.

1. LALBAGH, BANGALORE (KARNATAKA)

- Lal bagh is the *Karnataka State Botanical Garden* situated at Bangalore.
- The initial layout of the garden was started in **1760 by Hyder Ali**.

The most attractive features of the garden are :

- ✚ A **large glasshouse** where the annual flower shows are held.
- ✚ The **tall majestic-looking Araucarias**, especially *Araucaria excelsa* (syn. *A. cookii*) which steal the eyes of the visitors.
- ✚ The avenue of the large *Ficus benjamina* near the glasshouse is definitely a special feature of the garden. Plants such as *Tecoma argentea*, *Tabebuia avalandii* and *Tabebuia spectabilis* are prize collections of the garden.

- ✚ The garden has good collections of different Cassias.
- ✚ The collections of bugainvillea and hibiscus are also very rich.
- ✚ The other attractive features of the garden are collections of foliage plants,
- ✚ Pergolas, arbours, statues, water garden, aquarium, rose garden,
- ✚ A beautiful natural rock formation and others.
- ✚ The garden with its well-laid-out features, paths, open spaces, shade and flowering trees attracts a large number of visitor's everyday.

2. BRINDAVAN GARDENS, MYSORE

- This garden is one of the most important tourist spots in India.
- The garden is **famous mainly for its illuminated running waters and innumerable fountains decorated by coloured lightings**.
- In the evening when all the fountains and running water start working and are illuminated with changing colour of lights, **the whole place looks like a paradise**.
- The fountain and lightings apart from the garden have open spaces under lawn, illuminated flower beds and other ornamental plantings.
- The river Cauvery below the giant dam divides the garden into two parts and visitors enjoy a boat ride in the river.

3. GOVERNMENT BOTANIC GARDENS, OOTACAMUND (Ooty)

- This garden is situated at an altitude of 2,175 to 2,280 m above sea level in the **Nilgiris Hills**.
- It actually started functioning in 1848.
- The garden covers an area of 20 hectares in ascending terraces.

The garden has six major sections:

- The lower gardens consisting of the main entrance, the lower lawns, and the new gardens:
- The Bandstand;
- The Conservatory, the Bog Garden, and the Tennis Court Gardens;
- The terrace with fountains and picnic spots;

- The new Bandstand and its surroundings; and
- The nursery area.

4. SIM'S PARK, COONOOR (TAMIL NADU)

- ❑ The park was **established in 1874 by J.D. Sim** after whom it was named.
- ❑ This park in the Nilgiri Hills is the center of attraction for the people of Coonoor and Wellington.
- ❑ The park is spread over an area of 15 hectares at an altitude of about 1,740 m above the sea level.

Some of the important features of the garden are

- ✚ The terraces with winding paths,
- ✚ lawns,
- ✚ beds of annuals,
- ✚ rockeries,
- ✚ a pond with two islands,
- ✚ Arches and pergolas training creepers.
- ✚ The park has a good collection of roses, trees of ornamental as well as economic value, shrubs, and creepers.

5. BOTANIC GARDEN, COIMBATORE (TAMIL NADU)

- ❑ The botanic garden situated on the campus of Tamil Nadu Agricultural University.
- ❑ The layout in the garden is a harmony between the formal and the informal designs.
- ❑ In the background of this garden is a bluish-green hill range which has been incorporated in the designing of different garden features.
- ❑ It was established in 1908 by the Department of Agriculture, Madras.
- ❑ The main function of the garden is to rise and maintain trees, shrubs, herbaceous plants, etc., which are useful from economic as well as ornamental and bio-aesthetic point of view.
- ❑ The garden meets the needs of public, scientist and government department in the supply of plants.

The garden has many features

- ✚ The **sunken garden is most interesting.**
- ✚ The topiary work in the garden is most interesting which attracts the attention of any visitor.
- ✚ The children's corner,
- ✚ Greenhouses,
- ✚ Rockery,
- ✚ Hibiscus varietal collection,
- ✚ Large stretches of lawns, and
- ✚ Rosary is also important features of the garden.

6. THE BYRANT PARK, KODAIKANAL (TAMIL NADU)

- ❑ The park has a total area of 10 hectares. The park was actually laid out in 1909.
- ✚ The park has, Terrace gardens, Lawns, Children's park, A sunken garden,
- ✚ A good collection of roses, chrysanthemums, trees and shrubs.
- ✚ The park is a centre for supplying ornamental plants.

7. THE INDIAN BOTANIC GARDEN, SIBPUR, KOLKATA (WEST BENGAL)

- ❑ Actually speaking, the garden is not situated in Kolkata proper, but is in the twin city of Howrah, on the opposite side of the river Hoogly.
- ❑ The garden was established in 1787 on a 150 hectare land. It ranks among the great botanical gardens of the world and is the seat of the Botanical Survey of India.
- ❑ **The garden was established on the suggestion of Robert Kyd, an army man.**

THE FEATURES ARE -

- The giant 200-year-old banyan tree (*Ficus benghalensis*).
- The large collection of palms in the Palmetum with a pond in the foreground.
- The garden has 26 lakes.

- The giant lily, *Victoria regia* which has giant disc-like leaves raised at the margins. It is reported that the leaves floating on the surface of water can withstand the weight of a baby.
- The garden has 15,000 trees and shrubs in the open, representing 2,500 species.
- The palm houses, orchid houses, and ferneries house several thousand herbaceous plants.
- The Royal Palm Avenue near the river gate is another beautiful feature of the garden.
- The garden houses the best herbarium in the country and the library has more than 25,000 volumes.

8. THE AGRI-HORTICULTURAL SOCIETY GARDENS, KOLKATA (WEST BENGAL)

- ❑ It is possibly the oldest Horticultural society of India. The society first started its garden in 1825, but the garden in the present site was established in 1872.
- ❑ The Society's gardens are well laid out and a metalled path goes round the major parts of the garden.
- ❑ A collection of Bougainvilleas
- ❑ A large pond houses good collections of water-lilies.
- ❑ Rockeries and rock garden
- ❑ Lily ponds, a large independent
- ❑ Sunken garden, and a long beautiful pergola with a rich collection of creepers and climbers,
- ❑ A huge open lawn,
- ❑ Children's corner,
- ❑ The largest collection of trees, shrubs, and creepers including some hybrids developed in this garden by the famous horticulturist, S. Percy Lancaster.

9. LLOYD BOTANIC GARDEN, DARJEELING (WEST BENGAL)

- ❑ Established in 1878 and situated at an altitude of about 2,100 m in the midst of the Himalayas,
- ❑ it is **one of the most picturesque botanic gardens of India**. The garden was laid by Sir George Kind, donated by William Lloyd.

- ❑ The garden has a total area of 24 acres laid out in beautiful terraces and provided with metalled approach roads. The garden has the following sections:

- 1) Upper indigenous section consisting of dominant species of the eastern as well as of the Western Himalayas and Burma.
- 2) A central or middle section containing coniferous plants.
- 3) A rock garden, naturally displaying flora of high altitudes and of the alpine region of this locality.
- 4) The lower exotic section houses plants mainly from the temperate regions of the world.
- 5) **Orchidarium:** There are two large greenhouses having about 2,500 orchids of different species.
- 6) Students' garden consists of the Sikkim Himalayan flora, arranged family-wise.
- 7) Cacti and other succulents are housed in a greenhouse.
- 8) In the bulbous section there are collections of various species of lilies, amaryllis and tuberous begonias.
- 9) There is a rosary containing many cultivars of roses.
- 10) The aquatic garden is housed in two pools consisting of species of *Nymphaeaceae* and other submerged aquatics.
- 11) The Herbarium and seed section contains 30,000 herbarium sheets
- 12) The garden has about 1,800 botanical species representing regions such as Burma, Malaysia, Central Asia, Japan, North and South America, Europe, and Africa.

10. NATIONAL BOTANICAL RESEARCH INSTITUTE, LUCKNOW (UTTAR PRADESH)

- The **National Botanical Research Institute** popularly known as **Sikander Bagh**,
- Laid out by Nawab Saadat Ali Khan (1789 – 1814) which was further improved upon by Nawab Wajid alishah, the latter naming it after his wife Sikander Mahal Begum.
- The present area of the garden is 27 hectares.

Important features:

- The garden has a library,
- A large herbarium and has well-equipped laboratories on different branches of botany, chemistry, and a tissue culture laboratory.
- The gardens with fine lawns,
- Rose gardens,
- Conservatory,
- Cactus house, and
- A Lily pool is very well maintained and attracts streams of visitors from all over the country.

11. HORTICULTURAL RESEARCH INSTITUTE, SAHARANPUR (U.P.)

- The garden was possibly laid out well before 1750.
- The garden was taken over by the East India Company in 1817.
- The well-known botanists such as Falconer, Jameson and Duthie worked in this garden.
- The garden mainly conducts research on sub-tropical fruits.
- The garden has a good collection of fruit trees.
- The collection of ornamental plants such as trees, shrubs, cacti and succulents are also worth mentioning.

12. RASHTRAPATI BHAVAN GARDEN, NEW DELHI

- ❑ **Rashtrapati Bhavan** is the official residence of the President of India and one of the largest buildings of its kind in the world. It was completed in 1929.
- ❑ The architecture of the palace is a mixture of Indian and Western style.
- ❑ The garden inside this palace was laid on the pattern of Mughal gardens with conventional arrangement of squares, terraces, water channels, etc.

- ❑ The main garden area is roughly 134 square metres and is bounded from all sides by a paved red stone path.

- Two canals each of 5.40 m width run from north to south and two similar canals intersect these to form a 60 m square island in the centre. This island is the venue for the most of the receptions held at *Rashtrapati Bhavan*.

- There is a sunken or circular garden which is a beautiful spot especially during the winter when innumerable seasonal flowers bloom.

- The garden is famous for quantity and quality of seasonal flowers.

- There are good collections of Bougainvilleas, different bulbous plants as well as flowering trees which ensure enough of colour throughout the year.

- There is a large collection of roses also.

- Greenhouses with collection of orchids, cacti, succulents and ferns.

- The pergolas are laden with fine creepers.

- There are a large number of trees, especially cypress (*Cupressus*) which are clipped in the topiary style. The garden remains open for about a month for the general visitors during the winter months when the seasonal flowers are in full bloom.

- This garden is popularly referred to as **Mughal Gardens**.

13. BUDDHA JAYANTI PARK, NEW DELHI

- ❑ To commemorate the 2500th birth anniversary of Lord Buddha a park was laid out in the rugged and rockery "Ridge" of New Delhi which turned out to be one of the best laid-out landscape gardens in the country.
- ❑ The garden is of about 30 hectares in size.

Important feature of this garden are:

- Most of the existing natural flora such as *Butea monosperma*, *Acacias*, etc.,

- The natural hillocks and rock formations were incorporated in the garden without trying to level or distort them.
 - The barren rocks and woodland areas have been planted with bulbs such as *Narcissus*, *Oxalis*, *Zephyranthes* and hardy annuals such as *Coreopsis*, *Cosmos*, and *Tithonia* which seed themselves and grow year after year giving a natural effect.
 - There is a Japanese style of garden in one portion.
 - There is a floral clock also.
 - This garden is a favorable spot of picnickers and other people and children.
 - The garden has a good collection of trees and shrubs.
- The garden played an important part in the introduction of forest trees, ornamental and other economic plants. The collection of indigenous flora is also quite rich.
 - **The important features of attraction are**
 - ✚ A greenhouse containing large collection of terrestrial and epiphytic orchids, ferns and other shade-loving plants,
 - ✚ a greenhouse containing cacti and succulents; and the plant introduction nursery including a net-house.
 - ✚ In addition to the botanic garden, there is an arboretum of 50 hectares containing mostly forest plants yielding timber and other economic products.
 - ✚ The garden has a herbarium containing 300,000 sheets. The collection of water plants is also quite good. It has a plant and seed exchange programme.

14. JAPANESE STYLE GARDENS

- Dr. M.S. Randhawa, when he was the Vice-President of the Indian Council of Agricultural Research, once decided to lay out a chain of Japanese style gardens and with this in view he visited the famous Japanese landscape architect Prof. K. Mori in 1958.
- **The first Japanese style garden was laid out in the Roshanara Park, Delhi.**
- The garden was laid out complete with rivulets, water falls, pond with stepping stones, wooden bridge and the like which are common features and a Japanese garden.
- **Another garden** with rivulet, stones, bridge, etc., was laid out in the official residence of the **Prime Minister's house at Safdarjung Road.**

15. BOTANICAL GARDEN, FOREST RESEARCH INSTITUTE, DEHRADUN (U.P.)

- The botanical garden occupies about 10 hectare.
- In this 500-hectare Forest Research Institute's estate.
- The botanic garden was started in 1934 at an altitude of 663 m. The garden is well laid out and is a place of attraction for the visitors.
- The primary function of the garden is to introduce new plants from all over the globe.

16. MUGHAL GARDENS OF KASHMIR

- The credit of developing the Mughal gardens in Kashmir goes to Akbar, Jehangir and Shah Jahan.
 - ✚ The gardens have a series of descending terraces,
 - ✚ The flow of water which is another main stay of the Mughal gardens.
 - ✚ The gardens on the bank of the Dal Lake, Shalimar, Nishat Bagh, and Chasma-e-Shahi are well preserved and mostly frequented by visitors.
 - ✚ Some other popular gardens are at Achabal, Verinag, and Bijbehara.
 - ✚ A most spectacular feature of these gardens is the planting of the majestic *Chenar* trees in groups.

I. SHALIMAR GARDEN:

- This garden was initiated by Jehangir in 1619 and extended in 1630 by Zafar Khan, the then Governor of Kashmir, under the instructions of Emperor Shah Jahan.

- ❑ The garden is connected with the Dal Lake by a 1.6 km canal which is about 10.8 m wide.
- ❑ On both sides of the canal there are broad green paths lined by majestic *Chenar* trees.
- ❑ The garden consists of three terraces, the first having a *baradari*, the *Diwan-e-Am*, and the second contains the *Diwan-e-Khas*. But, unfortunately, both these buildings do not exist today, but only their stone bases are left surrounded by fountains.
- ❑ Along the centre of the garden there are a series of water reservoirs interconnected by a wide canal.
- ❑ The canals and the reservoirs are paved with polished limestone.
- ❑ The source of running water is a stream which flows through these reservoirs and canals and sometimes through beautiful chutes of various designs.
- ❑ The third terrace containing a magnificent black stone pavilion was meant for ladies.
- ❑ The pavilion is surrounded by a reservoir containing 140 large fountains.
- ❑ Maharaja Hari Singh of Kashmir provided electricity to the garden.

II. NISHAT BAGH:

- ❑ The literary meaning of *Nishat* is "pleasure".
- ❑ This pleasure garden was built by a Persian, Asaf Jah, who happened to be the brother of Nur Jahan.
- ❑ The garden has twelve terraces each representing the sign of the Zodiac.
- ❑ The two wooden doorways and the *baradari* in the third terrace were added by Maharaja Ranbir Singh.
- ❑ The water runs all along the garden through a limestone lined wide canal which has a number of fountains.

- ❑ In the second terrace, there is a large reservoir containing 25 large fountains.
- ❑ There are two main pavilions, one at the lower end and the other at the upper end of the garden.
- ❑ The other pavilion is situated at the end of the upper terrace from where one can have a thorough view of the entire garden.
- ❑ The beautifully designed flowerbeds and the avenue of *Chenars* attract immediate attention of the visitor.
- ❑ Morning is the best time for visiting this garden.

III. CHASMA-E-SHAHI:

- ❑ The garden situated about 8 km away from Srinagar is the smallest among the three gardens of the valley.
- ❑ The main attraction of this garden is a spring spewing clean, ice-cold water having appetizing properties.
- ❑ The garden was constructed by Ali Mardan Khan, the Governor of Kashmir, under the instructions of Emperor Shah Jahan.
- ❑ The garden consists of three terraces, a central aqueduct, water tanks, waterfalls or chute, and fountains.
- ❑ The two *baradaris* of the garden are of recent origin, although the plinth was provided by the Mughal designer.
- ❑ The garden provides a panoramic view of the Dal Lake.

IV. VERINAG:

- ❑ The centre of attraction of this garden is the Verinag spring, the water of which is exceedingly pure and highly transparent.

- ❑ The reservoir around it was commenced by Jehangir and completed by Shah Jahan.
- ❑ The garden here has a charming beauty.
- ❑ Emperor Jehangir who expired on his way back from Kashmir wished that he be buried there. But his followers buried him near Lahore. Thus his last wish to have eternal rest in a beautiful surrounding remained unfulfilled.

V. ACHABAL:

- ❑ This garden on the outskirts of the town **Anantnag** was built by Nur Jahan in 1620.
- ❑ The spring at Achabal is the largest in Kashmir, which flows through this garden traversed by three aqueducts.
- ❑ Along the central aqueduct there are two large tanks and the upper one of these has a wooden pavilion constructed on a wooden base.
- ❑ There are six vertical waterfalls in the garden, three on the upper part and three in the lower.
- ❑ The banks of the tanks and the canals are lined with stone and these abound in fish.
- ❑ There is a ruin of *hammom* (Turkish bath) and some other buildings.
- ❑ The garden has a good collection of different fruit trees besides the large majestic *Chenars*.

VI. BIJBEHARA:

- ❑ This garden constructed by Dara Shikoh, the eldest son of Shah Jahan, is situated about 48 km from Srinagar.
- ❑ There are magnificent *Chenars* in this garden; the girth of one of the tree measures about 16.2 m.
- ❑ The garden was divided in two parts which were connected by a

stone bridge, only the ruins of which remain today.

- ❑ The design of the garden is typical of the Mughal style.

17. THE MUGHAL GARDEN, PINJORE (HARYANA)

- ❑ This garden situated 5 km below Kalka on the Ambala – Simla road.
- ❑ Laidout by Fidai Khan, the foster – brother of Aurangazeb during his reign in the seventeenth century.
- ❑ The original name of the place Panchapura or Punjpur has association with the five *Pandavas* of our epic *Mahabarata*.
- ❑ It is one of the best preserved gardens of north India and is famous for its beauty.
- ❑ The garden is uniquely laidout in an area of 25 hectares and is divided into six terraces.
- ❑ As customary with all Mughal gardens, this garden is also encircled by an embattled wall.
- ❑ Along these paths there are lawns, flower beds, trimmed hedges, rows and bottle palms and many other ornamental shrubs and trees.
- ❑ There is a good collection of fruit trees, especially of mango, litchi, and sapota.
- ❑ There are **three magnificent buildings** – the *Shish Mahal*, the *Rang Mahal*, and the *Jal Mahal*.

18. CHANDIGARH ROSE GARDEN

- ❑ Rose is a very important ornamental flower for its beauty, elegance, grace, as well as fragrance.
- ❑ The garden has an area of 10 hectares and contains more than 36,000 roses of all types including hybrid tea, floribunda, polyanthas, miniatures, climbers and standards.
- ❑ The Chandigarh rose garden is situated in the centre of the city on a 15 hectare plot.
- ❑ It is designed to contain about 60,000 roses when completed.
- ❑ It is also contemplated to collect about 5,000 outstanding cultivars of roses.

- ❑ The garden is situated in a valley and a natural stream runs through it.
- ❑ A section will be developed as a moonlight garden planted with only pure-white scented roses.
- ❑ At present about 1,500 named roses are there in the museum.
- ❑ Although the ambitious plans and targets of the garden have not yet been fulfilled, still this garden is a wonderful place to visit.

19. MANDOR GARDEN, JODHPUR (RAJASTHAN)

- ❑ This garden is situated about 5 km away from the heart of Jodhpur.
- ❑ It is one of the most beautifully laid-out landscape gardens in our country but unfortunately many people do not know about it.
- ❑ The credit of laying the garden goes to Raja Abhai Singh (1724 - 1749 A.D.).
- ❑ It is highly creditable that such a beautiful garden has been laid out in the desert region of Rajasthan.
- ❑ The garden is fairly large in size and terraces have been constructed on the slopes of the hillocks to extent the garden up to the peaks.
- ❑ The large spaces provided under lawn, the flower beds, trees, and shrubs add beauty to the garden.
- ❑ There are fountains fitted with coloured lights which are run on a payment of Rs. 20 per hour. The tea stall situated at a higher terrace adds beauty to the garden.

20. SAYAJI PARK, BARODA (GUJARAT)

- ❑ The Sayaji Park in Baroda is named after its founder the former Maharaja Sayajirao III who established it in 1879 over an area of 40 hectares.
- ❑ The garden is a beautiful belt of greenery in the otherwise dry climatic region of Baroda.
- ❑ The garden has about 8,000 various ornamental trees with rare plants such as *Hyphaene thebaica*, the branching palm, forming an avenue in one corner.
- ❑ This formal portion of the garden has the arbour - like bandstand, paved walks, lush green lawns, four fountains. The park has a zoo also with rare animals such as white tiger.

@@@@@

LECTURE-20

GARDEN ADORNMENTS

- ◆ In a garden several adornments and necessities should be provided to make it look more ornamental and useful.
- ◆ Garden seats, boxes, tubs, urns, ornamental vases, fountains, bird baths, sundials, floral clocks, Japanese lanterns, statues, ornamental stone pillars or pieces, pergolas and arches are some of the few examples of such garden ornaments/adornment.

1. GARDEN SEATS

- Garden seats are necessity in any garden.
- The seats should be comfortable, durable, artistic-looking and should not look out of place.
- Wooden and fabric seats are comfortable to seat compared to those built in stone or iron.
- When wooden seats are selected they should be made of good timber like teak to withstand the vagaries of weather especially moisture as the furniture has to remain outdoors.
- The wood is treated with preservative and painted with moisture-proof chemicals.
- The chair or bench should have an appropriate design. For example, a chrome seated chair will look completely out of place in the midst of woodland scenery. Similarly, rustic furniture in front a modern sophisticated house may be completely out of place.
- Iron or stone or concrete seats get easily heated in the summer and become cool in the winter thus making them uncomfortable to seat.
- But for durability and to prevent from damage and theft concrete or stone seats are preferable in Public Park.
- Though iron furniture is also durable it is more likely to be stolen because of the value of metal unless firmly fixed.

2. ORNAMENTAL TUBS, URNS AND VASES

- These add beauty to a garden.
- Plants displayed in ornamental tubs or urns at suitable places look beautiful.

- The tube or the vase can be made of timber or preferably of brick, concrete or, carved out of stone.
- These can be built permanently in position or may be kept just like that and moved whenever needed.
- When fixed permanently, these should generally be positioned over an ornamental pillar keeping in view the proportion between the two.
- If there is a paved path an ornamental vase or tub can be placed at the end of it or one each on both sides.
- Similarly, these can be placed near the gate or near the staircase of the main entrance.
- Ornamental urns preferably of metal with carvings outside look beautiful in the terrace, near the staircase, or even inside the house.
- Suitable ornamental plants should be grown in such containers. Window boxes are also useful garden ornaments.

3. BIRD BATHS

- These are nothing but large bowl-shaped containers, generally made of concrete, fixed over a pillar or column which is about one metre tall.
- Water is stored in the bowl for the birds to come and drink or bath in it.
- Bird's baths should be constructed at a quiet corner of the garden.

4. SUNDIALS

- A sundial has many roles to play in a garden.
- It can be used as a focal point in a garden, can form a center-piece of a formal flower bed and can be placed in the center or at the end of the lawn and at the junction or termination of a path.
- A sundial is also a good feature in a sunken garden.
- The sundial should be positioned in a place where the shadow from a tree or building does not fall for a long duration, otherwise the feature becomes meaningless.

- ❑ There should be free access to the base of the column, so that one can closely observe the dial.
- ❑ The column of the sundial should be fixed firmly in the ground and is generally made of bricks, tiles, stones, or a combination of these without a mortar coating to look more artistic.
- ❑ The top is generally square where the sundial with the compass is fixed.
- ❑ This is also made of stone or concrete. In western countries, metal sundial plates with compass are available for sale. Even dials for specific districts are available there.
- ❑ In India one has to get it made with the digits. The digits can be carved on the cement or the stone itself.
- ❑ Before fixing the dial, the movement of the sun should be observed and then the dial is screwed to the base.
- ❑ The height of the column should not exceed 60-90 cm or the dial will not be visible easily.
- ❑ Live sundials made of living plants complete with the figures, compass etc., in the form of topiary can be seen in some western countries.

5. FLORAL CLOCKS

- ❑ These are nothing but huge clocks, generally operated by electricity, having huge hands for showing the seconds, minutes, and hours.
- ❑ The machinery of the clock is concealed in an underground chamber with only the hands showing above the ground against a dial of carpet bedding plants or flower beds.
- ❑ A carpet bedding of green plants (E.g., *Pilea muscosa*, *Sedum*) with figures made of red plants (e.g., *Alternanthera*, *Iresine* sp.) or vice-versa looks quite ornamental.
- ❑ Similar effects can be obtained by various coloured flowering annuals. The problem with annuals is that these are to be replaced seasonally, whereas carpet bedding plants are of permanent nature.
- ❑ Instead of living plants the dial can be decorated with various coloured (natural or artificially coloured) pebbles also.

6. JAPANESE LANTERNS

- ❑ These are highly sought-after garden ornaments.
- ❑ The lanterns should preferably be carved in stone and should be low and decorative as the Japanese would prefer.
- ❑ The column may be cylindrical or square faced with ornamental carvings.
- ❑ Similarly, the fire box should also be carved in an ornamental manner.
- ❑ The roof may be broad-roofed, commonly called "Snow View" or Yukimi, so called because it gives a charming effect to the landscape when it is snow-bound.
- ❑ Obviously these types of lanterns are made of white stone or white marble and are suitable for areas having a snowfall.
- ❑ There is no harm even if these are preferred in a tropical country especially near to pool.
- ❑ The narrow-roofed or Kasuga lanterns have a six facet fire box.
- ❑ Hundreds of these lanterns are found in the Kasuga temple near the town of Nara in Japan and hence the name.
- ❑ Many people also fix decorative metal lanterns over ornamental columns or pillars, also of metal.
- ❑ The lanterns should be positioned in suitable places - near the house or near a stream or pool.

7. ORNAMENTAL STONES

- ❑ Ornamental stone pillars or pieces of rounded form or other abstract designs, if properly placed, improves the look of any garden to a great extent.
- ❑ The stones can be placed near lily pools, along or in the midst of streams and waterfalls.
- ❑ Large ornamental pieces can also be placed at the doorway and other suitable places.
- ❑ The Japanese create most artistic stone gardens with pieces of stones.
- ❑ First a large bed of crushed stone is made which is raked artistically to create ripples to simulate sea, over which single large piece of stone or a group of stones are placed artistically at intervals.

8. FOUNTAINS

- ❑ Unless there is water under pressure one cannot have any good fountain.
- ❑ Fountains are made to work by circulating the same water contained in a pool.
- ❑ There are various designs of fountains.
- ❑ There may be a straight upright water jet or a number of finer water jets conversing in the form of an umbrella.
- ❑ Water jets can also be designed in the form of rainbows.
- ❑ The jets and pipes are made of anti-corrosive material.
- ❑ To make the fountains more colourful during the nights, coloured lights are provided under water, with water-proof fittings.
- ❑ With an automatic switch it is possible to change the colours at regular intervals which further adds to the beauty of the fountains.

9. STATUES

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

10. PLANT STANDS

- ❑ The plant stands are also very useful structures for decorating the gardens.
- ❑ Plant stands are generally made of mild steel rods molded in different fashions with various-sized rings attached to hold the pots growing the plants.
- ❑ These can be displayed in the terrace garden, at the entrance of the house, in the roof garden or in any other advantageous position in the garden.



LECTURE-21

GARDEN ELEMENTS AND PRINCIPLES OF GARDEN DESIGNS

The planning of a garden is an art. A garden architect should learn enough of geology, geography, garden history, styles of gardening, and above all should have a profound knowledge about plants.

Basic Principles of Landscaping / General Principles of Garden Design:

1. **Simplicity:**
 - ✓ Garden design should be simple.
 - ✓ It should not have scope for under complexity.
 - ✓ Visitors should catch entire effect.
 - ✓ Visitors should know purpose of garden design/plan.
2. Ideal garden should have space i.e. over crowding of plants should be avoided.
3. Judicious uses of more number of varieties/species of plants, instead of going for few plants go for more number of plants because it serves two purposes.
 - a) Increases aesthetic beauty.
 - b) Serves the scientific purpose.
4. Garden path/ drive should not too straight and long.
5. Garden should layout for owners comfort and convenience.
6. Natural grade of greens taken in to consideration.
7. All garden features should be accommodated in proper place in a proportionate manner, careful selection of plant and also increase beauty of garden.
8. It should comfortable to living (Private garden).
9. It should serve perfect place for passing leisure time.
10. Easy to maintain to carry out all intercultural operations.
11. When we say garden is complete garden should look beautiful and should give pleasant look to the garden.

DESIGNS

1. Major elements : plants and water
2. Minor elements : Stones, bricks, tiles, tar, metal, grass, plastic, wood, sculpture etc.,
3. Other elements : Light, sound, smell, touch, food etc.,

Major elements:

1. PLANTS:

Classification of plants based on utilities and functional value:

1. Aesthetic purpose:

- a) Avenue planting- flower parade
- b) Ground planting
- c) Shrubbery, rockery, topiary, hedges, edges
- d) Potted plant, flower beds, boarders
- e) Ground cover
- f) Water garden

2. Functional purpose:

- a) Control pollution
- b) Reduces noise
- c) Control soil erosion
- d) Wind break
- e) Deciduous plants can utilize to increase temperature during winter

Criteria for selection of plants:

Morphological character should be considered while selecting the plants;

- Height of the plant
- Types of branches- upright, drooping, horizontal
- Spread and width of the plant
- Form of the plat
- Type of plant- evergreen, deciduous
- Colour of the plant
- Texture of the plant- smooth, rough
- Flowering time of the plant

1. **WATER:** water has the ability to change form, at low temperature water freezes, evaporates at high temperature and liquefies at moderate temperature

i. Aesthetic use:

- ❖ Water falls- cascade type, fountains, streams, lakes, ponds, Nappe, Chadar, chute.

- ❖ Water is used for creating reflection during night time along with lighting.
- ❖ The use of water helps in reducing the temperature in the microclimate.
- ❖ Sound of water makes a person feel comfortable.
- ❖ Water may mask the over power unwanted sounds

ii. **Functional use:** Water will nourish the plant, increases growth and development

MINOR ELEMENTS:

i. **STONES:**

- For creating rockery, statues or sculptures, to imitate natural water falls, garden benches, path/walks
- Keep in mind that stone radiates heat and will have to be used carefully

ii. **BRICKS:**

- For creating garden walls, ponds
- As paving material
- For constructing plant boxes

iii. **WOOD:**

- Wood adds colour and texture to the garden
- Used for creating paths, steps, garden bridges, ornamental picket fence, country fences, arches, pergolas
- Wood should be coated with paints/preservatives to prevent decay

iv. **METAL:**

- For creating artistic features like garden bridges, arches, pergolas, Arbour, fence, light stands, metal gardens
- Used as a base material for plants to grow on, when used for topiary
- Metals should be treated with anti corrosive materials before using in the out doors

v. **SCULPTURES:**

- Artistic material adds beauty to the garden with the use of stones, granites, sandstone, marbles, metals
- Sculptures includes birds, human being, animals etc
- It can be kept in front, middle part, and in running streams of the garden

vi. **GLASS :** It includes mist chamber, green house, conservatory, terrariums and illumination purpose

vii. **Concrete:** Used for creating drives, paths, walks, ground cover

viii. **Tar/ Asphalt:** Creating drives

ix. **Plastic :** Drippers, sprinklers, pots, waste bin

OTHER ELEMENTS:

i. **Lighting:** Illumination, focusing the focal points, illuminating water

ii. **Sound:** water falls, running streams, musical fountain, and wind chimes

iii. **Smell:** planting of aromatic plants in different parts of the garden, trees, Aromatic plants, annual beds can be used

iv. **Touch:** Texture of materials like plant surface, sculptures, paving, Garden benches

v. **Food:** Created at out side boundary of the garden

BASIC PATTERN IN GARDEN DESIGN

1. **Circular pattern-** series of circles can utilize to create circular. It is used in formal and informal gardens
2. **Diagonal pattern-** draws a grid line at 45° to the boundary. It is also used in formal and informal gardens
3. **Rectangular pattern-** it is utilized in formal garden in a symmetrical manner

STEPS IN GARDEN DESIGN

- | | |
|---|--|
| <p>i. Identification of site: Identify the site for two purposes</p> <p>a. Public garden: give importance for likings of the public</p> <p>b. Private garden: Give importance for owners comfort</p> <p>ii. Analysis: Need to study two factors</p> <p style="padding-left: 40px;">i. Physical factor- climate, weather, soil type, existing vegetation, existing manholes, roads, path</p> <p style="padding-left: 40px;">ii. Social factors</p> <p>iii. Measuring up: Draw rough sketch of the area like existing features, length and width of all features</p> <p>iv. Drawing to the scale: based on sheet available for small garden 1: 50 and for big garden 1: 100</p> <p>v. Evolving a pattern: Fence, lawn, flower beds, hedge, edge, border, water falls, rock garden, pond, shrubbery, island beds, carpet beds, standards etc</p> <p>vi. Turning pattern in to reality: Mark the area using pegs and bars and plant the permanent features on marked ground</p> <p>vii. Xeriscaping: This is a technique use to practice water conservation in creative landscape, this can be practiced in areas where scarcity of water.</p> <p><i>This can be achieved by:</i></p> <p style="padding-left: 40px;">i. Grouping/selection of drought tolerant plant, trees, shrubs, annuals, cacti and succulents</p> | <p>ii. Mulching</p> <p>iii. Ground covers</p> <p>iv. Minimize water loss by providing drips</p> <hr style="width: 50%; margin-left: auto; margin-right: 0;"/> <p style="text-align: right;">@@@@@</p> |
|---|--|

LECTURE-22

ELEMENTS OF INTERIOR DECORATION AND PRACTICE

- ❑ The term “Interior Decoration” refers to decorating the interior of a house with objects of ornamental and aesthetic value so as to make the appearance of indoors beautiful, pleasant and attractive.
- ❑ It is less costly to decorate the interior of a room with live plants compared to flowers, which are becoming costlier day by day and besides they are to be replaced frequently.
- ❑ Either foliage or flowering plants or even Bonsai plants may be selected for decorating the indoor.
- ❑ A houseplant should be compact in growth habit, evergreen in nature and should stand some amount of shade around its growing environments.
- ❑ For decorating a small table, the plant should be compact and bushy in nature.
- ❑ Besides the ornamental foliage and flowering plants, cacti and succulents, palms, ferns and some bulbous plants can be grown inside a house.
- ❑ The art of growing houseplants or indoor plants inside a house is known as indoor gardening.
- ❑ The popular methods of growing indoor plants are in hanging baskets, china baskets, and tubs made of concrete, wood cane etc., bowls and dishes, bottles and windows.
- ❑ Gardening in trays and trolleys are also part of indoor gardening. Trolleys fixed with flexible wheels meant for serving tea and snacks are quite suitable for growing indoor plants.
- ❑ All the four sides of the trolley should be raised to conceal the pots kept in it.
- ❑ Trays of different make and size can be used for growing indoor plants.
- ❑ Growing of houseplants in China baskets made of cane even plastic gives an artistic and elegant touch to the décor of the room.
- ❑ Troughs made of cane standing on its own legs are very artistic and pleasing for growing plants indoors.
- ❑ When specimen plants grown in clay pots are used for interior decoration, these may be plunged in a larger sized ceramic, glazed pot, or in any other good looking metallic container to improve the look.
- ❑ Potting the plants in various shaped plant stands also improved the look of display plant stands may be made to accommodate only one plant or it may be branching to hold several pots together.
- ❑ These are generally made of mild steel rods or plates with a heavy base and having a ring to hold the pot.
- ❑ The branching types generally have several protruding hands from the main support at the end of which there will be rings to hold the pots.
- ❑ It is advisable to fix buckets made of GI sheets or plastic at each ring and to place the pots inside the bucket to arrest the drips.
- ❑ A live screen can be created in window by growing light indoor creepers.
- ❑ Growing a screen of creepers in between can separate the dining space in a drawing or living.
- ❑ Plants grown in bowls or metal hanging baskets can be fixed on the walls by using brackets, which will bring a relief to an otherwise empty expanse of a wall.
- ❑ Tubs and urns are portable and hence can be used for temporary decoration indoors and elsewhere.
 - Wooden tubs can be made with artistic designs.
 - All tubs should stand on their leg or should be placed over bricks for easy drainage.
 - Wooden or cement tubs are painted to match with the color of the house.
 - The tub should be quite aesthetic in look.
- ❑ The topiary work should be displayed against a wall or a screen in the terrace.
- ❑ **Hanging baskets** can be hanged at the entrance of the house to welcome the visitor.
 - Hanging baskets can also be placed in the hall the drawing room besides a well lit window or in the bathroom above a fluorescent light.

- A plain wall in a sunny room or a passage can also be artistically decorated with hanging baskets.
 - The containers should be attractive, light and easy to hang, wire baskets with three hooks for hanging is a good container as they provide good aeration.
 - Wooden baskets are better looking.
 - Earthen pots of various sizes and shapes are available for use as hanging baskets can also be made out of dried gourd and coconut shells.
 - For indoor purposes baskets of brass, copper and glazed pottery may be used.
 - Even ordinary earthenware or ceramic pots can be hanged in brackets on the wall.
 - For a larger basket two or three types of plants; one of vertical statue and the other of training nature can be used.
- **Window garden** also known as window box gardening refers to that kind of gardening where plants are grown within the room just, opposite or close to the window or on the windowsill outside.
- There are different types of window boxes such as Fiberglass box, pottery box (Terracotta boxes), Iron boxes, cast cement boxes, Asbestos boxes, plastic boxes or wooden boxes can be used.
 - The security of the boxes can be achieved by fastening the boxes with the window frame by a hook-and-eye arrangement, or the boxes can rest over metal or wooden brackets attached to the frame of the window aluminum nails or screw should be used to prevent rusting.
 - In addition to brackets, with boxes can be secured further by tying them round with galvanized wires and fixing the ends of the wires with the window frame.
- The boxes should rest on wooden edges to keep a gap between the sills for drainage.
 - The boxes are also fitted about 2cm away from the frame or wall to prevent rotting and attack by termites.
 - The boxes should be painted every two years to keep them showy and attractive and also rust-free. A miniature rock garden can be built in the window box.
- **Trough** is larger in size containing more number of plants which can be displayed in the window sill, on the floor or at the entrance of the house under a covered veranda, bowls and dishes are meant for decorating dining table, television set, radio set, tea table bowls and dishes generally have to drainage holes.
- Troughs can be made of concrete, stone, wood, plastic or fiber glass.
 - Fruit bowls, conical baskets, wooden dishes or bread trays, pottery, conical and low plastic bowls are used for flower arrangements are very suitable for starting a dish or bowl garden. Island or forest scenery can be created.
- **Jar** made of glass having fall sides with or without lid is good for bottle gardening as this conserves moisture.
- The jar has a wider mouth than a bottle.
- **Terrarium** is a glass bowl of 25-30cm diameters having an airtight lid.
- Any size of bottle, jar or jug is suitable for gardening provided these are made of clear glass.
 - These offer a good display on a table, a stand, or a well-lit window. Fish aquariums also serve this purpose.

- For glass gardening long handle tea spoon, table fork and a long pair of tongues are used as tools.
 - Bottle garden plants need a reasonable amount of light but direct sunlight will overheat the plants.
 - The lamp is to be fitted in the neck of the bottle, with the help of a clamp.
- Interior decoration not only includes the above mentioned subjects of beautification but also the other objects such as
- Use of screens for doors and windows,
 - Drapery rods,
 - Coir mats for floorings,
 - Tiles for floorings,
 - Painting the walls with light color attractive paints,
 - Decorative ceiling fans,
 - Lamp shades,
 - Wall plates depicting wild life or natural scenery,
 - Mirrors,
 - Statues,
 - Carvings artistic furniture,
 - Showcases and positioning them at appropriate positions or spots or places.

@@@@@

LECTURE- 23

THE DIFFERENT FEATURES OF A GARDEN

□ GARDEN WALLS

- ♣ A garden lover will never like to block the view of his garden by putting a wall along its periphery.
- ♣ A garden as it is enjoyed from inside should also be visible from outside.
- ♣ But, sometimes, from safety or beauty point of view (e.g., to obscure the ugly sight of an open drain), it may be necessary to erect a brick, concrete, or stone wall along the periphery of the garden.
- ♣ A compromise is to have a low brick (or concrete or stone) wall of say 60-90 cm height and to put over it some grills, so that the view is not totally obscured from outside.
- ♣ Alternatively, walls from 1.80 to 5m may also be erected depending upon the size of the garden.
- ♣ To break the drabness of a concrete or brick wall, at least in the more prominent places, one may grow creepers such as *Ficus repens* over the wall.

□ FENCING

- ♣ Though not exactly a part of the garden in the stricter sense, fences are a utility item essentially needed for marking the boundary and for protection.
- ♣ Sometimes, fences are also put to separate one part of the garden from the other.
- ♣ Several materials such as wood, bamboo, wire, wire nettings and chain-link fences may be used for this purpose.
- ♣ Fences of wood and bamboo get spoilt quicker than the wire fences.
- ♣ The simplest wire fencing will be to put stout wooden posts at 3m distance and

pass the wires through these posts starting from 22.5cm intervals at ground level to 30cm upwards up to a height of 1.8m.

- ♣ The posts are embedded at least 45-60 cm in the ground and the wires are stretched with the poles with strong staples or clamps.
- ♣ Wire netting fence is cheaper than chain-link fence but is less durable.
- ♣ Wire netting can also keep away the rabbits, provided the netting is buried at least 22.5 cm in the soil and turned outward at the bottom to stop burrowing.
- ♣ Chain-link fencings of various designs are available and these are fixed in angle iron poles spaced at 3m distance.
- ♣ Iron grills of various designs can also be used for fencing but the cost, of course will be prohibitive.
- ♣ The sight of an expanse of fencing does not suit to the artistic design of a nicely laid-out garden and hence people would like to obscure it from view as quickly as possible by growing quick-growing and elegant creepers such as *Bignonia venusta*, 'Honeysuckle' (*Lonicera periclymema*), *Vernonia elaeagnifolia*, etc.

□ STEPS

- ♣ Sometimes it becomes necessary to have steps in a garden, as for example, when a path goes from one level to the other or one has to climb or get down from the terrace garden.
- ♣ Steps can be made of various materials but usually the same material used for the path is used for steps also.
- ♣ The materials used are concrete, stone, wood, or gravel.
- ♣ The gravel can be held in position with a stone-retaining wall.
- ♣ Grass should not be used in the steps as it becomes slippery when watered.
- ♣ The steps in the garden should be different than those in the building.
- ♣ Here, the treads (i.e., steppings) should be quite broad and the risers low, so that people can have an easier climb.

- ♣ A garden is meant for leisure, pleasure and comfort and hence steep and narrow steps are unsuitable as they cause discomfort in climbing.

□ GARDEN DRIVES AND PATHS

- ♣ A garden must have a carriage drive leading to the house and garage besides several other paths or walks leading to different parts of the garden.
- ♣ The main criterion of a good garden drive or path is to provide a flat, dry and pleasant passage for the persons or vehicles and it should harmonize with the other garden features.
- ♣ A path in the garden should be laid out after due consideration is given to its necessity and artistic appeal.
- ♣ Too many paths, especially in a small garden, may spoil the artistic value.
- ♣ A path with graceful and gentle curves will look much better than a straight path.
- ♣ Materials used for the construction of drives are gravel, asphalt, or concrete, whereas
- ♣ For garden paths much more attention should be taken for the appearance and as such concrete or asphalt is seldom used.
- ♣ Garden paths are generally made of gravel, paving-stones, crazy-paving, bricks, or grass.

(A) DRIVES

(a) Gravel drives:

- ♣ A gravel drive should be given adequate foundation to prevent it from sinking.
- ♣ The soil is excavated to a depth of about 30 cm but in heavy clayey soil this should be a little more to ensure proper drainage.
- ♣ About one-third to half of the excavated depth is filled up with rough stones, well-burnt brick pieces, clinkers, or any other hard material.
- ♣ The greater part of the remaining excavated depth is filled with coarse gravel mixed with a little earth and rolled.

- ♣ A depth of 50 to 7.5cm of fine gravel is spread over this, sprinkled with water, and rolled heavily.

- ♣ The drive should be kept free of weeds with the help of some weedicide.

(b) Asphalt or Concrete Drives:

- ♣ For asphalt or concrete roads also the foundation is prepared in the same manner and on top of it either asphalt or concrete is laid.
- ♣ A layer of 5cm concrete will be enough for most roads.
- ♣ For long roads a slope of 1: 100 may be allowed for drainage.
- ♣ All roads should be a little higher (2.5cm) than the surrounding ground.
- ♣ The width of the garden roads should be about 3-5m.

(B) PATHS

- ♣ A garden path should never be less than 60cm wide but should be preferably between 90 and 120cm, if sufficient space is available.
- ♣ A wider path allows easy passage for wheel barrows and other garden implements.
- ♣ Paths should not be generally too high or too low from the adjoining ground except in a marsh or a rock garden.
- ♣ Gravel paths, Brick paths, Stone paving, Crazy paving, Grass Paths,

□ HEDGE

- ♣ Shrubs or trees planted at regular intervals to form a continuous screen are called a hedge.
- ♣ The above definition is broad-based, but many other plants such as succulents, cactus, and sub-shrubs also form beautiful and useful hedges.

Purpose:

- ♣ A garden hedge can serve the purpose of a compound wall, give shelter from strong gails ensure privacy, i.e.
- ♣ Serve the purpose of a screen, form a background for a floral display such as herbaceous border, as a part of the garden on

its own merit, separate one component of a garden from the other (e.g., the vegetable garden from the flower garden).

- ♣ Screen the ugly and unwanted spots such as manure pits, lavatory, servant's quarters, etc., in the garden.
- ♣ **Criteria for selecting a hedge plant:** In a garden a hedge is planted with two purposes:
 - (a) Protective, which means protection against theft, trespass, wind. etc., and
 - (b) Ornamental purposes or screening.
- ♣ For protection a hedge plant should have the following characteristics -
 - Quick growing, hardy, including drought-resistant character, thorny, dense, should respond to frequent pruning and clipping and can be raised quickly by seeds or cuttings.
 - Though attractive foliage and flower is not a criterion in this category, definitely these characters will be an added attraction.
 - Ornamental hedges should have attractive foliage and/or flowers, should be dense in growth habit and stand regular clipping.
 - The ornamental hedges are generally low in height and they do not obstruct the view completely since the other portion is visible over the hedge.

Selection of suitable plants: There is a wide variety of trees, shrubs and other plant which can be formed into hedges. Some trees form good tall hedges. A list is provided below for a general guidance.

(A) Palms as Hedge: *Areca lutescens*, *Ptychosperma macarthurii*, *Rhapis excelsa*

(B) Trees as Hedge: *Acacia farnesiana*, *Erythrina*, *Grevillea robusta*, *Inga dulcis*, *Parkinsonia aculeate*, *Polyalthia longifolia*, *Pongamia glabra*, *Putrajniva roxburghii*, *Thevetia nerifolia*.

(C) Conifers as Hedge: *Casuarina equisetifolia*, *Cryptomeria japonica*, *Thuja*

- i. Trees are generally planted 60-90 cm apart in a hedge.

(D) Shrubs for Hedges:

- i. *Acalypha*, *A. tricolor*, *A. hamiltoniana*, *A. wilkesiana* var. *musaica* and other small-leaved species can be trimmed regularly to form ornamental hedges. The tall species can be used as protective hedge also. Cuttings are planted 25-30 cm apart.

- ii. *Aralia*: Different species.
- iii. *Barleria*: Different species with their beautiful flowers subject themselves to be trimmed to beautiful hedges; plants are 60-100 cm high. Rooted cuttings are planted 20-25 cm apart.
- iv. *Bauhinia acuminata*: It can be trimmed to a nice hedge, which looks more beautiful with its white flowers.
- v. *Bougainvillea*: *B. spectabilis*, *B. glabra*, 'Mrs. Fraser', 'Partha', and some other cultivars form good protective as well as ornamental hedges withstanding frequent trimming planting is done at 60-90 cm spacing.
- vi. *Caesalpinia pulcherrima*: It should be pruned tall; harder pruning forces it to ageing faster. The plant flowers freely.
- vii. *Carissa carandas*: A thorny bushy shrub which is used as an effective protective hedge. Seeds are sown 60-75 cm apart in single rows. Cuttings also root easily.
- viii. *Clearodendron inerme*: It is most suitable for ornamental hedge and can also be used as protective hedge. It is planted 15-20 cm apart in double rows spaced at same distance.
- ix. *Duranta*: It forms a good ornamental as well as a protective hedge. The variegated variety looks very ornamental. It is planted 30-40 cm apart and can be kept quite low by trimming.
- x. *Eranthemum*: Several species (see page 144) are used as ornamental hedge. Cuttings are planted 15 cm apart in double rows.
- xi. *Hamelia patens*: A beautiful shrub which stands trimming and attains a height of 75-90 cm. It is planted 30 cm apart.
- xii. *Hibiscus*: Different types especially *H. rosa-sinensis* are grown as hedge mainly for ornamental purposes. It is frequently pruned to keep a height of 75 to 90 cm.
- xiii. *Lantana*: Different species of this genus are used as hedge and these stand trimming and pruning very well.
- xiv. *Murraya exotica*: It also forms a good atall attractive hedge when properly trimmed.
- xv. *Plumbago capensis*: It forms a pretty ornamental hedge. Cuttings are put in double rows, 15-20 cm apart.
- xvi. *Punica granatum*: It forms a tall hedge, 1.5 to 2m high. It is drought-resistant.
- xvii. *Poinsettia pulcherrima*: It can be used as a beautiful ornamental hedge.

- xviii. *Rosa*: Some species such as *R. multiflora* can make a good spiny hedge.
- xix. *Sesbaia aegyptica* (*Syn. Aeschynomene sesban*): It grows to a height of 2m within 2-3 months and is a popular hedge in the drier parts of India.
- xx. *Strobilanthes anisophyllus*: A shade-loving ornamental hedge.
- xxi. *Tecoma stans*: It forms an attractive tall (1 ½ to 3m) hedge within a span of two years.

- Edging may be **formal**, made of stone, bricks, tiles, etc.,
- **Informal** edges consisting of living plants.
- There are certain plants which are very suitable for edging purposes and these are known as edge plants.
- Edge plants, unlike hedges, should grow very low as the purpose is not for screening but to provide a lining only, for the purpose of decoration or demarcation.

(E) Cactus, succulents, and others as hedge

- i. *Agave Americana*: This and other tall growing agaves are used as barriers to cattle.
- ii. *Bambusa*: Some dwarf species such as dwarf Chinese bamboo (*B. nana*) make untidy hedge. Bamboo hedge may harbour snakes, if kept untidy.
- iii. *Euphorbia antiquorum*: A spiny succulent shrub which makes a tall hedge up to 3m.
- iv. *E. bojeri*: With its pretty scarlet flowers this forms a good hedge, 45-60cm high.
- v. *E. splendens*: It is similar to above but stems and spines are stouter.
- vi. *E.tetragona*: It is used to form a tall spiny hedge.
- vii. *E. tirucalli*: It is a spineless succulent tree, branches slender, brush-like and cylindrical.
- viii. *Furcraea selloa*: A plant like agave with spines can be used as cattle-proof hedge.
- ix. *Optmtia*: Many species of *Opuntia*, belonging to Cactaceae, form into thorny hedges.
- x. *Pandanus*: The screw pine is a thorny plant and should not be used as hedge in a small garden. It is used as hedge in large commercial farms growing food crops. The plant bears scented flowers. Because of its thick growth, the plant is a good hiding place for snakes.
- xi. *Pedilanthus tithymaloides* (*Syn.Euphorbia canaliculata*): A spineless plant belonging to Euphorbiaceae is commonly used as ornamental hedge. Cuttings are planted 10-15 cm apart in double rows spaced 15cm from each other.
- xii. Cactus (*Cereus, Opuntia*) when used as hedge outgrows in size and should not be used in home gardens.

□ EDGING

- Lining of borders of flowerbeds, paths, lawn and shrubbery with brick, concrete, living plants, etc., is known as edging.

(A) Foliage Plants for Edging

1. *Alternanthera, A. amabilis, A. amoenga, A. bettzichiana var. spathulata, and A. versicolor*. The last two are very colourful, shaded red, bronze, and pink. Cuttings are planted 3-5 cm apart in double rows spaced at 5 to 10cm in situ.
2. *Acalyphas* or similar shrubs in shrubberies.
3. *Coleus*: Family: *Labiata*. Some dwarf *coleus* (20-45 cm high) can also form edging to ornamental shrubs.
4. *Pilea muscosa* (*Syn. P microphylla*)

(B) Flowering Plants Used of Edging

Many of the flowering annuals and some perennials are used for edging. The most important among these are *Alyssum, Amaryllis, Brachycome, Gerbera, Torenia, Zephyranthes* different types, pansy and perennial verbena. Many cultivars of miniature roses are also used for edging.

□ ARCHES

- A garden may need some arches for training climbers or ramblers.
- Arches are generally constructed near the gate or over paths in the garden.
- An arch should be at least 2 to 2.5m high, so that the branches of creepers hanging down should not interfere with access.
- The breadth depends upon the path over which it is constructed but should not be less than 1m.
- Galvanized wire nettings may be fixed on the sides of the arches to help the creepers to climb up.

- The portions above ground should be painted green.

❑ PERGOLAS

- ❑ For growing creepers in a row pergolas are ideal structures on which these may be trained.
- ❑ A pergola may be defined as a series of arches joined together.
- ❑ Pergolas are generally constructed over pathways, which add beauty to a garden.
- ❑ Like arches the support can be made of wooden or stone or brick pillars, angle iron and G.I. pipes.
- ❑ The supporting pillars may be connected together by wooden rafters or MS rods may be welded to the pillars.
- ❑ The roof may be made of angle irons of different sections with longitudinal and cross rails.
- ❑ Over this base strong galvanized wire-mesh or welded-mesh may be placed for the creepers to spread easily.
- ❑ The width of pergolas is kept generally within 2-2.5m and the height is also the same but preferably on the higher side.
- ❑ The width may be increased or decreased a little, if necessary.
- ❑ The length will depend upon the area to be covered, the number of creepers available and of course the budget.
- ❑ The roof of a pergola may be flat or in the shape of an arch.
- ❑ As in the case of an arch, the pergola is also painted green to merge with the colour of the foliage.
- ❑ A pergola is a useful resting place during the summer months in a tropical country.
- ❑ The path below remains cool due to the creepers growing above.
- ❑ If the pergola is side enough concrete or wooden benches may be constructed for sitting.

- ❑ In broad pergolas it may also be possible to keep a few shade loving plants to protect them against sun, but this may not be desirable all the time.

▪ TOPIARY

- ❑ It is an art of trimming plants into different shapes i.e., of birds, animals, domes, umbrellas etc.
- ❑ It is an old art but how-a-days.
- ❑ It is becoming popular in city parks to recreate visitors specially children's.
- ❑ For making good topiary, ideal shrubs and trees should be selected.

❑ Characteristics of plants

- ❑ Plant should be quick growing in nature.
- ❑ Leaves should be small, green or yellow in color.
- ❑ Ability to withstand frequent clipping/pruning.
- ❑ Produces good number of lateral shoots.

E.g. *Clerodendron inermae*, *Duranta plumari*, *D. variegata* *D. goldiana*, *Juniferous chinensis*, *J. horizontalis*, *Cupressus sempervirans*, and *Thuja orientalis*. For temperate countries English yew, Box tree.

- ❑ **Method:** Training frames are generally employed for making topiary.
- ❑ These frames are generally made from soft steel rods or galvanized wire frames.
- ❑ Making frames true to shape is highly technical and artistic for true depiction of figures.
 - Identify and mark the suitable place for planting
 - Excavate the pit with the size of 3 cft or 2 cft
 - Both pit and soil should be exposed to sunlight for the period of 10-15 days
 - Fill the soil into the pit without changing the soil strata. Top soil

should be mixed with enough quantity of sand and FYM.

- Leave the soil for 10-15 days for proper settling.
- Select healthy, strong seedling and plant exactly centre of the pit.
- After put forth the new growth, pinch/stopping should be done to encourage the laterals shoots.
- After plant attaining proper height and with, lace pre-fabricated iron or steel frame over the plant cut all the shoots which come out from the frame to achieve desired shape.
- **Maintenance:** The topiary plants should be watered fertilized liberally so that plants make a dense and colorful growth.

10. ROCK GARDEN:

- Rocks and soils are arranged in such a fashion that conditions are created for the growth of different plants.
- In nature, rocks may be getting covered with different colored moss and if soil collected in cracks and crevices of rocks, plants grow there naturally.
- **Selection of site:** It is easy to create rock garden where natural rocks are available nearby. But large rock garden should be situated in a place where there will fit with the other garden features. Apart from this corners, middle part of garden, under large trees are better places for creating rock garden.
- **Characteristics of rocks:** The rocks should be of local origin, porous and have a weathered look. Stones having diameter of 60cm or more should be selected.

Types of rockery: Common types are

- a. Tyre type of rockery
- b. Round rockery
- c. Rectangular rockery
- d. Square rockery
- e. Rockery under tree
- f. Alpine rockery
- g. Flat type rockery

Suitable plants

1. **Annuals:** All annuals may be accommodated in the rockery depending on their height in between shrubs and other perennial plants- *Asclepias, Calliandra, Clerodendron, Crossandra, Cuphea, Euphorbia* .
2. **Shrubs:** *Duranta, Juniferous, Lantana sellowiana, Russelia junta, Thuja orientalis* etc.
3. **Cacti and Succulents:** *Adiantum, Pony tail plant, Opentia, Cerus, Mumalaria, Agave, Kalanchoe, Sansiveria, Yacca, Hawarthis, Furcrea, Sedum* etc.
4. **Ferns:** *Nephrolepsis, Polypodium and Adiantum* etc.
5. **Shade plants:** *Imparatiens sultaniana, Pedilanthus tithymaloides, Pilea muscosa, Portulaca sps, minature roses, Zebrana pendula, Tradescantia albifolia, Vincea rosea* etc.

11. CARPET BED:

- It means covering an area preferably a bed or a series of beds, with dense low growing herbaceous plants according to a set of design.
- It looks attractive in sloppy land when it is not existed in the selected area, the soil should be imported from the other places for creating the slope.
- **Carpet bed can often utilized for creating figures or letters are cutout with the help of plants having different growth habits or having different colored leaves.**
- To have a contrast, plants with one color as background and then other color may run through in groups, strips or lines or letters to have the desired effect.
- It can also be created in an artistic manner depending upon the taste of the designer and plants available at hand.

Plant characteristics:

- a. They should be perennial in nature
- b. They should retain better contrast through out the year
- c. They should have quick recuperative quality
- d. They should withstand to frequent pruning and mowing

- e. They must be capable to withstand summer sun and heavy rains
- f. They must be capable to withstand drought

E.g. *Alternanthera* (Red, green, variegated, range types), *Dwarf coleus*, *Irisine lindanae*, *Pilea microphylla*, *Portulaca*, *Sedum*, *Mexican grass*, *Korean grass*, etc

12. FLOWER BEDS:

- ❑ Main idea of creating flowerbeds in the garden is to display the flowers in best way as possible.
- ❑ The flowerbeds can be planted with winter flowering annuals sown during September-October or summer flowering ones sown during February-March and rainy season flowers sown during April-June.
- ❑ The perennial plants like Canna, daisy etc., are planted in flower beds.
- ❑ **Designs:** The shape of flowerbeds should be simple designs such as **circles, rectangles, squares, ellipses** are easier to maintain.
- ❑ **Kidney shaped beds, beds with sharp points and angles also look very attractive.**
- ❑ For marking the beds simple plastic hose pipe or wet rope may be used to obtain the desired shape on the ground then mark out the outer border with lime powder followed by digging.

13. SHRUBBERY:

- ❑ "Growing of shrubs in a groups is referred as Shrubbery
- ❑ Shrubs are the permanent features and once planted will become permanent features unlike the seasonal flowers which are to be replaced every season.
- ❑ If shrubs are properly selected, the shrubs in the shrubbery will provide flowers throughout the year.

- ❑ Suitable places for shrubbery in the garden are
 - Centre part and
 - Corners of the gardens

14. BORDERS:

- ❑ It is defined as beds, which are more in length than breadth and contain plants of heterogeneous character.

There are **three types of borders**

1. Herbaceous border
2. Annual mixed border
3. Mixed border

❑ HERBACEOUS BORDER:

- ❑ This is a characteristic of English garden, containing hardy perennial herbaceous plants, which die down to the ground level after flowering, but put up new growth from the roots in the next season.
- ❑ Herbaceous border needs good depth of soil and sunny situation.
- ❑ The border may be placed against a wall, a fence, shrubbery, a hedge or a double divided grass path.

- ❑ **Annual mixed border:** A border consisting of mixed annual flowers. The beds are annual in duration.

❑ Mixed border:

- ❑ A mixed border generally herbaceous shrubs with less spreading root system, sub-shrubs, herbaceous perennials, bulbous plants and annual flowers.
- ❑ A mixed border is arranged against the background of walls, ornamental trees or fencing and compound walls.

15. ARBOUR

- ❑ It is nothing but a hut like structure having more than eight entrances".
- ❑ It acts as a resting place for visitors.

- ❑ Suitable place of construction of arbor is preferably highest part of the garden so that visitors can see overall structure and beauty of garden.
- ❑ **Materials:** For pillars: Wooden poles, metal pipes, brick pillars, concrete pillars.
- ❑ **Roofing materials:** Metal rods, wooden flats GI mesh or tiles.
- ❑ Construction procedure similar to pergola.

16. GARDEN BRIDGES

- ❑ Bridges are necessity item in a garden to cross the stream or pond.
- ❑ This should be developed harmoniously with landscape.
- ❑ The shape, size and material of the bridge depend upon the type of water barrier it is to transverse.
- ❑ In pictures are garden designs, rustic looking materials is more appropriate than the formal one. They are made up of stone, wood or concrete materials.

17. LAWN:

- ❑ Lawn is defined as “a piece of land thickly covered with uniformly green soft grass”. It is also called as Green carpet
- It is like a cushion, velvet carpet giving pleasure both to sight and feeling”.
- Lawn is an art of any garden.
- It is a center peace around which all garden elements are placed in subordinate order like the royal court where the king occupied the central position surrounded by his courtiers.
- Lawn was introduced by Englishmen’s, since then it has continued to stay as the most important feature in our garden.

Selection of grasses:

- A good grass is one, which should put-up fair growth of uniform texture and greater tolerance to abuse.

Common grasses

- a. Calcutta doob b. Mexican grass
 c. Korean grass d. Kentukey blue grass
 e. Zade velvet f. Bermeda g. St. Augustian grass
 h. Green gem i. Polypogium

18. BONSAI

- Bonsai is a tree or simply a plant cultivated in a pot or container, resembling a fully grown tree on a miniature scale”.
- Bonsai first appeared in China over a thousand years ago on a very basic scale, known as pun-sai.
- The word is derived from Chinese Penjing and In Japanese ‘Bon’ means, ‘Shallow pan/pot’ and ‘Sai’ means “Plant’, it is literally called as ‘Tray planting’.
- Bonsai is an art of growing trees, plants proportionately in smaller containers occasionally in combination with rocks of many forms, by treating them with certain technique in order to reproduce in miniature appearances found in nature.
- Bonsai comprises a tree or shrub planted for developing as a miniature plant showing the general appearance of that plant species found in nature for many years.
- It is the art of dwarfing trees or plants and developing them into an aesthetically appealing shape by growing, pruning and training those in containers according to prescribed techniques.
- Overall, bonsai is a great interest, hobby or even profession to undertake.
- A bonsai is not a genetically dwarfed plant and is not kept small by cruelty in any way.
- It is also common belief that bonsai are only a few centimeters tall.
- Most are over 05 centimeters (2¹¹) tall and max upto 1 meter (3.33 ft).
- This is what is meant by the expression "heaven and earth in one container".

BONSAI STYLES:

There are many styles in bonsai, which have been developing over the ages. The following are the principal classical bonsai styles developed over the years.

1. **Formal upright style (Chokkan):** In this style branches grow symmetrically and horizontally around the upright straight trunk.
2. **Winding or Kyokkum/Curved trunk style (Moyogi):** In this style plants retain a very natural appearance with the help of curving nature of the trunk. The branches get smaller in size towards the top growing also in the edge of the curves.
3. **Oblique/Leaning trunk style (Shakank):** The trunk leans to one side; branches are positioned horizontally, shooting out in all directions. The surface roots clearly visible in the side opposite to the lean.
4. **Windswept style (Fukinagashi):** This differs from previous style that branches grow on one side of the trunk only. This gives the impression of the blowing continually from the direction.
5. **Broom style (Hokidachi):** This style having the similarity in appearance to unturned broom. It spreads the branches in the shape of a fan, may occupy half the total height of the tree. The trunk is upright.
6. **Cascade style (Kengai):** The branches grow out over the edge of the container chosen for this style is high enough to show off cascade effect to best advantage.
7. **Multiple trunks style or Clump shaped (Kadudaki):** Trunks are allowed to grow a single root, which has put several shoots. The result of this is a little group of trees. Generally, they should make up an odd number but if only trunks appear, they should of different sizes.
8. **Raft style (Ikuabuchi):** This style creates an effect of fallen trunk, which has put out roots downward, and branches upward. The final impression, which is quite original, is one of the groups of individual plants all spring from a horizontal trunk.
9. **Woodland (Yose ue):** In this fascinating style, in a single container a number of all individual plants of the same species are laid out in a correctly proportioned manner.
10. **Twisted trunk style:** The trunk diminishes size toward the top and gives the appearance of twisting in upon itself; the branches break out in all directions.
11. **On the rock:** The piece of rock is placed appropriately in the container to be embraced eventually by the roots of the bonsai. This however sinks into the soil below. Once the little tree starts growing and putting new roots in to small cavities in the rock, one can get so called "rock planting".
12. **Memo bonsai/Mini bonsai/Disc bonsai:** The plants are often not more than 8 - 15cm high (3 - 6 inches) and grow in containers after no bigger than a thumb.

@@@@@The End@@@@@