HOR.411 – FLORICULTURE – SPICES AND PLANTATION CROPS

Lecture No.1 – Importance – History and scope of gardening. Styles of garden and garden components

What is Floriculture?

- Floriculture is the aesthetic branch of horticulture which deals with cultivation of ornamentals, annuals, biennials and perennial plants including potted ones and also their marketing.
- This also includes marketing for local, distant markets and export of cut flowers, live plants and economic products like scents, oils and medicines etc.

Important fields of floriculture:

- Loose flowers or traditional flowers
- Cut flowers
- Cut Foliage Plants
- Ornamental plants production
- Floral concrete
- Natural dyes
- Dry flowers
- Seed production in flowering annuals

Flowers

- Flowers are associated with mankind from the dawn of civilization.
- Indian is born with flowers, lives with flowers and finally dies with flowers.
- Flowers are used for various purposes in our day to day life like worshiping, religious and social functions, wedding, interior decoration and self adornment.
- Saying it with flowers is very common and different flowers are used to convey the human feelings.

Flowers commonly used for such purposes are:

- Rose for **Love**
- Pansy for **Thoughts**
- Carnation (white) for **Women's love**
- French marigold for **Jealous / Sorrow**
- African marigold for **Vulgar minds**

- Narcissus for **Self-Esteem**
- Daffodil for **Regard**
- Amaryllis for **Pride**
- Iris for **Message**
- Snap dragon for **Presumption**
- Jasmine for **Amiability**
- Lily for **Purity**
- Stock for **Luxury**
- Sweet pea for **Departure**

Importance of gardening

- The importance of gardening is realized by every individuals now in the globe.
- The gardens serve the purpose of public recreation and education.
- They serve to refresh the body and the mind.
- They are virtually a retreat for the public from the harsh strains and stresses of public life.
- Gardens have become essential to modern civilization.
- Home gardening is an integral part of family life and it lends itself for the family life and it lends itself for the family to relax and enjoy the nature and beauty of garden.
- It also helps to develop some useful hobby and the 'skill' in flower and dry arrangements.
- In the recent years, landscape architecture has come to play a vital role in the developments of home, public institutions, public places like bus stand, railway stations, towns and cities.
- Landscaping the roadsides on cities and towns is also given much importance in tropical countries like India as they provide shade and beauty to that area.
- In Western countries landscaping of homes and public building is an important art and there are professional and qualified landscape architects who do the job.
- This field of gardening is slowly gaining momentum in our country especially in big cities.
- The government has also established many parks and a few Botanic gardens in our country.

- In most of the big cities and towns, Agri-Horticultural societies have been established with the sole objective of promoting horticulture, more particularly gardening.
- These societies organize annual flower shows and garden competition to have healthy competition among the public to develop gardening.

History and development of gardening in india

Introduction

- It is believed that the gardening in India is as old as its culture.
- Five to six thousand years before Christ, gardening was in vogue.
- It is understood that Indians were the first to choose gardening as the proper atmosphere for meditation.
- Gardening has been mentioned in classical literature of India.
- **Asoka vana** of Ramayana was believed to be established with trees, shrubs and ponds etc.
- The use of **'Brindavan'** (landscaped city) and **'Raja-vanam'** (large park where kings go for hunting) did find very frequent mention in ancient literature.
- Many trees were considered, **'Sacred'** to Hinduism e.g. *Ficus religiosa*, *Saraca indica*, *Aegle marmelos* and *Mimusops elengi*.
- During Bhuddha's period (about 563 B.C) gardening received further encouragement.
- Gardening is considered as a source of peace and solitude.
- Imitation of nature and improvement over nature were considered as a primary goal in these types of gardening.
- **King Asoka** could be considered as the Father of road side avenue planting as he was the first king to other planting to road side avenue trees in India.
- From 6 to 10^{th} Century gardening received a great deal of encouragement from Indian kings.
- During the time of **King Somadeva** (11^{th} Century) and **King Hamira** (13^{th} Century) gardening developed into a fine art.
- The **'Vanas'** and **'Ashrams'** gave way to gardens established by kings and nobles and gardening became virtually the monopoly of the feudals(sociale system).

Moghul era

- The period between the beginning of the 14th Century to the end of 16th Century showed sudden change in the style of gardening due to the influence of Moghul emperors who ruled India during these centuries.
- **King Feroze Shah** and **King Baber** brought with them the finest art of gardening from their country and the moghul style gardens were established in Delhi, Hyderabad, Agra, Kashmir, Lahore and Pinjore. Some of these gardens are still famous to this day. E.g.
    1. **Garden at Fatepur** Sikri (U.P.) by king **Akbar.**
    2. **Moghul garden** at Pinjore (Punjab) by king **Fadaikhan.**
    3. **Shalimar Bagh** at Lahore-by **Shah Jahan**.
    4. **Taj Mahal** garden in Agra by **Shah Jahan**
- These Moghul gardens had a distinct style.
- They were laid out near river, or rivulets, slope of a hill or river bank.
- The garden may be square or rectangular and paths running parallel to water courses.
- **Running water** is the life and soul of the garden and the water channels are paved with tiles of brilliant blue colour to reflect the sky and give the impression of depth.
- On either side of the central channel or sheet of water were planted with flowering shrubs, trees, scented flowers like rose and jasmine.
- All the moghul gardens had high wall surrounding them.

British period

- During the 16th Century when British came to India they introduced the styles of gardening of England and continental Europe.
- The first style developed by the British was the **formal** or **symmetrical_**style of gardening.
- By 18th Century, this style became monotonous and then **informal style** or **natural gardens** began to develop.
- The modern gardens, developed during 19th and 20th Centuries, involved the **combinations of the formal and informal** styles.
- The important features in English gardens are **lawn, rockery**, **mixed borders** of herbaceous perennials, annuals and shrubs etc.

- **Lal Bagh at Bangalore, Government Botanic Garden at Ooty, Sims park at Coonoor and Bryant park at Kodaikanal** are examples of gardens established in British style.
- Britisher's memorable gift to Indian gardens was making of herbaceous border and lawn.
- Concentrated efforts were initiated to improve the gardening in three ways *viz.,*
    - (i) introduction of exotic plants from England and other countries,
    - (ii) establishment of royal-agri-horticulture societies and botanical gardens, and
    - (iii) compilation of local flora of different regions.

Post independence period

- There have been radical changes in the field of ornamental gardening during post-independence period.
- Remarkable achievements have been made at all three important fronts *viz.,* conscious planning for improving total environmental, commercial floriculture and teaching and research of ornamental horticulture at graduate and post-graduate levels.
- Several gardens in different cities have been laid out to provide active and passive recreational facilities and to improve the environment.
- Important gardens are Budha Jayanthi Garden, Delhi; Rose Garden, Chandigarh and Ludhiana.
- The main features of these gardens are undulating grassy lawns, serpentine pathways and colourful plant material.
- These gardens are deviated from traditionally Mogul gardens in their layout.
- As a general rule, landscaping of public and private buildings has become an integral part of planning.
- State Departments like Urban Development, Archeological and Tourism are actively busy improving total environment of buildings by conscious planning and planting.
- Green belts are being provided in industrial towns to reduce air pollution.
- It is becoming customary to engage technical trained persons for such purposes.
- Keeping the immense scope of commercial floriculture in view, much attention is being given to exploit it fully.

- The cut-flower trade in big cities like Bombay, Calcutta, Bangalore, Madras, Delhi, Pune, Ludhiana, etc. has developed tremendously during the last two decades.
- Now farmers earn good income by growing flowers around big cities. The growing of certain flowers and production of planting material like corms, bulbs and pot plants have been specialized in different agro-climatic zones, as detailed below.
- *Hilly region* (Srinagar, Darjeeling, Nainital, Himachal Pradesh) – gladiolus, narcissus and other bulbous plants.
- In North India Plains: -roses, gladiolus, carnation, marigold, other seasonal flowers; Western ghats (Pune, Nasik): -rose, gladiolus, marigold, aster; South India:-tuberose, jasmine, marigold, crossandra, barleria and foliage plants. Eastern region: – chrysanthemum, tuberose, aster and lotus and foliage plants.

Designing a garden

- A garden may be defined as an area **embellished** with plants, a valuable and pleasurable adjunct to a house/building.
- It is the skillful arrangement and disposition of plants over an area making a design or pattern or picture as it were that forms a garden.
- Therefore, gardening warrants apart from science, it needs artistic taste of the gardener.

Botanical Garden **:** It is a place where plants are assembled for study and display purpose.
It is situated on a vast land.

Park **:** It is a pleasure ground suitably landscaped with plants and play equipments for recreation.
It is raised in a smaller area, in the heart of the cities (or) towns, due to the pressure on land.

Components of garden

1. Lawn
2. Shrubs and shrubberies
3. Climber and creepers
4. Trees
5. Flower beds and borders
6. Ornamental hedges
7. Edges (or) Edging

8. Drives, Roads, Walks and Paths
9. Rockery
10. Carpet beds
11. Topiary
12. Trophy
13. Conservatory (or) Green house (or) Fern house (or) Fernery
14. Sunken Garden
15. Garden adornments
16. Arch
17. Pergola

1. Lawn

- It is defined as the green carpet for a landscape.
- It is a basic feature for home ground development and an essential feature for any other type of garden.
- It provides a perfect setting for a flower bed, a border, a shrubbery (or) a specimen tree (or) a shrub.

  Eg. 1. *Cynodon dactylon* (Doob) (or) Bermuda grass

  2. Korean grass – *Zoysia japonica*

  3. Korean velvet grass – *Z.aenuifolia*

  4. Kentuky Blue grass – *Poa pratensis*

  5. Shade grass (Buffalo grass) – *Stenotaphrum secundatum*

Different methods of lawn making

(i) Seed sowing

(ii) Dibbling

(iii) Turfing

(iv) Turf plastering

2. Shrubs and shrubberies

Shrubs form part of the frame work of the garden and create very pleasing picturesque effect if selected and planted carefully.

A shrubbery is a border planted with different kinds of shrubs and a shrub border is one where only one kind of shrub is used.

Eg: Flowering shrubs

(i) *Hibiscus rosa-sinenis*

(ii) *Neerium indicum*

(iii) *Ixora parviflora*

(iv) *Bougainvillea* sp. etc.

Foliage shrubs

(i) *Acalypha tricolour*

(ii) *Codium variegate*

(iii) *Manihot variegateta* etc.

3. Climbers and creepers

- Climbers and creepers are used to grow against or over walls, trellises, arches, pergolas, arbours, pillars or large trees.
- These climbers may be light or heavy depending upon the amount of wood it produces.

Climbers Example

(i) *Clitoria ternatea*

(ii) Bougainvillea

(iii) *Jasminum grandiflorum*

(iv) *Ipomoea tuberosa* (wood-rose)

(v) *Quisqualis indica*

(vi) *Ficus repens*

Creepers

- Creepers are those plants which are unable to climb vertically on their own because of their week stems.

Creepers Example

(i) Morning Glory

4. Trees

- They form the main frame work of the garden.
- They are generally planted along the boundaries.
- Masses of trees in a corner will help to give depth and perspective.
- A spreading tree is an ideal feature for ‘picnic’ ground in large public garden.
- Trees with beautiful or fragrant flowers or handsome foliage or form, and trees which provide adequate shade are grown in gardens.

Eg: a. Specimen tree

(i) *Araucaria cookie*

(ii) *Plumeria alba & P.rubra*

b. Shady tree

(i) *Azadirachta indica*

(ii) *Ficus religiosa*

c. Flowering tree

(i) *Cassia fistula* (Yellow)

(ii) *Spathodea campanulata*

d. Trees for avenue (or) road side

(i) *Grevillea robusta* (Yellow)

(ii) *Jacaranda acutifolia* (Blue)

e. Screening purpose

(i) *Eucalyptus* sp.

(ii) *Polyalthia longifolia*

f. Fragrant flowers

(i) *Michelia champaka*

(ii) *Millingtonia hortensis*

g. Checking air pollution

(i) *Morus* sp.

(ii) *Plumaria acutifolia*

5. Flower beds and borders

- Several flowering annuals and herbaceous perennials can be grown in beds and borders.
- **Flower beds** of simple designs can be laid out on the outskirts of lawn along the foundation of buildings, in the path leading to the entrance of the house and on sides of foot steps.
- **Borders** are continuous beds of more length than width containing plants of a heterogeneous character as distinguished from flower beds which are composed of plants of one kind only.
- Borders are named as '**shrub border**', herbaceous border or '**mixed border**' according to the plant materials used to fill them.
- These borders can be had on the sides of path, walks and drives or in front of shrubberies and trellises with climbers.

6. Ornamental hedges

- A good live hedge is essential to enclose a garden.
- Ornamental 'Internal' hedges can also be planted inside the garden with attractive foliage or flowering shrubs.
- These are pruned to maintain a height of 50 to 65cm.
- They help to divide the garden into a number of parts, each will have its own distinct features.

  Eg.

  (i) *Lawsonia alba*

  (ii) *Duranta plumieri*

  (iii) *Casuarina equisetifolia*

  (iv) *Murraya panniculata*

7. Edges (or) Edging

- These are the materials of any description which is used in gardens for dividing beds, borders etc. from roads, walks or paths demarcating spaces allotted for particular purposes as flower beds.
- These can be either dwarf growing plants upto 20-30cm. (Eupatorium, Alternanthera) which would stand frequent trimming or they may be made of bricks, stones or concrete slabs.

8. Drives, roads, walks and paths

- All these should occupy minimum space and not be too many in number.
- They should serve to link one part with the other part.
- Paths may be made up of earth, brick, concrete or be paved.
- Paved paths are particularly effective in formal gardens.
- Paving can be done by flat stones or concrete slabs or bricks.
- Sometimes paving with irregularly sized stones to create on old pattern will result in a '**crazy path'.**
- The inter spaces can be planted with ground spreads.

9. Rockery

- This is intended to bring together in a short space an idea of a mountain or alpine garden with plants growing in the crevices of rocks.
- This is an elevated structure resembling a miniature mountain range or the slope of a hill with a few dominant peaks or valleys.

Eg.

(i) *Agave,* - Cacti & Succulents

(ii) *Aloe vera* ,,

(iii) *Sedum* ,,

(iv) *Yucca* ,,

(v) *Nephrodium* – Ferns

(vi) *Polypodium* ,,

(vii) *Vinca rosea* - Flowering

(viii) *Verbena* ,,

10. Carpet beds

- In large public garden, close growing plants like **Verbena** or **Alternanthera** are used to form certain **designs or letters of alphabets**.
- Foliage plants are better suited than flowering plants as they stand severe clipping much better.
- Carpet beds are troublesome to maintain in good health.
- They require constant attention.
- The plants should be trimmed now and then, not allowing them to overgrow.

11. Topiary

- **C**ertain plants are often trimmed to shapes of **animals, birds, seats**, etc.
- The shrubs which are amenable for bending and withstanding frequent trimming are suitable for developing '**topirary**'.
- **Cupressus, Casuariana** and **Bougainvillea** are suitable for topirary work.

12. Trophy

- It refers to the arrangement of **potted colourful foliage** or **flowering shrubs and flowering annuals or herbaceous perennials** around a tree or any central object such as a '**statue**'.
- These potted plants are often arranged in **tiers.**

13. Conservatory or green house or fern house or fernery

- There are certain ornamental plants with beautiful foliage or flowers or both which cannot thrive in the open, exposed to direct sun or wind.
- Such plants can be grown in conservatory or green house or fernery wherein required shade, humidity and cool are provided.

- By having a small pool inside, the conservatory is rendered cool and humid.
- Shade is provided by growing a creeper over the roof which will not shut out light completely.
- **Ferns, Anthurium, Dieffenbachia, Peperomia** are some of the examples of plants which are commonly grown inside a green house.

14. Sunken garden

- This is formed taking advantages of a **natural depression**.
- The garden goes down through a series of terraces to a small pool or a fountain at the bottom.
- In the terraces, flower beds and strips of lawn are laid out.
- It breaks the monotony of flat ground in a garden.

15. Garden adornments

- There are several adornments and accessories such as fountains.
- **Statues, garden seats, ornamental posts and pillars, arches** and **pergolas, trellises, hanging baskets, tubs, vases and urns** with plants which make the garden more enjoyable.
- Playing of a fountain is an interesting feature in a garden and the water in the cistern should be kept clean.
- Garden seats made up of stones, concrete or metal are placed under the tree.
- Hand some tubs, vessels and urns are utilized to display plants in conspicuous places.
- Arbours, arches, pergolas and trellises serve as support to several beautiful plants and to dispel monotony in garden.
- Arbours are usually open on all sides.
- Very often a long wall or the end of a pergola leads to an arbour.
- Arches are generally erected over walks, usually at the entrance and are usually two meters in height.
- Pergolas are series of arches connected over a walk.

Lecture No.2

DIFFERENT TYPES OF GARDENS

- Landscaping of Public Buildings
- Landscaping of Education Institute
- Landscaping of Factories (or) Industries
- Landscaping of Places of Worship
- Landscaping of Small Home Ground

Landscaping of Public Buildings

- There are several buildings in towns and cities which are frequently visited by a large number of people.
- The government and private offices, courts, auditoria, cinemas, hotel and travelers' bungalows fall under this group.
- A large cement and concrete building by itself is not very attractive unless the harshness of this structure is mellowed by appropriate landscaping.
- In large cities, due to paucity of space, hardly any compound is left around these buildings for gardening.
- Therefore, in most of such buildings one has to remain content by arranging some potted plants near the entrance and a few indoor plants may be arranged to decorate the corridors.
- But where space is available a lawn should be laid with a few flower beds and possibly some shrub border may be added.
- The entrance and exit roads may be lined with flowering trees.
- The kind and the size of the trees will depend upon the size of the building.
- Dwarf trees in front of a sky-scraper will be a total misfit.
- Majestic looking non-spreading large trees will be the right choice for such buildings.
- Some flowering climbers may be trained over the portico.
- One or few bougainvilleas or some other flowering creepers can also be trained over the front walls.
- Since space is a problem in large cities, the scope of gardening around the compound is limited.
- To overcome this, the public buildings, especially hotels and banks, can have roof and indoor gardens.

- As in educational institution gardens, the aim of planting trees around public buildings should also be to cut down noise and dust and to provide shade.

Landscaping of Education Institute

- The compounds around our educational institutes such as schools and colleges are generally grossly neglected.
- It is a pity that the importance of landscaping in schools and colleges is not properly understood by the authorities.
- As a result, the campuses present a bare and neglected appearance.
- A planned and properly landscaped school building brings a world of difference in appearance and beauty than an unplanned one.
- Moreover, a good garden in the campus inculcates aesthetic sense to our younger generation.
- The general recommendation is to plant large trees in the school compound.
- In the periphery of the school campus, along the rear and wings, a thick of large shady trees should be planted to bring down noise and cut down dust and storms.
- This plantation will also help keep down severe heat and cold.
- The front should be planted with medium-sized flowering trees for beauty.
- The trees should not completely obstruct the view of the building from outside.
- For enhancing the scenic beauty it is also suggested to plant a row of flowering trees, with different blooming seasons, in front of the large trees along the periphery.
- Eg. Silver oak (*Grevillea robusta*), *Polyalthia longifolia,* rain tree (*Samanea saman*), *Cassia fistula, Tecoma argentea, Erythrina indica,* and *Bauhinia variegata.*
- The roads and paths are to be formally planted with medium to tall flowering plants.
- Small flowering trees such as *Callistemon lanceolatus, Bauhinia variegata,* and *Tecoma argenetea* can be planted.
- Shrubs play an important part in the school landscaping.
- Border planting of shrubbery on large grounds or at the back of the school campus serves useful purpose of filling the gaps between the trees and lawns.Eg. *Tecoma stan, Hibiscus* and *Ixora* etc.
- A lawn looks nice in an education institution, but it is very difficult to maintain.
- The playground can be planted with lawn, if this can be maintained or should be left bare.
- A bougainvillea creeper trained over the wall of the building can change the whole look.

- Similarly, a *Bignonia venusta* supported against a wall also looks beautiful.
- Creepers climbing with their rootlets such as *Ficus repens, Campsis radicans* (Syn. *Tecoma radicans*) can also be trained over some stone or brick wall or pillar.
- Besides an ornamental or a landscape garden, universities and colleges can also maintain a botanical garden or a student garden, where the plants are arranged in groups, family wise, so that such gardens become educative.

Landscaping of Factories (or) Industries

- In modern times, a factory should not become a place of only machinery, dust, pollution and noise, but should also be provided with nicely laid-out parks and gardens.
- This is not only needed from the point of beautification, but also to fight pollution and dust.
- The factories may be broadly categorized into two groups.
- The first group comprises comparatively neat factories such as a plywood factory or a fruit processing plant which emit less dust and other polluting materials.
- The second group consists of factories such as cement, steel, fertilizer, etc., which emit a lot of dust, smoke and harmful chemicals.
- If gardens are to be laid out in the factory premises itself one has to be choosy in selecting the plant materials depending upon the type of the factory.
- In factories belonging to the second category, comparatively hardy plants are to be selected.
- For the factories of the first group a wider range of plant materials can be used.
- The primary aim in a factory garden will be to plant trees such as *Casuarina equisetifolia, Eucalyptus, Polyalthia longifolia,* and silver oak should be planted all around or in the direction of the winds to stop the spread of dust and smoke.
- In a large factory a buffer zone may be created by afforestation between the factory and its residential colony.
- Afforestation can be done with hardy ornamentals such as *Acacia auriculiformis, Casuarina equisetifolia, Dalbergia sissoo* and some other shade trees.
- Besides planting of trees, a factory area can also be beautiful with rockeries, statues, water pools or lakes, fountains, etc.
- Lawns laid in vacant lands not only add to beauty but also cut down dust.
- The other places where gardens can be laid in the factory area are canteen, rest-shed, hospital, administration building, etc.

Landscaping of Places of Worship

- The places of worship such as temples, gurdwaras, mosques, churches, etc., offer a good opportunity for landscaping.
- In a temple the offering is made with flowers and hence it is important to have a garden with the right type of flowering plants.
- The association of *Plumeria acutifolia* is so common with Budhist temples that it is commonly called as "Temple tree" or "Pagoda tree".
- Shrubs such as Jasmines, Crossandra, Barleria etc., are quite useful in a Hindu temple.
- Seasonal flowers such as marigold and small-flowering chrysanthemums yellow-flowering type can also be planted around Hindu temples.
- Some sweetly-scented flowering trees such as *Mimusops elengi* and *Michelia champaca* should be planted around the temple to create an atmosphere of serenity and sanctity.
- A tree of *Aegle marmelos (bael)* may also be planted in a temple as the foliage of this tree is sacred to Hindus and used for offering.
- Similarly, *Saraca indica,* the Asoka, is another sacred tree which should find a place in a Hindu temple.
- Churches also offer good scope for planting of ornamental trees.
- Foundation planting with shrubbery is quite useful.
- Potted plants can also be arranged near the portico.
- There is scope for displaying hanging baskets especially for those Gothic-type buildings.
- In front of Mosques, Mughal-type gardens can be laid out with stress on formal water pools fitted with fountain.

Landscaping of Small Home Ground

- There are some basic guideline for a home landscape.
- But personal preference plays a considerable role in developing a home garden.

Basic principles

- Before actually drawing the master-plan the following points should be kept in mind in home landscaping.
    1. **Background:** The background in a garden, whether a wall, tall trees or a hedge should be neutral in nature; that is to say this should not become a distracting feature over the main features of the garden.

2. **Contrast:** The design should be such that it should break monotony. To achieve this a variation in form, texture, or colour has to be brought in.
3. **Balance or Proportion:**
    - A balance has to be maintained between different components (masses, forms, colour, etc) of a garden.
    - In a formal garden, this is achieved by balancing the quantity or by objects, whereas in an informal garden this can be achieved by planting a small mass of colour in front of a large neutral mass.
    - Overcrowding of plants or other garden features should be avoided.
4. **Open Centre:**
    - The central area of the garden should be left out of nay items of major interest.
    - The best way to achieve this is to have a lawn, which also gives an effect of largeness to the property.
    - A specimen shrub in the centre of the lawn is unsuitable as this counters the principle of a spaciousness, but a tree branching at higher levels from the ground could be planted.
5. **Repetition:**
    - The repetition or duplicating some features of a garden helps achieve rhythm, balance and unity.
    - In a formal garden, generally the same feature is repeated. But for an informal design this need not be so.
    - Here one may repeat the colour tone without disturbing the texture, form or quantity.
    - If there is a circular path this can be repeated by having two or three consecutive circular shaped beds of annual flowers, hedges and shrubbery border.
    - Thus, through the shape is repeated, the variation in texture, colour and form ensure that the design does not look monotonous.
6. **Rhythm:**
    - A landscape designer should have an artistic sense to understand how to bringing in rhythm in the design.

- Arranging the different elements haphazardly, without harmony, does not enhance beauty.
- Harmonious lines, often artistically curved, bring in rhythm to the landscape.
- A group of shrubs in front of a rockery breaks are rhythm.
- Repetition of certain elements, such as form, enhances the rhythm.

7. Variety:

- To break the monotony in a garden, variety is essential. This is achieved by contrast of colour, form and texture.
- Planting of different seasonal flowers all in red colour, does not necessarily mean variety.
- But red salvias contrasted against bright green hedge or shrubbery is a good contrast and may look very attractive.
- Besides these, a design should be simple, easy to maintain and provide comfort for inmates.

Lecture 3 **BONSAI**

- The art of bonsai is the growing and training of a plant to a miniature form having a natural look of old age.
- Although the age-old bonsai culture originated in China. It is generally considered to be a Japanese art.
- The bonsai thrives best in a sunny location and fresh air. If a bonsai is to be kept indoors it should be placed near a window where it may receive full sunshine.
- A bonsai is not a genetically dwarfed plant and is not kept small by cruelty in any way.
- In fact, given an adequate supply of water, air, light and nutrients, a properly maintained bonsai should outlive a full size tree of the same species.

Styles

- There are may styles of bonsai, such as '**formal upright**', '**informal upright**', '**slanting**', '**semi-cascade**', '**cascade**', '**wind-swept**', '**broom**', '**root-over-rock**', '**clinging to a rock**', group planting of more than one style and a few others.
- The tree in the '**formal upright**' style, has a straight tapering trunk while in the '**informal upright**', the trunk is not straight and the top is bent slightly to the front.
- In the '**slanting**' style, the trunk of the tree is slanting and the lowest branch spreads in the opposite direction of the slant with the top slightly bent forward.
- The tree trunk in the '**semi-cascade**' style grows upwards for a short distance and then falls over the side of the pot or container but above its bottom.
- The '**cascade**' style is almost similar to '**semi-cascade**' except that in this case the tree trunk reaches below the level of the pot.
- When all the branches of the tree grow from one side only, as if these were swept by wind, the style is known as '**wind-swept**'.
- In the '**broom**' style all the branches grow almost from the same place.
- Sometimes the tree is planted on a rock with the roots extending down into the soil or roots are attached or clasped to the rock in the '**root-over-rock**' and '**clinging-to-a-rock**' styles of bonsai respectively.

Cultural Practices

Propagation

- The bonsai plants are grown from seeds, cutting, layering or grafting. It takes a longer time to propagate a bonsai from seeds than by other methods.
- A few species, like pine and Juniper are grown from seeds.
- Ficus species, pomegranate, mulberry and bougainvillea may be propagated from cuttings.
- Layering is a useful method for raising plants of Bougainvillea, *Petrea volubilis*, Ixora, jasmine and pomegranate.
- Sometimes grafting is used to propagate mango and citrus.
- The most convenient method is to start a bonsai from a small plant obtained from a nursery.
- Another method is to bring a natural dwarf and stunted plant for making a bonsai from a rocky area where it may be growing wild.

Time of planting

- The bonsai plants are generally started in February-March or July-August.
- However, the best time to start it is before the new buds open.
- The temperate species like cherry, peach and plum are planted in spring (Feb-March) before the new leaves appear on the plant.
- Potting of bonsai should not be done in winter or in severe hot months.

Potting and repotting

- For starting a bonsai from the natural stunted plant or from a dwarf plant obtained from a nursery, it is necessary to prune the roots.
- Generally one-third of the roots is cut off and the tap root also may be pruned if there is an abundant growth of fibrous, lateral roots.
- The unnecessary branches are removed before planting.
- The basic principle in bonsai culture is to restrict and slow down the growth of the plant by selective pruning of roots and branches.
- However, at the same time, it is necessary to provide just adequate but balanced nutrition and regulated watering for proper and healthy but slow growth of the bonsai.
- Before potting the plant one must decide the style of bonsai to be followed.

- The method of planting in the pot or container and the training of the plant will depend upon the style of bonsai.
- The old bonsai requires repotting after 2 or 3 years depending upon the plant species and its growth. The repotting is done in the same way as the potting.

Training

- After planting, the plant is trained according to the style of bonsai.
- The branches or stem can be bent in the desired direction and form with the help of a copper wire which is removed once the required shape is formed.
- Sometimes polythene tape can also be used for the purpose.

Pruning and pinching

- The new growth is pinched once or twice and the branches are pruned sometimes to maintain the shape of the tree.

Pot or Container:

- The pots and containers used for bonsai vary in material, shape and size.
- Small ceramic or terracotta pots and containers of square, rectangular, oval or round shape are the best for bonsai.
- Sometimes small cement containers are also utilized for this purpose but these are not convenient to handle because of their heavy weight.
- The choice of the shape and colour of the container depends upong the style and the type of plant used for bonsai.
- Usually terracotta and light colours are preferable. The rectangular and oval shaped containers are ideal for most of the bonsai styles.
- The round or square container is suitable for growing a single plant in its centre unlike the other shapes in which the plant is placed on one side of the container.

Planting medium

- Generally the planting medium in the pot or container consists of a mixture of two parts of loam soil, one part of fine leaf-mould and a little coarse sand.
- The medium for growing bonsai should be porus with a good drainage. Bonemeal or superphosphate in small quantity is added to the planting medium.
- If possible, sterlize the medium with steam or chemical like formaldehyde.
- Often the soil in the pot is covered with moss and one or tow small stones are placed to give a natural look.

Plant species

- Several plant species are suitable for bonsai.
- The most commonly used species include Ficus (*F.benghalensis*, *F.religiosa, F.benjamina, F.microcarpa*), Mulberry (*Morus*), *Malpighia* coccigera,pomegranate (*Punica granatum*). Pine (*Pinus roxburghii*), Juniper (*Juniperus prostrate*), bottle brush (*Callistemon lanceoletus*), willow (*Salix* sp.), bougainvillea (varieties Sanderiana, Lady Mary Baring, Louise Wathen, Mrs H.C.Buck etc.), Duranta, Bamboo, Chinese orange or Hazara and many other trees and shrubs.
- A few creepers like honeysuckle (*Lonicera japonica*), *Petrea volubilis* and star jasmine (*Trachelospermum jasminoides*) are also suitable for bonsai.

Nutrition

- A mixture of NPK or liquid manure prepared with oilcake (neem or mustard) may be applied once a week after about a month of potting but not during the active growth or dormant stage of the plant.
- The application of bonemeal or superphosphate is useful in flowering while for fruiting add a little potash also to the potting medium.

Watering

- Regular and judicious watering is required but overwatering and waterlogging should be avoided.
- Watering is beneficial at the time of flowering but not in bougainvillea as frequent watering results in shedding of flowers.
- Conifers like pine and juniper require less water that other species.

After care

- The soil in the pot should be hoed lightly when it becomes hard.
- Frequent weeding, control of diseases and insect pests by pesticides, pinching and pruning whenever required, regular watering, balanced nutrition and providing adequate sunlight, are the necessary after-care of bonsai.
- Repotting of old bonsai after every 2-3 years is also helpful in proper maintenance of the bonsai.

Lecture No 4 **LANDSCAPING CITY & TOWN (URBAN)**

- In India most of the old cities and town are very much unplanned without any consideration given to landscaping with trees and plants and as a result they look nothing but like brick and concrete jungles.
- T he city dwellers grossly lack in sun, space, and verdure and are thus deprived of the essential joys of like.
- Our towns and cities can be made more livable, healthy, and beautiful by resorting to bio-aesthetic planning. This can be achieved by planting roadside trees and establishing parks planted with green plants.
- The planning of new towns poses no problem as this can be planned in advance even before construction strarts.
- In a tropical country like India, the planting of roadside avenues are not only important for beautification, but also from utility point of view.
- Trees provide cool shade which is so much needed in the long hot summer months.
- Trees also help bring down air pollution, act as windbreak, and cut down noise.
- Parks are places of relaxation, entertainment, and fresh air in an other wise congested city.
- India possibly has the largest number of flowering trees, both indigenous and exotic which can be used for landscaping town roads.
- Except a few cities such as New Delhi, Chandigarh, Bangalore, etc, no other city has utilized these vast resources to beautify the roads.
- In selecting trees for cities and towns the main criteria should be beauty and shade.
- The broad roads in the cities should be planted with double rows of trees, the outer rows should consist of shade trees, so as to provide shade to the footpath users and the inner row consisting of flowering trees adding beauty.
- M.S. Randhawa suggested long back that wide roads in the cities and town should have two lanes on each side, one for fast-moving vehicles and the other for slow-moving vehicles flanked by footpaths.
- Each lane should be separated by a patch of land planted with grass and shrubs, while the outer rows are planted with double rows of flowering and shade trees.
- Planting the roads in a town or a city is a difficult proposition and this should be done in coordination with the electricity, telephone, and sewerage departments.

- The tree should not interfere with the telephone or electric lines or the underground sewers. For this reason, tall trees (*Eucalyptus*, *Araucaria*, *Millingtonia hortensis*) and trees with spreading havbit (banyan, *cedrus deodara*, *Ficus benjamina*, etc.) are not suitable for city or town roads.
- The trees in both the rows, or when there is only a single row, should be planted in pure avenues, i.e., with one kind of tree only.
- The spacing should be 10 m between the trees and in the case of double rows the distance between the rows will vary between 3 and 10m, depending upon the trees planted and the situation.
- The trees in the opposite rows are planted in a staggering (alternating) fashion. For dwarf trees and non-spreading trees (e.g., *Tecoma argentea*, *Cochlospermum gossypium,* etc.) the spacing can be a little less.
- Though it has been suggested to plant flowering trees in pure avenue for beauty, it is possible to combine two different species flowering in the same season and whose flower colours also harmonize. For example, the scarlet *gulmohar* combines well with the yellow *amaltas.*
- In many cities a piece of land is left out at the intersection of roads as a safeguard against accidents. These plots should be planted with grass and shrubs. One more novel way of beautifying the city roads is to train creepers on iron structures at regular intervals on footpaths.
- This has been done with bougainvilleas in cities such as New Delhi and Baroda.

City parks

- In city there may be parks of several sizes from very large to medium size and also squares or small gardens are generally found at street intersections.
- The small gardens or squares are planted with a view to relieving the eyes of the people passing by them or for a short resting period for those who care to use them.
- Therefore, these may be planted with a patch of grass, few flower beds, one or two shade or flowering trees or a group of shrubs and trees.
- The medium to large parks are meant for a place of recreation and these are considered as lungs of the cities. These should be a place of beauty as well as utility.
- The Prospect Park has
    I. a long meadow, which is a park-like open space;
    II. an undulated and rising hilly section with woodland scenery;
    III. a lake and its surrounding;
    IV. a number of sceneries and objects of beauty.

The Budha Jeyanthi Park in New Delhi somewhat falls into this category. The vast park called "Rabindra Kanan" in south Calcutta with large grassy open spaces, a huge lake with islands, stadium, lily pool garden with a miniature zoo, flowering trees, shrubs, and a hanging bridge may come into this category.

Lecture No. 5 Importance and scope of traditional and non-traditional flowers

Traditional flowers (or) Economic flowers (or) Loose flowers

1. Jasmine – Mullai, Pitchi, Malligai and Kakada
2. Scented Rose – Edward and Andhra Red Rose
3. Chrysanthemum
4. Marigold
5. Tuberose
6. Crossandra

Non-Traditional flowers

1. Nerium
2. Gophrena
3. Barlaria
4. Celosia
5. Nanthyavattai
6. Champaca
7. Manorangitham

Importance

- Among different traditional flowers, **Jasmine** occupy the major area followed by Tuberose, Crossandra, Rose, Marigold and Chrysanthemum.
- The traditional flowers are picked **individually** mostly as **buds without the stalk** and marketed as **loose flowers,** on **weight basis.**
- Flowers are mostly used for hair adornment and for garland making.
- Large quantities of flowers are used for decorating marriage halls, temple chariots and arches.
- Jasmine and Tuberose are commercially cultivated for **concrete** and **absolute** extraction.
- Value added products like pigments from Marigold, Gamphrena etc.

Scope

- Traditional flowers have large scope in India due to the availability of congenial climate, trained man power, skilled and unskilled worker.
- Good scope for domestic and export market for the loose flowers.
- It is more profitable since the income realized per unit area is much higher than many commercial crops.

- Suitable for small and medium level farmers who can engage the family members for picking and handling of flowers.
- Foreign exchange can be earned by exporting the flowers and other related value added products.
- Flower cultivation is labour oriented and provides employment for unskilled rural labours. Even old people and disabled persons can be employed in garland, veni marking etc.
- Income can be realized every day by the small farmers and other people involved in flower trade.
- Commercial units can be started for floral concrete extraction in the rural areas to promote employment for unemployed graduates and entrepreneurs.
- Particularly in Tamil Nadu, based on the climatic conditions, natural resources and infrastructural facilities **seven** floriculture zones are identified to promote flower cultivation.
- Tamil Nadu Government has sanctioned 25 crores for the first phase for Floriculture development during 2003 – 04.
- TANFLORA already started Floriculture development unit at Hosur for the promotion of flowers in Tamil Nadu

Zones		**Flowers**
1. Hozur zone	-	Jasmine, Marigold, Chrysanthemum, Tuberose Gophrena, China aster.
2. Hill area zone (Nilgris, Kodaikkanal,and Yercaud, Kolli hills, Kalrayan hills)	-	Chrysanthemum, Marigold. Rose (in Kalrayan hills Kolli hills),Lilies, Alstroemaria, Limonium, Gypsophyla etc. (Ooty, KKL, YCD)
3. Coimbatore zone (Salem, Coimbatore, Erode)	-	Jasmine, Rose, Tuberose, Chrysanthemum, Crossandra, Marigold, Gophrena, Celosia etc.
4. Madurai zone (Madurai, Dindigul, Virudhunagar, Sivagangai, Ramanathapuram)	-	Jasmine, Rose, Tuberose, Crossandra. Marigold, Gomphrena, Nerium etc.
5. Chennai zone (Chennai, Chingelpet, Kancheepuram, Vellore)	-	Jasmine, Crossandra. Marigold, Tuberose
6. Kanyakumari zone	-	Jasmine, Rose etc.

(Kanyakumari, Tirunelveli, Tuticorin)

7. Tiruchi zone - Jasmine, Rose, Crossandra, Tuberose.

(Tiruchi, Thanjavur, Karur, Perambalur,
Pudukottai, Nagapattinam, Cuddalore, Villupuram)

- The increase in demand and growth of domestic flowers is mainly due to the following reasons.
    1. Advance made in cultural practices and research.
    2. Development of superior varieties with high yield and quality.

Awareness, changing cultural habits and also rise in standard of living have encouraged the people to buy flowers.

Lecture No. 6

Area and production of Commercial flowers and their domestic and export Marketing

Area and Production

In India

- India ranks 2nd next China with an area of 80,000 hectares and production of 4.16 lakhs tonnes.
- India occupies 15% of area in the world.
- The major producing states are Tamil Nadu, Karnataka, Maharashtra, West Bengal, Andhra Pradesh and Uttar Pradesh.

State wise area and production (1999-2000)

State	Area (Ha)	Production (MT)
Andhra Pradesh	8420	32900
Assam	442	79
Bihar	104	1710
New Delhi	1866	10274
Hariyana	1950	33040
Himachal Pradesh	114	589
Jammu & Kashmir	167	1.6
Karnataka	20780	124290
Mathya Pradesh	1334	13127
Maharastra	4786	33250
Manipur	78	20
Panjab	550	3355
Rajasthan	2048	2585
Sikkim	60	1
Tamil Nadu	16745	142333
Uttar Pradesh	321	195
West Bengal	13720	17685
Daman & Dyue	5	57
Pondicherry	46	427

Area and Production in Tamil Nadu

- Flower cultivation is taken up in 16,745 ha area in Tamil Nadu with an annual production of 1,42,333 tonnes of flowers (approximately 1.5 lakhs t).
- The data on area and production of flowers in different districts indicate that Dindigul, Erode, Dharmapuri and Vellore districts are the major flower growing districts with more than 1400 ha. in each district.

District wise area and production in Tamil Nadu

District	Area (Ha)	Production (MT)
Dindigul	2378	14268
Erode	1773	10638
Dharmapuri	1532	9192
Vellore	1426	8556
Thiruvannamalai	936	5616
Tirunelveli	894	5364
Thiruvallur	798	4788
Coimbatore	712	4272
Tiruchirappalli	709	4254
Salem	708	4248
Madurai	677	4062
Virudhunagar	549	3294
Theni	404	2424
Kancheepuram	314	1884
Thoothukudi	299	1794
Kanyakumari	225	1530
Karur	221	1326
Villupuram	201	1206
Thanjavur	143	858
Nagapattinam	108	648
Pudukkotai	106	636
The Nilgris	91	546
Perambalur	68	408
Namakkal	49	294
Sivagangai	15	90
Thiruvarur	12	72

Domestic market

- Total area of loose flowers in India is 80,000 hectares and production is 4.16 lakh tonnes. Of which, the value of loose flowers production is Rs. 150-200 crores.
- In loose flowers production Tamil Nadu ranks first (24.7%) followed by Karnataka (23.1%), West Bengal (9.3%), Andhra Pradesh (9.0%) and Rajasthan (7.4%).
- Encouraging specific flower crops in intensive floricultural zones.
- Encouraging organized auction centres in different intensive flower growing areas to safeguard the growers
- Creation of more awareness regarding use of flowers through media and other agencies and organizing exhibitions.

- Encouraging florist organizations as co-operatives for more systematic functioning of the domestic market.
- Strengthening research facilities for floriculture to meet the requirement of local farmers.
- Retail marketing through super markets.
- Effective implementation of Lab-to-land technology transfer.
- The trade of domestic flowers has also increased in spite of shrinking of land near cities due to rapid urbanization and industrialization.
- The per capita consumption of flowers is the highest in Norway in the world.
- In India, consumption of flowers in the southern states is much higher than the northern counterparts.
- Though the industry is comparatively growing at a faster rate, still there is scope to bridge the gap of demand and supply in domestic as well as in world market.

Export market

- Traditional flowers like jasmine, 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 Rs. 30,000/- and Rs. 60,000/- per kg. respectively. The exported flowers, fetch Rs. 30 crores to Rs. 40 crores foreign exchange annually.
- Extracting essential oils from flowers is another major industry in India.
- Damask rose is widely cultivated particularly in Ajmir, 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 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 agroclimatic 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.

Lecture No. 7

ROSE

- Rose belongs to the family **Rosaceae**
- Rose is a symbol of love, adoration and innocents not in our time only but also for thousands of years and it has been growing on the earth since time immemorial.

Importance and uses

- Traditional roses are mostly grown for garden display purpose.
- They are widely used for edging and pot cultivation.
- Roses especially damask rose, Red rose, Edward rose are good source for the Extraction of rose water, rose attar and rose oil (Otto of rose)
- Rose oil is commercially used for the preparation of cosmetics, perfumes and flavors which are exported.
- *R.hybrida* which is having long stem called cut flowers are shown under green house and exported.
- The miniature roses (or) Button roses are mostly grown for indoor display and pot culture.
- Loose flower used for worship, garland, bouquets and veni making.

Jasmine

- 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* -Mullai
    2. *Jasminum grandiflorum* -Jathimalli (or) Pitchi (or) Spanish jasmine
    3. *Jasminum sambac* -Gundumalli (or) Malligai (or) Arabian jasmine (or) Tuscan jasmine
    4. *Jasminum pubescens* -Kakada

Uses and Importance:

1. They are mainly grown as climbers, shrubs and rarely as pot plants.
2. Jasmine flowers, known for their fragrance are used for making garland.
3. Used for personal adorning by women and in religious offerings.

4. The essential oil extracted from the flowers are of high value as starting material for the perfume industry.
5. There is tremendous scope for the development of jasmine essential oil industry for export.
6. Some portion of the flowers are also used for the production of perfumed hair oil and 'attar'.
7. 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.
8. The jasmine oil is considered unique as it blends well with other floral extracts to make high grade perfumes and cosmetics.

Importance of tuberose

- Tuberose (*Polianthes tuberose* L.) is one of the most important bulbous ornamentals of tropical and sub-tropical areas.
- People all over the world realize that flowers enhance the quality of life and human feelings more than words or other gifts, which results in increased use of flowers and ornamental plants.
- Tuberose is one of the most important commercial flower crops in India and abroad.
- Its blooms are mainly used for making garlands, bouquets, floral ornaments for bridal makeup and other floral arrangements and also as cut flowers.
- The long spike of flowers is excellent for table decoration.
- The flowers remain fresh for days together and impart sweet and ligering pleasant fragrance to the atmosphere.
- Highly valued essential oil extracted from the tuberose flowers is used in the perfume industry.
- Tuberose is native of Mexico from where it is spread to the different parts of the world during 16^{th} century.
- Tuberose is botanically known as *polianthes tuberose* Linn. Belonging to the family Amaryllidacease.
- The generic name Polianthes is probably derived from the greek 'polios' shining or white, and 'anthos', a flower, in allusion to the blooms of the common tuberose and species 'tuberosa', the plant being tuberous in nature.
- The name, therefore, is tuber-ose, not tube-rose.

Lecture No.8.Importance and scope of cut flowers and loose flowers in Indian and global trade

- India as developing country is heading for a major expansion of floricultural products with an annual export target of Rs.100 crores.
- The export from floricultural products during 1991-92 was Rs.14.55 crores and is expected to reach the target within a year or two with the annual growth potential of 25-30 per cent.
- The total area under flower crops in India is estimated to be 34,00 hectares of which Tamil Nadu ranks first in area (8384 hectares). So far, traditional flowers like Jasmine, chrysanthemum, crossandra, tuberoses, etc., were grown in the state.
- Priority is now given to the production of cut flowers like rose, gladiolus, orchids, anthurium and gerberas which are high value cropsa.
- Recently many of the private entrepreneurs have ventured into the floriculture trade by diversifying to the production of orchids and anthurium flowers, both for the domestic as well as the export trade.
- With the prevalence of optimum conditions for growing these high value crops in many parts of our state, the floricultural trade can be expressed.
- The climatic conditions of shevroys offer good scope for the cut flower industry in Gerbera, anthurium and orchids, while the Nilgris and lower pulneys have good scope for Gladiolus, rose and carnations.
- The economic thrust to the grower of these crops is very high and profits ranging from rupees three to seven lakhs in a year from one hectare is quite possible.
- With the view to identify suitable cultivars for higher production of good quality flowers and to standardize the production technology, research programmes are in progress at the Horticultural Research Station, Yercaud.
- Already nine different types of anthuriums are under evaluation. Breeding and Crop Improvement work has been initiated to develop varieties with different colours and good quality flowers.
- Anthurium are generally propagated by suckers that arise at the base of the mother plant. The seeds which set on the spadix can be also sown in sand or coir dust to develop seedlings.
- By employing tissue culture technique, uniform plants can be successfully produced.
- For commercial production of cut flower plants produced by suckers or by tissue culture techniques are more advantageous as uniform, good quality flowers can be obtained early.

- Seedlings will take 2 ½ to 3 years for flowering and due to genetic variability of the seedlings, flower quality cannot be assured.
- A desirable anthurium should grow straight and should produce more flowers and suckers. The flowers should have ideal heart shaped symmetrical spathe and reclining spadix which is shorter then spathe.
- Anthurium flowers have great demand in the domestic market as well as the export trade. Recently, by the venturing of certain private enterpreuners, the marketing of anthurium flower has been standardized to certain extent.
- The grower can fetch from about rupees three to seven lakhs from one hectare.
- Gerbera is another important cut flower crop that finds a major usage in the floriculture industry.
- Gerbera is a cool climate loving plant that can be successfully grown in hill stations of Tamil Nadu viz., the Western ghats, Anamalai, and Eastern ghats comprising the Shevroy hills. Flowers will be available almost through out the year.
- Flowers have a long vase life of 10 to 15 days. Demand for this flower is high both in domestic and international market.
- With proper care and maintenance, about 44 lakh flowers can be obtained in one hectare every year. The grower can easily earn about 7.0 to 9.0 lakh rupees from one hectare.

Lecture No.9 Cultural requirements of Jasmine

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.

Varieties

J.auriculatum

Parimullai - Selection from a local type.
Medium round bud. Resistant to gall mite. Yield 8 t/ha with flowering duration about 9 months/year.

CO 1 - Selection from a Long Round type.
Flowers have long corolla tube; easy for harvesting and marketing. Yield 8.8 t/ha.

CO2 - Induced mutant from a Long point type.
Longer corolla tube; flower buds bolder; field tolerant to phyllody; Yield 11.1 t/ha.

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

J.grandiflorum

CO 1 - Clonal selection from germplasm.
Suitable for both loose flower production and oil extraction. Pink streaks are found on external surface of petal. Average yield 10 t/ha. The concrete recovery is 0.29 per cent.

CO2 - Induced mutant from CO1 Pitchi.
Bolder pink buds with long corolla tube yield 11.68 t/ha.

J.sambac

Ramanathapuram gundumalli - Round flowers with good fragrance; yields 7 to 8 t/ha.

Khoya - Flowers familiar to *J.sambac*, but bolder buds with less fragrance.

Others - Ramabanam, Madanbanam, Single Mogra, Double Mogra, Iruvatchi, Kasthurimalli, Oosimalli, Soojimalli.

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 baral cut end before planting in the medium.
- Best rooting medium is sand : Vermiculate : moss at 1:1:1 ratio.

Plant Spacing, density and season

Species	Spacing	Density(Plants/ha)	Season
J.auriculatum	1.5 x 1.5 m	4400	June to November
J.grandiflorum	2.0 x 1.5 m	3350	- do -
J.sambac	1.25 x 1.25 m	6400	- do -

Planting

- Land with proper drainage, irrigation facilities and sunny location are essential.
- Pits of 45 cm^3 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.

Nutrional requirement

Species	Quantity(g/plant) $N - P_2O_5 - K_2O$	Method
J.auriculatum	60 – 120 -120	Six split doses at Bimonthly interval
J.grandiflorum	100 – 150 -100	In two split doses first June-July and second dose at **December** after pruning
J.sambac	60 – 120 -120	Two split doses first at June-July and second at **November** after pruning

Foliar Nutrition

- Spraying of zinc 0.25% and magnesium 0.5% before flowering increases the yield of flowers.
- Spray $Feso_4$ 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 **Oryzalin** 1 or 2 application 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 11 a.m. 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
J.auriculatum	4636 – 9022	0.28 – 0.36 (13.44 – 28.24 kg/ha)	28-30 hrs.
J.grandiflorum	4329 – 10144	0.25 – 0.32 (13.85 – 29.42 kg/ha)	24 hrs.
J.sambac	739 – 8129	0.14 – 0.19 (1.18 – 15.44 kg/ha)	28-30 hrs.

Lecture No.10 **EXTRACTION OF JASMINE CONCRETE**

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.

PICKING OF FLOWERS FOR EXTRACTION:

- Freshly picked fully opened flowers are required.
- Jathimalli flowers open in the evening between 5-7 p.m.
- Picking of flowers is before 9.30 a.m.
- Picking after 11.00 a.m. will reduce the yield and quality of concrete.
- Flowers are collected in clean baskets (or) cloth bags without damage and contamination.
- Harvested flowers are kept in cool atmosphere and processed within two hours after harvest.

PROCESSING:

Two steps

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

Equipments

1. Extractor (Rotary type of 3 kg capacity)
2. Evaporator (wide mouthed circular stainless steel bowel 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^{o}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^{o}C.

↓

Vapour of the solvent condemned 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) aluminium containers

Lecture No.11Cultural requirements of Rose

Groups

1.	Scented Roses	:	Damask Rose - *Rosa damascene* Edouard Rose -*R.bourboniana* Red Rose -*R.centifolia*
2.	Hybrid Tea Roses	:	*Rosa hybrida*
3.	Floribunda Rose (or) Polyanthas Rose	:	*Rosa multiflora*
4.	China Rose	:	*Rosa chinensis*

Varieties

	Variety	**Source**
Hybrid Tea	Mother Teresa, Priyadharshini, Jawahar, Soma, Arjun, Anurag, Mirnalini	IARI, New Delhi
	Dr.G.S. Randhawa, Kiran,	IIHR, Bangalore
	Mirnalini Stripe, Mirnalini Light pink mutant, Pink Contempo	NBRI, Lucknow
	First Red, Profita, Alimir Gold,Saffire, Grand Gala	The Netherlands (Cut flower for Export)
Floribunda	Manasi, Kavitha, Mohini, Deepika, Dr.S.S. Bhatnagar	IARI, New Delhi
	Sharada, Sukumari, Yellow Contempo	NBRI, Lucknow
	YCD-1, YCD-2, YCD-3	TNAU, Yercaud
Miniature	Windy City mutant	NBRI, Lucknow
Climbers	Climbing Sadabahar	IARI, New Delhi
	Climbing Cri-Cri	NBRI, Lucknow
Scented Rose	Edouard Rose,Damask or Bulgarian Rose,Andhra Red	-

Soil

- Well drained, sandy (or) sandy loam with pH 6-7.

Climate

- Temperature : **18 -20 C**
- RH : 75 %

Propagation

- Commercial method of propagation is by **cutting** and **budding.**

a) Cutting

- Scented roses are mainly propagated through cuttings.
- Cuttings are collected from healthier plants having 15-20 m and 3-4 nodes.

- Cuttings are treated with IAA, CO1, BA 100ppm
- Planted in mist chamber for easy and quicker roofing.

B) Budding

- Hybrid and Floribunda roses mainly propagated through budding.
- 'T' budding is the common method
- Root stocks used are Briar root stock, *R.indica* var. *odorata, R.bourboniana* and *R.multiflora*

Spacing and planting

- Spacing : 60 x 60 cm (27,777 plants/ha) – Loose flowers
  90 x 60 cm (18,518 plants/ha) – Cut roses.
- Planting is done during **June-July**
- The pit size is 45 cm^3.

Pruning

Pruning is the removal of unwanted and unproductive portions of the plant and make the plant more vigorous and productive.

Objective

- To increase the no.of flowers
- To improve the flower size
- To get long stalked flowers
- To open up the bush for proper utilization of solar energy
- To remove dead and diseased shoots
- To remove weak, straggly and cris-crossing branches

Time of pruning

- Exactly 45 days prior to the date of requirement of flowers
- During October-December
- Pruning is necessary when the yield and quality declines.

Method

1st Year

- Cut back the shoots to four developed buds remain
- Allow the lateral shoots

2nd Year

- Retain all strong shoots and remove weak and diseased shoots
- Cut back the strong shoots to 4-5 buds

3rd Year

- Cut back vigerous shoot to half of its growth

Rejuvenation

- After 5-6 years the plants are to be rejuvenated
- Cut back all the main branches at 15-20 cm from the base
- Apply Bordeaux paste over cut ends to prevent diseases.

Manuring

- After pruning basins are formed around the plants and manures are applied 10-15 cm depth.
- Dose/plant – FYM 10 kg, Urea 65 gm, Super phosphate 25 gm, MOP 50 gm

Irrigation

- Flood irrigation is given at 10 days interval depends upon the soil and climate.
- Avoid irrigation immediately before and after pruning.

Harvesting

- Flowering starts from 1st year onwards.
- Economic yield 2nd to 10th year
- Flowers are harvested when the flower buds are in half open stage
- For cut flowers, they are harvested at tight bud stage with long stalks.

Handling

- **A**s soon as the flowers are harvested ,the stems are harvested the stems are lowered in to clean buckets containing w3ater with preservative
- The flowers are then cooled down to 2-4 C for 5-6 hours.
- The flowers are graded according to the length of the flower stalk
- It varies from 40-110cm depending on the variety and packed 20 per bunch

Yield

- Loose flowers : 7.5 t/ha
- Cut flowers : 1st year : 100-120 flowers/m^2

  2nd year: 200-240 flowers/m^2

3rd year: 300-360 flowers / m^2

Lecture No.12 **MARIGOLD**

***Tagetes erecta* – African Marigold**

***Tagetes patula* – French Marigold**

Importance

- Marigold is easy to culture and has wide adoptability.
- Free flowering, short duration.
- Wide spectrum of colour, shape, size and good keeping quality.

Uses

- Garland, Veni and decoration
- Long stem flowers used for vase arrangements/
- Used for flower beds and border making.
- French marigold used for rockery, edging, hanging baskets and window boxes.
- Has medicinal properties to cure boils and carbuncles.
- Flower extract used as a blood purifier and a cure for bleeding piles.
- Good remedy for eye diseases and ulcers.
- Some species of Tagetes used for essential oil extraction.
- Pigments (Xanthophyll) used as a natural colour.

Species

***Tagetes erecta* – African Marigold**

- Plant is hardy, annual about 90 cm tall, erect and branched.
- Flower varies from Lemon yellow to yellow, golden yellow, orange.

***Tagetes patula* – French Marigold**

- A hardy annual, about 30 cm tall, bushy type.
- Foliage is dark green with reddish stem.
- The flower colour varies from yellow to mahagony – red.

Other species

T .tenuifolia (*T.signata*) – Bushy type (less than 30 cm)

T.lucida – Sweet scented Marigold

T.lacera – Californian Marigold

T.lemmonii – Shrubby Marigold

Types

***Tagetes erecta* – African Marigold**

- Carnation flowered
- Chrysanthemum flowered
- Tall F_1 hybrids, Semi tall F_1 hybrids, Dwarf F_1 hybrids, F_1 triploid

***Tagetes patula* – French Marigold**

- Dwarf double – (20-30 cm)
- Dwarf double – Scabious flowered (flowers with crested centre)
- Dwarf double – Petite (15-20 cm)
- French Dwarf single – (20-35 cm)

Varieties

***Tagetes erecta*– African Marigold**

MDU-1, Giant double African orange, Giant double African yellow, Cracker Jack, Climax, Dusloom, Golden Age, Chrysanthemum Charm, Crown and Gold, Spun Gold

***Tagetes patula* – French Marigold**

Red Brocade, Rusty Red, Butter Scotch, Valencia Sussana

Tagetes tenuifolia

Golden Gem, Lulu, Pumila, Ursula

MDU-1

- Selection from germplasm type.
- Light orange colour petals.
- Medium tall with moderate branching habit.
- 97 flowers weighing 561.40 gms.
- Stalk length 8.39 cm.

Culture

Soil

- Marigold can be successfully cultivated on a wide variety of soils.
- However, a soil that is deep fertile, friable having good water holding capacity, well drained and near to neutral in reaction viz. pH.
- 7.0-7.5 is most desirable.

Climate

- Marigold requires mild climate for luxuriant growth and profuse flowering.
- It ceases to grow at high temperature thereby flower quantity and quality are 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.

Preparation of soil

- Land should be well prepared by ploughing 2-3 times and 50 tonnes of well rotten farmyard manure should be well mixed.
- Beds of convention size be made to facilitate irrigation an other cultural operations.

Propagation

- There are two common methods of propagation of marigold ie., i) by seeds ii) by cuttings.

Seeds

- Crop raised from seeds is tall, vigorous and heavy bloomer; thus, it is preferred over cuttings.
- For better seed germination, optimum temperature range is between 18 to 30^{o}C.
- For raising seedlings for one hectare, about 1.5 kg. seed is required.
- 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 rotten farmyard manure per sq.m.

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 easily establish after transplanting in the field without much mortality.
- At the time of transplanting, seedlings normally of about one month old should have attained 3-4 true leaves and must be stocky.

Spacing

- *Tagetes erecta* requires wider spacing than *T.patula*
- *T.erecta* – 40 x 30 cm
- *T.patula* – 20 x 20 cm

Manures and Fertilizers

- To get highest flower yield, 100 kg N, 100 kg P and 100 kg K_2O should be mixed at the time of preparation of land.
- Remaining 100 kg N per ha should be applied one month after seedlings are transplanted.

Weeding

- 3-4 manual weedings are done 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 of Marigold plants

- In tall varieties of *Tagetes erecta*, emergence of side branches and their flowering is influenced by the presence of apical dominance.
- It has been observed that the plants of marigold grow straight upwards to their final height and develop into terminal flower bud.
- Pinching the plants 40 days after transplanting enabled the plants to yield more flowers.

Harvesting of flowers

- 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 so that flowers keep well for longer period after plucking.
- Flowers plucked should be covered moist gunny bags if kept over night before taking to market.

Yield of flowers

- Flower yield depends upon season of planting and cultural practices adopted.
- On an average a fresh flower yield of 20-22 tonnes per ha during rainy season, 15.0 to 17.5 t per ha in winter and 100-120 t/ha in summer can be obtained.

Seed production

- Marigold is a cross pollinated crop; hence, proper isolation distance of 1-1.5 km should be given amongst varieties.
- **Seed yield** 312 to 375 kg per ha in *T.erecta* 1000-1250 kg per ha in *T.patula*

TUBEROSE

Cultivars:

- Tuberose varieties on the basis of number of rows of petals, are classified into three types.

(i) Single flowered tuberose:

- 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.
- Concrete content has been observed to be 0.08 to 0.11 per cent.
- Loose flowers are used for making floral ornaments.

(ii) Semi double flowered tuberose:

- Flowers with 2-3 row of corolla segments on straight spikes used for cut flowers also e.g. cv. Semi Double: White flowers with tow to three rows of corolla.

(iii) Double flowered tuberose:

- Flowers with more than three row 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 0.0621%.
- 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.

- Two mutants named ‘Rajat Rekha’ (single) and ‘Swarna Rekha’ (double) are released from NBRI, Lucknow (Sane, 1986) and two varieties Shringar (single) and Suvasini (double) were evolved though hybridization from IIHR, Bangalore.

Rajat Rekha:

- Single flowered type with silvery white streak along the middle of the leaf blade.
- It is a mutant evolved by irradiating bulbs of single flowered cultivar.
- Concrete content has been found to be 0.089 per cent.

Swarna Rekha:

- Double flowered type with golden yellow steaks along the margins of leaf.
- It is a gamma ray induced mutant, in which mutation occurred in chlorophyll synthesis resulting in change in leaf colour.
- Concrete content has been found to be 0.062 per cent.

Shringar:

- This variety has been developed form a cross between ‘Single x Double’.
- It bears single type of flowers on sturdy spikes.
- The flower bud is slightly pinkish tinged.
- Florets are bigger and appealing than ‘Calcutta Single’.
- Resistant to *Meloidogyne incognita* nematode.
- Loose flowers are ideal for making garland, while spikes can be used as cut flower.
- Yield of loose flowers is about 15,00 kh/ha per year, which is 40% higher than ‘Calcutta or Mexican Single’ and the concrete content of the Hybrid is at par with Mexican Single.
- Shringar is preferred by farmers and perfumery industries.

Suvasini:

- A multi whorled variety developed form the cross between ‘Single’ x ‘Double’.
- Pure white flwers are bold and big, borne on a long spike.
- Spikes are best suited as cut flower.
- Suvasini recorded 25% more yield than cv. Double.
- IIHR, Bangalore has also evolved two more new varieties of tuberose namely Prajwal and Vaibhav recently.

Prajwal:

- This hybrid which bears single type flowers on tall stiff spikes is from the cross 'Shringar' x 'Mexican Single'.
- The flower buds are slightly pinkish in colour while the flowers are white.
- The individual flowers are large in size, compared to 'Local Single'.
- It yields twenty per cent more loose flowers than 'Shringar'.
- Recommended both for loose flower and cut flower purpose.

Vaibhav:

- The hybrid which bears semi-double flowers on medium spikes is from the cross 'Mexican Single' x IIHR – 2.
- The flower buds are greenish in colour in contrast to pinkish buds in 'Suvasini' and 'Local Double'.
- Flowers are white.
- Spike yield is 50 per cent higher compared to 'Suvasini'.
- Hence, recommended for cut flower purpose.

CLIMATE

- Tuberose grows in a wide range of climatic conditions but prefers mild climate.
- It is cultivated both in tropics and sub-tropics.
- In India, commercial cultivation of tuberose is confined to warm humid areas with average temperature ranging from 16^{o} to 30^{o}C.
- Tuberose is also grown in hilly areas upto 1200 to 1500 meter height.
- It prefers sunny situation and should not be grown on shady or even semi-shady situation which drastically reduces the flower yield.

Light:

- Tuberose although not strictly photosensitive, long-day exposure promotes vegetative growth as well as early emergence of the first flower spike and also increases the length of flower spike.
- A day length of 16 hours promoted growth and flowering.

Effect of growth regulators

- The effects of pre-planting treatment of bulbs with GA_3, ethereal or thiourea promoted early appearance of flower and the number of flower spikes but reduced the number of bulbs per plant.

- Treatment with GA_3 (200ppm) produced highest number of longer spikes with maximum number of florets.

Propagation

- Tuberose is propagated by seeds, division of bulbs of through tissue culture.
- Tuberose multiplies fast through bulbs in comparision to the other bulbous plants.
- It is largely grown by division of bulbs planted in the month of March-April.
- Bulbs of different sizes (1-3 cm diameter) are used.

Cultivation

Selection of site

- For proper growth and high yield of tuberose it is better to choose a place having plenty of sunlight.
- Tuberose should be grown in well drained place as it cannot tolerate water logging even for a short period.
- Soil should be thoroughly prepared and clods should be broken properly.
- Decomposed organic matter or well rotten cow dung manure or FYM should be thoroughly incorporated into the soil.

Soil

- Tuberose is grown in wide range of soils from light sandy to clay soils including those affected by salinity and alkalinity conditions.
- However, sandy loams or loams having pH range from 6.5 to 7.5 with good aeration and drainage are ideal for tuberose cultivation.
- Soil should be porous and rich in organic matter.

Selection of bulbs, spacing and planting

- Selection of good planting materials is necessary for obtaining higher yield and better quality flowers.
- After lifting the bulbs, they should be cleaned, dried and stored properly before planting.
- Bulb size is 1.5-2.0 cm in diameter is optimum.
- Planting at a spacing of 30 cm x 30 cm is recommended

Nutrition

- Tuberose is a heavy feeder and highly exhausting crop, responds well to the application of organic and inorganic nutrients.

- In general, a basal dose consisting of FYM @ 10kg/sq.m., single superphospate and muriate of potash each @ 80 g/sq.m., 10-15 days prior to the planting of bulbs is recommended.
- Fertilizer application @ 200 kg N, 400 kg P_2O_5 and 200 kg K_2O per has been recommended.

Irrigation

- Irrigation is an important factor affecting growth and flowering in tuberose.
- It is very essential to irrigate before planting to provide optimum moisture for sprouting and further irrigation should be avoided until the bulbs are sprouted.
- During summer irrigation should be given at weekly intervals or even earlier in case soil dries out and during winter at 10 days interval.

Weed Control

- Tuberose field can be kept almost weed free by the pre-emergent application of gamaxone at 3.0 l/ha followed by post-emergent sprays thrice at an interval of 40 days in between the rows of the crop with a spraying hood fitted to the nozzle.
- Pre-planting application of atrazine at 3.0 kg/ha was also recommended for weed control in tuberose and more production of good quality flowers.

Harvesting

- Flowering of tuberose starts 80 to 100 days after planting and flowering time is July onwards.
- Tuberose flowers all the year round.
- Spikes are harvested at bud-burst stage preferably in the morning before sunrise or late in the evening by clipping with a sharp knife or secateur thatgives a clean cut.
- About 4-6 cm basal portion has to be left to allow the growth of bulb.
- The lower portion of the cut spikes immediately after harvest, are to be immersed in water for prolonging life of spikes.
- For loose flower purpose individual flowers are plucked early in the morning and usually packed in bamboo basket which can hold about 10-15 kg of flowers.
- The flower yield ranges from 150 to 200 quintals per hectare in the first year, 200 and 250 quintals per hectare in the second year and 75 to 100 quintals per hectare in the third year.

Grading

- The flower spikes are graded according to the stalk length, length of rachis, number of flowers per spike and weight of spikes.
- Straight and strong stem of uniform length and uniform stage of development are preferred.
- Flowers should be free from bruishes and diseases and pests.
- Florets are graded according to their size for loose flowers.

Packing and Transport

- For room decoration, long spikes are preferred and are sold in bundles.
- Each bundle contain 100 spikes.
- These bundles are packed in rectangular bamboo baskets lined with Hessian cloth.
- For long distance transport, it is better to pack them in corrugated cardboard boxes.

Holding solutions

- A holding solution consisting of sucrose 2% + $Al_2(SO_4)_3$ 300 ppm was found best for increasing the post harvest life and quality of cut spikes of tuberose

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 the graded based on the size into mature (> 1.5 cm diameter) and immature (< 1.5 cm diameter).
- Cleaned and graded bulbs are placed on sheives to dry or cure.
- To hasten curing, artificial heat of 27^o to 35^o C may be applied.
- The bulbs must be stirred or have their position changed every few days to prevent fungal attack and rotting.
- An ambint air temperature of at least 18^oC for four to six weeks or exactly six weeks at 30^oC stimulates the yield of commercial sized bulbs.

- Longer storage at 30^{o}C advances flower spike yield but the quality of spike deteriorates and the bulb number decreases.

Flower and Concrete yield

- Production of tuberose flowers varies with the soil type, climate, planting material, cultivars and cultivation practices.
- The yield of fresh loose flowers per year per hectare in "Single" tuberose varies form 10,000 to 14,000 kh.
- In the first two years, flower yield is high while in the third year, the yield reduces considerably.
- Out of the approximate total yield of 30,000 kg of loose flowers from one hectare, in three years, 27.5 kg of 'concrete' can be obtained.
- This concrete in turn will yield about 5.50 kg of absolute.

Diseases and Pests

- Bulbous plants like all living organisms subject to attack by numberous insects, pests and diseases.

Diseases

Stemrot or sclerotial wilt (*Sclerotium rolfsil*)

- Drenching soil with Zineb (0.3%) or Bavistin (0.5-1%), Thiram (0.2%) or Brassicol (0.1%), three times at 20 days interval has been recommended to control the disease.
- Soil application of Brassicol (20%) @ 30 kg/ha also controls the disease effectively.

Flower-bud rot

- It is a bacteria disease caused by *Erwinia* sp.
- The disease can be controlled by spraying of streptomycine (0.01%).

Leaf blight or Botrytis blight

- Fungal disease caused by Botrytis elliptica.
- The disease can be controlled by spraying the plant with ammonical copper (2%) or Greeno (0.5%).
- The treatment should be repeated at 15 days interval.

Alternaria leaf spot

- Fungal disease caused by *Alternaria polyanth.*
- The disease can be controlled by the spray of Mancozeb (0.2%) or Iprodione (0.2%) at 10 days interval.

Pests

Thrips

- This is the most serious pest of tuberose.
- Thrips can be controlled by spraying with endosulfan (2ml-l) or malathion (1.5 ml/l).

Bud borer (*Helicoverpa armigera*)

- This can be controlled by the spray of endosulfan (0.2%), monocrotophos (0.2%) or Thiodan (0.5-0.8%).

Aphids

- These can be controlled by dusting BHC (10%) in the soil before planting.

Nematodes

- Tuberose is damage by nematodes and resulting extensive yield losses
- Nematodes like too-knot nematode (*Meloidogyne incognita* and *M. javanica*) and reniform nematode (*Rotylenchulus renioformis*) and also greasy steak caused by *Aphelencoids besseyi* have been reported to be responsible for complete wiping out of tuberose flower industry.

Application of Furadon @ 2 g/plant or carbofuran @ 2-5 kg/ha, neem @ 1 tonne/ha controls nematode infestation.

Lecture No13 ORCHIDS

Orchids are the most fascinating and beautiful of all flowers. They exhibit a wide range of diversity in form, size, colour and texture of flowers beyond the imagination of human mind. Orchids constitute an order of royalty in the world of ornamental plants and they are of immense horticultural importance and play a very useful role to balance the forest ecosystem.

Importance

Orchids are the most fascinating and beautiful of all flowers.

They exhibit a wide range of diversity of flowers

Orchids constitute immense horticultural importance and play a very useful role to balance the forest ecosystem.

Cultivation of orchids has become a very profitable occupation.

New hybrids and commercial cut flowers expanded tremendously in Europe, USA, South America, Thailand, Singapore, Malaysia, Japan and Srilanka.

In spite of their commercial value, the orchids in India have not get gained the attention and popularity they deserve.

As compared to the above countries, the export and sale of orchids in India is negligible.

Only few nursery men based at Kalimpong in Darjeeling district of West Bengal and in Sikkim export some orchids but the trade is unorganized

Like other important orchid growing countries, India is blessed with a wealth of orchid flora, and about 1600 species are estimated to occur in this country

There is tremendous scope for orchid improvement and development of industry based on these wonderful plants.

Many orchids native to this country are important parent plants for the production of several outstanding hybrids in the world.

Hybrids of certain Indian orchids like *Vanda coerula* (Blue vanda or Blue moon vanda) and species of *Cymbidium, Dendrobium* and *Paphiopedilum* are considered the monarchs in the orchid world.

Due to the diversity of environmental condition in India, it is possible to grow all types of orchids in suitable places without the control of environment.

Dendrobium species is a typical tropical orchid species suitable for Chennai and other coastal areas where the humidity is high.

The important varieties of Dendrobium

Sonia-17, Sonia-28, Madam Pampadour, Pravit white, Sarifa Fatima, Emma white, Ekapal Panda etc.

Botany

Orchidaceae is the largest family of angiosperms.

It comprises of over 800 genera and 35,000 species.

The family, in addition, contains more than 80,000 hybrids.

Sub Kingdom --- Phanerogams
Division --- Angiosperms
Class --- Monocotyledous
Order --- Orchidales
Family --- Orchidaceae
(Bentham & Hooker)

Origin : Tropical Forests of Amazon & Indo - Malayan region

Based on growth habit orchids are classified in two monopodial and simpodial

Based on their habitats, orchids fall under 5 classes

(i) Terrestrial (or) Ground Orchids

* Grow in soil
* Sympodial and perennial
* Example : *Spathoglottis plicata*
Arundina graminifolia
Phaius tankervilleae

(ii) Epiphytic Orchids

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

(iii) Saprophytic Orchids

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

(iv) Lithophytic Orchids

* Rare and grown in moist, shaded rocks and crevices of walls.

* Example : *Cymbidium munronianum, Diplomeris birsuta*

(v) Subterranean Orchids

* Underground orchids

* Found in Australia

***** Example : *Rhizanthetta* and *Cryptanthemis*

Propagation

Traditional methods of propagation are all slow processes and help in producing only a few additional orchid plants in an year. But they ensure uniformity among the plant types. Most growers multiply orchid plants by division, through off-shoots and by cuttings.

Division : It is suitable for sympodial orchids. In about 4-5 years growth, an orchid clump may acquire some 8-10 good sized canes and such a plant can be divided to 4-5 individual units having at least 2 canes per division. Eg. *Dendrobium, Cattleya*, *Epidendrum, Oncidium* etc.

Off-Shoots (Keikis) : Off-Shoots are miniature plants with roots from the nodes of old canes. Application of cytokinins like BAP 1g/litre will stimulate new off shoots in *Dendrobium, Phalaenopsis, Paphiopedilum* etc.

Cuttings : Matured stems should be cut neatly into pieces with 3-4 nodes and a few roots. They can be planted on sand and kept in shade for root development. Eg. *Vanda, Arachnis, Ascocentrum* etc.

Flower stalk cuttings of *Phalaenopsis, Phaius* etc., can also be used for multiplication.

Treatments with 4000-5000 ppm IBA or NAA enhance root development.

Air-layering has reported as a propagation method in vanda and some other monopodials.

As all these methods can generate only a few plants at a time, nowadays newer techniques like dry seed culture, green pod culture and meristem culture are resorted to by both growers and breeders to produce large number of plants in a short period.

Cultivation practices

Unlike many other cultivated ornamentals, orchids are very hardy plants which can withstand quite a lot of adversities. However, for growing them successfully upto flowering condition, a number of key factors must be satisfied. These are temperature, humidity, light, aeration, watering, pots and potting materials, repotting and division, fertilizer application and plant protection.

As the orchid family is comprised of a large number of genera having characters of extreme diversity, different groups of orchids need different conditions of growth.

Temperature

Orchids have originated from all the different temperature regimes of the world and consistent with its place of origin, each orchid requires a specific temperature for optimum growth.

For orchids suitable to cool climates the temperature requirement is 12 °- 25°C (night / day).

For temperate orchids the temperature requirement is 15°-30°C (night /day).

In the case of orchids suitable for hot climate (tropical) 18° - 32°C (night /day).

From these basic temperature requirements, we can see that orchids which grow well and flower under our climatic condition.

Humidity : This is a critical factor especially for orchids coming from the tropics. Humidity should range between 50 and 75%. When temperature is high, humidity will be correspondingly low. So in the warm months of the year, humidity can be raised by frequent sprays of water.

Light : Light is the most important single factor that controls healthy growth of the plant and their ability to reach flowering. Some orchids need full sun to flower while others die if kept in full sun. Again basically orchids fall under three groups i.e., those that require full sun, those that need intermediate exposure to sunlight and those that need full shade.

Intensity of light that falls on the plants can be controlled by proper shading methods. Poly propylene shade nets of various intensities such as 25%, 50%, 75% etc., are now available in the market and those should be used judiciously to provide optimum light /shade condition to the plant.

Aeration : Air that constantly circulates keeps the orchid plants in good health. Stagnant and still air promotes fungal growth. A fresh moist atmosphere with good air circulation is ideal.

Watering : Watering is also one of the important factors that controls successful orchid cultivation. The two questions that arise here are : 1. how much water is to be given? and 2. when watering is to be done?.

Too much water will encourage fungal and bacterial growth. Too little water will stunt the plant. The latter is better than excess watering. However the best way is to get adjusted to the right amount of watering for healthy growth. This depends on several factors such as the type of orchid, type of pot, potting medium, position of shade house etc.

Containers and supports

Climbing orchids and terrestrial orchids can be generally planted on the ground but it is better to grow epiphytic orchids in some type of container or support such as pots, wooden baskets, coconut husks, tree fern rafts, pieces of wood etc.

Potting medium

Orchids thrive well under a wide range of growing media but the most common mixture consists of charcoal, coconut husk pieces, dried tree fern roots, sphagnum moss, broken pieces of bricks, perlite pieces etc., either singly or in combination. The principle is that there should be good drainage and at the same time sufficient water retention.
A micro climate of an optimum combination of moisture and aeration must be created within the pot which will favour the healthy growth of the plant.

Repotting : Orchids need repotting regularly, usually every two to three years. This is necessary when the plant grows large and overgrows its container or when the potting material deteriorates or when the plant has to be split or divided. It is better to repot epiphytes every year. The best time for repotting is when fresh roots emerge at the bases of the previous year's growth. In the case of monopodial climbers, repotting or division has to be done when new leaf growth shows at the top and there is new root growth.

Splitting or division of plants

Whenever a plant has grown to a large clump with 2 or 3 old canes and new shoots, it can be divided before repotting. Each division must have at least one old cane of two years' growth, one new shoot and some new roots.

When monopodial climbers have grown to be very tall and unmanageable, it is possible to cut the top region with a few roots and plant it anew. Off-shoots that arise from the nodes of the stem also can be cut and potted.

Fertilizer application

In their natural habitats, orchids grow on no special nutrients, depending only on what they could absorb from decaying tree bark and the atmosphere.

A synthetic inorganic fertilizer, equally balanced in nitrogen (N), phosphorus (P) and potassium (K) of strength 17:17:17 or 20:20:20, dissolved in water at the rate of 1-5g per litre applied once or twice a week gives satisfactory results. To promote flowering, a higher proportion of phosphorus and potassium such as 10:20:20 is helpful.

Organic fertilizers like cowdung, chicken manure, groundnut cake, neem cake etc. can be moderately used. It must be soaked in water at 1:10 or 1:20 for 2 to 3 days to allow decomposition of the fertilizer. The supernatant solution is used for spraying once of twice a month.

Harvesting and Handling

- Both are very important operations.
- Proper time and method of harvest controls vase life and the quality
- Dendrobium flower fully matured only 3 or 4 days after it opens.
- A spike can be cut at last 1or 2 buds are yet to open or 20 per cent of flowers are in bud condition.
- Immediately after harvest, the lower 0.75cm of the peduncle is cut off, and the flower is inserted into a fresh tube of water containing preservative.
- Treatment with 8-HQC+5% sucrose improve the flower quality and vase-life of flowers.

CARNATION

Carnation *(Dianthus caryophyllus)* belongs to the family caryophyllaceae is one of the important cut flower crops in the international flower market. Its large array of colours and excellent keeping quality has made it one of the most demanded flowers. Carnations in general are grown only under protected cultivation of carnation**.**

Varieties

Standard Carnation

Red : Scania, Tanga, Killer

Pink : Nora, Pink Sim, Candy, Calypso

Yellow: Pallas, Murcia, Tahiti

White : Sim, Roma, Candy white

Others: Charmeur, Santiago, Vanessa

Spray Carnation

Red : Rony, Karma, Etna

Pink : Annelies, Barbara, Silvery Pink

Yellow: Odeon, Alicetta, Lior

White : Royalette, Tibet, Excel

Others: Exquisite, Scarlet Elegance, Kissi

Micro Carnation: Eolo, Pink Eolo, Wiko

Mini Spray Carnation: Lima, Onia, Roland

Soil and Climate

Soil should be ploughed upto 80-100 cm deep. Optimum soil pH is 6.5. Addition of calcium carbonate or dolomite limestone corrects too acid condition and also supplies calcium and magnesium for plant nutrition. Addition of sulphur or use of acid forming fertilizers will in turn reduce the soil pH if it is on the higher side. EC of 1.2 at the start and 1.5 at the generative period is ideal.

Climate

Light is the most important factor, which influence 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^{0}C is considered to be the ideal one for the crop.

Propagation

Carnations are multiplied vegetatively through cuttings 10-15 cm cuttings with 3-4 nodes weighing around 10g is 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^{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.

Planting and Aftercare

Carnation plants are planted in different spacing normally, 30-45 plants per sq.m 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. 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.

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 10x10cm, then two nets of 12.5x12.5cm and the upper most can be 15x15cm.

Pinching

Pinching refers to breaking out tip of budding and encouraging growth of side shoots. Depending upon the need of crop spread a) single, b) one and half and c) double pinches are given. Ideal time for pinching is morning. When the plant attains 6 nodes, the first pinch is given. This is referred as 'single pinch'. This would give rise to six lateral shoots. With a 'one and half pinch', 2-3 of these lateral shoots are pinched again. For the 'double pinch', all the lateral shoots are pinched off.

Disbudding

Disbudding refers to removal of side buds so that the central/terminal bud receives maximum food for the full development. In standard carnations, side buds should be removed where as in spray carnations, the terminal bud has to be removed.

Manuring

Fertilizer application of 40g N, 20g P and 10g K, in addition to 5kg of well rotten FYM /m^2 increase yield of flowers.

Irrigation

Over watering and poor drainage causes root death and stunted growth. Water logging would cause deprival of oxygen to plants. The growing medium should be evenly moist.

Disorder

Calyx Splitting

Cultivars with too many petals are susceptible to calyx splitting. Varying temperature and environmental conditions also influences calyx splitting.

Selection of cultivars that are less prone to splitting, regulation of temperature and maintenance of optimal fertilizer level can minimize this disorders. 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.

Harvest and Postharvest

After planting normally it takes 110-120 days to come to peak flowering. A commercial carnation plant is capable of producing 10 to 20 flowers per year. Standard carnation flowers are cut when they are still in tight bud stage with the petals emerging. Spray type carnations are cut when two flowers are open and the remaining buds are showing colour. 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 for carnations should be acidic (pH 4.5) with 2-5 per cent sucrose and a biocide not phytotoxic to carnations. After keeping in preservative solution for 2 to 4 hours. Carnation flowers can be stored for two to four weeks before marketing. For this, 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 0^0 C with good air circulation and a constant relative humidity of 90-95 per cent.

Plant Protection

Pest and Diseases

Aphids: Aphids suck the sap from leaves of growing plants and can be most series insect pest of carnation. They are 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 Nematodes can be eliminated by growing plants in fumigated soil. Application of furadan, aldicarb or nemaphox controls nematode infestation.

Lecture No.14 **CHRYSANTHEMUM**

Dendranthema grandiflora

Native: Europe and Asia

- Second largest cut flower grown all over the globe.
- Queen of the East.
- Japanese National Flower.
- It has a wide range of **type**, **size** and **colour** and also '**forms**'.
- Short day plant – 'Photo sensitive' (10 hours day light)

Uses

1. Tall growing type suitable for **background** planting in borders.
2. Dwarf growing for flower beds and pot culture **(potmums)**
3. Loose flowers – garland, veni, worship etc.
4. Long stem flowers – cut flowers for Bouquet, Vase etc.

Classification

I. Classified based on kind and arrangements of florets into 5 broad groups. (National Chrysanthemum Society, England).

a. Single: Have one or more outer pistillate flower (ray) with disc florets at the centre.

b. Anemones: Similar to the singles except the disc florets are elongated and tubular forming a cushion. Disc flowers may be the same or a colour different from the ray flowers.

c. Pompons: A globular head formed by short uniform ray flowers, the shape is considered formal, disc flowers are not apparent, further classified into three distinct size,

(1) Small buttons (4 cm or less in diameter)

(2) Intermediate (4-6 cm in diameter)

(3) Large (6-10 cm in diameter)

d. Decorative: Have a floret arrangement similar to pompons since they are composed mainly of ray flowers but the outer rows are longer than central flower giving the flowers a flatter appearance or informal shape, sizes are mostly intermediate and large.

e. Large flowered: Blooms are greater than 10 cm and are classified in many shapes, disc florets are not apparent in most of these forms.

(i) In curved double: Globose and formal with ray flowers similar in size to the disc flowers and that curve inward and towards the top.

(ii) Reflexed double: Less formal and globose than the incurved double with over lapping ray flowers curved downward except for the ray flowers.

90 **Tubular ray flowers**:

(a) Spider: Ray flowers tubular and elongated into the outer rows but short in center. The dropping outer row ray flowers are some times hooked on the ends.

(b) Fuji: Similar to the spider except the ray flowers may be shorter, droopless and lakc hooks on the ends.

(c) Quill: Tubular ray flowers, long on the outside and short near the center, resembling feather quills. Ends of flowers are open and not flattened.

(d) Spoon: Similar to the quill except the outer row flowers are open and are flattened, resembling a spoon.

(f). Miscellaneous: Novelty types consisting of feathery plume, like of hairy ray florets.

91 **Classification based on temperature requirement for flowering (Cathey 1954).**

Thermo zero cultivar: Varieties which flower at any temperature between 10-27^{o}C but most constantly at 16^{o}C night temperature.

Thermo positive cultivars: A minimum of 16^{o}C required for initiation and at 27^{o}C there will be rapid initiation but delayed flowering.

Thermo negative cultivars: Bud initiation occur at low or high temperature between 10^{o}C and 27^{o}C but continuous high temperature delay bud development.

III. Varieties are also classified depending upon duration as early, medium and late varieties:

Early	**Medium**	**Late**
90 days to bloom from final transplanting	100-110 bloom form final transplanting	110 and more days to bloom form final transplanting

<u>Varieties</u>

CO1

- **S**election from Hosur type
- Flowers are attractive canary yellow
- Single flower weight 2.5 g
- Flower yield 16.7 t/ha

CO2

- **S**election from the variety Jaya from Lucknow
- Flowers are purple coloured
- Flower yield 20.3 t/ha

MDU.1

- Selection from germplasm type.
- It is an early type, coming to first flowering in 104 days as against 120 days by the local type.
- The flowers are large and attractive sulphur yellow in colour.
- Yield: 30.59 t/ha.

Cut flowers

Colour and varieties preferred at Dutch market

Colour	**Preference**	**Varieties**
White	35%	White Reagan, Cassa Cream, Polaries
Yellow	25%	Sunshine, Yellow Spider
Pink	25%	Reagan, Money maker
Red	10%	Dark Flamence
Other	5%	-

Export standards for chrysanthemum

Parameter	**Standard**	**Spray**	**Dwarf**
Stem Length	88-100 cm	75-88 cm	25-38 cm
Weight	30g/stem of 90 cm	30g/stem of 85 cm	15g/stem of 30 cm
Number of flowers	Only 1 flower With 5 buds	10 flowers with 5-8 buds	10-12 flowers
Diameter	60-80 mm	35 mm for half Bloom 30 mm	45 mm for full bloom

Propagation

- Sucker - Separated form mother plant
- Cuttings – 5-7 cm length, 2500 ppm IBA
- Micropropagation

Culture

- It requires a well drained loamy soils and prefers a soil P^H ranging between 6.0-7.0.
- It is a short-day plant normally initiates and flowers during September to December under South Indian conditions.
- Hence, planting during April-May is recommend.
- 90,000 to 1,10,000 suck 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.
- The suckers or slips are planted at a spacing of 30 x 30 cm on one side of the ridges.
- 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 are heavy feeders and hence they are to be adequately manured.
- They are applied with 25T of FYM along with 125,120, 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.

Pinching

- 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 one of most important operations in chresanthemum culture.
- Pinching is most essential for small flowered chrysanthemum.

- 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.

Disbudding and Dis-shooting

- These operations are mostly performed for large flowering an 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.
- Staking of plants is required for vertical support of the plants.

The art of training

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

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

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

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

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

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

Green house cultivation

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.

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

i) Thermozero cultivars which flower at any temperature between 10-27^{o}C but most constantly at 16^{o}C night temperature.

ii) Thermopositive cultivars in which continuous low temperature between 10-13^{o}C inhibit or delay flower bud initiation and at 27^{o}C there will be rapid initiation but delayed flowering.

iii) Thermonegative 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^{o} 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.

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

Growth regulators:

- The plant starts flowering from 3rd months onwards. G.A 50 ppm can be sprayed 30, 45 and 60 days after planting to increase the yield.

Harvest and Yield:

- Yield start from 3-4 months after planting.
- Main crop duration 6 months.
- Ratoon crop 4 months. Total duration (6+4) 10 months.
- Yield Main crop 9-10t/ha.
  Ratoon crop 4-5 t/ha.

CHINA ASTER

China aster (*Callistephus chinenesis* (L)Nees) belongs to the family Asteraceae is native to China.

Varieties

Kamini, Poornima, Shashank, Violet Cushion, Phule Ganesh White, Phule Ganesh Pink, Phule Ganesh Violet, Phule Ganesh Purple

Uses:

- 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.
- It is also used in garden decoration as a herbaceous border.

Advantages of growing China aster.

- Popularity is increasing in and around cities.
- Short duration crop, availability of various colours.
- It can be grown in various agro climate zones.
- It is also suitable for growing as intercrop in coconut gardens.
- 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.
- When compared to crops like **Crossandra** and **Jasmine**, the labour utilization is less.

Climate and Growing Seasons.

- China aster is mainly a **winter season flowering** annual crop. The best growing **temperature** is around **15^{o}C** (night) and it performs well **upto 20^{o}C** (night) temperatures. Humidity **50-60%.**
- It was observed that the flower colour is well developed in the temperature range of 20-30^{o}C during day and 15-17^{o}C during night with relative humidity of 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.
- Rainfall requirement is 500-700 mm/annum. 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 **6.0 heavy soils** with high calcium are not suitable.

Cultivation

Propagation

- China aster is propagated through **seeds** and there is a great demand for the seeds.
- The seeds will not have dormancy and germinate in a week at **about 21^{o}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

Seedbed Preparation

- 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**.

Method of Sowing

- 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 sunshine.**

Field preparation and spacing

- The field should be ploughed thoroughly and brought to a fine tilth.
- About **10 -15 tonnes 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 90 + 90 = **180kg nitrogen**, **60 kg phosphorus** and **60 kg potash per hectare** at the time of preparation of land.
- A top dressing of nitrogen **@ 90 kg/ha 40** days after transplanting proved beneficial.

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** promote growth and flowering.

Use of growth regulators

- In China aster, the **number of flowers per plant** and the **duration of flowering** were increased by spraying **GA_3 at 200 or 300ppm**.

Harvesting, post harvest handling and yield

- **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.

With the improved package of practices, a **yield of 18 – 20 t/ha** can be obtained.

Lecture No.15 **Gladiolus**

***Gladiolus* sp. Iridaceae**

Introduction

- Gladiolus is an important florist crop, most popular as cut flower in the domestic and international market.
- 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 laciniated tepals.
- The flower spikes are used in flower arrangements, in bouquets and for indoor decoration.
- Spikes of gladiolus have good keeping quality and can be transported to long distances.
- Gladiolus (Tourn.) L. takes its name from the Latin word *Gladius* because of sword like shape of its foliage.
- There are some 226 recorded species scattered in Republic of South Africa.
- *Gladiolus natalensis, G.cardinalis, G.communis, G.callianthus, G.arneus, recurvus, G.tristis*
- 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.
- India around 1270 ha of land is under gladiolus cultivation.
- 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)
1.	Miniature	< 6.4
2.	Small	≥ 6.4 to < 8.9
3.	Medium	≥ 8.9 to < 11.4
4.	Large	≥ 11.4 to 14.0
5.	Giant	> 14.0

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

Culture

Climate

- 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^{o}C is good for better growth and flower production.

Soil

- 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. Soil pH 5 to 8.

Field preparation

- Preferably, the bed size should be 6 x 2 meters.
- Planting is carried out during October in plains and March-April in hills.
- The depth of planting of the corms ranges from 5 to 10 cm.
- The row to row distance is normally 40 cm while plant-to-plant distance is maintained at 15 cm.
- The requirement of the corms per hectare is roughly 1-1.5 lacs.

After care

- Lifting of corms is carried out 6-8 weeks after harvesting of spikes.
- 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 should be cold-stored at 3-7^{o}C.
- From cold storage, these corms should be taken out one month prior to planting and kept at ambient conditions at an aerated place.
- Before planting, these are once more dipped for one hour in 0.3% Captan solution.

Propagation

- 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 an average of 1 to 3 flower-grade 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 healthier 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.

Cultivation

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.

Method of 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.

Irrigation

- Gladiolus requires water in plenty but does not grow well under water-logged conditions.
- Frequency of irrigation depends upon the soild 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.

Flower Production

- Gladiolus takes 60-120 days to produce spikes.

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

- The spikes of gladiolus generally exhibit vase life of about 7-15 days.
- (i) The spikes should be harvested in the morning or evening hours when temperatures are mild.
- (ii) Spikes should preferably be cut with sharp knives or secateurs.
- (iii) While harvesting, at least four basal leaves should be retained on the plant to ensure proper development of corms and cormels.
- (iv) 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

Harvesting of Corms

- It generally takes 6-8 weeks after harvesting of spikes fro 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.
- They should, therefore, be treated with fungicides (see Under 'Diseases and Disorder')
- The corms or cormels of different cultivars must be handled separately and labeling properly so that they do not get mixed up.

Storage of corms

- Storage of corms at low temperature (4-5^{o}C) is an established commercial practice.
- It serves three main purposes:
  i) It helps to break dormancy of corms raised under warmer climates,
  ii) It helps to overcome warm and dry conditions of summer months that intervene between lifting or corms and their planting in the subsequent season, and
  iii) It prevents premature sprouting of corms.

GERBERA

Gerbera – Asteraceae

Gerbera jamesonii – 40 species

G.asplenifolia

G.auyantiaca

G.kunzeana

G.vindifolia

- Barberton Daisy, African daisy Native to South Africa region ideal for beds, borders, pots and rock gardens.
- Plants – stenless and tender perennial herb.
- Leaves are radical, petioled, Lanceolate, deeply lobed some time leathery, narrow at base, wide at the top arranged in a rosette at the base.

Flower colour **:** Yellow, Orange, Cream white, Pink brick red, Scarlet, Salmon and Intermediate shades.

Flower stalks are long, thin and leafless. Flower heads are grouped into single, double and semi double cultivars.

Poly/shade house

Production of quality flowers need either shade house (50%) or naturally ventilated poly house.

Cultivars

Frede King (23stems/19 days)	Nadja (23/20.5)	Terraqueen (22/19)
Dusty (22/17.5)	Labalga (30/14)	Joyee (30)
Kabada	Lalazzo	Appel Bloesem
Amber	Komilda	Rosabella
Ibiza	Randez-vous	

Propagation

- Seed or vegetative
- Vegetable – clumps (June)
- Micro propagation (shoot tips, inflorescence buds, flower heads).

Soil and temperature

- Well drained, rich, light, neutral or slightly alkaline
- Day temperature 22-25^{0}C and night temperature 12 to 16^{0}C is ideal.

Bed preparation

- Raised beds of 30cm height with 1 to 1.2m width.
- Media mixture FYM : Sand : Cocopeat/Paddy husk (2:1:1).
- Sterilize the bed with formaldehyde (100ml in 5L/m^2) or methyl bromide (30g/m^2) covered with plastic sheet for 3 days.
- To control soil borne phytophthora, fusarium and pythium.

Planting

Season 1. Spring (January-February and March)
2. Summer (June, July and August)

- Planting in raised beds improve drainage and aeration. Plants are to be planted at shallow depth.
- The crown of the plants at the level with soil or just above when planted deep leads furgual incidence.
- Spacing between rows 30-40cm and 25-30 within the row accommodating 6-7 plants/m^2.

Manures and fertilizers

- Requires plenty of organic matter, macro and micro nutrients.
- Organic manure @ 7.5kg/m^2, pH should be 6.0 – 7.5.
- Ammonium nitrate + Superphosphate + Potassium sulphate @ 4g/lit for better flower yield.
- Above nutrients @ 2g/lit for vegetable growth.
- NPK @ 10:15:20g/m^2/month for first three months.and 15:10:30g NPK/m^2/month after three months resulted in good production of flowers.

Irrigation

- Provide sufficient irrigation soon after planting.
- 500-700ml of water/day/plant to be given through drip.

Harvesting

- Starts flowering in 3 months after planting.
- Average yield in polyhouse around 200 flowers/m^2/year.
- Harvesting is done when outer 2-3 rows of disc florets are per pendicular to the stalk.
- The heel of the stalk is cut about 2-3cm above the base and kept in fresh chlorinated water.

Lecture No.16 **DRY FLOWERS**

Introduction

- Flowers are integral part of heritage, for its aesthetic value and now realized for their economic importance.
- During last few years, various export oriented units sprang up, in collaboration with European Union nations.
- But poor technology transfer, in adequate export infra-structure, lower price realization have led to reduced exports.
- These constraints led to the commercialization of dry flower industry.
- Dry flowers accounts for 15% in total floriculture export during 1988-89 and increased to 64% in 1994-95.
- The export value of dried plants and plant material has increased from Rs.109.21 million in 1993-94 to Rs.364.55 million in 1995-96.
- India has a share of 1.5% of European union export of dry flowers and is expected to rise high. USA is the largest consumer of dried and artificial flowers estimated at 2.4 million dollar annually.
- Dry flowers are near natural, dried, preserved and processed having beauty as well as ever lasting value.
- The microbial activity, the aging effect come to a stand still in the absence of moisture. It can be stored for a long period.
- They are used in bouquets and floral arrangements making flower pictures, festive decorations, used in pot-pourri (a mixture of scented plant material that are for room freshness) used for making cards, covers, wall plates, wreaths etc.

Preparation

The dry flower preparation involves major steps like

I Drying

II Bleaching

III Dyeing

I Drying

Dehydration process, (i.e) dry under artificially produced heat and controlled temperature, humidity, air flow. There are many methods to dry they are

1. **Air drying**

- Flowers are attached to rope/wire and kept hanging either in dark/sun or may be spread over blotting sheets.
- It is simple, cheap and weather dependent, quality of flowers is not good.

2. **Embedding and drying**

- The flower and foliage are embedded in drying material, sand/silica gel in a container here original shape of flower is maintained.
- Silica gel → highly hipgroscopic and expensive. So fine sand is best for drying.

3. **Press drying**

- Flowers/leaves are placed between pages of a book. But original shape can't be maintained. Flowers, which are dried by methods, are listed as follows.
    a) Zinnias are best dried in sand/borax method
    b) *Gomphrena globosa* by hanging upside down.
    c) Bougainvillea, Dahlia, Candytuft, Dombeya, Gerbera, Rose, Limonium were embedded in white silver sand or borax or silica gel medium in suitable containers and allowed to dry naturally in shady and well ventilated place.
    d) Statice → air drying is easiest and effective.
    e) River sand mixed in varying proportion with borax (Sand: Borax ratio 1:1,2:1,3:1) and flowers dried in 10,15,20 days and flower quality was good in terms of blemishes, texture. Roses, carnation dried in 15-20days with river sand that contained a high proportion of borax.
    f) Thomler (1997) → majority of upright growing flowers dry their best upside down.
    g) Straw flowers, globe amaranth, cockscomb, statice, baby's breath is best when air dried after harvesting in morning hours after dew has disappeared.
    h) Alleman (1994) →reported silica gel which is in the form of small crystals used to dry roses. The self indicating nature of silica gel ensures the moisture content by exhibiting blue colour when dry and pink when it regained mositure from the flowers. Flowers are placed face up in a shallow pan and silica gel is poured to about 2 inches to completely cover the flowers. Aster, Balloon flowers, Daffodils, Pansies, Carnation, Rose, Iris, Tulip dried with silica gel.
    i) Verey (1994) → glycerinizing replaced water content of leaves giving them a strong and pliable nature. The preserving solution consists of 1 part glycerin and 2 parts hot water

along with addition of chlorohexidine to reduce bacterrial growth. Eucalyptus, Choisya, Hydrangea, Iry, Magnolia, Barries also be glycerinized, foliage of Holly, Crab apple, Sycamore also glycerinized.

j) Anon (1997) → pressing easiest for fine textured like Pansies, Viola, Azalea and soft foliage of ferns and lace leaf.

II Bleaching

- The process of bleaching any plant material was chemical modification of coloured compounds within the plant tissues.
- Plant tissues contained variety of coloured organic pigments (Chlorophyll), Carotenoid pigments (Xanthophyll), Anthocyanins and lignin.
- The molecules appear coloured due to presence of chromophore.
- Joyce (1992) described sodium chlorite is an excellent bleaching agent for its selective action against lignin. 2 classes of bleaches (Oxidative and reductive) have different mode of action.
- The hypochlorite and peroxidases (Oxidative) destroys the chromophore by cleaning the double bonds and brought about the bleaching.
- The reductive bleaches eliminated double bond by facilitating formulation of covalent bonds at the double bond site. Peroxidase poses no pollution hazard.

Activators of bleaching

- Chlorites need to be activated. Skelly (1960) reported formic acid and acetic acid preferred to strong mineral acids.
- Commercial bleaching is carried by raising pH to 10.5 by adding Na silicate.

III Dyeing

- Dyeing of fresh flowers is by the method of absorption. The cut stems are placed in dye solution causing the petals to become coloured.
- Also flowers might be dipped into a solution of dye to which few drops a washing up liquid is added to increase the spreading.

a) Hydrangias and Gypsophila dyed by absorption (dyes added to water, plant material takes it).

b) For colouring seed heads and pods, dip dyeing and spraying is done. Cooled juice from black berry, goose berries may be used. Azo dyes are banned by GOI. List of dyes from strong tea. Rit dyes, Easter egg dyes, Mushrooms, Flowers of Marigold, Iris, Hulls of walnut, Sunflower etc.

Storage of dried flowers

- Dried flowers are stored in cool, dry, airy place otherwise lead to wilted and limp flowers.
- Flowers dried through silica gel are stored by sprinkling some of crystals on the bottom to prevent moisture from being picked up by them.
- Plastic is not used for wrapping flowers because it can retains moisture and rain the dried flowers.

Flowers and leaves are packed in cardboard boxes and placed in a cool and dry place. Fragile material wrapped with tissue paper and kept in boxes.

Lecture No.18 LAYOUT AND MANAGEMENT PRACTICES OF GREEN HOUSES

- Greenhouse technology is being used in India as a solution to a number of specific situations relating to the increase in production and productivity of crops.
- India, therefore, relate to appropriate greenhouse structures, environmental control systems and crop production practices for the specific situations.
- This prospect presents a challenge to both plant scientists and greenhouse engineers.

Greenhouse

- A greenhouse is usually a framed structure covered with transparent or translucent material (usually UV stabilized LDPE film), large enough for a person to walk inside and carryout cultural operations and in which, crops may be grown under conditions of partial to fully controlled environment.
- Because of considerably lower initial investments, almost all new commercial greenhouse constructions utilize plastics as the glazing (cladding) material.
- Generally people assume that greenhouse are required only in the colder regions of the world. However, the fact remains that greenhouses are required in any climatic conditions to grow a better crop.

Uses

- With a greenhouse, it is possible to create a micro-climatic environment which is better-suited for the development of the crop than the outside environment.
- The overall intent is the most effective use of land, water, energy, mineral nutrients and space and the climatic resources of sunlight, temperature, relative humidity and atmospheric CO_2.

Advantages

i High productivity as the genetic potentiality of the crop is fully exploited.
ii Growing crops round the year and in off-season.
iii Preventing crop damage caused by birds, rodents, pests, diseases etc.
iv Preventing crop damage caused by extreme temperatures, heavy rain, high wind etc.
v Effective water management and reduction in use of water.
vi Optimum use of pesticides, fungicides and fertilizers.
vii Effective use of biological pesticides and pheromones.
viii Growing crops in a growing media, thus avoiding soil-borne diseases.
ix Utilizing manpower efficiently.

Greenhouse design criteria

- Greenhouse should be designed to adopt to the local conditions and should be capable of withstanding the most extreme climatic conditions.
- Greenhouse design may consist of systems including.

i Top ventilation and side ventilation
ii Overhead shading
iii Heating
iv Carbon dioxide monitoring and dosing
v Fan and Pad cooling
vi Misting and fogging
vii Irrigation and fertilization

- The local environmental factors such as temperature, light intensity, wind speed and direction, humidity and rainfall have to be taken into account to decide the type of greenhouse to be installed.

Site selection and location

- A good site can make a difference in the functional and environmental operations of greenhouses.
- Ground slope for drainage is an important factor.
- Adequate provision should be made to divert surface water away from the greenhouse.
- A greenhouse needs a dependable source of energy in the form of electricity and other fuel for environmental control, as well as good quality water supply.
- It should be located away from other buildings and trees to avoid obstruction of sunlight.

Orientation of greenhouse

- An East-West oriented free standing greenhouse maintain better winter light level.
- However gutter-connected greenhouse should be oriented North-South to avoid continuous shading of certain portions of the greenhouse due to structural members.

Interior layout

- The choice between production on the floor or on the benches depends on the crop and production schedule.
- Benches are usually provided for pot plant production.
- Bedding plants are generally grown on the floor.

- Benches improve labour efficiency, permit more effective display and inspection, and assist air circulation.

Types of greenhouse

i) Tunnel greenhouse

- The simplest form of plastic film greenhouse is the round arched tunnel greenhouse.
- This type can only be built of single-span.
- Openings are provided for ventilation on each side by parting the overlapping film sheets.

ii) Multispan greenhouse

- In multispan greenhouse, the greenhouse volume is larger and the climatic conditions are also better.
- The ventilation with side wall ventilators can prove sufficiently efficient if the whole structure has a width of 16 to 22 m.
- The crop density is higher, the border effect is less important, and this will allow the machines to work inside the greenhouse.

iii) Saw-tooth greenhouse

- The roof construction consists of vertical and sloped surfaces.
- For a maximum incidence of light, the vertical surfaces have to face the sun in winter.

iv) Wooden greenhouse for tropics

- A wooden greenhouse construction with ventilation openings are given at ridge and gutter.
- Specifications for a standard greenhouse.

Size	:	30’ x 96’
Height	:	12’
Bay	:	20’ or 30’
Fan	:	1 hp
Pad	:	Espen fibre 5’ ht x 30’ L x 4” thick
Roofangle	:	25□
Vent opening	:	50% of floor area
Infrastructure	:	Hot dip GI frames
Exhaust fans	:	0.5 hp
Fogging	:	30 – 50 Micro droplet size
Capacity (Planting)	:	10 Nos. of 4” pot/sft.

Cost estimate of a greenhouse

- In general 9m x 30m is a ideal unit.
- Many such units can be jointed together by gutter system.
- Cost estimate for the standard size of a green house will be as follows.

Sl.No.	Items and Speicification	Cost (Rs.)
1.	G.I.tubes, MS angles and flats an fixing units	30.000.00
2.	Civil work	15,000.00
3.	Power supply	20,000.00
4.	Water storage system	15,000.00
5.	Drip irrigation system	13,000.00
6.	Fan and Pad unit	55,000.00
7.	UV stabilized plastic film	25,000.00
8.	CO_2 generator and dispensor (optional)	30,000.00
9.	Additional lighting (optional)	20,000.00
10.	Shading system	10,000.00
11.	Fertigation unit	25,000.00
12.	Benches (optional)	20,000.00
13.	Electrical in shalltions	10,000.00
14.	Exhaust fans (axial)	10,000.00
15.	Humidistat	1,000.00
16.	Miscellaneous items	10,000.00
	Total	**3,09,000.00**

The average cost of different type of greenhouse worksout to the following levels.

1. Less expensive greenhouse without fan and pad — Rs.300 to 500/m^2
2. Medium cost greenhouse with pad and fan but without automation — Rs.800 to Rs.1100/m^2
3. Expensive greenhouses with fully automatic control system — Rs.2000 to Rs.3500/m^2

Covering/cladding of frame

- As regards classing material, 200 micro (800 gauge) polyethylene film or any other UV stabilized material is ideal.
- These materials would cost Rs.25 to Rs. 30/m^2 as against Rs.300 to 500/m^2 for fiber glass sheets.

Comparison of different kinds of covering materials.

Sl. No.	Type	Durability	Transmission		Maintenance
			Light	Heat	
1.	Poly ehtylene	One year	90%	70%	Very high
2.	Poly ethylene UV resistant	Two years	90%	70%	High
3.	Fibre Glass	Seven years	90%	5%	Low
4.	Tedlar coated Fibre Glass	Fifteen years	90%	5%	Low
5.	Double strength Glass	Fifty years	90%	5%	Low
6.	Poly carbonate	Fifty years	90%	5%	Very low

DETAILS OF ORNAMENTAL FLOWERS FOR ARRANGEMENT

Botanical name	Common name	Description	Approx. vase life	Suggested use
1. *Alyssum* sp.	Alyssum	Seasonal dainty white flowers grown in borders.	5 - 7 days	Use as fillers. Excellent in rose bowls and small arrangements.
2. *Ammi majus*	Ladies' Lace	Tall-stemmed seasonal flowers with umbrella-like white dainty florets.	7 - 10 days or everlasting	Defoliate before use as leaves look untidy and wilt. Use for creating lines or for fillers. Dry by hanging upside down.
3. *Anthurium andreanum*	Anthurium	Glossy, red or white spade shaped single petal with a pointed tongue. Tropical hothouse flowers bought at the florist, normally high-priced.	10 - 15 days	Make eyecatching geometric, modern or Ikebana styles with economic use as only a few of these unusual flowers are enough for `Lines' or strong points for the focus. A solitary flower can also look compeeling.
4. *Antirrhinum majus A. namum*	Snapdragon or Dogflowers	Tall-stemmed seasonal flowers in yellow, pink magenta and white.	5 - 7 days	Use graceful bud-tipped stems for lines for all styles. Also as fillers for mass arrangements.
5. Aster chinensis	Aster	Bi-annual medium sized flowers. Purple, pink or white in colour with petals grouped around yellow centres. Also in double `pompom' varieties. Usually sold by the bunch.	3 - 5 days	Substantial trimming of leaves and selective use of flowers required. Use as points or fillers.
6. *Calendula officinalis*	Calendula	Sunny yellow, orange seasonal flowers with short stems and broad leaves. Medium sized with brown centres.	3 - 5 days	Flower heads usually turn when arranged. `Doctor' beforehand with teel wire. Suitable points for all styles.
7. *Iberis umbellata*	Candytuft	Small white seasonal border flowers growing in clustered stems	5 - 7 days	Very useful for fillers. Make a dainty combination with roses or strike a pleasing contrast against dark colours.
8. *Dianthus caryophyllus*	Carnation	Elegant, aromatic spring flowers with ruffled textures in several colours also available in the upper price range.	5 - 7 days	A universal appeal for all styles. Use as attractive points. but double varieities can serve as lines in geometric styles as stems are fairly tall. Can also combine well with roses as both are quality flowers.
9. *Celosia* sp	Cockscomb	Early summer seaonsal flowers with tall stems and velvety textures in shapes suggestive of the common name. In shades of pink, yeloow, red and white.	5 days to everlasting	Remove leaves from stems as flowers alone are ornamental. Use for lines or fillers. Also good for drying.
10. *Chrysanthemum sp*	Chrysanthemums or `mums'	High quality annuals available in late autumn and early winter months, before the frost set in. Several colours ranging from while, honey brown, yellow, pink. Several shaped varieties include small `button', medium sized spoon, incurving, decorative and reflex.	5 - 10 days	Versatile uses according to individual shapes. `Button' variety ideal for small bowls. All varieties suitable for mass, or geometric styles. Ideal for Ikebana arrangements. Make the most of these flowers as seaon is short lived.

Botanical name	Common name	Description	Approx. vase life	Suggested use
11. *Coreopsis* sp	Coreopsis	Thin stalked seasonal flowers in sunny double colours of yellow and maroon.	3 - 5 days	Use as points in western mass arrangements. Essentially supported by wiremesh.
12. *Cosmos bipinnatus*	Cosmos	Flower textures similar to coreopsis, in single colours of yellow, pink, white, magenta.	3 - 5 days	Recommended for tall vase mass arrangements. Use like coreopsis, wire mesh essential.
13. *Dahlia variabilis*	Dahlia	Attractive bi-annuals in varying sizes, single-layered or many-layered petals. Small be gigantic dimensions in brilliant colours, including white, pink, magenta, red, maroon, orange, yellow. Double varieties also immixed colours.	3 - 5 days	Preferably use double varieties as single varieties have thin stems and heavy flowers that may not last well. Cut life is prolonged in tall vase designs with wire mesh support rather than a pinholder. Adopt reel whire method for reinforcing weak stems.
14. *Dimorphotheca sp*	African Daisy	White single petalled spring flowers circled around yellow centres.	5 - 7 days	Pretty for mass arrangements. Round forms serve well as points for all styles. Use with wire mesh support.
15. *Gaillardia sp*	Gaillardia	Seasonal flowers, with serrated petals in mixed yellow-maro colours. Medium, thin stems.	3 - 5 days	Best for mass arrangements or table bowls. Wire mesh necessary to support stem.
16. *Gerbera jamesonii*	Gerbera	Ornamental seasonal flowers with ribbon like petals in bright hues of pink, peach, white, red, yellow, orange. Single and double varieties.	5 -7 days	Best used as points. Attractive for all styles but particularly charming for Japanase arrangments.
17. *Gladiolus sp*	Gladioli	Tall and elegant almost perennial flowers with florets along the stems. Beautiful colurs such as white, pink, orange, puple manuve, yellow available in double `Dutch' varieties during Spring. Smaller single varieties in rust-red orange colours available in summer.	7 - 10 days	Graceful for all styles. Use stems with buds on the tips for creating lines and stalks with fuller flowers as fillers. Leaves are equally useful. Curl by rolling over a pencil.
18. *Gomphrena globosa*	Bachelor's Button	Small round button-like purple seasonal flowers with papery textures. Thin stems.	7 days to everlasting	Use in mass arrangements. Ideal for small bowls. Wire mesh necessary flowers dry well.
19. *Gypsophila elegans G. paniculata*	Gyposphila or Baby's Breath	Small, delicate seasonal flowers on thin branching stems. Usually in white, but also available in pink.	7 - 10 days	Dainty as fillers, especially when partnered with roses. Also useful for drying.
20. *Helichrysum bracteatum*	Paper flowers or straw flowers	Seasonal flowers with papery textures. Commonly available in yellow, pink, magenta and white. Round small to medium forms.	Everlasting	Use in fresh arrangements as points or fillers. Dry by hanging upside down. Use reel wire to support stems. Defoliate leaves.

Botanical name	Common name	Description	Approx. vase life	Suggested use
21. *Limonium sinuatum*	Statice	Papery textured flowers in vivid colours, purple mauve, yellow, white, pink. Fairly tall stems.	Everlasting	Use as fillers lines in fresh arrangements. Hang upside down to dry.
22. *Orchids*	Orchids	Top quality topical flowers eliciting universal appreaciation. Several varieties including spurred spidery forms on long stems, or large flecked petals with a tongue like mount. Wiry sturdy stems. Common colours; white, puple orange, yellow pink	10 - 15 days	Excellent for all styles. Impressive for special occasions. Use tall stemmed varieties for mass arrangements, individual large flowers for points of focus.
23. *Phlox* sp	Phlox	Colourful seasonal flowers growing in clusters, along borders. Available in white, pink, magenta, red short stems.	5 - 7 days	Useful for fillers for all arranagements.
24. *Polianthes tuberosa*	Rajinigandha	Tall, erect bi-annual flowers, in fragrant white. Single varies have spurred star shaped flowers. Double varieties have the same form but heavier textures.	A week or more	Select stems with buds at the tips for a longer cut-life. Use as lines for all styles. Use as fillers in mass arrangements. A good choice for ethnic themes.
25. *Rosa* sp	Rose	Popularly loved flowers in several colours and varieties. Mixed colours also available in cross-bred culture. special fragrant varieties.	3 - 5 days	Project charm in all kinds of arrangements. Make single rose designs, Ikebana, geometric or modern styles. Or make mass arrangements. Roses mix well with all other varieties of flowers. Use tall stems and buds as lines, and fuller blown flowers as fillers. Hang to dry (Refer to Chapers seven and eight)
26. *Sterlitzia reginae*	Bird of paradise	Vigorous tall stemmed flowers with exceptional forms shaped like a bird's head. Orange in colour with a purple `eye'. Oval tough leaves. Tropical or hothouse flowers. Bought at the florist.	10 - 12 days	Make ey-catching geometric, modern or Ikebana arrangements as exceptional forms stand out well if they are spaced out. Leaves are equally useful for arranging. When dried upside down, they adopt interesting sculptured shapes.
27. *Tithonia* sp	Tithonia	Brightly coloured seasonal flowers in red, yellow, white, pink. Single petals grouped around yellow centres. Fairly long stems.	5 - 7 days	Use as points for all styles.
28. *Verbena hybrida*	Verbena	Small seasonal flowers in clustered heads on short stems. Purple mauve in colour.	5 - 7 days	Use as fillers in small bowls or in large arrangements towards the focus as stems are short. Wire mesh support is advisable.
29. *Zinnia elegans*	Zinnia	Colourful bi-annual flowers in round forms with multilayered petals. Usually in white, pink, red, yellow, purple. Small `lilliput' variety also available.	5 - 7 days	Round forms make good points for all styles. Or use as fillers in mass arrangements.

DETAILS OF ORNAMENTAL FOLIAGE PLANTS FOR DECORATION

Botanical name	Common name	Description	Approx. vase life	Suggested use
1. Aglonema whiterajah/ A. crispum	Aglonema or Silver Queen	Houseplant, green leaves with yellow markings or with light green markings variegated varieties	7 - 10 days	Cut short leaves from parent stem. Use as fillers.
2. Araucaria heterophylla	Araucaria	Tree. Pine variety. Enjoys cool climate. Branches green and feathery.	7 - 10 days	Use branches for line or fillers. Leaves can be dried.
3. Areca lutescens	Areca palm	Garden palm or houseplant. Tall feathery light green fronds.	10 days to everlasting	Clip edges of leaves . Curve into shapes. Excellent for stvlished designs. Dry after use.
4. Asparagus sprengeri/ A.densiflorus	Asparagus	Houseplant. Fern with many varieties. Feathery or `furry tail'. Lush green in colour	5 - 7 days	Dainty as fillers. Useful for breaking two similar lengths of material in an arrangement. Tall stems may be used as lines.
5. Begonia	Begonia	Outdoor potted ornamental plant with pink flowers. Can be kept indoors for short spells. Glossy round leaves tinged pink.	7 - 10 days	Circular shapes of leaves pretty for fillers and for concealing the pinholder / netting.
6. Bambusa sp.	Bamboo	Outdoor plant. Grows in groves. Tall thick green woody stems with flat, thin pointed leaves.	10 days or more (stems only)	Remove leaves as they wilt quickly. Stems recommended for Ikebana, geometric or modern designs. Very thick stems can be carved out for making receptacles for containers.
7. Caladium	Caladium	Outdoor plant in gigantic variety. Smaller varieities make ornamental house-plants. Spade shaped leaves, can be variegated with pink strips. Stems fairly long.	5 - 7 days	Make picturesque additions to the design. Tall enough to use as lines, or group together near focus.
8. Callistemon	Bottlebrush	Ornamental tree with feathery leaves and red brush-like flowers in Spring. Thick main stems with thin, curving branches.	7 - 10 days	Decorative particularly for Ikebana arrangements. Use graceful thicker branches, preferably in bloom. Short feathery branches can be used as fillers for all styles. Leaves may be dried.
9. Canna indica / C. hybrida	Canna	Garden plant with broad green or purple leaves and bright yellow, red, flecked flowers.	7 - 10 days	Use for large designs, goemetric, modern or Ikebana. Trim leaves along edges if necessary. Leaves can be curled and moulded with scotch tape. Can also dry leaves.

Botanical name	Common name	Description	Approx. vase life	Suggested use
10. Casuarina sp.	Casuarina	Outdoor tree. Pine family. Feathery leaves.	10 - 15 days	Use leaves as fillers for all styles.
11. Cordyline sp.	Cordyline / Dracaena var. Vokart & yellow king	Houseplant. Thin leaves, sometimes with red edges, growing in clustered heads formation. Dracaena family. Stems throw roots when kept in water over a long period.	10 - 15 days to a month	Cut stems with the `head' for making compelling designs, geometric, modern or Ikebana. Do not use liberally as plant is slow growing (Individual leaves make good fillers).
12. Cycas revoluta *C. circinalis*	Sago palm	Ornamental garden palm, spreading out gracefully with resilient shiny dark green fronds. Can be used as houseplant when potted.	15 days to everlasting	Clip edges and use for giving beautiful interesting lines for all styles. Extremely pliable, can be curved and tied in circular shapes. Slow growing plant, hence use leaves economically. Dry leaves in curved forms.
13. Cyperus alternifolius, *C. circinalis*	Umbrella plant	Outdoor plant or houseplant. Commonly grown beside ponds for decorative value. Tall erect stems with ribbon like leaves in the formation of an umbrella.	10 days to everlasting	Clip edges of leaves. Use for creating lines for unusual designs. Use heads as fillers. Stems alone can be used for geometric or modern styles. Dry leaves after use.
14. Diffenbachia sp.	Diffenbachia `Seguine'/ `Tropic snow' / Tropicsun	Houseplant. Broad green leaves with yellow flecks growing along a thick parent stem. Several varieties.	10 - 15 days	Use as attractive fillers as leaves are short. Add colour to any design or to an all green arrangement with these leaves.
15. Ferns (Individual names vary with each variety)	Ferns	Several varieties. Medium sized fronds growing in shady outdoor conditions. Can be used as houseplants over short spells. Delicate, feathery textures in all varieties.	7 - 10 days	Graceful fillers for all styles. Combine well with delicate flowers. Taller stems can be used for lines.
16. Grevillea robusta	Sliver Oak	Tree with feathery leaves, dark green in colour with greyish underside.	5 days to everlasting	Leaves make pretty fillers. If branches are tall, use as lines for large arrangements. Dry leaves between newspaper.
17. Ipomoea tuberosa	Woodrose	Outdoors climber in cool temperate climates shiny green leaves with ornamental seed pods.	Everlasting seed pods	Seed pods of wood roses make beautiful points in dry arrangements. Can be combined as well with fresh flowers.
18. Howea palm (also known as kentia)	Sentry palm	Garden palm or indoor plant with tall fronds.	10 days to everlasting	Clip edges and use for designs. Dry after use.

Botanical name	Common name	Description	Approx. vase life	Suggested use
19. Ixora coccinea	Flame-of-the-woods	Outdoor shrub with light green leaves and orange, clustered flowers.	5 - 7 days	Trim branches to remove top heavy foliage. Curve gently and use as lines for Ikebana geometric or modern styles. Use small dusters of leaves for fillers in mass arrangements. Flowers wilt, but may be used for spreading styles.
20. Jatropha sp	Jatropha	Ornamental outdoor shrub with small red flowers.	5 - 7 days	Pliable branches. pretty especially for Ikebana or for creating lines.
21. Juniperus sp	Juniper	Coniferous picturesque tree. Commonly trained for bonsai.	10 - 15 days	Associated with Japanese arrangements. Use branches as fillers for mass arrangements.
22. Livistona chinensis	Chinese fan palm	Durable species with fan shaped leaves. Garden palm or indoor plant.	10 days to everlasting	Clip edges to use for designs. Hang upside down to dry.
23. Maranta bicolor	Maranta	Houseplant. Oval green leaves with markings and purple underside.	5 - 7 days	Ornamental as fillers or for creating lines for small arrangements.
24. Monstera deliciosa	Monstera or Swiss Cheese Plant	Houseplant. Broad green leaves with incisions.	7 - 10 days	Use for fillers or in focus for all styles suitable especially for modern designs. Use leaves selectively as plant is slow growing.
25. Nerium oleander	Oleander	Outdoor shrub with oval narrow spurred leaves bearing pink or white flowers in single and double varieties.	5 - 7 days	Use for lines in large arrangements or as fillers in small arrangements. Flowers last for two-three days. Stems ooze latex. Treat by singeing ends.
26. Philodendron (Several varieties)	Philodendron	Outdoor and indoor plant. Climber with arrow shaped leaves. Creeps along tree trunks or can be trained to climb around moss sticks several varieties.	7 - 10 days	Cut short stems off parent twine. Use as fillers or group around focus in tall arrangements. Ideal for concealing wire or pinholder.
27. Phoenix roebeleni	Phoenix palm	Grand outdoor palm with feathery fronds. Also used indoors.	10 days to everlasting	Clip and use for stylished arragements, as other palms. Dry after use.
28. Sansevieria trifasciata var. `Laurenti'	Mother-in-law's tongue	Very hardy narrow days sword shaped succulent variety leaves. Plain varieties have light green pattern. Variegated varieties have yellow border. Can be used as houseplants.	10 - 20 days	Very versatile for creating imaginative designs. Leaves can be twisted, curled and split to assume different forms. Use as lines, or curl leaves as points near the focus.

Botanical name	Common name	Description	Approx. vase life	Suggested use
29. Scindapsus aureus *S. pothos*	Marble Queen / money plant	Money plant variety with strongly variegated, leaves with whitish markings, Climber.	7 - 10 days	Short stemmed leaves. Use for fillers. Very ornamental as light markings can relieve an arrangement with dark colours or offset dark green foliage.
30. Thuja orientalis	Thuja	Oval shaped formation of outdoor shrub, composed of feathery leaves, associated with Christmas. Evergreen variety. Can also be used as an indoor plant.	10 - 15 days	Pluck leaf stems of parent bush. Use as fillers for western arrangements, also for other styles. Tall stems can be used for lines. Recommended for X' mas arrangements. Dries initially to light green colour. Foliage tends to fall when dry, but can be used.
31. Typha latifolia *T. augistifolia*	Bulrush	Tall stems with slim brown oval heads. Plants grow near water. Ribbon like grass.	Everlasting	Excellent for lines and dramatic effects for geometric, modern styles. use for creating waterside scenes for Ikebana styles. Use for dry arrangements as well.
32. Zebrina pendula	Zebrina	Trailing houseplant for hanging baskets. Oval shaped leaves with purple central stripe.	7 - 10 days	Use for giving trailing effects to the arrangement. Stems make colourful fillers for all styles.

DESCRIPTION OF ANNUALS AND HERBACEOUS PERENNIALS

	Botanical name	Common name	Family	Height	Colour	Month of flowering	Remarks
1.	*Althea rosea*	Holly hock	Malvaceae	1.5-2.5 m.	Scarlet rose, lilac, deep violet white,etc.	August-September	Propagated by seeds, blooms, 9 months after sowing. It is a perennial but often considered as a biennial.
2.	*Amaranthus* sp.	Lovelies Bleeding	Amaranthaceae	0.5-1.0 m	Red	-do-	It is an ornamental foliage as well as a flowering annual
3.	*Aster amellus*	Blue Aster	Asteraceae	20-25 cm	Blue	Almost throughout the year	It is a herbaceous perennial and a very good cut flower suitable for beds & borders
4.	*Calendula officinalis*	Pot marigold	Asteraceae	20-25 cm	Mostly orange	August-September	It is an ideal bedding plant, easy to grow
5.	*Celosia plumosa*	Cock's comb	Amaranthaceae	Dwarf : 10-20 cm Tall : 30-60 cm	Golden yellow and shades of red	Throughout the year	A group of half hardy annuals with terminal fasciated flowers of varying colours. Useful for borders and mixed borders
6.	*Chrysanthemum sagetum*	Annual chrysanthemum	Asteraceae	60-90 cm	Crimson, Yellow, white, etc.	August – September	Excellent cut flower. Flowers are eigther single or double or with quilled petals
7.	*Coreopsis drummondii*	Tick seed	Asteraceae	50-60 cm	Yellow crimson	Throughout the year	It is good for beds and background borders

	Botanical name	Common name	Family	Height	Colour	Month of flowering	Remarks
8.	*Cosmos bipinnatus*	Mexican aster or cosmos	-do-	50-120 cm	Yellow, orange, rose, pink, purple and white with yellow centre	Throughout the year	Good for cut flower, borders, beddings and also for growing in a mass in the midst of tall shrubs.
9.	*Dianthus caryophyllus*	Carnation or fairy queen	Caryophyllaceae	15-30 cm	White, red, scarlet, pink violet and maroon	August – September	Single or double flowered cultivars are available. Produces flowers throughout the year.
10.	*Gaillardia pulchella*	Blanket flower	Asteraceae	40-45 cm	Yellow, yellow-purple, orange maroon and their combination	Almost throughout the year	Useful for bedding, border and for cut flower
11.	*Gomphrena globosa*	Globe amaranthus or Bachelor's button	Amaranthaceae	30-60 cm	Pink, purple orange and white	Throughout the year	A highly esteemed bedding plant and can be grown in carpet beds and rose beds and also used as a ground cover
12	*Gerbera jamesonii*	Gerbera	Asteraceae	15-30 cm	Various colours	August – September, December– February	It is a herbaceous perennial propagated by suckers and divisions. Suitable for beds and borders
13	*Helianthus* sp.	Ornamental sunflower (Annual.)	-do-	1-3 m	Yellow	August – December	May be useful as a screen or hedge against a wall

	Botanical name	Common name	Family	Height	Colour	Month of flowering	Remarks
14	*Helichrysum bracteatum*	Everlasting flower or straw flower	-do-	50-80 cm	Silvery white to rich yellow / rich red	August – November & January – March	Both dried and fresh flowers are used for table decoration and dry arrangement
15	*Impatiens balsamina*	Perennial Balsam	Balsaminaceae	50 m	Pink, shades of white, violet purple, rose pink, red & mauve with single & double flowers	August – September	The stem is succulent, hollow & brittle, both annuals and perennial varieties are available, Seed pods burst and scatter their seeds when touched. Can be grown throughout the year.
16	*Mirabilis jalapa*	4'O clock plant	Nyctaginaceae	60-90 cm	Red, yellow, pink, white & often striped	Throughout the year	The plants will flower in afternoon or cloudy weather, They can be grown as a border at the rear end of the flower garden
17.	*Petunia hybrida*	Petunia	Solanaceae	20-40 cm	Pink, red, pale blue, violet, yellow, cream and purple	June to November– December	Flowers are trumpet shaped. It is a popular bedding plant
18.	*Phlox drummondii*	Phlox	Polemoniaceae	15-45 cm	White, pink, crimson, violet & purple	September – October & December to January	They are excellent for beds, borders and as cut flowers
19.	*Portulaca grandiflora*	Sun plant or Table rose	Portulacaceae	10-15 cm	White, purple, sulphur yellow, pink	Throughout the year	Widely used as a ground cover, good for rock garden, edging along paths and for growing in shallow pots and for containers
20	*Salvia* sp. *S. splendens*	Sage plant	Labiatae	60-90 cm	Scarlet, pink, violet	Grown throughout the year	Ideal for growing in mass and in beds and borders as background

	Botanical name	Common name	Family	Height	Colour	Month of flowering	Remarks
21	*Salidago canadensis*	Golden rod	Asteraceae	20-40 cm	Yellow	-do-	Herbaceous perennial used as a bedding plant and a good cut flower
22.	*Tagetes erecta*	African marigold or tall marigold	Asteraceae	90 cm	Yellow, bright yellow, lemon yellow and orange	August-September &December–February	A common bedding plant equally useful for mixed border and ideal for cut flower
23	*Tagetes patula*	French marigold or dwarf marigold	-do-	30-40 cm	Scarlet, yellow orange, combination of these colours	August-September & December-February	Generally preferred for carpet beds and edging and also for growing in small pots
24	*Tithonia rotundifolia*	Mexican sunflower	-do-	120-180 cm	Orange with yellow	May-September & December-January	Suitable for growing as a hedge and for background in beds, used as a cutflower
25.	*Verbena* sp. *V. hybrida*	Verbena	Verbanaceae	20-30 cm	White, pink, purple, mauva red, & deep violet	Throughout the year	Suitable for beds, borders and as cut flowers and thrives well in any garden soil.
26	*Zinnia elegans*	Zinnia	Asteraseae	Dwarf 15-20 cm Tall: 80-90 cm	White, cream, yellow, orange, red, pink, purple, etc.	August-September & December-January	Suitable for cut flower as it lasts long. Also suitable for beds and borders

DESCRIPTION OF ORNAMENTAL SHRUBS

COMMON NAME	BOTANICAL NAME	FAMILY	REMARKS
1. Pavala malli or coral plant	*Nyctanthes arbon-tristeris*	Nyctaginaceae	Tall growing shrub, nocturnal in flowering
2. Hibiscus varieties (Thilagum, Punnagai, CO3)	*Hibiscus* sp.	Malvaceae	Various colour forms are available; white, Red, Orange, Pink, Yellow, Rose etc. single & Multi whorls are available.
3. Snow fall bush	*Phyllanthus nivosus*	Malvaceae	Newly emerged leaves are white and appear like a plant covered by snow.
4. Nandiyavattai or star flower	*Tabernaemontana coronaria*	Apocynaceae	Single and double forms are available. Flower is star shaped with little fragrance. Leaves are single and glossy.
5. Coral bush	*Jatropha multifida*	Euphorbiaceae	Flower colour is coral red. Poisonous plant: Leaves are multiple and Somewhat sagitate in shape.
6. Thangarali	*Tecoma stans*	Bignoniaceae	Flowers are tubular & yellow colour; profusely flowering in bunches, used as a hedge as well as shrub.
7. Night queen	*Cestrum nocturnum*		Flowers are dull white; Flowering during night time and flowering is profused.
8. Tecoma	*Tecoma capensis*	Bignoniaceae	Flowers are orange red in colour; flowering is profuse, tubular in nature; flowering throughout the year. Used as a border plant & amenable for pruning.
9. Tecoma	*Tecoma biflorus*	Bignoniaceae	Flowering is profused and in bunches. Flower colour is orange yellow & somewhat tubular in shape.
10. Euphoria	*Euphorbia leucocephala*	Euphorbiaceae.	Flowering is highly profuse in nature; flowers are white in colour; small. Flowering almost throughout the year & from a distance periphery is fully covered by flowers.
11. Jathi malli	*Jasminum grandiflorum*		Shrubs grown for fragrance.
Gundu malli	*Jasminum sambac*	Oleaceae	
Mullai	*Jasminum auriculatum*		
12. Rose	*Rosa indica*		Various colour forms are available; white, pink, orange, yellow, dark pink, pink, orange etc. giving fragrance Australian Blue rose-Neelam bari
	Rosa odorata	Rosaceae.	
13. Eranthemum	*Eranthemum seticulatum*	Acanthaceae	Green, yellow, white, dark purple, & light purple forms are available. Suitable for semi shoded conditions.
14. Pentas	*Pentas carnea*	Rubiaceae	Rosy red, violet, purple, dark, red forms are available suited for semi shaded conditions.
15. Idlypoo or Ixora.	*Ixora singaporensis* (Red) *Ixora coccinia* (White)	Rubiaceae	Heads, Nuisance to the growes used as a foliage plant grown under shaded & semi shaded conditions foliage is variegated & attractive foliage can be seen in different colours.

COMMON NAME	BOTANICAL NAME	FAMILY	REMARKS
16. Crotons	*Codiaeum variegatum*	Euphorbiaceae	Used as a foliage plant grown under shaded & semi shaded conditions foliage variegated & attractive, foliage can be seen in different colours.
17. Aralia	*Aralia* sp.	Euphorbiaceae	Leaves are variegated; vary in size & shape, used as a foliage plant for shaded and semi shaded condition.
18. Plumbago	*Plumbago capensis*	Plum paginaceae	Flowers are azor bule colour; Doesnot produce woody branch; straggling shrub, in small bunches flowers are produced.
19. Acalypha	*Acalypha* sp. *Sanderina*	Euphorbiaceae	Foliage shrub; flowers appear as long pendulous catkins; f oliage is attractive; suitable for open & semi shaded condition
20. Hibiscus	*Hibiscus mutabilis*	Malvaceae	In the morning, flower colour is pink; when opened white in colour in the evening, single whorled and attractive.
21. Tree lettuce (Lachsakottai keerai)	*Pisonia alba*		Used as a green; foliage shrub; grown under semi shaded & indoor conditions.
22. Mandharai (mountain eboni)	*Bauhinia tomentosa* (Yellow) *B. purpurea*. (Purple)	Fabaceae	Both yellow & purple forms are available, when leaves dried used for rolling tobacco leaves.
23. Mayil kondri (peacock flower)	*Caesalpinia pulcherrima*	Febaceae	Flowers appear in bunches; usually at the tip of the shoot, yellow & Red colour forms are available.
24. Thumbergia	*Thumbergia erecta / Meyneya erecta*	Acanthaceae	Flowers are single; petals are violet in colour; base is tubular in shape; calyx is cup like with prominant yellow centre; white colour flowers are also available.
25. Lantana	*Lantana* sp. *L. camera* *L. lutea*	Rubiaceae	Flowers are red with yellow centre.
26. Sarpaganthi	*Rauvolfia canescence*	Apocynaceae	Berries of the plant are red in colour & attractive berries are also available in green & black forms. Roots possess medicinal value.
27. Ruby plant	*Hemelia patens*	Rubiaceae	Flowers arise in bunches, red-orange in colour, used as a flowering shrub; suitable for semi shaded & open conditions.
28. Nithya kalyani (periwinkle)	*Catharanthus roseus*	Apocynaceae	Flowers are single; available in rose &white forms

COMMON NAME	BOTANICAL NAME	FAMILY	REMARKS
29. Dragon bush	*Dracena* sp.	Liliaceae	Leaves are green, purple, yellow & variegated forms are available ; No veination in leaf & leaves are no stalked (Sessile) suited for semi shaded & indoor conditions.
30. Nerium	*Nerium oleander*	Apocyanaceae	Flowers are single & dos mulli whorled white forms, flowers one use for pooja purpose.
31. Yellow oleander	*Thevetia nerifolia*	Apocyanaceae	Yelllow & creamy white flowers are available; Tall shrubs used for fencing; plant are poisonous .
32. Notchi/chinese chastetree	*Vitex negundo*	Acanthaceae	Used as samll tree or shrub violet flowers & funnel like; appear in clusters.
33. Duranta	*Duranta plumeri*	Verbenaceae	Blue flowering in drooping clusters with light orange berries & attractive; used as shrub as well as hedge; amenable for pruning.
34. Unnimul / unnipalam	*Lantana camera*	Rubiaceae	Flowers appear in colour ; Red with yellow centre; emerging flowers are pink; changed to Red after opening; white yellow & variegated colours one available.
35. Changing rose	*Dombeya spectabilis*	Sterculiaceae	Flowers are light rose; appear in globular heads; after flowering the colour become foded and the flowers look ugly.
36. Graphtophyllum	*Graphtophyllum* sp	Acanthaceae	Foliage plant; can be grown as indoor & semi shaded condition; leaves are variegated.
37. Cassia	*Cassia biflora*	Fabaceae	Yellow flowers in bunches or clusters; and from each axile there will be 2 flowers.
38. Lantana	*Lantana lutea*	Rubiaceae	Flowers are yellow in colour modified bracts look like flowers.
39. Mussanda	*Mussanda erythrophylla*	Rubiaceae	Modified bracts look like flowers.
40. Hibicus	*Hibicus schizopetalous*	Malvaceae	into 5 of each petal at the & CP it looks like cut flowers . Flowers are drooping in nature.
41. Lantern plant	*Malvaviscus arboreus*	Malvaceae	Red, pink,white flowers are available ; the flowers open only partially.
42. Poinsettia	*Euphorbia pulcherrima*	Euphorbiaceae	Bracts are modified & look like a flower are samll & appear in cluster in shoot tip.
43. Mehanthi	*Lawsonia alba*	Lythraceae	Red colouration is due to the action of dye with some amino acids in the skin.
44. Aduthinna palai	*Adathoda vasica*	Acanthaceae	Medium shrub & used as a hedge or grown as hedge.
45. West Indian cherry	*Malphigia coccigera*	Malphigiaceae	Ornamental; attractive edible red berries.
46. December flower	*Barleria cristata*	Annonaceae	Violet, pink, white , violet striped, yellow are available.

List of some ornamental flowering trees suited to landscape gardening

Sl. No.	Common Name	Botanical Name and family	Colour of flowers	Flowering Time	Salient characters
1.	Silver wattle	*Acacia dealbata* (Leguminaceae)	Yellow	Feb-March and July August	A small tree, finely cut leaves, underside silver white, propagated by seeds, sucker.
2.	Queen of flowering trees	*Amherstia nobilis* (Leguminaceae)	Vermillion	April - May	Trees 6 to 12 m, high leaves coppery green, clustered and hanging
3.		*Bauhinia purpurea* (Leguminaceae)	Purplish rose	Throughout the year	Good sized trees, fragrant flowers
4.	Thiruvatti	*B. tomentosa*	Sulphar yellow flowers	-do-	Small trees, 2 to 3m. height
5.	Trumpet flowers	*Bignonia megapotamica* (Bignoniaceae)	Light pink flowers	March-April	Handsome deciduous trees 7 to 9 m. height
6.	Pinnai	*Calophyllum inophyllum* (Guttiferae)	Fragrant white flowers	May - June	A beautiful evergreen tree with large racemes, round fruits raised from seed
7.	Sara konnai or Golden shower	*Cassia fistula* (Leguminaceae)	Bright yellow flower	February - May	Medium size beautiful tree with long pendulous racemes, propagated by seed and suckers
8.	Pink shower	*Cassia grandis*	Rose pink	March -April	Spreading quick growing tree, pinnate leaves, pods are long
9.	Nagalingam or cannon ball tree	*Couropita guinensis* (lecythidaceae)	Pink or marron	-do-	Flowers have curious hood-like structure made up of united stamens in the centre of the flowers, fruits are large and round
10.	Gul mohar	*Poinciana regia* (Leguiminaceae)	Orange scarlet flowers	Apri l -May	Raised from seed
11.	Kalyana Murungai or Indian coral tree	*Erythrina indica* (Leguiminaceae)	Scarlet red flowers	March - May	Propagated by seed and cuttings
12.		*Jacaranda mimosaefolia* (Bignoniaceae)	Blue color	March - May	Deciduous often grows to 10 m. height, pretty foliage, feathery
13.	Persian Lilac	*Melia azedirach* (Meliaceae)	Lilac flower	March - May	Deciduous 15 to 20 feet height. bipinnate leaves small heliotropic scented lilac flowers in large panicle

Sl. No.	Common Name	Botanical Name and family	Colours of flowers	Flowering Time	Salient characters
14.	Shenbagam	*Michelia champaca* (Leguminaceae)	Light yellow whitish and red flowers	April - May and Sept-October	Seedling takes three years to bloom
15.	Bad-minton ball tree	*Parkia biglandulosa* (Leguiminaceae)	White flower	April - May	Pretty foliage, pinnate leaves, small white flowers with long peduncle, propagation through seed
16.	Copper shield	*Peltophorum ferrugneneum* (Leguiminaceae)	Pale yellow colour	April - May	Quick growing tree, fine graceful feathery foliage, pinnate leaves, raised from seed
17.	Indian Tulip	*Spathodia campanulata* (Bignoniaceae)	Orange Scarlet flowers	June - July	Leaves are glossy and bright green raised from seed

Ornamental foliage trees

Botanical Name	Family	Salient features
1. *Araucaria excelsa*	Coniferae	A very tall tree, conical in shape, short, slender, horizontal branches, starting from the trunk with a certain regularity
2. Causuarina equisetifolia	Causuarinaceae	Tamil: Chavukku, a lofty tree, rapid growth, slender branches, ornamental, fuel value, propagated by seeds
3. Cupressus macrocarpa	Pinaceae	Cypress, evergreen tree suited to higher elevations propogated by cuttings and seeds
4. Grevillea robusta	Proteaceae	Silver oak, reaches 8 to 11 m height, handsome foliage, propagated by seed
5. Terminalia catappa	Combretaceae	The Indian Almond tree-quick growing tree reaches, about 10 m height handsome stately growth with branches 10 m spreading horizontaly and coming from the main stem or axils in whorls, propagation from seed

Shade trees

Botanical name	Family	Salient characters
1. Albizia lebbek	Leguminaceae	Tamil: Vahai, quick growing shade trees with thin feathery foliage.
2.Azadirachta indica	Meliaceae	Tamil: Vembu, medium sized ever green tree with foliage, light green, serrated leaves.
3. Ficus elastica	Moraceae	Indian Rubber Tree, quick growing often reaching 15 to 60 m height, smooth shining leaves.
4. Enterolobium saman	Leguminaceae	Rain tree: large wide spreading tree propagated by seed.
5. Swietenia mahagoni	Meliaceae	Mohogani tree: ever green good- looking tall tree with good shape and attractive foliage;
6. Tectona grandis	Verbenaceae	Teak: It is truly a grand and majestic tree with large leaves.

List of commonly available shrubs.

A. Shrubs grown for flowers.

Sl. No.	Botanical Name	Family	Colour of the flowers
1.	*Acalypha hispida*	Euphorbiaceae	Long drooping spikes of crimson red flowers
2.	*Allamanda grandiflora*	Apocynaceae	Yellow funnel shaped flowers
3.	*Artabotrys odoratissimus*	Annonaceae	scented flowers, green and turn to yellow on ripening
4.	*Barleria cristata*	Acanthaceae	Flowers are pink, violet, yellow in colours
5.	*Bauhinia tomentosa*	Caesalpiniaceae	Sulphar yellow in colour
6.	*B. acuminata*	Caesalpiniaceae	White flowers
7.	*B. galpinii*	Caesalpiniaceae	Bright scarlet flowers
8.	*Bougainvillea sp.*	Nyctaginaceae	Single or double in red, rose, pink, yellow or white colour, including variegated leaves
9.	*Camellia japonica*	Theaceae	Double flowers with white, rose, or pink colour
10.	*Cestrum nocturnum*	Solanaceae	Scented flowers at night
11.	*Clerodendron inerme*	Verbenaceae	White flowers
12.	*Dombeya spectabilis*	Sterculiaceae	Cream/deep pink flowers
13.	*Duranta plumeri*	Verbenaceae	Blue flowers
14.	*Hamelia patens*	Rubiaceae	Orange red flowers
15.	*Hibiscus rosa-sinensis*	Malvaceae	Mostly red in color, yellow, pink and orange colours also avilable
16.	*H. mutabilis*		Flowers fade from pink to crimson
17.	*Ixora singaporensis*	Rubiaceae	Red
18.	*Mussaenda erthyrophylla*	Rubiaceae	Red, pink, yellow and white colour
19.	*Nerium oleander*	Apocynaceae	Single or double in rosy pink colour
20.	*Pentas cornea*	Rubiaceae	Red, pink or violet colour

Sl. No.	Botanical Name	Family	Colour of the flowers
21.	*Poinsettia pulcherrima*	Euphorbiaceae	Red, pink or violet colour
22.	*Tabernaemontana coronaria*	Apocynaceae	White
23.	*Tecoma stans*	Bignoniaceae	Yellow
24.	*Thevetia nerifolia*	Apocynaceae	Yellow colour
B. Shrubs grown for attractive leaves			
1.	*Acalypha sp.*	Euphorbiaceae	Red and green coloured leaves
2.	*Aralia sp.*	Araliaceae	Large pinnated/pinnatifid, variegated, trilobed leaves.
3.	*Codiaeum sp.*	Euphorbiaceae	Variably coloured and haped leaves.
4.	*Eranthemum elegans*	Acanthaceae	Blotched with white, green, grey and bronze coloured leaves.
5.	*Graptophyllum hortense*	Acanthaceae	Variegated blotched creamy white
6.	*Panax fruiticosum*	Araliaceae	Feathery, tripinnate leaves
7.	*Phyllanthes nivosus*	Euphorbiaceae	Small mottled pinkish white leaves
8.	*Pisonia alba*	Nyctaginaceae	Pale yellow foliage
C. Shrubs grown for attractive berries			
1.	*Duranta plumeri*	Verbenaceae	Yellowish Orange coloured berries
2.	*Ardesia crenata*	Myrsinaceae	Greyish red or crimson berries
3.	*Nandita domestica*	Berberideae	Red colour fruits

DESCRIPTION OF POPULAR INDOOR PLANTS / HOUSE PLANTS

S. No.	Botanical name / Common name / family	Propagation	Remarks
1.	*Aglonema commutatum* / Aglonema /Araceae	Tip cuttings / stem cuttings	A hardy houseplant with oblong-lanceolate leaves, 20-30 cm long rounded at the base, green silvery marking
2.	*Ananas comosus* var *variegata* Bromeliaceae	Suckers	Leaves green, broadly marginated, creamy-yellow, tinged red towards the margins, spiny and in a rosette form.
3.	(i) *Anthurium andreanum* (ii) *A. clarinenum* (iii) *A. crystallinum* Flamingo plant Araceae	Stem cuttings / seeds	(i). spathe erect, scarlet, cordate (ii) plants with rosette of fleshy ling, shining, green elliptic leaves 75-90 cm iii) Large cordate leaves, velvetty, ivory veins, delicate
4.	Asparagus (i) *A. sprengeri* (ii) *A. plumosus* (iii) *A. falcatus* / Liliaceae	Division of clumps	(i) Needle-like leaves borne on long, trailing and thorny stems. Ideal for hanging baskets. (ii) dark-green plume-like leaves on smooth, wiry, trailing stems (iii) A climbing plant with slender branches and bright green sickle-shaped leaves borne in clusters.
5.	*Araucaria heterophylla* / Araucariaceae	Seeds / tip cuttings	Symmetrically arranged branches with needle-like leaves on the central stalk
6.	*Begonia rex* / Begoniaceae	Division of rhizomes	Rex begonias are grown for the beautiful foliage, also flowering spp are available.
7.	*Schefflera actinophylla* / Araliaceae	Stem cuttings	It is tall, woody and branched with palmetely lobed, soft, feathery leaves forming umbrella like tops.
8.	*Caladium biocolor* / Araceae	Bulbs	It bears fancy, long-stalked, arrow-head leaves with many colours.
9.	*Calathea zebrina* / Marantaceae	Division	These are rhizomatous herbaceous plants and grow rapidly in warm humid condition.
10.	*Chlorophytum comosum* / variegatum / Liliaceae	Offsets / Division	Variegated narrow leaved foliage plant tolerate both shade and partial shade.
11.	*Codiaeum variegatum* var. *pictum* /crotons / Euphorbiaceae	Stem cuttings	The leaves are gorgeously coloured with red, maroon etc. Leaf shapes are also different.
12.	*Coleus blumei* / Labiatae	Stem cuttings	Ideal for growing in pots in a sunny-situation
13.	*Cordyline terminalis* / Liliaceae	Stem cuttings	Many varieties available. Bronze leaves with shades of brown or red.
14.	*Cyperus alternifolius* / Cyperaceae	Seeds or stem cuttings	Plant has ribbon-like stems, leaves grass-like arranged like umbrella spokes
15.	*Dieffenbachia picta* / Dumb cane /Araceae	Stem cuttings	The plant is tall with thick stem and lame-shaped, dark green, broad leaves.

S. No.	Botanical name / Common name / family	Propagation	Remarks
16.	*Dracaena sanderiana* *D. fragrans* *D. godseffiana* / Liliaceae	Stem cuttings	Hardy house plants
17.	*Episcia cupreata* / Flame violet Gesneriaceae	Stolons produce plants at the nodes which are separated and planted	Perennial herbs with beautiful-foliage
18.	*Ficus elastica decora* / Indian Rubber Plant	Stem cuttings / Air-layering	The leaves oblong, dark-green leathery leaves with bright red growing tip.
19.	*Heliconia metallica* / Musaceae	Division of clumps	Slender perennial herb, oblong leaves on long red stalk.
20.	*Maranta leuconeura* / Marantaceae		Leaves are oval, round, pale green with dark-brown markings along the central vein.
21.	*Peperomia argyreia* / Piperaceae	Stem / leaf cuttings	Ornamental, foliage plants, succulent and herbaceaus, quick growing.
22.	*Philodendron* spp / Araceae	Stem cuttings	Several ornamental species are grown indoor-plants.
23.	*Pilea muscosa* syn. *P. microphylla* / Artillery plant. Urticaceae	Stem cuttings	A dwarf trailing plant having small leaves in the attractive markings
24.	*Polyscias balfouriana* / Araliaceae	Stem cuttings	Plants are bushy with attractive foliage
25.	*Rheo discolor* / Commelinaceae	Division of clumps	The plant has a short, thick, fleshy stem bearing a rosette of leaves.
26.	*Sansevieria trifasciata* / Liliaceae	Division of rhizome	Thick fleshy leaves emerge erect from the ground and are sword-shaped.
27.	*Scindapsus aureus* / Money plant. Araceae	Stem cuttings	It has a trailing habit with small heart shaped, light green leaves flecked with yellow.
28.	*Sstcresia purpurea*	Stem cuttings	It has thick and fleshy stem with a tendency to trail and has pale purple leaves.
29.	*Spathiphyllum wallisii* *Peace lily* / Araceae	Division of clumps	The flowers are pure white, arum-shaped with glossy green leaves.
30.	*Syngonium podophyllum* Araceae	Division / Stem cuttings	A trailing plant with rough, triangular-shaped, bright emerald-green leaves with extended base.
31.	*Tradescantia fluminensis* / Wandering jew. / Commelinaceae	Stem cuttings	It has trailing habit with glossy-green leaves. Variegated varieties also available.
32.	*Zebrina pendula* / Commelinaceae	Stem cuttings	It closely resembles Tradescantia. It is also a trailing plant with paired leaves and are glisting silvery-grey green stripes down the centre.

Description of popular cacti and succulents.

Sl. No.	Botanical Name / Common name	Propagation	Remarks
1.	*Agave filifera* *A. americana*	Detach small plants forming around the base. Seed propogation also possible	Succulent-like plants that develop a rosette of fleshy leaves, some of which end in thorns can be kept outdoor during summer.
2.	*Aloe arborescens*	Offsets	An erect plant with thorny, curving, tentacle-like fleshy leaves. Spikes of orange-red flowers.`
3,	*Aporocactus flagelliformis* *Rat's-tail cactus*	Rooted cuttings, seeds	Green cascading stems, 40-60 cm long, covered with small thorns. Rose flowers 7 to 10 cm long.
4.	*Astrophytum ornatum* *Bishop's cap catus*	-Seeds -Grafting	A spherical to cylinderal cactus with eight ribs edged with clumps of spines. The surface has pathes of white scales. Flowers yellow.
5.	*Chamaecereus silvestrij* *Peanut cactus*	Shoot cuttings, Seeds	Finger-like, usually eight ribbed, Orange-red flowers, star like.
6.	*Crassula arborescens* *(Cape Province)*	Shoot tip cuttings Leaf cuttings	Thick, sturdy stems, branching tree-like to give bonsai appearance. white flower.
7.	*Echinocactus grusonii* *Golden barrel cactus*	Seeds	A spherical cactus, becoming more barrtel-shaped with age. Yellow flowers
8.	*Epiphyllum hybrids* *Orchard cactus*	Rooted / cuttings	The flowers are in shades of red or yellow or white, 10-15 cm width. The long notched stems are leaf-like in appearance.
9.	*Haworthia fasciata* *Wart Plant*	Offsets	Small succulents grown for their thickned attractively marked leaves, arranged as a rosette.
10.	*Kalanchoe sp.* *Syn: Bryophyllum* *(i) Flowering K. blossfeldiana* *(ii) Viviparous K. diagremontiana*	Cuttings & seeds (Flowering type)	Leathery, glossy green leaves, brittle and easily broken clusters of red / orange / yellow flowers
11.	*Lobivia* sp.	Offsets	A densely thorned, short cylindrical cactus. Red, Orange or yellow funnel shaped flowers 5 cm across.
12.	*Mammillaria* sp.	Offsets	A large group of spherical or columnnar cacti, grown for their interesting shape or spines & sometimes flowers
13.	*Notocactus* sp. *(golden ball cactus)*	Offsets, Seeds	Cylindrical light green stems, forming clusters. 20-30 ribs with fine, pale yellow spines. Flowers lemon yellow inside, green outside.

Sl. No.	Botanical Name / Common name	Propagation	Remarks
14.	*Opuntia sp.* *Prickly pear*	Cuttings and allow them to dry for two days before planting	Commonly grown cactus for fencing in fields. Broad, flat pads are spiny yellow flowers only on older plants.
15.	*Parodia sp.*	Seeds	A globular cactus with spiralled ribs. Apricot. colured flowers.
16.	*Rebutia sp.*	Offshoots, seeds	Small, globular free flowering cacti. Red flowers.
17.	*Rheo discolor* *Boat lily*	Cuttings, offsets	Semi-erect, strap-shaped leaves, long dark-green on top, purple beneath.
18.	*Sanevieria trifasciata* *Mother-in-law's tongue*	Division of established plants and leaf cuttings	Sword-like thick, fleshy leaves,. Dull green with mottled grey cross-banding.
19.	*Sedum* sp. *S. Pachyphyllum*	Seeds, cuttings	Plants mostly used in the rock garden succulent, Club-shaped to cylinderical blue-green leaves.
20.	*Sempervivum sp.* *Houseleek*	Offsets around the parent plant	Rosette of bright green leaves with pink flowers
21.	*Setcreasea purpurea* *Purple heart*	Cutting	Erect, oblong to lance-shaped purple leaves. Stems are also purple. Small rose-purple flowers.
22.	*Yucca aloifolia*	Rooted sideshoots	Spiky rosette of stiff, spine-tipped, sword shaped leaves. Often a stout trunk-like stem.

CLIMBERS AND CREEPERS

Sl. No.	Botanical Name	Family	Colour of flowers
1.	*Allamanda grandiflora*	Apocynaceae	Bright yellow
2.	*Antigonon leptopus*	Polygonaceae	Bright pink and white
3.	*Aristolochia elegans*	Aristolochiaceae	Dark purple and cramy yellow
4.	*Asparagus sprengeri*	Liliaceae	Leaves are attractive
5.	*Bignonia venusta*	Bignnoniaceae	Golden orange
6.	*Bougainvillea sp*	Nyctagineae	Varios colours
7.	*Ipomoea palmata*	Convolvulaceae	Purple
8.	*I. tuberosa*	-do-	Yellow
9.	*Jacquemontia violacea*	-do-	Bright blue
10.	*Jasminum grandiflorum*	Oleaceae	White, tinged pink scented
11.	*Monstera deliciosa*	Araceae	Leaves are attractive
12.	*Petrea volubilis*	Verbenaceae	Purple blue
13.	*Porana volubilis*	Convolvulaceae	White
14.	*Quisqualis indica*	Combretaceae	Pale pink and white
15.	*Scindapsus*	Aroidae	Variegated leaves
16.	*Solanum seaforthianum*	Solanaceae	Purplish blue
17.	*S. wenlandi*	do	Lilac blue
18.	*Tecoma jasminoides*	Bignoniaceae	White with rose purple streak in the throat
19.	*Thunbergia grandiflora*	Acanthaceae	Bluish, purplish or white
20.	*Vallaris solanacea*	Apocynaceae	White scented flower

Ex. No. 15.

FLOWER CROP VARIETIES RELEASED FROM TAMIL NADU AGRICULTURAL UNIVERSITY

Sl. No.	Crop	Variety	Parentage / Breeding method	Duration (days)	Yield (t/ha)	Special features	Year of release
1.	Rose	YCD.1	Selection from progeny	Perennial	100-200/ plant	Bright yellow with tinge of pink on the outer whorl	1985
2.	Rose	YCD.2	Clonal progeny of seedling No.1043	Perennial	150-200 flowers/ plant	Bright yellow with a scarlet red with yellow shade at the petal base	1992
3.	Rose	YCD.3	Selection from open pollinated progeny	Perennial	80-100 flowers/plant/annum	Deep vermillion	1995
4.	Mullai	Parimullai	Clonal selection	Perennial	5800 kg/ha	Buds are white with moderate corolla tube length	1972
5.	Mullai	Co.1	Selection from local	Perennial	8800 kg/ha	Buds are white and bolder with long corolla tube	1980
6.	Mullai	Co.2	Clonal selection	Perennial	11,198 kg/ha	Field tolerance to phyllody disease and gall mite infestation	1988
7.	Pitchi	Co.1	Secondary clonal selection	Perennial	10,144 kg/ha	Pink tinged flower bud with long corolla tube	1980
8.	Pitchi	Co.2	Induced Mutant from Co.1	Perennial	116800 kg/ha	Bolder pink buds	1991
9.	Chrysanthemum	Co.1	Selection from Hosur Local	9 months	16.7 t/ha	Canary yellow flowers	1985
10.	Chrysanthemum	MDU.1	Selection from the germplasm type	8 months	16.59 t/ha	Sulphur yellow color	1985

Sl. No.	Crop	Variety	Parentage / Breeding method	Duration (days)	Yield (t/ha)	Special features	Year of release
11.	Chrysanthemum	Co.2	Selection from germplasm type received from NBRI, Lucknow	8 months	18.47 t/ha	Purple colour (Rhodamine purple-29)	1989
12.	Gerbera	YCD.1	Clonal selection	Perennial	56 flower/clump/year	Flowers are double in form with cherry red colour	1992
13.	Gerbera	YCD.2	Selection from germplasm	Perennial	80 flowers/clump/year	Rose pink flowers	1995
14.	Gladiolus	KKL.1	Selection from American Beauty	120 days	2,11,100 flowers (spike) /ha	Red purple flower with white flushed throat	1993
15.	Hibiscus	Co.1 Thilagam	Intergeneric hybrid (*H. rosasinensis* X *Malvaviscus arboreus)*	Perennial	3055 flowers/bush/year	Flowers are carmine red colour	1981
16.	Hibiscus	Co.2 Punnagai	Selection from OP seedlings of Chandrika	Perennial	1000 flowers/bush/year	Apricot yellow flowers	1981
17.	Hibiscus	Co.3	Hybrid between Bright Yellow X Red Gold cvs.	Perennial	1309 flowers/bush/year	Chinese yellow with Turkey red throat	1984
18.	Barlaria	Co.1	Clonal selection from local type	Perennial	2.11 kg flowers/bush	Pink colour flowers	1982
19.	Marigold	MDU.1	Selection from a germplasm type	4 months	41.54 t/ha	Light orange colour	1986

EX.NO.2

BRIEF DESCRIPTION OF THE VARIETIES OF VEGETABLE CROPS

1.	**Tomato**	**CO.1**	**(1969)**	It is a pureline selection from an exotic type. It is a semi determinate type. The crop duration is 135 days and yields 38 tonnes/ha. It bears in clusters of 6 to 8 fruits. The fruits are round pale green at unripe stage and turns to capsicum red on ripening. The plants are dwarf and semi round and need no staking. The fruits contain high TSS (4.2°Brix) and acidity (0.69%).
2.	**Tomato**	**CO. 2**	**(1974)**	It is a pureline selection from U.S.S.R. type. The plants are semi-dwarf, leaves broad and thick. Fruits are ovate, large, devoid of cracking and rich in ascorbic acid (18-21 mg/100g). 4.22°Brix TSS and 0.90% acidity. It yields 42 t/ha (18.2% increase over CO.1).
3.	**Tomato**	**CO. 3**	**(1980)**	It is an induced mutant from CO. 1 having 100 days duration with very dwarf, compact and determinate plants. Fruits are globular attractive red, borne in cluster of 4-5 fruits, rich in vit C (25 mg/100g), TSS (3.2° Brix) and acidity (0.8%) with a flesh to seed ratio of 17%. It yields 50 t/ha and is suitable for summer season also.
4.	**Tomato**	**PKM 1**	**(1978)**	It is an induced mutant from Annanji giving 32.0 t/ha in a duration of 135 days. The plants are determinate with fruits of attractive capsicum red in colour with green shoulders and uniform ripening. The fruits are best suited for long distance transport. The fruits contain 3.6°Brix of TSS 23.7 mg/100 g of vitamin C and 0.99% acidity.
5.	**Tomato**	**Paiyur 1**	**(1988)**	This variety is a hybrid derivative evolved by crossing Pusa Ruby x CO 3. It is suitable for rainfed cultivation. It yields about 30 t/ha.
6.	**Tomato**	**COTH.1**	**(1999)**	This was developed at the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore by crossing IHR 709 and LE 812. It is a determinate F_1 hybrid requiring minimum staking. The fruits are round to slightly oblong each weighing 50 g

				with deep red skin and thick flesh and borne in clusters of 4-5. The juice is acidic rendering the fruits for use in culinary preparation unlike the most of the hybrids developed by a number of private firms which lack acidity and hence used mostly for salad. The plants can be planted at a spacing of 60 x 45 cm. The estiamted yield is 96 tonnes / ha in a crop duration of 110-115 days after transplanting.
7.	**Brinjal**	**CO. 1**	**(1978)**	It is a selection. The crop duration is 160 days. The plants are erect, medium, bushy with greenstem and leaves and greenish purple petiole. Fruits are light green with
8.				white base, medium sized (50-60 g/fruit) with good keeping quality. It is moderately resistant to root-knot and reniform nematodes. It yields 24.0 t/ha.
9.	**Brinjal**	**CO. 2**	**(1988)**	It is a selection from the local cultivar called Coimbatore Varikkathiri. The plants are medium in height and spread and capable of yielding as high as 38 t/ha. The fruit are oblong in shape having eminent deep purple colour with inter mittent pale green streaks. The crop duration is 150 days. The quality is very good and this variety is suitable for growing in Coimbatore and Periyar districts.
10.	**Brinjal**	**MDU 1**	**(1979)**	It is a selection from a local type and yields 34.0 t/ha in a crop duration of 135 days. The plants are compact and medium spreading. The fruits are round, bright, purple coloured and each weights 280g. The leaves are broad with light green pigments. The fruits contain 0.38% acidity and 11.36 mg/100 g of ascorbic acid.
11.	**Brinjal**	**PKM 1**	**(1984)**	It is an induced mutant of a local type. It is high yielding (34.75 t/ha) with a duration of 150-155 days. The fruits measure 6 to 8 cm and 10-14 cm in length and girth respectively with a mean weight of 45 to 65 g. It is drought tolerant and can withstand long distance transport. It stores well under normal room temperature. The fruits contain 0.29% acidity and 14 mg/100 g of ascorbic acid.

12.	**Brinjal**	**PLR 1**	**(1990)**	This is a selection. The fruits are small to medium in size. Sometimes borne in clusters. Egg shaped and with bright glossy purple colour. It fetches premium price in the markets of Cuddalore, Chenglepet and Chennai. It has got a self life of 8-10 days under ambient temperature. It yields an average of 15 t/ha.
13.	**Brinjal**	**KKM 1(Killikulam-1)**	**(1995**	It is a pureline selection from Kulathur local. It is suitable for cultivation both under rainfed and irrigated conditions in Tirunelveli district. Fruits medium sized, egg shaped, milky white in colour and bears in clusters of 2-4 per cluster. It yields 37 t/ha in a duration of 135 days.
14.	**Chilli**	**CO. 1**	**(1979)**	It is a selection from Sathur Samba. The crop duration is 210 days and yields 2110 kg of dry pods per hectare. The plants are erect, medium tall and compact with medium branching. The fruits are green when unripe and bright shiny red on ripening. The fruits are 6-6.5 cm long with sharp tip and bulged shoulders. The seed content is 55% with high capsaicin (0.72 mg/g).
15.	**Chilli**	**CO. 2**	**(1982)**	It is a selection from a local Gundu type. The crop duration is 210 days and yields 2200 kg of dry pods per hectare. The stem is angular semidwarf and less spreading. The pods are oblong and bright red in colour. Seed content is high (60%) Capasicin content of dry pod is 0.56%. It is suitable for harvest as green pods and red ripe pods.
16.	**Chilli**	**PKM 1**	**(1990)**	This is a hybrid derivative of the cross between Ac.No. 1797 x CO. 1 selected in F_1 generation and fixed by selfing. It has very bold pods which are dark red in colour. It has got a very high yield potential of 3000-3200 kg of dry pods per hectare in a crop duration of 180 days.
17.	**Chilli**	**CO. 3**	**(1991)**	This is a dwarf and compact growing samba culture suitable for very close planting of 30 cm x 15 cm. The potential yield at this spacing is 3000-3500 kg of dried chilli per hectare. It is also suitable to be used as green chilli. It has a very low stalk weight in comparison with pod weight unlike other cultivars and high oleoresin and capsaicin content and hence suitable for

				export purpose.
18.	**Vegetable Chilli**	**CO.4**	**(2000)**	It is a pureline selection made from an open pollinated type introduced from Sri Lanka with a crop duration of 165 days after transplanting. It is suited for *kharif* and *rabi* seasons. This variety recorded 96.58% increased yield over PKM-1. The fruits are dark green, stout, less pungent and turns to capsicum red colour after ripening. It has the potential to yield 23 t/ha of green chilli.
19.	**Chilli**	**K 1**	**(1964)**	It is a selection from local Sathur Samba. The crop duration is 210 days and yields 1.8 t/ha. The fruits are long and contain high capsaicin. The variety is suitable for rainfed cultivation in southern districts of Tamil Nadu.
20.		**K 2 Chilli**	**(1975)**	It is hybrid derivative of the cross B 70-A and Sathur Samba. The crop duration is 210 days and yields 1980 kg of dry pods/ha. The plants are tall and compact. The pods are long and bright red in colour with high seed content. The increased yield is 29% over K1 chilli.
21.	**Chilli**	**MDU 1**	**(1978)**	It is a mutant from K 1 chilli. The fruits are longer and bears in clusters of 6 to 8. The crop duration is 210 days with an yield of 1.9 tonnes of dry pods per ha. It is more suitable for southern districts of Tamil Nadu. The fruits contain 0.70 mg/g of capsaicin.
22.	**Chilli**	**PLR 1**	**(1994)**	It is a pureline selection from Kandengadu local. It is more suited for green chillies and yields per hectare. The crop duration is 210 days.
23.	**Chilli**	**PMK 1**	**(1993)**	Plants are medium tall. Duration is 200 days and suitable for semi-dry cultivation in Ramanathapuram district. It yields about 2.4 tonnes of dry pods/ha.
24.	**Bhendi**	**CO. 1**	**(1976)**	It is a selection from 'Red Wonder' of Hyderabad. The crop duration is 90 days with an

				yield of 14.25 t/ha. The plants are medium tall, moderately vigorous and deeply lobed leaves. Pods are slender, smooth and fleshy.
25.	**Bhendi**	**CO.2**	**(1987)**	It is a F_1 hybrid bhendi involving two parents AE 180 and Pusa Sawani. First harvest can be done 45 days after sowing and the crop duration is 90 days. It yields 16.5 t/ha accounting for 26 to 64% increase over CO. 1, MDU 1 and Pusa Sawani. It can be grown throughout the year.
26.	**Bhendi**	**MDU 1**	**(1978)**	It is an induced mutant from Pusa Sawani. The fruits are long and light green in colour. It yields 12 to 14 t/ha in a crop duration of 100 days. The pods contain 12.3% crude fibre.
27.	**Hybrid Bhendi**	**CO.3**	**(1991)**	It is a high yielding hybrid evolved from the cross between Parbhani Kranti x MDU 1 and suitable for fresh Market with dark green colour of medium sized fruits. This hybrid has high degree of field tolerance to Yellow Vein Mosaic Disease. The yield is 18.75 t/ha.
28.	**Amaranthus**	**CO.1**	**(1968)**	It is a selection from a local type. The crop duration is 25 days for mulakkeerai and 50 days for thandukeerai. The yield is 8 t/ha. The leaves are dark and seeds are black and small sized. The greens contain 4.8% calcium and 3.85% iron.
29.	**Amaranthus**	**CO.2**	**(1979)**	It is a selection from a germplasm type with a duration of 25 days for mulakeerai and 35-50 days for thandukeerai. It yields 10.75 tonnes of greens/ha. The plants are erect, with moderate branching. The seeds are bolder with early germination and early vigorous growth. The crude fibre content is less (1.3%) with 19.0 mg of iron, 20.0 mg of calcium per 100 g.
30.	**Amaranthus**	**CO.3**	**(1988)**	It is a selection from the local type and yields 30.72 tonnes of greens per hectare. It lends itself for 10 clippings, commencing from 20 days after sowing and provide a continuous supply of luscious tender green for three months. It has high leaf to stem ratio (2.0). The plants are erect with green nutritious leaves containing 25.2 mg per 100 g of vitamin C, 1.75% crude fibre, 0.8% iron and 2.48% Ca. The seeds are black in colour.
31.	**Amaranthus**	**CO.4.**	**(1989)**	It is a selection from *A. hypochondriacus* which is suitable for growing in plains and hills

				throughout Tamil Nadu. It is a high yielding grain amaranthus with an yield of 2,555 kg/ha in addition to 8,200 kg/ha of leaf on 25 the day. The crop duration is 90 days/ The seeds are rich in protein (15.95%) and amino acids like lysine (7.5 mg/100g), phenylalanine (5 mg/100g), leycine (1.2 mg/ 100 g) and isoleucine (1.8 mg;/100 g). The grain can be substituted for minor millets like ragi and tenai. It is amendable for various food preparations just like any other grains.
32.	**Amaranthus**	**CO.5**		It is a single plant selection (A 166-I) from an OP plant introduction. The variety has double coloured leaves (green and pink). It gives a rosette growth in early stages. The stem is also free of fibres. The first harvest starts 25 days after sowing and in a crop duration of 55 days it produces on an average of 40 tonnes of green leaves per hectare.
33.	**Onion**	**CO. 1**	**(1963)**	It is a selection. The crop duration is 90 days and yields 10 t/ha. Bulbs are medium sized, pink in colour with 8 bulbs per plant weighing 55 to 60 g. The bulbs are fairly pungent.
34.	**Onion**	**CO.2**	**(1975)**	It is a selection from a germplasm type, CS 911. The crop duration is 65 days yielding 12 t/ha. It is a photo insensitive type. This variety is pungent with high total soluble solids (12.0°Brix).
35.	**Onion**	**CO.3**	**(1979)**	It is a clonal selection from open pollinated progenies of CS 450. The crop duration is 65 days and yields 15.8 t/ha. The bulbs store well over 120 days. The variety contains 17.5% dry matter, 0.53 per cent sulphur and 13.0°Brix TSS.
36.	**Onion**	**CO.4**	**(1982)**	It is a hybrid derivative of the cross AC 863 x CO3. The crop duration is 65 days and yields 19.0 t/ha.. The bulbs store well over 150 days devoid of sprouting in well ventilated store rooms.
37.	**Onion**	**MDU 1**	**(1984)**	This is a selection from a local type, Sempatti. Bulbs are big sized with attractive red colour. It yields 52.7% higher than CO 2. It keeps well for a long time with less reduction during storage in bulb weight (45%) for 5 months compared to 65% in CO 2 onion.

38.	**Snake gourd**	**CO. 1**	**(1976)**	It is a selection from a local germplasm type. The crop duration is 135 days and yields 18.0 t/ha. The fruits are dark green with white stripes, long fruits (160-180 cm) each weighing 500 to 750 g with good cooking quality. It is moderately resistant to powdery mildew.
39.	**Snake gourd**	**CO.2**	**(1986)**	It is a selection from a local type. The fruits are short and stout. It yields on an average 36 t/ha. The fruit is light greenish white and each weighs 400-600 g. The crop duration is 105 days. The variety does not require pandal.
40.	**Snake gourd**	**MDU 1**	**(1981)**	It is a hybrid between Panri Pudal and selection 1. It is an early flowering type (84 days) with an average yield of 31.74 t/ha. The fruits are medium long (66.94 cm) and short with an average weight of 551 g. The fruits are fairly rich in Vit. C (44.4 mg/100g) and very low in fibre content (0.6%).
41.	**Snake gourd**	**PKM 1**	**(1979)**	It is an induced mutant from H 375 type and yields 25.5 t/ha in a duration of 145 days. The vines are vigorous giving fruits of dark green colour with white strips outside and light green inside. Each fruit weighs 700 g.
42.	**Bitter gourd**	**CO.1**	**(1978)**	It is a selection from a local type. The crop duration is 115 days and yields 14.0 t/ha. The fruits are green, long (30-35 cm) and contain 1.8 mg/100 g of iron, 20 mg/100g of calcium and 1.1g/100 g of minerals.
43.	**Bitter gourd**	**MDU 1**	**(1984)**	It is an induced mutant, developed by gamma irradiation of local cultivar (MC 103). It is early in flowering (60 days) and yields 16.66 fruits/plant. The fruits are long with mean length of 40.34 cm and a girth of 17.54 cm and each fruit weighs 410.0 g on an average. It yields 32.19 t/ha.
44.	**Ribbed gourd**	**CO.1**	**(1976)**	It is a selection from a local type. The crop duration is 125 days and yield of 14.0 t/ha. Fruits are long (60-75 cm), light green, attractive in appearance each weighing 300 g on an average. Moderately tolerant to pest and disease.

45.	**Ribbed gourd**	**CO.2**	**(1984)**	It is a selection from a germplasm type. The fruits are green, long (1 m) and fleshy. The crop duration is 120 days with an yield of 25 t/ha.
46.	**Ribbed gourd**	**PKM 1**	**(1980)**	It is an induced mutant from the type H 160 and gives 28.0 t/ha of fruits in a duration of 160 days/ The fruits are dark green with shallow grooves. The plants are tolerant to pumpkin beetle, fruit fly and leaf spot.
47.	**Bottle gourd**	**CO.1**	**(1981)**	It is a selection from a germplasm type. The crop duration is 135 days and yield of 36.0 t/ha. Fruits are round at the base with a prominent bottle neck at the top., medium sized, attractive light green in colour with mean weight of 2.025 kg.
48.	**Pumpkin**	**CO.1**	**(1971)**	It is a selection from a local type and yields 30 t/ha. The vines are vigorous and spreading. The fruits are bigger and globular, each weighing 7.00 kg. One vine yields 6 to 7 fruits. First harvest can be had 115 days after sowing and the total crop duration is 180 days.
49.	**Pumpkin**	**CO.2**	**(1974)**	It is a selection from a local type. The duration is 135 days and yields 23.0 t/ha. The vines are moderately vigorous and less spreading. Individual fruit weighs 1.5 to 2.0 kg with 5 to 6 fruits per vine. It is a small fruited variety suitable for kitchen garden. The fruits contain 9.2% starch, 10.8 brix TSS, 10 mg/100 g of ascorbic acid and 0.14% acidity.
50.	**Ash gourd**	**CO.1**	**(1971)**	It is a selection from a local type with a crop duration of 150 days. The fruits are globular, light green with ash coating with less seeds. The yield is 25 t/ha.
51.	**Ash gourd**	**CO.2**	**(1982)**	It is a selection from a local type. The duration is 120 days and yields 34.0 t/ha. The fruits are light green with waxy bloom, small sized with a mean weight of 2.5 to 3.0 kg. The fruits contain 200-300 seeds. It takes 85-90 days from sowing to harvest.
52.	**Annual Moringa**	**PKM.1**	**(1989)**	It is a pure line selection from the population generated by continuous selfing of the seed moringa types for six generations. The plants grow to a height of 4-6m and come to flowering 90-100 days after planting. The first harvest starts 160-170 days after planting. Each tree bears

				on an average 200-225 fruits/year (3 kg). The pods are 65-70 cm long with 6.3 cm girth and 150 g weight. Ratoon crops can be taken for 3 years. Every year after the harvest is completed, the trees have to be cut back to about one metre from ground level.
53.	**Annual Moringa**	**PKM.2**		It is a high yielding type with an increase of 9.18% in number of pods over PKM-1 Annual Moringa. The pods are long, less seeded, more fleshy and delicious. It comes to bearing in six months after sowing. It yields 98 tonnes/ha/year.
54.	**Tapioca**	**CO.1**	**(1977)**	It is a clonal selection with a crop duration of 8½ -9 months. The tuber is whitish brown with white flesh, and is suitable for industrial uses and consumption purpose. The starch content of tubers is 35.0 per cent with an out turn of 10.35 tonnes of starch per hectare. The HCN content is less (10g/g) in the flesh. It yields 30 t/ha. The plants are tolerant to mosaic virus.
55.	**Tapioca**	**CO.2**	**(1984)**	It is also a clonal selection. The tubers are medium sized with whitish grey skin, creamy white rind and white flesh. The crop duration is 8 ½ to 9 months . The starch content is 34.50 per cent. It yields 38.6 t/ha of tubers. The incidence of mosaic virus is low. The tubers contain low HCN of 10 g/g in the flesh.
56.	**Tapiaco**	**CO.3**	**(1993)**	It is also a clonal selection from open pollinated seeds obtained from Ibadan, Nigeria. It yields 43 t/ha in a crop duration is 8 months. The tubers contain high starch 35.6% and low HCN of 77.89µg/g. The plants exhibit field tolerance to mosaic virus disease. It is a branching type. Tuber flesh is white with brown skin and creamy white rind.
57.	**Sweetpotato**	**CO.1**	**(1976)**	It is a clonal selection. The crop duration is 135 days and yields 28 t/ha. The tubers have light pink skin and white flesh. The number of tubers per plant is 3.2 with a starch content of 24% and a TSS of 10.6° brix.

58.	**Sweetpotato**	**CO.2**	**(1980)**	It is a clonal selection. The crop duration is 110 to 115 days and yields 32 t/ha. Tubers have pink skin and white flesh and have a starch content of 29.5 per cent and TSS of 10.8°Brix.
59.	**Sweetpotato**	**CO.3**	**(1982)**	It is also a clonal selection. The crop duration is 105-110 days and yields 42 t/ha. It is suitable for cultivation in both seasons and tolerant to root weevil. The tubers have light pink skin and orange flesh and contain a carotene of 13.28 mg/100 g and starch of 30.72 per cent.
60.	**Sweetpotato**	**CO.CIP. 1**		It is a clonal progeny of IB 19.10.20 developed through half-sib evaluation of open pollinated seedlings. Duration is 95-110 days September-October, February-March and June-July are best suitable seasons. It yields 31.76 t/ha. Tolerant to weevil incidence (14.85%).
61.	**Coleus**	**CO.1**	**(1991)**	It is a clonal selection. It yields 32 t/ha in a crop duration of 180-190 days. The tubers have 21.5 per cent starch. The cooked tubers are tasty and have lesser soil odour.
62.	**Dioscorea**	**CO.1**	**(1991)**	It is a clonal selection. It gives 44.8 tonnes of tubers/ha in a crop duration of 8 to 8½ months. The tubers are big in size with white flesh. Tubers are rich in carbohydrate (28%) and protein (2.5%).
63.	**Colocasia**	**CO.1**	**(1991)**	It is a high yielding selection. It has an yield potential of 24 t/ha. Tubers have high starch content (22.5%) and higher protein content (2.4%) than cassava and sweet potato. Tubers have less acidity and good cooking quality.
64.	**Radish**	**CO.1**	**(1971)**	It is a selection from a germplasm type. Roots are milky white, less pungent, long (22 cm) cylindrical and tapering and thick (12.5 cm girth) and medium sized (226 g). Roots contain 10.9 mg/vit. C per 100 g and 1.28% crude fibre, suitable for intercropping and other systems of cropping. Roots have better consumer's preference. Top to root ratio is 0.99.
65.	**Beetroot**	**Ooty-1**	**(1992)**	It is a selection and yields 31.4 t/ha in the hills. The crop duration is 120-130 days if direct sown and 135-150 days if transplanted. It is suitable for growing in all seasons. The roots are blood red in colour with thin skin.
66.	**Moringa**	**KKL-1**	**(1996)**	It is a selection from a local type. The selection yields 7 tonnes of green pods/ha with 31

	bean			per cent increase over local. Pods are green, fleshy and thick.
67.	**French bean**	**YCD.1**	**(1994)**	It is a pureline selection from a local type and suitable for rainfed cultivation in the hills upto an elevation of 1500 m above M.S.L. It yields 9 tonnes of green pods or 6 tonnes of grain per hectare in a duration of 105 days. The pods are flat, green with dark purple bold seeds. It exhibits field tolerance to yellow vein mosaic and anthranose disease.
68.	**Butter beans**	**KKL-1**	**(1991)**	KKL-1 butter beans (*Phaseolus lunatus*) is a selection from a type collected from Vilpatti. It is a pole type and bears pods in clusters. The pods are 11.6 cm long, beans are 5-6 in number per pod. The crop will be ready for harvest from 100 days. The harvest will continue upto 140 days. It yields 3.47 t/ha in 3 to 4 pickings.
69.	**Dolichos bean**	**CO.1**	**(1993)**	It is a selection. Pods are dark green flat and slightly curved, tender and fleshy. Pods contain 4.69% protein, 12 mg vit. C, Fe 2 mg, P.14 mg, Ca 39 mg. 100 g or edible portion with 1.33% crude fibre. Matured seed is black in colour. Yield 18 t/ha, duration 165 days.
70.	**potato**	**CO. Simla**	**(1970)**	It is a selection from the hybrids obtained from CPRI, Simla. It is suitable for cultivation in the plains during monsoon seasons. The yield is 12 t/ha in a crop duration of 110 days.
71.	**Palak**	**Ooty 1**	**(1995)**	It is a selection and can be grown all through the year. It is tasty green leafy vegetable in which first picking can be had 45 days after sowing and continued at 15 days interval for a period of 2 years. It yields 15 t/ha/harvest. The leaves contain higher carotene.
72.	**Watermelon**	**PKM.1**	**(1993)**	Fruits are oblong, green in colour with light green stripes. Each fruit weighs about 3-4 kg. Duration is 120-135 days and yield is 38 t/ha.
73.	**Cucumber**	**CO.1**	**(1989)**	It is a selection from Kanyakumari local type. It is a high yielding selection (25-28 t/ha). The fruits are long (60 to 65 cm), slightly curved, tapering towards stalk end.
74.	**Garlic**	**Ooty.1**	**(1991)**	It is a high yielder and gives on an average 17.1 t/ha. Comes to harvest in 120-130 days. The bulb is dull white in colour.

EX.NO.2

BRIEF DESCRIPTION OF THE VARIETIES OF VEGETABLE CROPS

No	Crop	Variety	Year	Parentage	Breeding method	Duration	Yield	Special features
1	Tomato	CO.1	(1969)	American variety Pearl Harbour	Pureline selection	135 days	38 tonnes/ha	It is a semi determinate type. It bears in clusters of 6 to 8 fruits. The fruits are round pale green at unripe stage and turns to capsicum red on ripening. The plants are dwarf and semi round and need no staking. The fruits contain high TSS (4.2°Brix) and acidity (0.69%).
2	Tomato	CO. 2	(1974)	Russian introduction	Pureline selection	145 days	42 tonnes/ha	Fruits are smooth medium size, flat with 4-5 furrows, green colour when unripe and reaching capsicum red after ripening. The plants are semi-dwarf and need no staking. Fruits are ovate, large, devoid of cracking and rich in ascorbic acid (18-21 mg/100g). 4.22°Brix TSS and 0.90% acidity. (18.2% increase over CO.1).
3	Tomato	CO. 3 (Marthusm)	(1980)	Induced mutant of CO.1 (IM.39)	Mutation breeding	100-105 days	45 tonnes/ha	It is an induced mutant from CO.1, very dwarf, compact and determinate plants. Fruits are globular attractive red, borne in cluster of 4-5 fruits, rich in vit C (25 mg/100g), TSS (3.2° Brix) and acidity (0.8%) with a flesh to seed ratio of 17%.
4	Tomato	PKM 1	(1978)	Inducted mutant from Annanji	Mutation breeding	135 days	32 tonnes/ha	The plants are determinate with fruits of attractive capsicum red in colour with green shoulders and uniform ripening. The fruits are best suited for long distance transport. The fruits contain 3.6°Brix of TSS 23.7 mg/100 g of vitamin C and 0.99% acidity.
5	Tomato	Paiyur 1	(1988)	Pusa Ruby x CO.3	Hybridization		30 tonnes/ha	It is suitable for rainfed cultivation. It is early flowering extended harvest (10-12). Fruits are round medium size slide ribbing at calyx end with medium keeping quality

								and long distances transport and low incidence of fruit borer.
6	Tomato	COTH.1	(1999)	IHR.709 x LE.812	Hybridization	110-115 days	96 tonnes/ha	The fruits are round to slightly oblong each weighing 50 g with deep red skin and thick flesh and borne in clusters of 4-5. The juice is acidic rendering the fruits for use in culinary preparation unlike the most of the hybrids developed by a number of private firms which lack acidity and hence used mostly for salad. The plants can be planted at a spacing of 60 x 45 cm.
7	Brinjal	CO. 1	(1978)		Pureline selection	160 days	24 tonnes/ha	The plants are erect, medium, bushy with greenstem and leaves and greenish purple petiole. Fruits are light green with white base, medium sized (50-60 g/fruit) with good keeping quality. It is moderately resistant to root-knot and reniform nematodes.
8	Brinjal	CO. 2	(1988)	Local variety vari kathiari of Nagamam	Pureline selection	150 days	38 tonnes/ha	The plants are medium in height and spread and capable of yielding as high as 38 t/ha. The fruit are oblong in shape having eminent deep purple colour with inter mittent pale green streaks. The quality is very good and this variety is suitable for growing in Coimbatore and Periyar districts.
9	Brinjal	MDU 1	(1979)	Kallampatti local of Madurai	Selection	135 days	34 tonnes/ha	The plants are compact and medium spreading. The fruits are round, bright, purple coloured and each weights 280g. The leaves are broad with light green pigments. As the fruit matures, the purple colour fades to pale pink. The variety is preferred in Madurai and Trichy districts of Tamil Nadu.
10	Brinjal	PKM 1	(1984)	Mutant from Puzhuthi Kathiri	induced mutant	150-15 days	34.75 tonnes/ha	The fruits measure 6 to 8 cm and 10-14 cm in length and girth respectively with a mean weight of 45 to 65 g. It is drought tolerant and can withstand long distance transport. It stores well under normal room temperature. The fruits contain 0.29% acidity and 14 mg/100 g of ascorbic acid. The fruits are small with green stripes. Adapted to rainfed cultivation in

								Maduari and Dindigual districts.
11	Brinjal	PLR 1	(1990)	A Nagpur ecotype.	Pureline selection	145-150 days	25.1 tonnes/ha	The fruits are small to medium in size. Sometimes borne in clusters. Egg shaped and with bright glossy purple colour. It fetches premium price in the markets of Cuddalore, Chenglepet and Chennai. It has got a shelf-life of 8-10 days under ambient temperature.
12	Brinjal	KKM 1 (Killikulam-1)	(1995)	Kulathur local	Pure line selection	135 days	37 tonnes/ha	It is suitable for cultivation both under rainfed and irrigated conditions in Tirunelveli district. Fruits medium sized, egg shaped, milky white in colour and bears in clusters of 2-4 per cluster. Preferred in the markets of Sourthern districts.
13	Brinjal	COBH.1	(2001)	EP.45 x CO.2	Hetersosis breeding	145-150 days	65 to 70 tonnes/ha	F1 hybrid fruit, medium sized, oblong in shape and dark violet in colour, each weighing around 60 to 65g. It has as much as 16.65 mg of ascorbic acid / 100 g of edible portion, 1.78 per cent protein and 3.10 per cent of total sugars. It is suitable for Coimbatore, Erode, Salem, Cuddalore, Trich, Karus, Dharmapuri, and Thiruvannamalai districts.
14	Chilli	CO. 1	(1979)	Reselection from Sattur Samba (CA (p) 247).	Selection	210 days	1.8 tonnes/ha	The plants are erect, medium tall and compact with medium branching. The fruits are green when unripe and bright shiny red on ripening. The fruits are 6-6.5 cm long with sharp tip and bulged shoulders. The seed content is 55% with high capsaicin (0.72 mg/g).
15	Chilli	CO. 2	(1982)	Selection from Nambiyur local 'Gundu' type (CA (p) 63)	Selection type	210 days	1 tonnes/ha	The stem is angular semidwarf and less spreading. The pods are oblong and bright red in colour. Seed content is high (60%) Capasicin content of dry pod is 0.56%. It is suitable for harvest as green pods and red ripe pods.
16	Chilli	PKM 1	(1990)	Ac. No.1797	Hybridizati	180 days	3000 –	It has very bold pods which are dark red in colour. It

				x CO.1	on		3200 kg	has got a very high yield potential of 3000-3200 kg of dry pods per hectare.
17	Chilli	CO. 3	(1991)		Open pollinated	165 days	3000 – 3500 kg	This is a dwarf and compact growing samba culture suitable for very close planting of 30 cm x 15 cm. It is also suitable to be used as green chilli. It has a very low stalk weight in comparison with pod weight unlike other cultivars and high oleoresin and capsaicin content and hence suitable for export purpose.
18	Vegetable Chilli	CO.4	(2000)		Open pollinated type	210 days	23 tonnes/ha	It is suited for *kharif* and *rabi* seasons. This variety recorded 96.58% increased yield over PKM-1. The fruits are dark green, stout, less pungent and turns to capsicum red colour after ripening.
19	Chilli	K 1	(1964)	Local Sattur Samba	Pure line selection	210 days	1.8 tonnes/ha	The fruits are long and contain high capsaicin. The variety is suitable for rainfed cultivation in southern districts of Tamil Nadu.
20	Chilli	K 2	(1975)	B 70-A (Assam type) x Sattur Samba	Hybridazation	210 days	1980 kg	The plants are tall and compact. The pods are long and bright red in colour with high seed content. The increased yield is 29% over K1 chilli.
21	Chilli	MDU 1	(1978)	Induced mutant form K.1	Mutation breeding	210 days	1.9 tonnes/ha	The fruits are longer and bears in clusters of 6 to 8. It is more suitable for southern districts of Tamil Nadu. The fruits contain 0.70 mg/g of capsaicin.
22	Chilli	PLR 1	(1994)	Kandengadu local	Pure line selection	210 days		. It is more suited for green chillies and yields per hectare
23	Chilli	PMK 1	(1993)	CO.2 x Ramanathapuram gundu		200 days	2.4 tonnes/ha	Plants are medium tall., suitable for semi-dry cultivation in Ramanathapuram district. The fruits are conical in shape with attractive red colour with 0.36 per cent capsaicin content.

24	Bhendi	CO. 1	(1976)	'Red Wonder' of Hybridizatio n	Pureline selection	90 days	14.25 tonnes/ha	The plants are medium tall, moderately vigorous and deeply lobed leaves. Pods are slender, smooth and fleshy.
25	Bhendi	CO.2	(1987)	AE.180 x Pusa Sawani	F1 hybrid	90 days	16.5 tonnes/ha	Fruit surface is less hairy with a better consumer's appeal and market preference equal to Pusa Sawani. It is suitable for both kitchen garden and commercial gardens basides as an intercrop.
26	Bhendi	MDU 1	(1978)	Mutant from Pusa Sawani	Mutation	100 days	12 to 14 tonnes/ha	The fruits are long and light green in colour. The pods contain 12.3% crude fibre. The plants are dwarf with determinate plant growth having shorter internodes, each node bears fruits.
27	Hybrid Bhendi	CO.3	(1991)	Parbhani Kranti x MDU.1	Mutation		18.75 tonnes/ha	It is a high yielding hybrid evolved from the cross between Parbhani Kranti x MDU 1 and suitable for fresh Market with dark green colour of medium sized fruits. This hybrid has high degree of field tolerance to Yellow Vein Mosaic Disease.
28	Amaranthus	CO.1	(1968)		Selection	25 days	8 tonnes/ha	The leaves are dark and seeds are black and small sized. The greens contain 4.8% calcium and 3.85% iron.
29	Amaranthus	CO.2	(1979)	A. trucolor (syn. A gangeticus)	Germplasm type	25 days	10.75 tonnes/ha	The plants are erect, with moderate branching. The seeds are bolder with early germination and early vigorous growth. The crude fibre content is less (1.3%) with 19.0 mg of iron, 20.0 mg of calcium per 100 g.
30	Amaranthus	CO.3	(1988)	--	Local type	20 days	30.72 tonnes/ha	It lends itself for 10 clippings, commencing from 20 days after sowing and provide a continuous supply of luscious tender green for three months. It has high leaf to stem ratio (2.0). The plants are erect with green nutritious leaves containing 25.2 mg per 100 g of vitamin C, 1.75% crude fibre, 0.8% iron and 2.48% Ca. The seeds are black in colour.

31	Amaranthus	CO.4.	(1989)	Grain type from A. hypochondriacus	Selection	90 days	2,555 kg/ha, addition 8,200 kg/ha of lead	The seeds are rich in protein (15.95%) and amino acids like lysine (7.5 mg/100g), 3phenylalanine (5 mg/100g), leycine (1.2 mg/ 100 g) and isoleucine (1.8 mg;/100 g). The grain can be substituted for minor millets like ragi and tenai. It is amendable for various food preparations just like any other grains.
32	Amaranthus	CO.5		--	A 166 –I	55 days	40 tonnes/ha	The variety has double coloured leaves (green and pink). It gives a rosette growth in early stages. The stem is also free of fibres. The first harvest starts 25 days after sowing and in a crop duration of 55 days it produces on an average of 40 tonnes of green leaves per hectare.
33	Onion	CO. 1	(1963)	--	Germplasm type	90 days	10 tonnes/ha	Bulbs are medium sized, pink in colour with 8 bulbs per plant weighing 55 to 60 g. The bulbs are fairly pungent.
34	Onion	CO.2	(1975)	--	Germplasm type	65 days	12 tonnes/ha	It is a photo insensitive type. This variety is pungent with high total soluble solids (12.0°Brix).
35	Onion	CO.3	(1979)	--	Open pollinated crop	65 days	15.8 tonnes/ha	The bulbs store well over 120 days. The variety contains 17.5% dry matter, 0.53 per cent sulphur and 13.0°Brix TSS.
36	Onion	CO.4	(1982)	AC.863 x CO.3		65 days	19.0 tonnes/ha	The bulbs store well over 150 days devoid of sprouting in well ventilated store rooms.
37	Onion	MDU 1	(1984)	--	Local type		52.7%	This is a selection from a local type, Sempatti. Bulbs are big sized with attractive red colour. It yields 52.7% higher than CO 2. It keeps well for a long time with less reduction during storage in bulb weight (45%) for 5 months compared to 65% in CO 2 onion.
38	Onion	CO.on.5	(2001)	Mass pedigree method	Selection	95-100 days	18 tonnes/ha	Seed propagated aggregatum onion free flowering and seed setting type. Setting ability (250-300 kg/ha). Attractive pink in colour. 3-5 bulp per clump. Seed bulb is 90 days. TSS of 13.17°C brix, pyruvic acid is 2.37 micro moles.

39	Snake gourd	CO. 1	(1976)	--	Pureline selection	135 days	18.0 tonnes/ha	The fruits are dark green with white stripes, long fruits (160-180 cm) each weighing 500 to 750 g with good cooking quality. It is moderately resistant to powdery mildew.
40	Snake gourd	CO.2	(1986)	--	Pureline selection	105 days	36 tonnes/ha	The fruits are short and stout. It yields on an average 36 t/ha. The fruit is light greenish white and each weighs 400-600 g. The variety does not require pandal.
41	Snake gourd	MDU 1	(1981)	Panripudal and Selection .1	F1 hybrid	145 days	31.74 tonnes/ha	It is an early flowering type (84 days). The fruits are medium long (66.94 cm) and short with an average weight of 551 g. The fruits are fairly rich in Vit. C (44.4 mg/100g) and very low in fibre content (0.6%).
42	Snake gourd	PKM 1	(1979)	Mutant from H.375	Mutation	145 days	25.5 tonnes/ha	The vines are vigorous giving fruits of dark green colour with white strips outside and light green inside. Each fruit weighs 700 g.
43	Bitter gourd	CO.1	(1978)		Local type	115 days	14.0 tonnes/ha	The fruits are green, long (30-35 cm) and contain 1.8 mg/100 g of iron, 20 mg/100g of calcium and 1.1g/100 g of minerals.
44	Bitter gourd	MDU 1	(1984)	Induced mutant	Mutation		32.19 tonnes/ha	It is early in flowering (60 days) The fruits are long with mean length of 40.34 cm and a girth of 17.54 cm and each fruit weighs 410.0 g on an average.
45	Bitter gourd	CoBgoH.1	(2001)	MC.84 x MDU.1		115-120 days	44 tonnes/ha	F1 hybridization. The fruits creamy white in colour with pale green tinge, pointed at both the ends, stout and having short pointed warts on the skin.
46	Ribbed gourd	CO.1	(1976)		Local type	125 days	14.0 tonnes/ha	Fruits are long (60-75 cm), light green, attractive in appearance each weighing 300 g on an average. Moderately tolerant to pest and disease.
47	Ribbed gourd	CO.2	(1984)		Germplasm type	120 days	25 tonnes/ha	The fruits are green, long (1 m) and fleshy.
48	Ribbed gourd	PKM 1	(1980)	Induced mutant	Mutation	160 days	28.0 tonnes/ha	It is an induced mutant from the type H 160 and gives 28.0 t/ha of fruits. The fruits are dark green with shallow

								grooves. The plants are tolerant to pumpkin beetle, fruit fly and leaf spot.
49	Bottle gourd	CO.1	(1981)		Germplasm type	135 days	36.0 tonnes/ha.	Fruits are round at the base with a prominent bottle neck at the top., medium sized, attractive light green in colour with mean weight of 2.025 kg.
50	Pumpkin	CO.1	(1971)		Local type	115 days	30 tonnes/ha	The vines are vigorous and spreading. The fruits are bigger and globular, each weighing 7.00 kg. One vine yields 6 to 7 fruits.
51	Pumpkin	CO.2	(1974)		Local type	135 days	23.0 tonnes/ha	The vines are moderately vigorous and less spreading. Individual fruit weighs 1.5 to 2.0 kg with 5 to 6 fruits per vine. It is a small fruited variety suitable for kitchen garden. The fruits contain 9.2% starch, 10.8 brix TSS, 10 mg/100 g of ascorbic acid and 0.14% acidity.
52	Ash gourd	CO.1	(1971)		Local type	150 days	25 tonnes/ha	The fruits are globular, light green with ash coating with less seeds.
53	Ash gourd	CO.2	(1982)		Local type	120 days	34.0 tonnes/ha	The fruits are light green with waxy bloom, small sized with a mean weight of 2.5 to 3.0 kg. The fruits contain 200-300 seeds. It takes 85-90 days from sowing to harvest.
54	Annual Moringa	PKM.1	(1989)		Pure line selection	The first harvest starts 160-170 days after planting.	200-225 fruits /year	The plants grow to a height of 4-6m and come to flowering 90-100 days after planting. The pods are 65-70 cm long with 6.3 cm girth and 150 g weight. Ratoon crops can be taken for 3 years. Every year after the harvest is completed, the trees have to be cut back to about one metre from ground level.
55	Annual Moringa	PKM.2	(2000)		Hybridazation		98 tonnes/ha	It is a high yielding type with an increase of 9.18% in number of pods over PKM-1 Annual Moringa. The pods are long, less seeded, more fleshy and delicious. It comes to bearing in six months after sowing.
56	Tapioca	CO.1	(1977)		Clonal	8.5-9	35.0	The tuber is whitish brown with white flesh, and is

					selection (ME.7)	months	tonnes/ha	suitable for industrial uses and consumption purpose. The starch content of tubers is 35.0 per cent with an out turn of 10.35 tonnes of starch per hectare. The HCN content is less (10g/g) in the flesh. The plants are tolerant to mosaic virus.
57	Tapioca	CO.2	(1984)		Clonal selection (ME.167)	8.5-9 months	38.6 tonnes/ha	The tubers are medium sized with whitish grey skin, creamy white rind and white flesh. The starch content is 34.50 per cent. It yields 38.6 t/ha of tubers. The incidence of mosaic virus is low. The tubers contain low HCN of 10 g/g in the flesh.
58	Tapiaco	CO.3	(1993)		Open pollinated	8 months	43 tonnes/ha	The tubers contain high starch 35.6% and low HCN of 77.89µg/g. The plants exhibit field tolerance to mosaic virus disease. It is a branching type. Tuber flesh is white with brown skin and creamy white rind.
59	Sweetpotato	CO.1	(1976)		Clonal selection	135 days	28 tonnes/ha	The tubers have light pink skin and white flesh. The number of tubers per plant is 3.2 with a starch content of 24% and a TSS of 10.6° brix.
60	Sweetpotato	CO.2	(1980)		Clonal selection	110-115 days	32 tonnes/ha	Tubers have pink skin and white flesh and have a starch content of 29.5 per cent and TSS of 10.8°Brix.
61	Sweetpotato	CO.3	(1982)		Clonal selection	105-110 days	42 tonnes/ha	It is suitable for cultivation in both seasons and tolerant to root weevil. The tubers have light pink skin and orange flesh and contain a carotene of 13.28 mg/100 g and starch of 30.72 per cent.
62	Sweetpotato	CO.CIP.1				95.110 days	31.76 tonnes/ha	Tolerant to weevil incidence (14.85%).
63	Coleus	CO.1	(1991)		Clonal selection	180-190 days	32 tonnes/ha	The tubers have 21.5 per cent starch. The cooked tubers are tasty and have lesser soil odour.

64	Dioscorea	CO.1	(1991)		Clonal selection	8-8.5 months	44.8 tonnes/ha	The tubers are big in size with white flesh. Tubers are rich in carbohydrate (28%) and protein (2.5%).
65	Colocasia	CO.1	(1991)		Germpleasm type		24 tonnes/ha	It is a high yielding selection. It has an yield potential of 24 t/ha. Tubers have high starch content (22.5%) and higher protein content (2.4%) than cassava and sweet potato. Tubers have less acidity and good cooking quality.
66	Radish	CO.1	(1971)					Roots are milky white, less pungent, long (22 cm) cylindrical and tapering and thick (12.5 cm girth) and medium sized (226 g). Roots contain 10.9 mg/vit. C per 100 g and 1.28% crude fibre, suitable for intercropping and other systems of cropping. Roots have better consumer's preference. Top to root ratio is 0.99.
67	Beetroot	Ooty-1	(1992)		Selection type	120-130 days & direct sown 135-150 days	31.4 tonnes/ha	It is suitable for growing in all seasons. The roots are blood red in colour with thin skin.
68	Moringa bean	KKL-1	(1996)		Local type		7 tonnes/ha	Hreen pods/ha with 31 per cent increase over local. Pods are green, fleshy and thick.
69	French bean	YCD.1	(1994)		Pure line selection	105 days	9 tonnes/ha	Suitable for rainfed cultivation in the hills upto an elevation of 1500 m above M.S.L. The pods are flat, green with dark purple bold seeds. It exhibits field tolerance to yellow vein mosaic and anthranose disease.

70	Butter beans	KKL-1	(1991)				3.47 tonnes/ha	It is a pole type and bears pods in clusters. The pods are 11.6 cm long, beans are 5-6 in number per pod. The crop will be ready for harvest from 100 days. The harvest will continue upto 140 days.
71	Dolichos bean	CO.1	(1993)		selection	165 days	18 tonnes/ha	Pods are dark green flat and slightly curved, tender and fleshy. Pods contain 4.69% protein, 12 mg vit. C, Fe 2 mg, P.14 mg, Ca 39 mg. 100 g or edible portion with 1.33% crude fibre. Matured seed is black in colour.
72	potato	CO. Simla	(1970)		Selection from the hybrids	110 days	12 tonnes/ha	It is suitable for cultivation in the plains during monsoon seasons.
73	Palak	Ooty 1	(1995)		Selection type		15 tonnes/ha	It is tasty green leafy vegetable in which first picking can be had 45 days after sowing and continued at 15 days interval for a period of 2 years. It yields 15 t/ha/harvest. The leaves contain higher carotene.
74	Watermelon	PKM.1	(1993)			120-135 days	38 tonnes/ha	Fruits are oblong, green in colour with light green stripes. Each fruit weighs about 3-4 kg.
75	Cucumber	CO.1	(1989)		Selection type		25-28 tonnes/ha	It is a high yielding selection (25-28 t/ha). The fruits are long (60 to 65 cm), slightly curved, tapering towards stalk end.
76	Garlic	Ooty.1	(1991)			120-130 days	17.1 tonnes/ha	It is a high yielder and gives on an average 17.1 t/ha. Comes to harvest in 120-130 days. The bulb is dull white in colour.