Acharya N G Ranga Agricultural University

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Floriculture, Landscaping, Medicinal and Aromatic Plants

DA - 282

Credit Hours: 2 (1+ 1)

ANGRAU

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PREFACE

We are happy to present the Agricultural Polytechnic course material on Floriculture, Landscaping, Medicinal and Aromatic plants. This is compiled from different sources of information including previous manuals of ANGRAU, online resources, and textbooks for easy understanding. We are thankful to the content providers. It is sincerely hoped that the content of the course material will meet the requirement of the student and assist with vital information.

We are highly thankful to **Acharya NG Ranga Agricultural University** for providing the opportunity to prepare this Course material for the benefit of students of the University. We are also thankful to the Teaching staff of the University for their whole hearted support during the preparation of the Course material.

AUTHORS

Course title: FLORICULTURE, LANDSCAPE, MEDICINAL& AROMATIC PLANTS
COURSE No. - DA-282 Credits: 2(1+1)

Lec. No.	Lecture outlines
1	Importance and scope of floriculture and Landscaping - Features of Ornamental gardening – Fence – Hedges – Edges – Drives and paths – Lawn – Shrubbaries & Shrub boarders – Flower beds – Carpet beds – Topiaries – Arches and pergolas – Pot galleries –Lilly pool – Rockery – Single specimen .
2	Rose-Importance –Rose products – Classification – Soil & climate –Propagation – Prunning - Irrigation & Manuring - Plant management practices –Harvesting – Yield - Physiological disorders in Rose.
3	Orchids – Importance – Varieties – Classification of Orchids – Propagation – Temperature – Light – Repotting – Media – Watering – Harvesting – Yield.
4	Gerbera–Importance – Varieties- Climate and soil – Propagation – Irrigation – Manures – Intercultural operations- Harvesting – Yield.
5	China aster –Importance – Varieties- Climate and soil – Propagation – Irrigation – Manures – Intercultural operations- Harvesting – Yield.
6	Carnation – Importance – Species and types – Climate – Soil – Propagation – Planting – Irrigation – Manuring – Special cultural practices – Harvesting – Yield- Calyx splitting
7	Chrysanthemum – Importance – Soil – Climate – Cultivars & Varieties – Classification- Propagation –Planting – Irrigation –Manuring –Intercultural operations- Regulation of growth and flowering- Harvesting – Yield.
8	Marigold– Importance – Species & Varieties- Soil - Climate – Cultivars & Varieties –Propagation –Planting – Irrigation –Manuring- Intercultural operations –- Harvesting – Yield.
9	Crossandra & Jasmine – Importance – Species & Varieties- Soil - Climate – Cultivars & Varieties –Propagation –Planting – Irrigation –Manuring- Intercultural operations –- Harvesting – Yield.
10	Importance & Scope of Medicinal plants – Isabgol – Importance – Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.
11	Ashwaghandha & Periwinkle - Importance – Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.
12	Aloe & Tulasi - Importance – Varieties- Propagation –Planting – Irrigation – Manuring –-Intercultural operations- Harvesting – Yield.
13	Importance & Scope of Aromatic plants – Lemongrass – Importance - Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.
14	Citronella & Palmarosa – Importance - Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.
15	Vettiver & Mint - Importance - Varieties- Propagation –Planting – Irrigation – Manuring –-Intercultural operations- Harvesting – Yield.
16	Geranium & Davanam - Importance - Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.

Lec No. 1 : Importance and scope of floriculture and Landscaping - Features of Ornamental gardening – Fence – Hedges – Edges – Drives and paths – Lawn –

Shrubbaries & Shrub boarders – Flower beds – Carpet beds – Topiaries – Arches and pergolas – Pot galleries –Lilly pool – Rockery – Single specimen .

FLORICULTURE

Floriculture is derived from two Latin words *i.e*. Florus meaning flower and Cultra meaning cultivation. So floriculture means study of flower crops.
In this there are again two sub-divisions.

(1) Commercial Floriculture (2) Ornamental Floriculture.

Commercial floriculture: Deals with the cultivation of flower crops grown on commercial scale for profit (Income). **E.g.:** Rose, Jasmine, Carnation, Aster, and Marigold etc.
Ornamental floriculture: It deals with the raising of flower crops for ornamental, pleasure and fashion purposes. **E.g.:** Dahlia, Zinnia, Cosmos, Hibiscus, Balsam, Nerium, Poinsettia, Hollyhock, Gerbera, and Gaillardia etc.

Importance

India has a long tradition of floriculture. Many flowers and ornamental plants are being grown for domestic as well as for export market will provide more return/unit area than any other agricultural/horticultural crops. Gestation period of flower crop is very less compared to other crops and returns from flower cultivation are also early.

Flowers symbolize the purity, beauty, peace, love, adoration, innocence and passion etc. Hence, many flowers are used to express the most sensitive, delicate and loving feelings eloquently what our words fail to express. In our society no social function is complete without the use of flowers, floral ornaments, bouquets or flower arrangements they are invariably used in all social functions. Floral garlands, gajras and venis are required in marriage ceremonies for adornment of hairs by women of all ages, especially in the south India. In the present modern era sicks are wished for speedy recovery by offering beautiful cutflowers, while the deads are bidden farewell with flowers along with tear of sorrow.

Tamilnadu is the leader in floriculture followed by Karnataka, accounting for 75% of India's total flower production and the state is having the highest area under both modern and traditional flowers. The country's first and the only Digital Flower Auction Centre is located in Bengaluru, running by Karnataka Agro Industrial Corporation (KAIC) at Hebbal.

Scope of Floriculture

- ✓ The sale of loose flowers of Jasmine, Crossandra, Marigold, China Aster, Chrysanthemums, Berlaria and Gaillardia etc., are a roaring busyness in south India.
- ✓ Modern-day floriculture refers to the production of high-value cutflowers such as rose, gladiolus, carnation, mums, orchids, tuberose, anthurium, lilium, gerbera etc,.
- ✓ Now days, growing of the cut flower crops, suited for flower arrangements/decorations for bouquets preparation and for floral boskets, have increased substantially and its share of the total trade has also improved.
- ✓ The present trend in floriculture is for making dry flowers, extraction of natural colours and essential oils.
- ✓ There is lot of demand for good quality flower seeds and ornamental planting materials. Floriculture generates *self* employment opportunities round the year.
- ✓ The employment opportunities in the field are varied such as. Floriculture also provides service career opportunities which include such jobs like floral designers, grounds keepers, landscape designers, architects and horticultural therapists.
- ✓ Now the floriculture has become one of the extreme focus segments for development of export by the Government of India.
- ✓ The varied agro climatic conditions prevailing in the country with ample sunshine can maintain regular supply of any floricultural commodity throughout the year.

- ✓ Winter is being very mild and hence there is lot of scope to export Indian flowers to temperate countries during the winter season, when the demand is in peak because of important winter festivals like Christmas, New Year Day and Valentine‟s Day.
- ✓ Keeping in view of pollution problems and other aesthetic values of the flowers, we must try to sustain our floriculture industry.

Landscape gardening

The history of gardening in India is as old as its civilization. The association of different trees with the life of Lord Buddha is well known. The great Emperor Asoka adopted arboriculture as one of his state policies. Babur was a great lover of flowers and gardens. He laid out a garden at Agra, now known as „Rambagh‟. Jehangir (1605-1627 A.D.) was also a great admirer of gardens and flowers and so was his famous wife Nur Jahan.

The gardens at Shalimar, Achhabal and Verinag in Kashmir were created by him. The best garden created by Shah Jahan was the Shalimar garden in Lahore (Pakistan). The Mughal gardens in India were laid out in symmetrical patterns, but the English changed the style into informal patterns by laying out parks and gardens. Before the arrival of the English the Indian knew about how to make garlands and Guldasta (bouquets), but had no idea of flower arrangements for interior decoration, which was taught by the British.

Landscape gardening deals with the planning and execution of ornamental gardens, parks, landscape gardens etc.

The credit for giving floriculture and gardening- a good start and consequently some status goes largely to the noted administrator-cum –scientist, **Dr. M.S. Randhawa**. His work in this field was carried further by another noted scientist and great lover of flowers, particularly roses, **Dr. B.P. Pal.**

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

A **Landscape Architect** is a person involved in the planning, design and sometimes direction of a landscape, garden, or distinct space. The professional practice is known as Landscape Architecture.

An ornamental garden is a place where plants are arranged in an aesthetic manner.

Importance of garden

In modern cities with growing slums and factories gardens are essential to improve the environment and to provide healthy air for the inhabitants.They are really the lungs of the city. Gardens serve to beautify the country.Gardens are said to be the yardstick of the culture.This is true to some extent as they reflect the aesthetic taste of the people and are the chief pieces of art that confront a visitor and help him asses the cultural standards of the region.

An ornamental garden is a place where plants are arranged in a manner. Plants can be grouped together in various ways to give an aesthetic effect. Each such grouping is called a **Feature.** Any garden comprises some of all of such features and hence the features are also called the **components of garden**. Some of the important features found in most of gardens are

1. Fence: Fence is the outer most boundary to prevent tres pass and to ensureprivacy in home gardens. Fences can be created, eitherby using closely planted thorn bearing plants, hedges and shrubberies or structures where wood, bamboo, wire netting and chain links are used. Various climbers can be trained over the fences to enhance attractiveness.

Ex. *Casuarina equisetifolia* –sarugudu,*Prosophis juliflora*,*Caesalpinia pulicherima*

2. Hedges:are useful to divide the garden in to sections, to line the drives so as to direct the visitors to a central object.They aresown and grown in the same manner as the fence and plants are pruned to a height of 3-4 feet.
Ex.*Clerodendron, Duranta, Lantana camera, Lawsonia inermis*

3. Edges: These are row of plants which do not exceed one foot height. They are grown along with paths and around the flower beds.Non living materials like bricks , tiles are also used for this purpose.Live hedges are more in harmony with the garden than features. The foliage hedges are not trimmed.
Ex.*Alternanthera sps, Eupatorium cannabium, Pilea, Aerus tomentosa, Tradescantia*

4. Drives and paths: can be primarily functional facilitating easy and purposeful movement within a garden, providing access to all features with in a garden or can be included for their decorative value, usually designed to provide a visual line between separate areas. Cobbles, granite, flagstones, brick, concrete or wooden materials may be used. They should be laid with
easy gradients and perfect paving and leveling.

5. Lawn: Lawn focus the background colour in the garden picture against which the colour of shrubbaries and flower beds is brought in to relief. Whether the garden is big or small it must have a lawn. In fact a lawn and a mass of flowers beyond it will constitute a garden without any other features. The lawn should be sown only to a single species of grass so as to give a uniform colour. The most common lawn grass is ***Cynodon dactylon.*** It prefers slightly acidic soils (pH 5.5 -6.0). It does not grown well undershade of a tree. ***Dichondra ripens*** a new type of ground cover that has been recently introduced can stand sun and grows well under shade. ***Festuce*** is the quick growing and finest of lawn grass.

6. Shrubbaries and shrub boarders: When the plants are grown in a row but not trimmed the feature is called border.Borders are planted to different species of plants, while hedges are generally planted to a single species.Boarders may be of herbaceous plants they are called herbaceous borders or comprises of shrubs they are called as shrubborders. The shrubborders may be grown along wall or infront of fence of tree and also to seen together but are not in the row the feature is known as Shrubery.The border of the shrubbery consists of more than single row of plants.
Ex. Crotans – *Codium variegatum pictum*, *Hibiscus rosasinensis, Acalypha marcinata, Cestrum nocturnum, dracera*

7. Flower beds: These are also known as annual flower bedsas they are planted with annuals or herbaciousperennials which are treated as annuals. They should be planted to a single species and variety so that each bed is of single colour. A flower bed should be behind a lawn or in the middle or atleast should have a strip of lawn in front of it.
Ex. Marigold: Zimnnia, Cosmos:Petunia, Phylo: Celosia

8. Carpet beds: Plants of different colour foliage which can be clipped close to the ground are choosen for planting in an intricate design on the ground. Such a feature knownas carpet bed. The design may be conventional, geometrical ones or map or clock or a sundial.
Ex. Alternanther Sps. (Purple and green varieties)

9. Topiaries: Certain plants which can stand severe and constantpruning and which posseses small foliage and relatively short internodes can be trimmed into globes, ovals or in to fancy shapes of animals etc. These are generally found in formal gardens.
Ex. *Thuja orientalis*, *Casuarina equisetifolia, Murraya paniculate, Polialthis longifolia*

10. Arches and pergolas: Arches can be semicircular or rectangular shaped and are used to link one part of the garden with another. Arches are constructed near the gate or over paths. Its proper place is astride a path and its purpose is to support climbing plants. Pergola is a narrow vista consisting of a series of arches connected with climbers preferably leading to some other interesting feature of a garden. Pergolas are constructed over pathways. It brings height to the flat planes of a level compound.
Ex.*Bougenville, Quisqualis indica, Vernomis, Allamonda catharties*

11. Pot galleries: Circular galleries are constructed of masonry and on the steps of which potted plants are arranged. The height of each step and pot on the lower step should be the same.The plants grown should be taller than the height of steps so that the pots and the masonry structures are both hidden behind plants and present the apperence of a mound of plants.
12. Lily pool: Aquatic plants are grow in lily pools which may be dug in the ground and abetted with stones so as to look natural or may be constructed in cement of regular shape. In cement pools there should be an inlet at the bottom and an outlet a few inches below the top of pool, so that a constant level of water is maintained.

Ex. *Nelumbium speciosum, Pistia, Nymphea, Eichornia crassipes*
13. Rockery: Plants growing on rocky situation are grown in the garden is rockery. The rockery is constructed by keeping up manured soil to a desired height and embedding rocks into it. The plants are set in the crevices between rocks. It can be raised under the tree or separately. Generally both foliage and flowering succulents as well as xerophytes are grown.
Ex. *Opuntia, Eupatoria, Agave, Coleus, Sansveria, Bryophyllum, Tradescantia*

14. Single specimens: In an extensive lawn the monatany can be broken by single beautiful tree of exiting quality without blocking the view of the other features beyond. Trees like ***Polyalthis pendulus, Aracariacolummeris, Ravenalis medagescrensis*** are useful for such a purpose.

Lec No 2 : Rose-Importance –Rose products – Classification – Soil & climate – Propagation – Prunning - Irrigation & Manuring - Plant management practices –Harvesting – Yield - Physiological disorders in Rose.

ROSE

Botanical name**:** *Rose sinensis*
Family **:** Rosaceae
Origin : Oregon and Colorado of USA

Importance

Roses have a long and colorful history. They have been symbols of love and beauty. The rose, according to fossil evidence is 35 million years old.

Rose is one of the natures beautiful creations and is universally called as the Queen of the flowers. No other flower is a better symbol of love, adoration, innocence than the Rose. It has different types with beautiful flowers of definite shape, size, colour and most delightful fragrance. It is an important flower for its varied uses.

Rose Products

a) Rose Oil: It is an important commercial product obtained from rose petals. It has sweet fragrance, medicinal properties, hence used in ayurvedic medicines Bulgarian rose otto is largely used in perfuming soaps and cosmetics. Limited quantities of the oil are used in flavouring soft dringks and alcoholic liquors. Rose oil has got anti bacterial property.Commonly grown species for oil extraction are *Rosa damascene* (Damask roses)

Rosa borboniana (Edouard roses) (highly scented), *Rosa centifolia* (Cabbage roses) *Rosa alba* and *Rosa gallica***.** In India, however*, R. damascena* and *R. borboniana* are commercially cultivated for Rose oil.The flower should be harvested before 9.00 am. In dry hot weather the oil content of the open flowers decreased rapidly whereas the oil yield increased in wet cool weather.

b) Rose water: It is also an important commercial product from rose petals. It is used as a perfume and in medicines and confectionary. It has the property of cooling the body and is often used in eye lotions and eye drops for its soothing qualities. It is also used in drinking water and sprinkled on the guests at weddings, feasts and other social functions. Species like R. damascena , R. borboniana , R. centifolia , R. alba, R. gallica are used for extraction of Rose water.

c) Rose gulkand: Rose petals are preserved for direct consumption, by making gulkand, which is prepared by pounding equal proportions of petals and white sugar. It is both a tonic and laxative.Species suitable are R. damascena , R. chinensis, R. gallica, R. pomifera and other scented roses. Edouard are used for preparing gulkand.

Classification of Rose

There are many classes of present day garden roses. The main classes are as below.

1. Hybrid Teas: Obtained by a cross between Hybrid perpetuals and Tea roses. Hybrids are most popular type of roses. They bear large sized and highly scented flowers. First of Hybrid Tea is La France produced in 1867

2. Polyanthas: These are dwarf plants. Small flowers of Polyanthas were forerunners of popular large flowered Floibundas. Their ancestry includes crosses of Rosa multiflora, Rosa wichuriana, and Bengal hybrid Rosa indica major. The first cultivar of polyanthas was La Paquerette. Other cultivars are Baby Faurax and Echo.

3. Floribundas: They are also known as Hybrid Polyanthas. These are the crosses between Hybrid tea roses and Polyanthas. They combine beautiful forms of the Hybrid Teas with perpetual flowering habit of the Polyanthas.

4. Grandifloras: These are crosses between Hybrid Teas and Floribundas. Grandifloras covers large flowered and clustered cultivars of fine form or the type which produces beautifully formed, Hybrid Tea like blooms inclusters. The first Grandiflora developed was Buccaneer. Other cultivars are June Bride and Queen Elizabeth.

5. China Roses: China Rose(R. chinensis) is responsible for nearly all the present day popular roses. China Roses bear red to nearly white flowers in small clusters. China Roses were also known as monthly roses. They are known as Bengal rose. China roses are perpetually flowering types. The so called Green rose (R. chinensis viridiflora) is included in this class.

6. Minatures: These are popular Baby Roses, with small leaves and flowers. They are hardy and are multiplied by cuttings as well as propagated on root stocks. Those raised from cuttings are ideal for growing in pots. Examples are Baby Gold Star, Baby Masquerade, Peon.

7. Ramblers: They generally produce flowers with large clusters of small single or double flowers. They are of two groups namely Wichuriana Ramblers (R. wichuriana) and Multiflora Ramblers (Rosa multiflora). Examples: Wichuriana: American pillar, Multiflora: Crimson Rambler.

Soil

The ideal soil should be medium loam having sufficient organic matter, with a pH of 6.0 to 7.5. The land where the external drainage is poor and water stagnates during monsoon should not be selected for rose growing. The land with high water table is not suitable for rose beds.

Climate

Roses love sunshine and free ventilation. They need bright sunshine for the whole day, if not, at least for normal part of the day. The plants should be free from shades of trees and protected from the strong winds.

In the northern plains, roses flower best during winter whereas in the temperate hilly regions of the Himalayas best rose flowers are produced in summer. Bangalore has mild climate, where roses can be grown for flowers throughout the year.

Propagation

Roses can be propagated both by seeds and various vegetative methods like cutting, layering, budding and grafting.

a) Seed propagation: This is adopted by breeders for developing new cultivars with desirable characters. It is suggested to stratify the seeds at 35 to 40^{0} F i.e. 1.6^{0} C to 4.4^{0} C. **Stratification** for six weeks is sufficient for *Rosa multiflora*. In temperate regions the root stocks needed for budding can be raised through seeds.

b) Cuttings: Some of the vigorous cultivars can be grown from cuttings. Some of the Climbers, Ramblers, and Polyanthas are raised by cuttings. Miniatures are more widely propagated by cuttings rather than by budding.

c) Layering: This propagation method is limited to Climbing and Rambling roses. They can be propagated either by Ground Layering or Air layering.

d) Grafting: Inarching is another method of propagation of roses, but it has many disadvantages. The scion shoot should be of medium texture, free from pests and diseases and 1-3 eyes in length. Cleft grafting has been suggested for the multiplication of roses.

e) Budding: This is most popular and successful method for multiplying roses.

Shield or T-Budding is the most commonly used method of budding wherein on the selected root stocks, the buds are inserted into the T shaped incisions and then tied with a suitable wrapping materials like plastic film. Budding should be preferably done as low as possible on the root stock. When the new shoot from the grafted but is about 10 cm long. The top portion of root stock above the union is cut off and polythene tape is removed. It takes 3-4 weeks for the bud to unite. The side branches of the stock are removed, which compete with the scion for supply of nutrients and water.

Root stocks: Some of the commonly used root stocks for budding of roses are as follows: Rosa borboniana (Edward roses), Rosa canina, Rosa indica, Rosa laxa, Rosa manetti, Rosa multiflora, Rosa rugosa etc.

Layout and Preparation of Beds

The plan of rose garden and design of the beds should be simple and informal. Rose beds may be of various designs.

Rectangular beds are advantageous for maintenance. A plot size of 6.0 x 1.2 m or 6.0 x 1.65m is suggested for better management of rose plants.

Preparation of Rose beds: With the help of digging spade, the soil, up to a depth of about 30 cm, should be dug out and heaped on the ground of adjoining the beds. If the soil is light, sandy and stony, the next 30 cm of the soil in the trench should be dug as deep as possible, pulverized and leveled in the trench itself. After that about half portion of the dug out soil, heaped on the ground surface, should be returned to the trench, worked with digging fork and leveled. This layer needs manuring with organic manure at the rate of 50-60 tonnes of farm yard manure or compost per hectare. Super phosphate at the rate of 30 kg P2 O5 and Aldrin or BHC 5% dust at the rate of 100 kg per hectare are to be applied and the beds are irrigated thoroughly. Pits of 75 cubic centimeter size are dug out a fort night before planting.

Season of planting

In the most plains of India, the season of planting is during September – October and in the hills it is during October – November or February-March. Under the climatic conditions of northern India, October is the best month for planting.

Planting distance

A spacing of 60-75 cm is given between plants and rows, depending upon the vigour of the cultivars. The dwarf Polyanthas are planted 45 cm apart, Miniatures 30 cm apart and climbing roses 3m or more apart Hybrid Tea and Floribunda at 55 cm apart. Closer spacing tends to make the plants grow erect and produce long stalks.

Pruning

Pruning refers to the removal of certain portion of a plant. It is an important operation for maintenance of floriferous ness and flower quality along with vigour of rose plants. Roses should be trained to give a definite shape to the plants. The practice of rose pruning consists of two operations, thinning out and shortening of stems.Thinning out comprises removal of old, weak, dry, twiggy and diseased stems and branches from the point of start while shortening of the remaining shoots aims at cutting down of last year's growth to a desirable height.

Objects of Pruning in rose:

- ✓ To remove the unproductive growth, ensure production of large number of strong and healthy shoots, which will bear flowers and improve the quality of blooms.
- ✓ To force the strongest shoot bud to break in growth.
- ✓ To Keep the rose bush in proper shape and size.
- ✓ To allow light and air to reach the centre of plant. To encourage growth of new healthy shoots which bear more flowers than old branches.

The rose blooms harvested after pruning the bushes have longer stems than those cut from unpruned bushes.

Pruning time:

The best time of pruning is the period when the activity of the rose plant is least and the plant is at dormant to near dormant stage. The most usual time for pruning is during October- November in Indo- Gangetic plains after the rains are well over and the cold season is approaching.

Every rose stems has eyes (buds) alternating on opposite sides in the leaf axils (usually outward and inward). The basic rule in pruning is always to make the cut about half a centimeter above a vigorous bud that finds in the direction one desires the new shoot to grow.

Irrigation

Roses do not like water logging but need plenty of water for their optimum growth and development. The frequency of watering will depend upon weather and nature of soil. Sandy soils need more frequent watering than clayey soils. In loamy and alluvial soils, such as that of Delhi, thorough watering once in seven days in summer and once in 10 to 15 days in winter is considered sufficient. In rainy season, necessary adjustment will have to be made. In between each watering, when the top soil becomes dry it is useful to stir it up with a khurpi and a hand fork. In eastern India, where rainfall is heavy, no irrigation may be required at all during the rains.In a climate like that of Bangalore, having red soil, one heavy irrigation at 5 days interval is recommended throughout the year except during the rains. When this has to be adjusted depending on the rainfall.

Manuring

Roses are gross feeders. At the time of pruning, well rotten cow dung is applied. The doses would vary with soil type and its fertility status. Generally 4 to 8 kg cow dung manure per bush will be quite adequate. A hand full of bone meal should also be added along with manure. A little BHC or the Aldrin should be mixed with the organic manure to prevent the attack of white ants. Inorganic manures or fertilizers are more quick acting and small quantities of these are very effective. Nitrogenous fertilizers are more important. Phosphates also help in the production of more and better quality blooms. Indian soils are quite rich in Potash, but Potash fertilizers in combination with others give good results in some regions. Complete Rose fertililsers such as Rose mix are now available in the market.

Plant management practices

a) **Pinching:** This operation was found to reduce the plant height but promote axillary branching.
b) **Disbudding:** Removal of undesirable buds is known as disbudding. Keeping only the central bud and removal of others cause development of a quality bloom.
c) **Removal of young vegetative shoots:** This practice, also known as deshooting, is generally followed in Hybrid Tea roses. Young vegetative shoots developing from the axils of leaves of basal and lateral shoots are removed to allow only one terminal shoot. Deshooting in cvs. Sonia and Belinda was found to increase the flower production by 50 and 75% respectively.
d) **Defoliation:** Several attempts were also made to study the effect of leaf removal on subsequent growth and flowering of roses. Although defoliated plants produced about twice as many shoots as undefoliated, many of them were blind and the total number of flowers was less. Complete defoliation of mature and young leaves caused atrophy of almost all flower buds. Removal of only mature leaves caused about 50% blindness. Removal of only young leaves did not cause blindness.
e) **Desuckering:** Any sucker arising from stock should be removed from time to time.
f) **Removal of faded flowers:** If the spent blooms are not removed in time, there is a chance of developing fruits bearing seed. Once the hips are formed and reach the advanced stage of development, growth and flowering are severely reduced during the season. Cutting of faded flowers forced strong laterals which produced good quality flowers.

Harvesting

The stage at which flowers should be cut, either fordecoration or for dispatch is the **tight-bud stage** when the buds show full colour but the petals have not yet started unfolding.If harvested at this stage, they last longer in vases or during transportation, retain colour and freshness. The optimum stage may vary slightly depending on cultivar and one has to be experienced to judge the right stage for cutting.

Loose flowers, used for making garlands, preparing perfumes and various other products and for worshipping are harvested only when they are fully open and collected in large open baskets. The flowers should be cut in the early morning before sun rise or late in the afternoon when the sun is about to set so as to avoid damage of buds due to high temperature during the day. Late harvest results in short vase life of cut flowers and low oil content in loose flowers used for preparing perfumes.

For cut flowers, the stem length should be little more than what is required and bear fairly good number of leaves. The cut should always be above a healthy outward pointing bud, a with a clean and sharp secateurs. The general rule observed by the most rose growers in cutting the stem is to allow two five-leaflet leaves to remain below the cut. Immediately after cutting, the stem should be dipped in clean water up to the neck or base of the flower buds. Soon after cutting, the stems should be re-cut in water, about 2 cm above the previous cut end. If they are not required for immediate use, the cut flowers along with stems dipped in water, in the bucket, should be stored at a cool air temperature of 4.4 to 7.2^0 C, for about 6 – 12 hours to harden the buds and enhances the keeping quality.

Yield

The Hybrid Teas roses can yield about 70 – 80 stems/plant/year, while the Floribundas yield yields 80 -90 stems/plant/year.

Physiological disorders in Rose

Blind wood

The normal flowering shoot on a greenhouse rose possesses fully expanded sepals, petals, and reproductive parts. The failure to develop a flower on the apical end of the stem

is a common occurrence. Such shoots are termed as blind wood. The sepals and petals are present, but the reproductive parts are absent or aborted. Blind wood is generally short and thin, but it may attain considerable length and thickness when it develops at the top of the plant. This may be caused by low temperature, insufficient light, chemical residues, insect, pests, fungal diseases and other factors.

Bull heads or malformed flowers

The center petals of the bud remain only partly developed and the bud appears flat. They are common on very vigorous shoots, particularly bottom breaks, and it is possible that there is a lack of carbohydrates to develop the petals. The cause of bull heading is yet unknown, however, thrips infestation will also cause malformed flowers. Also at low temperature, some varieties will form bull heads.

Colour fading

The off- coloured flowers are seem to be a problem with some yellow varieties. In these varieties the petals may be green or a dirty white instead of a clear yellow. Raising the night temperature several degrees will reduce the number of off-coloured flowers. Occasionally the pink or red varieties develop bluish-coloured flowers. This is very often associated with use of organic phosphate and various other kinds of insecticides.

Limp necks

The area of the stem just below the flower “wilts” and will not support the head. This may be due to insufficient water absorption; cutting off the lower 1 to 2 inches of stem and placing the cut stem in water at 37°C will revive the flower.

Blackening of rose petals

This is caused by low temperature and high anthocyanin content. GA3 treatment causes accumulation of anthocyanin in petals of Baccara roses. This effect was more pronounced at low temperature (20°C at day and 4°C at night) than in higher temperature (30°C at day and 20°C at night).

Nutritional disorders

Iron deficiencies can cause pale foliage. Adjusting the pH of the soil may solve this problem.

Lec No. 3 : Orchids – Importance – Varieties – Classification of Orchids – Propagation – Temperature – Light – Repotting – Media – Watering – Harvesting – Yield.

ORCHIDS

Botanical name : *Cymbidium sps, Dendrobium sps.*
Family : Orchidaceae
Origin : Tropical Forests of Amazon & Indo - Malayan region

Importance

Orchids are accepted to be the world"s most exotic and fascinating flowers, with their extraordinary variety of form, sizes, shapes, colours, texture and markings. These features make them highly priced among the ornamentals. Majority of the cultivated orchids

are natives of tropical counties. In India, they are mainly found in North eastern hills, Kerala and Western Ghats and few in Kashmir. Cultivation of orchids has become a very profitable occupation.

Important genera of commercial importance

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

Important *Cymbidium* Varieties: Levis Duke , Bella Vista, Margaret Thatcher, Kennywine, Golden girl Mini Beacon Red torch, Beauty Fred 6, Ames Bury, Baltic Glacier Mint ice have been found to be suitable in Hill zone of West Bengal.

Important Dendrobium varieties

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

Classification of Orchids

A) Based on growth habit

1. Monopodial growth:

The orchids which do not make separate new growths in each season. The growth of the axis is stops at the end of each flowering season and continues in the next season by a newly grown axis. Do not have rhizome and where single stem increases its height throughout the life period.
Ex. Aerides, Rhynchostylis, Vanda, Phalaenopsis,

2. Sympodial growth:

The plant grows continuously in one direction only and their stems lengthen from one season to another and produce aerial roots along their whole length. Each new growth produces its own set of roots.They have more than one stem. Sympodial orchid stems are generally thickened and bulbous are named as pseudobulbs.
Eg. *Cattleya, Coelogyne, Epidenarum, Laelia* and *Sophronitis.*

B) Based on their habitats

1) Terrestrial (or) Ground orchids

Grow in soil, Sympodial and perinnial
Example: Spathoglottis plicata, Arundina graminifolia, Phaius tankervilleae, Cymbidiums, Paphilopeilum. *tankervilleae,*

2) Epiphytic Orchids

Grow well on other plants. Abundant in humid tropical rain forests of India.
Example:Vanda, Vanilla, Dendrobium, Cymbidium, Oncidium tc.

3) Saprophytic orchids

Lives on dead and decaying organic matter. Found on the moist forest floors.
Examle: Nettia, Galeola, Listera etc.

4) Lithophytic Orchids

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

5) Subterranean orchids

Underground orchids. Found in Australia.

Example: Rhizanthetta , Cryptanthemis.

C) Classification based on Temperature requirement

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

1. **Warm orchids**: Grows at 15.5^{0}C
   Example : Phalaenopsis, Vanda, Rhynchostylis and some Dendrobim sps.
2. **Intermediate orchids**: Grows at 13^{0}C to 18^{0}C
   Example: Cattleya, Laelia, Brassavola, Oncidium, Miltona
3. **Cool orchids**: Grows at 10^{0}C to 13^{0}C
   Example: Cymbidium plain leaf Paphiopdilum, some Miltonioa sps.

D) Classiication based on climatic zones

Orchids are broadly classified depending on the climatic zones which they choose to grow. Accordingly three different types of orchids are recognized.

1. **Tropical zone orchids:** The orchids in this zone grow in dense, humid tropical forests with high amount of rainfall and humidity (90-100%). The temperature in the zone ranges from 22-27^{0}C. Eg: Epiphytic orchids like *Aerides, Arundina, Dendrobium, Vanda, Ascocentrum* etc.
2. **Subtropical zone orchids:** The orchids in this zone grow in mixed forests with less rainfall, temperature of 25-30^{0}C and 100% humidity. The most beautiful orchids fall in this zone. Eg: **Epipytic Sps**- *Bulbophyllum, Cymbidium, Dendrobium, Eria*.**Terrestrial sps**: *Calanthe, Hebenaria, Phaius* etc.
3. **Temperate zone orchids:** The orchids in this zone grows at temperature 10-14^0 C with relative humidity of 80-100%. Eg: *Aerides maculosum, Vanda Coreulea, Bulbophyllum spp.*
4. **Alpine Zone orchids:** This zone is situated in Himalayan range and covered with snow for 4-6 months. Mostly terrestrial orchids grow on this zone. Eg: Bulbophyllum retusiusculu, Habenaria cumminsiana, Nervilla macroglossa etc.

Propagation

Orchids can be propagated my difference methods. They are

a) Divisions: his is perhaps the simplest method of propagation, as the relatively straightforward procedure requires little to no special training or equipment. The process involves splitting an existing plant into two or more parts so that each new section contains at least one new shoot or vegetative bud. the division process not only multiplies plant numbers, but can also promote more vigorous shoot growth.

b) Keikis: Keikis grow from buds on the cane, usually the upper portion. The keiki can be easily removed and repotted. leave the keiki attached to the mother plant until it sprouts new leaves and shoots that are at least 5 cm. long. When root growth is just beginning, remove the keiki. Pot it up using a well-draining orchid potting mix, or in the case of epiphytic varieties like Dendrobiums, use peat moss rather than soil.

c) Pseudobulbs : Mature pseudobulbs (or canes) of dendrobiums are placed on sphagnum moss and intermittently misted, allowing for new vegetative shoots to develop.

d) Back bulbs: Backbulbs as a pseudobulb ages, it loses its leaves and becomes dormant and new pseudobulbs develop. The old pseudobulb is known as a backbulb. Although not actively growing, backbulbs possess energy reserves that can be utilized by the growing plant and may possess dormant eyes that can be forced into active growth. Utilizing backbulbs is an effective way to increase plant numbers, but the resultant plants can take several years to flower from a single backbulb.

e) Off shoots: Some orchids, such as phalaenopsis, dendrobiums and vandas, can produce offshoots or plantlets at the nodes along the stem. once mature, these offshoots, can be separated from the parent plant and potted similarly to backbulbs. With care they will develop into adult plants.

f) Tissue Culture: Meristem culture, a type of micropropagation by tissue culture, is the standard method for mass propagation of the most popular orchids. Shoot tips and meristems are perhaps the easiest to use because of their unique qualities and undifferentiated cells, and are therefore used most frequently.

g) Seed: Flowers that are pollinated, either by hand or by insect, can develop seed capsules. The time from pollination until seed is mature is usually several months. If seed is collected, it should be harvested either just before or at the time of its release from the capsule. Seeds of orchids are extremely small and there may be up to a million seeds per capsule. Placing a bag around a maturing seed capsule can prevent loss of seed if the capsule ripens and releases the seed before the anticipated time. Seeds can either be sown immediately after harvesting or stored until a more convenient time. If seed is to be stored, it must be dried.

Temperature

Cymbidiums require warm and humid in growing period and cool climate in flowering seasons i.e. mostly in winter. They are most suited to the temperature regime of 20-24 ° C during growth and cooler temperature of 10-20° C at the time of flowering. Orchids flower best when they experience a difference (at least 10°C) between daytime and night time temperature.

Light

Cymbidiums need bright filtered light (55% -70 % shade) all day or full morning sun but cool temperatures. Plants require light shade from the midday sun. In cool areas full sun is tolerated. Leaves should be a medium to golden green in color, not dark green. If too shady, plants will bloom less or not at all.

Relative humidity

Relative humidity should be between 50-80 %. If the RH drops below 40%, shading and misting can be done.

Air movement

Good air movement is essential for Cymbidium growth. Ventilate the greenhouse whenever the weather permits. If the Orchids are grown in sheds, their sides should not be covered. It should be kept open to provide good air circulation system.

Repotting

Orchids should be repotted only if the pot is overcrowded which happens on average every two or three years or when the medium has broken down, for cymbidiums thrive best when left undisturbed. Repotting should be carried out during spring (after flowering). During repotting dead or withered roots should be removed. Older roots should be trimmed up to 10-15 cm from the base of the bulbs; Leave the root tissue to air dry. Use sterile utensils to carry out such work.

Media

Substrate should be light, aerated, capable of holding moisture but draining thoroughly. The potting mix for Cymbidium cultivation comprise of cocopeat, cocochips, perlite, leafmould, brick pieces and charcoal. The potting mix can be supplemented with N: P: K (30:10:10) during vegetative growth (March to October) and N: P: K (5:15:30) during flowering season to help form bloom spikes. Avoid fertilizers that use urea as a nitrogen source. Fertilize every week to two weeks. In winter, fertilize once a month as excess fertilization causes browning of the tips of the leaves. Cymbidiums cannottolerate high levels of fertilizers or salts and hence should be avoided. In the winter, or when the plants are not actively growing, don't fertilize the orchids at all. To remedy this situation, flush the pots with plain water to get the fertilizer out.

Watering

Cymbidium crop needs 2-3 liters water per sq mt per day for transpiration. Irrigate the plants whenever the media is dry. Only rainwater is suitable.

Harvesting of flowers

The optimum harvesting stage of Cymbidium is 2 bud open stage. Sharp tools should be used to cut the stem at a slant angle and the spikes should be dipped in a bucket containing water immediately after harvest.

Yield: 4-7 spikes/ plant/year.

Lec No. 4 : Gerbera and China aster –Importance – Varieties- Climate and soil – Propagation – Irrigation – Manures – Intercultural operations- Harvesting – Yield.

GERBERA

Botanical name : *Gerbera jamesonii*
Family : Asteraceae
Origin : South Africa and Asiatic regions

Importance

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

Varieties

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

Classification

There are "single" and "double" types of gerbera.

One or two rows of ray florets on the periphery of the disc and the rest are disc florets in the "single" types.

In the "double" type, more than two rows of florets are present

They are further divided into

- ✓ Standard
- ✓ Spider and
- ✓ Mini depending on the size and shape of the flowers.

Colour	**Variety**
Red	:Ruby Red, Sangria
Yellow	:Doni,Supernova, Mammut, Talasa
Rose	:Rosalin, Salvadore
Pink	:Pink Elegance, Marmara, Esmara
Orange	:Carrera, Goliath,Marasol
Cream	:Farida, Dalma, Snow Flake, Winter Queen

Climate

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

Soil

To be successful in Gerbera cultivation, the soil selection is very important. Soil pH should be between 5.5 to 6.5 or it should be maintained at this level to get maximum

efficiency in absorption of nutrients. Gerbera are deep rooted plants and the roots go as deep as 50 to 70cm. The soil should be highly porous and well drained to have better root growth and better penetration of roots.

Propagation

Gerbera is propagated by seed, by cuttings of side shoots and suckers.

- **Seed Propagation**

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

- **Vegetative propagation**

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

- **Micro-propagation**

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

Disinfection of soil

Before plantation of Gerbera, soil disinfection is absolutely necessary. In particular, the fungus *Phytophthora* is a menace to Gerbera. The various methods of sterilization are:

1. **Steam**: Not economically feasible for Indian conditions.
2. **Sun**: Cover the soil with plastic for 6-8 weeks. Sunrays will heat up the soil, which will kill most fungi.
3. **Chemical sterilization**:

Formalin @ 7.5-10 lit/100sqm is commonly used for sterilization.This pure chemical should be diluted 10 times in water and then sprayed/drenched on beds. Cover the beds with plastic sheets for 7 days. Then flush the soil approximately with 100 liters of water per square meter to drain the traces. After sterilizing, subsequent washing out of the soil.

Planting

In general, Gerberas are grown on raised beds to assist in easier movement and better drainage. The dimensions of the bed should be as follows:

- Bed height : 1.5 ft (45cm)
- Bed Width : 2 ft (60 cm)
- Pathways between beds : 1 ft (30 cm)

Irrigation

Immediately after plantation, irrigate the plant with overhead irrigation for four weeks to enable uniform root development. Thereafter gradually change to drip irrigation. Drip irrigation is mainly for correct doses and fertilizer application. Generally, one dripper per plant is required. As a thumb rule, the soil should be moderately moist-however never having excessive water.

Manures

While bed preparation, add Single Super Phosphate (0:16:0) @ 2.5 kg per 100 sqft for better root establishment and Magnesium Sulphate @ 0.5 kg per 100 sqft to take care of deficiency of Mg. 25-75 t/ha of well decomposed organic manure is required. 150:137:190 g NPK/m^2 (40:40:40 g, three months at monthly interval) . For the first three months after planting, application of 20:20:20:N:P:K @ 1.5 g/l of water every two days during the vegetative stage encourages better foliage.

Harvesting

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

Yield

The crop yields 2 stems / plant / month. Harvest starts from 3rd month of planting and continued up to two years. Under open condition, 130 -160 flowers / m^2 / year and under greenhouse condition, 175 - 200 flowers /m^2/ year can be obtained.

Lec No. 5: China aster –Importance – Varieties- Climate and soil – Propagation – Irrigation – Manures – Intercultural operations- Harvesting – Yield.

CHINA ASTER

Botanical name : *Callistephus chinensis*

Family : Asteraceae

Origin : China

Importance

Popularity is increasing in and around cities due to its short duration and bewitching colors. In India it is widely grown in Karnataka, Tamil Nadu, West Bengal and Maharashtra. It‟s accounting for 6 % of the total area and 8.8 % of the total flower production in Karnataka state. It can be grown in various agro climate zones. It is also suitable for growing as intercrop in coconut gardens and orchards also. Cheaply available cut flower. It can be mixed with other cut flowers for making bouquets. It can be grown by small and marginal farmers. Good seed setting and no dormancy.

Climate

China aster is normally a winter season flowering annual. The day temperature of 10-12^{0}C is favorable to develop large size flowers. The colour is well developed in the temperature range of 20-30^{0}C during day and 15-17^{0}C during night with relative humidity 50-60%. It needs sufficient sun light for both better growth and flowering. It needs limited rains, 500-700mm spread over from June to September.

Soil

The crop is susceptible to more water logging, hence well drained red loamy soils are required. The pH should be around 6.8-7.5. Heavy soils with high calcium content are not suitable.

Propagation

China aster is propagated through seeds. A seed rate of 625 – 750 g/ha is sufficient. The seeds will not have dormancy and germinate in a week at about 21^{0}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.

Nursery:

Generally sowing should be staggered by 10 – 15 days, so that one can get flowers for longer time and also can avoid glut in the market. Seeds can be sown in seed pans for obtaining seedlings for garden use and in small quantities. For commercial cultivation, seed is sown in raised beds measuring120x60x10cms (LxBxH). The seeds are sown thinly to avoid lanky tall seedlings. The seeds are sown at 10 -12cms apart and covered with a mixture of soil and FYM. After sowing, the beds should be watered gently with a rose can.

Transplanting:

Aster seedlings are usually transplanted when they have developed about three to four leaves. Seedlings at too early or late stages should be avoided and usually seedlings are ready for transplanting within 30 - 45 days. The seedlings are hardened sufficiently before planting. The transplanting should be done preferably during early morning or evenings to avoid bright sunlight. After planting the soil around the seedlings is to be firmed and watered thoroughly.

Planting and spacing

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.

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.

Manures

About 10-15 tones of well-decomposed farmyard manure may be incorporated in the soil at the time of soil preparation. 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 is180:120:60 kg NPK/ha. Of which 90 kg nitrogen, full dose of P & K has to be applied at the time of preparation of land. Remaining 90 kg/ha nitrogen has to be applied as top dressing at 40 days after transplanting.

Pinching

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

Harvesting

Flowers are ready for harvesting in 10-12 weeks after transplanting. Harvesting plays an important role in determining the flower quality. China aster is harvested in two different ways.

Individual flowers are harvested for decoration and worship purpose whereas flowers along with stalk or the whole plant just above the ground are cut for cut flower purpose.

Yield

Flower yield depends upon season of planting and cultural practices adopted. On an average a fresh flower yield of 20-22 tons per ha during rainy season, 15.0 to 17.5 t per ha in winter and 10.0-12.0 t/ha in summer can be obtained.

Lec No. 6: Carnation – Importance – Species and types – Climate – Soil – Propagation – Planting – Irrigation – Manuring – Special cultural practices – Harvesting – Yield- Calyx splitting

CARNATION

Botanical name : *Dianthus caryophyllus*
Family : Caryophyllaceae
Origin : Eurasia

Importance

It is one of the important cut flower crops in the International flower market. It is commonly called as Carnation, Divine flower, Clove pink, Gilly Flower. One of the top ten cut flower crops in the International flower market. Apart from cut flower it is being used for bedding, pots, rock gardens, window boxes and edging. It gives a unique softness in the rock gardens. Popular in flower arrangements for decorating homes. They are in large demand in Valentine‟s Day, Easter and Mother‟s day and during Christmas. In India the

major carnation producing centers are located in and around Bengaluru, Pune, Delhi, Trivandrum, Andhra Pradesh and HP. Flowers also have medicinal properties. Used as cardio tonic, diaphoretic and alexiteric. It is also used for perfume extraction in France.

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

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

Types of carnation

Perpetuals

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

a) Standard types:

Produces single large blooms with longer flower stalks.

b) Spray types:

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

Climate

Prefers cooler climates with day temperature of 20-25^{0}C, night temperature of 10-15^{0}C and relative humidity of 50-60%. Bright sunlight is required for growth and flowering. High day & night temperature during flowering leads to Abnormal flower opening and Calyx splitting .

Soil

China aster prefers to grow in an open sunny location. Crop is susceptible to water logging. Hence well drained red loamy soils are required. The pH of the soil should be around 6-7. Plants can be grown in soil mixture with 50 % sand, 30% loam and 20% clay Sol mixture have to be sterilized with methyl bromide@ 25-30g / formaldehyde @ 3-7% (7.5 to 10.0 l/100/sq.mt or Basamid (Dazomet) @30-40g/m^2 .

Propagation

Carnation can be propagated by seed, vegetatively and micro propagation. Using soft terminal cuttings is the common method of multiplication used by commercial growers throughout the world. Cuttings of 10-15 cm with 3-4 nodes weighing around 10g are ideal for multiplication. Rooting hormone such as IBA at 500ppm is used prior to planting of cuttings for rooting.

Planting and spacing

Beds of size 30 cm height 1 m wide and length varies as per the length of the protected structure. Spacing between beds should be 30 cm. Carnation plants are planted in different spacing normally, 30-45 plants per sqm is considered to be ideal. Different spacings 15x8cm, 15x15cm, 15x20cm and 15x10cm, are followed. Shading should be given in the beginning of the crop for few days.

Irrigation

Over watering and poor drainage causes root death and stunted growth. Water logging would cause deprival of oxygen to plants. The growing medium should be evenly moist. For proper establishing of the cuttings misting is require. Drip irrigation can be followed after 3-4 weeks of planting. Water requirement is 4 -5 l / m2/ day.

Manuring

No inorganic fertilizers applied in first 3 weeks after planting. Fertilizer application of 40g N, 20g P and 10g K per m^2 in addition to 5kg of well decomposed FYM /m2 will increase the yield of flowers.

Special cultural practices

a) 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. 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 every 2.5 to 3.0 m wires to be supported with poles.

b) Pinching

Pinching refers to breaking out tip of budding and encouraging growth of side shoots. First pinching done 3 -4 weeks after planting. Depending upon the need of crop spread it is classified into: Single Pinch, One and half Pinch and Double Pinches.

i) Single Pinch

- Ideal time for pinching is morning.
- When the plant attains 6 nodes, the first pinch is given.
- 5 -7 cm of apical portion has to be pinched off.
- This would give rise to 4-6 lateral shoots.

ii) One and Half Pinch

After single pinched shoots flower, half of side shoots are pinched off. 2-3 of these lateral shoots are pinched again.

iii) Double Pinch

All the lateral shoots are pinched off. i.e., 3 - 4 weeks after first pinch. Pinching is done at 4 well developed pairs of leaves

c) Disbudding

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

For Standards

- Removal of lateral buds.
- Main flower bud alone left.

For Sprays

- Terminal or main buds are removed to encourage more number of side shoots.
- Best time for disbudding – when apical bud is 15 mm in diameter.
-

Harvesting

The carnation flowers will be ready for harvesting in 15 – 20 weeks after single pinching

Yield

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

Physiological disorder

- **Calyx splitting:**

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

Measures

- ✓ Selection of cultivars that are less prone to splitting,

- ✓ Regulation of temperature and maintenance of optimal fertilizer level can minimize this disorder.
- ✓ This can also be reduced by placing a rubber band or 6mm wide clear plastic tape is used around the calyx of the flowers which have just start opening. This operation is referred as "**Calyx banding".**

Lec No. 7: Chrysanthemum – Importance – Soil – Climate – Cultivars & Varieties – Classification- Propagation –Planting – Irrigation –Manuring –Intercultural operations- Regulation of growth and flowering- Harvesting – Yield

CHRYSANTHEMUM

Botanical name: *Chrysanthemum indicum*
Family : Compositae
Origin : Europe and Asia

Importance

Chrysanthemum is a popular flower crop of commercial importance.
1. In Japan Chrysanthemum is regarded as a symbol of Royalty
2. It is known as Queen of East
3. In India it occupies a place of credit both as a commercial flower crop and as an exhibition flower.
4. It's erect and tall growing cultivars are suitable for background planting or as cut flowers.
5. Dwarf and compact growing ones are suitable for pot culture
6. Decorative and pluffy bloomed small flowered cultivars are ideal for garland making and hair decoration.
7. Extra large bloomed cultivars have a great exhibition value
8. Species like *Chrysanthemum cinerareifolium and Chrysanthemum coccineum* are cultivated as sources of Pyrethrum an important insecticide.
9. Ryori Giku is a yellow flowering culinary type which is eaten as delicacy in Japan after frying.

Soil

Chrysanthemum has shallow fibrous root system. This is very sensitive to water logging. It is prone to attack by diseases such as root rot and wilt, if there is lack of aeration. Physical, Chemical and Biological states of soil are therefore an important factor effecting growth of plants. Clay and Clay loams retain too much of moisture and thereby hinder the proper aeration resulting in rotting of roots. When dry, such soils become too compact and damage tender roots. Sandy soils on th e other hand, dry too quickly and require frequent irrigation and also suffer from loss of nutrients due to leaching, though root growth is enhanced due to the plenty of aeration. **Sandy loams** retain sufficient moisture and provide optimum aeration essential for proper root growth and hence ideal for chrysanthemum growing.

Climate

Chrysanthemum is a cool season crop. It is grown throughout the world. Light and Temperature are two important environmental factors influence growth and flowering. The former is dominative in autumn flowers and later in summer growing cultivars. Chrysanthemum is short day plant requiring short days at the time of flowering and long days for vegetative growth. As far as light is concerned, both photoperiod and intensity are known to have major effects.It is found that chrysanthemum flower when day length decreases and this leads to their classification as short day plant. In general they require high light intensity. Plants grown under reduced light become taller and have thin stems and larger leaves.Flower buds in chrysanthemums have been found to initiate and develop above a critical temperature below which only vegetative growth occurs. Most of cultivars needs warm nights at the time of flower bud initiation.For flower bud initiation minimum temperature of 60 ^{o}F (15.5 ^{0}C approximately equals to 16^{0}C) is required.

Cultivars

There are innumerous numbers of cultivars; in Japan more than 50 thousand; in Britain more than 60 thousand; in India more than 500 cultivars are available.

A) Exotic cultivars:

1. Spray cultivars:

i) White : Ex: Arctic white spider
ii) Yellow : Celebrate
iii) Pink : Blue marble

2. Standard cultivars:

i) White : Giant India Napolis white
ii) Yellow : Bright Golden Anne
iii) Pink : Cessandra

3. Pot cultivars

i) White : Mountain snow
ii) Yellow : Golden crystal
iii) Pink : Always pink

B) Indian cultivars:

1. Large flowered cultivars

i) White : snow ball, Beauty
ii) Yellow : Chandrama, Super Giant

2. Small flowered cultivars for pot culture

ii) Yellow : Aparajitha

3. Small flowered cultivars for cut flowers

i) White : Birbal Sahani
ii) Yellow : Sujatha
iii) Mauve : Apsara, Neelima

4. Small flowered cultivars for garland

i) White : Sharad shobha
ii) Yellow : Freedom

Classification of chrysanthemum

Several countries classified Chrysanthemum based on number, size, form and arrangement of disc and ray florets. The classification of National Chrysanthemum Society of America is given below:

- **Division A:** It includes classes 1 to 8. Ray florets are flattened to concave or convex. Visible portions are never tubular
- ✓ Section 1: It includes classes 1 to 3. Disc is prominent composed of many disc florets

Class 1: **Single:** Ray florets in a single row at right angle to the stem. Disc flat to slightly rounded.

Class 2: **Semi double:** Ray florets in more than one row at right angle to the stem, but may curve downwards at the tips.

Class 3: **Anemone:** Ray florets variable and equal in length. Prominent disc can be seen. It may range from flat to hemispherical in form.

- ✓ ii) Section2: It includes classes 4 to 8. Disc is not apparent. Disc florets may be concealed or entirely absent.

Class 4: **Pompon:** Bloom globular, flat or small button type. Ray florets broad and incurved. Disc is not prominent

Class 5: **Incurve:** Bloom is globular.Ray florets smooth, narrow to broad and incurved and they don't have open centres Ex: Snow ball

Class 6: **Reflexing incurve:** Bloom is globular, less compact than incurve. All mature florets not completely incurving or reflexed. The lower florets are reflexing to give a skirted effect. Ex: India-napolis.

Class 7: **Decorative:** Ray florets short and broad, long and pointed. Bloom are more flattened.Ex: Princess Anne
Class 8: **Reflex:** Bloom is globular, ray florets reflexed and gracefully overlapping. Ex: Coronation Pink.

- **2. Division B:** It includes classes 9 to 11. Tubular ray florets coiled and straight, hooked at distal end.

Class 9: **Spoon:** Ray floret is tubular distal potion is open and sppon like disc is apparent
Class 10: **Quill:** Ray florets tubular either closed to the tip and pointed or open and spatulate. Disc is not visible.
Class 11: **Spider:** Ray florets long and tubular, distal portion shows definite coils.Disc is not apparent.It has four sub classes namely a) thread b) fine c) medium d) coarse tubed

- **3. Division C:** It includes classes 12 and 13. Ray florets flattened or tubular Disc may or may not be present includes two classes 12 and 13.

Class 12: **Lacinated:** Ray florets may be lacinated or feathered at the tips. Bloom form may be any of the classes from 1 to 11 Ex. Jack Straw
Class 13: **Brush or Thisle:** Ray florets are fine tubes. They grow almost parallel to the stem in a brush or thistle like manner.

In India, chrysanthemums were classified into two broad groups, namely large flowered and small flowered. Large flowered cultivars are usually grown as standards with 1-3 stems, bearing a single flower each and Small flowered cultivars are grown as bushes with multiple branches bearing a very large number of blooms per plant.

Propagation

There are three methods of propagation in chrysanthemum.
Seed propagation: Mostly meant for establishment of crop for development of new varieties in Breeding programme. However for commercial cut flower production, seed is not used for propagation.
Vegetative propagation: Chrysanthemum is propagated vegetatively by Cuttings and Suckers.
Cuttings: Soft wood cuttings are obtained from laternal branches immediately after the completion of flowering. The terminal 8 to 10 cm long portions of laterals are simply cut from the left over plants and lower leaves of cuttings are stripped off. Then the 1/3rd portion of cuttings should be inserted into soil of the rooting beds. In due course of time, adventitious roots are formed from cutting underground. These cuttings are said to be rooted cuttings, which should be lifted from nursery beds at the time of planting in the main field (in July).
Suckers: Healthy suckers are obtained from healthy chrysanthemum crop of previous year. As soon as harvesting of cut flowers is over the left over plants are subjected to heading back to a height of 20 cm above ground level in the month of January and February.In due course of time the suckers will be arising from the adventitious buds present on the stem underground. As soon as they are long enough the suckers are cut to their base and are subjected to rooting in nursery beds (rooting beds)In rooting beds the suckers will produce roots at their bases and are said to be rooted suckers .These rooted suckers should be lifted from nursery at the time of planting in the main field.

Land preparation: Land is brought to fine tilth by repeated ploughings, harrowings and planking.Entire prepared land is made into flat beds on light textured soils, raised beds or ridges and furrows in heavy textured soils.Before last Ploughing 15 tonnes of well decomposed FYM are applied to enrich the soil organic matter. It is thoroughly incorporated into the soil by subsequent ploughing and harrowing.
Planting time:
June – July i.e. onset of South West monsoon.
Spacing: 35 cm x 20 cm
Method of planting: Rooted cuttings should be placed in a small planting hole made in the field at desired planting positions up to the point where it was there inside in the nursery.

Then the soil is firm around the base of cutting such that no air pocket is left around the root system. Planting should be followed by light watering.

Irrigation

Immediately after the establishment, the crop should be irrigated twice a week, depending upon the soil and climatic conditions. Care should be taken that water should not be stagnated in the field. Before harvesting of flowers, irrigation helps in enhancing the keeping quality of cut flowers.

Manuring

Fully decomposed FYM is applied @ 15 tonnes per hectare as basal application. Nitrogen @ 50 kg per hectare; Phosphrous @ 160 kg per hectare; Potassium @ 80 kg per hectare should be applied as basal dose at the time of land preparation. Another 50 kg Nitrogen should be top dressed 30 days after planted.

Intercultural operations

Gap filling: Immediately after the establishment of rooted cuttings in the main field, observe for the casualties. Replace the same with healthy fresh rooted cuttings.

Mulching: Mulch the inter spaces with any locally available mulching material like paddy husk, groundnut shells and saw dust and dry leaves to a thickness of 2.5 cm to check weed growth, to conserve soil moisture and to moderate soil temperature.

Earthing up: As soon as the plants are about 10 to 15 cm height, earthing up the soil around the base of plant is to be done to provide support to growing plant.

Staking: Individual laterals should be provided with stakes individually i.e. Multiple Single Staking. Staked portion should be cut just below the level of flower bud at the time of bud opening so as to avoid the disturbance to the development of flower.

Regulation of growth and flowering in Chrysanthemum

1. Stopping or Pinching: If the plant is stopped when it is 15 cm tall before even the break bud stage, the side shoots appear in leaf axils earlier by 2-3 weeks (first pinching is done at 4th week after planting). The second pinching is done at (7th week after planting) by removing the first crown bud at the end of each lateral growth or by pinching the primaries before the crown bud has appeared. It will delay the flowering and produce second crown buds on secondaries. Methods of pinching depends on nature of bloom to be obtained. If only one bloom per plant is required no stopping is needed. But if 3 or 6 stems are needed per the plant stopping is resorted too. The tip of the main stem measuring 3 to 5 cm is removed. This stopping will encourage the lateral shoots (breaks) to develop from the leaf axils. Three strong laterals are attained and others removed.

Deshooting: (Thinning out): When apical growing portion of main stem is removed number of laterals are produced from the leaf axils on the main stem. When all of these laterals (primaries) are allowed to develop, the size of the flower produced on this primaries is decreased. Keeping in this view three strong laterals are retained and others are removed. The laterals retained for flowering should preferably consists of one central stem and two on either side of it.

Deshooting is also practiced from time to time by removing all side shoots before they attain the size of 2.5 cm. The aim of deshooting is to divert the food materials to the retained laterals. In singles, Koreans and sprays deshooting is restricted to prevent the plant from being too much crowded.

Disbudding: First crown bud develops at the end of each lateral which contains maximum number of ray florets and will give the largest bloom, though may not be the best bloom. This is retained on all other growth arising from leaf axils is removed. Sometimes, the crown bud in laterals is stopped to obtain second crown bud which arises from leaf axils. In many

cultivars the second crown bud produce flowers of more intense colour, harder in texture, more symmetrical in crowd. However in most cultivars, the first crown bud produces largest bloom. Disbudding stops as soon as flower buds appear.

In chrysanthemum if all the buds in one stem are allowed to bloom, the flowers become smaller in size. Therefore in large flowering cultivars only one bud or stem is allowed to bloom and others are removed. The ideal time for disbudding is when buds surrounding the central bud have developed. However in singles, Koreans and sprays no disbudding is practiced.

Desuckering: All suckers that are arising from the adventitious buds present on the stem below the ground should be removed as and when they are produced. The practice of desuckering does not influence the flower number, but enhances the size and quality of flowers by diverting the nutrients to the flower bud.

Staking: Laterals that are obtained after deshooting, should be staked with small split bamboo stakes inserted in the soil with a few to give support and also to see that this are spread out from each other. When buds start showing colour the bamboo stake is cut just below the basal level of bud so that it does not obstruct the bud in developing into a perfectly shaped flower.

Harvesting

In general Chrysanthemum comes to flowering in about 80 to 90 days after planting (i.e. pre blooming period is three months). The early planted crop comes to flowering by July – August and late planted crop blossoms in January February. Early planted crops takes longer time to come to flowering than late planted ones. Flowers can be cut at an interval of 4 to 5 days in the beginning and once in three days during the peak period of production. Fully opened flowers are harvested during cooler times like mornings Standard chrysanthemum can also be harvested at unopened stage when only a few outer ray florets unfurl. The bud opening solution for this type is an absolute necessity. The ideal bud opening solution is 200 ppm, 8 HQC and 2 per cent sucrose (1-15%).

Yield

An average yield of 20 t/ha from plant crop and 10 t/ha from ratoon crop can be obtained.

Lec No. 8: Marigold– Importance – Species & Varieties- Soil - Climate – Cultivars & Varieties –Propagation –Planting – Irrigation –Manuring- Intercultural operations –- Harvesting – Yield.

MARIGOLD

Botanical name **:** *Tagetus erecta* - African marigold
Tagetus Patula - French marigold
Family **:** Compositae
Origin **:** Central and South America and Mexico

Importance

Marigold is one of the most popular flowering annuals cultivated in India. It is gained its popularity amongst gardeners and flower dealers on account of its easy culture wide adoptability, wide attractive colours, shapes, size and good keeping quality. In Andhra Pradesh Marigold is extensively used as loose flower for making garlands in religious and social functions.

- ✓ It is useful for floral decorations and floral arrangements.
- ✓ Used in mixed herbaceous borders and bedding, cut flower, pot culture.
- ✓ For religious offerings and French marigold is most ideal for rockery, edging hanging Baskets and window boxes.
- ✓ Both leaves and flowers are equally important from medicinal point of view
- ✓ Leaf paste is used externally against boils and carbuncles.

- ✓ Leaf extract is good remedy for earache.
- ✓ Flower extract is considered as blood purifier, a cure for bleeding piles and is also a good remedy for eye diseases and ulcers.
- ✓ Oil extracted from Tagetus can find a use in the perfume industry.
- ✓ Extracts used as *natural dye.*
- ✓ African marigold represents "*vulgar minds*" where as French marigold is a symbol of "*Jealousy*"
- ✓ Marigold is also known as *friendship flower* in the United States.

Soil and Climate

Marigold can be grown in a wide range of soils, except water logging situation. However a deep fertile soil having good water holding capacity well drained and near to neutral in soil reaction (P_H: 7.0 – 7.5) is most desirable. An ideal soil for marigold cultivation is fertile sandy loam. It requires mild climate for luxuriant growth and flowering. High temperature effects the growth besides reducing flower size and number. In severe winter plants and flowers are damaged by frost. Therefore depending on environment planting is done. The environmental conditions after seedlings are transplanted greatly influence growth and flowering. Mild climate during growing period (14 – 28 ^{0}C) greatly improves flowering while higher temperatures (28 – 36 ^{0}C) adversely affected flower production.

Species, Types and Cultivars

There are about 33 species of the genus Tagetus. Among all the species the following two species are important and suitable for commercial cultivation.

1. **African Marigold: - (Tagetus erecta):** The plant is tall and hardly. Flowers are single to fully double and large size globular heads. Flower colour varies from lemon yellow-to-yellow, golden yellow or orange. (90cm tall, erect, branched). It is a diploid, 2n=24. From commercial point of view African marigold is in greater demand as compared to French marigold.

Ex. Giant double African yellow, Giant double African orange (Early orange and Early yellow are commercially cultivated in West Bengal and Orissa).

Cracker Jack, Zinnea gold, Gold coin, Yellow supreme, Man in the moon.

2. **French Marigold: (Tagetus patula):** Plant is dwarf bushy, flowers are small either single or double. Flower colour varies from yellow, orange, reddish brown, golden yellow to bicolour. Foliage is dark green withreddish stem. (30 cm tall bush). It is tetra ploid 2n=48.

Important cultivars: yellow boy, Harmony boy, Red brocade, little devilbicolour, little devil yellow, Butterscotch, Royal Bengal, Queen Sophia, and Tangerene.

Dwarf varieties of African Marigold: Apollo, Aztee, Golden age, Spun gold, Spun yellow, Guys and Dolls, Happiness, Dolly, Pot -o- gold.

Important varieties of French Marigold: They are easy to grow and bloom earlier than African types. Sparky, Spanish brocade, flame, flaming of fire, orange flame and star of India.

The important varieties of **triploid varieties** are showboat, sever star *(T-erecta x T-patula)* most of them are used as pot mums.

Important improved Indian varieties:

1. Pusa narangi Gainda – Cracker Jack x Golden Jubilee (Suitable for garland.)
2. Pusa basanti Gainda – Golden yellow x Sun giant (Suitable for pots and beds in garden.)

Propagation

Marigold is (commonly) generally propagated either by seed or by herbaceous cutting.

Seed: Seed rate for marigold varies from 0.8 – 1 kg / Acre (2-2.5 kg / hector). Seed propagation is very common because readily available and germinate quickly marigold seeds are sown in raised seedbeds or pots or seed pans. During preparation of nursery bed 8-10 kg of well-decomposed cow dung manure per m_2 of bed is thoroughly mixed with the soil. The width of the seedbed should not be more than 1.2 meters and height should be 15

cm. During the winter, the beds are covered with a layer of straw to accelerate the germination process. Seeds are sown thinly without overcrowding. Seeds germinate well at temperature from 18 to 30 ^{0}C. Seeds take about 5-7 days for germination.

By cuttings (Herbaceous): Cuttings are generally used for perpetuation of a particular plant (or) cultivars. About 6 – 10 cm long cuttings are made from the apical portion of shoot and kept for rooting. Herbaceous cuttings each with one or two pairs of leaves are inserted in sand medium either in seed pan or nursery bed. Before putting the cuttings in rooting medium the basal portion of the cuttings is treated with Seradix B – 1 or Rootex – 1 to encourage profuse and early rooting. Regular watering should be done to keep the bed in moist condition within 8 – 10 days, rooting is observed in the cuttings, which are later used as planting material. Varieties like Giant African yellow, Giant African Orange does not set seed therefore these are usually multiplied by herbaceous cuttings.

Sowing time:

Marigold can be raised **thrice in a year**, i.e. rainy, winter and summer Season.

Season	Sowing time	Transplanting time
Rainy season	Mid June	Mid July
Winter season	Mid September	Mid October
Summer	January - Feb	Feb - March

Transplanting of Seedlings: One-month-old seedlings with 3 to 4 leaves are fit for trans planting. Watering of nursery bed one day prior to up rooting will lessen the damage to root system. Trans planting should be done in well-prepared land and soil is pressed around root zone to avoid air pocket. After temperature a light watering with rose can should be done.

Spacing: An African marigold – for seedling plants 40 x 30 cm spacing should be given while for rooted cuttings 30 x 20 cm is found to be ideal. French marigold – 20 x 20 cm or 20 x 10 cm.

Irrigation

Depending on soil and weather conditions, the crop should be irrigated at least once in a week during winter and once in 4-5 days during summer. It takes about 55 – 60 days to complete vegetative growth and enter into reproductive stage. At all stages of vegetative growth and during flowering production sufficient amount of moisture in soil is essential. Water stress adversely affects normal growth and flowering.

Manures

During last ploughing, incorporate 25t/ha of FYM. Apply 45:90:75 kg NPK/ha as basal and 45 kg N/ha as top dressing 45 days after planting.

Intercultural Operation

In marigold control of weeds is an important operation of the weeds are not removed in time, a great loss would occur in terms of growth and productivity and weeding should be done 3 to 4 times during the crop period.

Pinching: In tall cultivars of African marigold plants first grow up wards to their final height and later on produce a terminal flower by apical dominance. After the formation of terminal flower bud, axillary's branches develop which also bear flowers. However if the apical portion of the shoot is removed early, large number of axillary shoots arises resulting in well-shaped bushy plant bearing more number of uniform sized flowers. Removal of apical portion of shoot is known as 'pinching' it is observed that pinching 40 days after transplanting enhances flower yield. However Giant double African yellow and orange do not require pinching, as the plants are bushy and branching type.

Harvesting

Marigold flowers are plucked when they attain full size. Harvesting should be done either in the morning or evening hours. Field should be irrigated before harvesting of flowers so that the flowers keep well for longer period after harvest. The plucked flowers are collected in polythene bags, jenny bags or bamboo baskets for carrying to market.

Flower Yield:

The yield of flowers in African and French marigold varies cultivars cultural practices adopted, spacing and fertilization etc. An average the yield of French marigold and African marigold varies from 8 to 12 T/hector and 11 to 18 T/hector respectively. Normally 10 – 15 T/hector flower Giant African yellow may give 25 T/hector.

Seed yield:

African marigold –300 – 375 kg/ha, French marigold 1000 – 1250 kg/ha
Seeds should be collected from winter only.

Lec No. 9: Crossandra & Jasmine – Importance – Species & Varieties- Soil - Climate – Cultivars & Varieties –Propagation –Planting – Irrigation –Manuring- Intercultural operations –- Harvesting – Yield

CROSSANDRA

Botanical name : *Crossandra infundibuliformis*
Family : Acanthaceae
Origin : *South India and Sri Lanka*

Importance

It is also known as Kanakambaramu or Firecracker because of cracking sound during opening of seedpod.

Flowers are commonly used for hair adornment, though not fragrant, flowers are very popular because of its attractive bright colour, light in weight and good keeping quality. These are used for making garland either alone or in combination with Jasmine flowers. Crossandra flowers in combination with Jasmine flowers give fragrance and contrasting (striking difference) beauty. It can be grown in home gardens, rockery gardens and for land scaping as an herbaceous border.

Variety

Crossandra varieties are available in a range of colours. Apart from the orange, pink, red and yellow and double coloured blue types with white throat also exists.

- ✓ Tetraploid types - Orange, Lutea Yellow, Sebaculis Red
- ✓ Triploid types - Delhi Crossandra.

Soil

Crossandra can be grown in almost all types of soils. However, well drained loamy soils rich in organic matter with a pH of 6-7 are well suited. Alkaline and saline soils are not suitable as plant develops deficiency symptoms like chlorosis and lead to improper growth of the plant and poor flower production. This crop should not be cultivated in nematode infested soils.

Climate

It is a tropical plant and cannot tolerate low temperatures and frost conditions. It grows luxurious when temperature is around 30^0 C**.** It flowers profusely during cool months of the year; plants can also be grown under partial shade.

Propagation

Seed or cuttings can propagate Crossandra.

Seed: The seeds mature in small ears similar to those of wheat. Seeds attain physiological maturity at about 55-60 days after flowering. The seeds can be stored for 6 months with

seed treatment it either captain or Bavistin @ 2g/kg of seeds. Seedlings will be ready for planting when they have 4-5 pairs of leaves. To raise one hectare of crop of Crossandra about 22.5kg seed is required (9kg/acre).

Stem Cuttings: Crossandra may also be propagated vegetatively. The stem cuttings are rooted under mist chamber. The cuttings are transplanted in the field when sufficient numbers of roots have developed. It is preferable to treat the seedlings or rooted, cutting with nematicide and fungicide before transplanting.

Planting: The soil is ploughed 3 to 4 times to bring the soil to a fine filth. Well rotten FYM @ 25T/ha should be applied at the time of last ploughing. Furrows and ridges are opened at 60 cm. Apart. Rooted seedlings or cuttings are planted 30 cm apart on one side of the ridge. The seeds are sown in May- June and transplanted during August-September.

Irrigation

Depending upon climate and type of soil immediately after planting irrigation is necessary. It required irrigation once in 4-5 days.

Manures

Apply FYM 25 t/ha, Gypsum 100 kg/ha and P & K at 50 and 100 kg/ha respectively as basal dose. Top dressing is done 30 days after planting with neem cake 250 kg and N 40 kg/ha. Apply N P K @ 40:20:60 kg/ha 90 days after planting and repeat this dose at quarterly intervals for a period of two years.

Inter-cultivation

Flowering in Crossandra commences 2-3 months after planting and continues to bears flowers throughout the year flower production may drop during rainy season. Providing partial shade to the plants has been found to be beneficial to maintain the health of plants and obtain higher yield of flowers. During initial growth period the weeds are kept in check by manual method by using Khurpi or hand hoe. Timely application of fertilizer, irrigation, weed control, earthing of plants are required to maintain a good healthy crop. After the flowering is over, removed of dried spikes and branches will help in increased flower yield year round.

Harvesting

Crossandra can be flowered 2 – 3 months after planting. Crossandra flowers open in sequence from the base of the spike. Two flowers are diagonally opposite the spike open at the same time. It takes about 2 days for (Joining opposite corners of a square or rectangular) complete opening of the flower. Therefore picking of the flowers is done therefore alternate days in early morning hours. Depending on the length of the spike it takes nearly 15 – 25 days to complete flowering on a spike. Flower picking is done by pulling corolla out of calyx. In some plants flowers are picked along with the ovary. For local market flowers are packed in cloth or polythene bags. Crossandra flowers are very light and on an average about 15,000 flowers make on kg.

Yield

The flowers yield increases as the plants grow producing more number of laterals. Though Crossandra is reported to be perennial and lasting 2 or 3 years, it may be better replace every year to maintain healthy and fresh looking plants, capable of producing higher yields. 5.7 to 10 T/ha from earlier healthy crop.

JASMINE

Botanical name: *Jasminum sps*
Family : Oleaceae
Origin : India

Importance

- ✓ Jasmine is one of the most important traditional flower of India. Jasmine flowers buds are used for grand hair dressing of women on special occasions.
- ✓ Extraction of essential oil from jasmine for preparing perfume, hair oils and attar.
- ✓ The wedding garland made of jasmine flower buds are predominant than garlands made from other flowers because of its special fragrance and manifestation.
- ✓ Women of all age groups need adorn their hair with flower string. Mostly jasmine strings are liked by women folk as it adds to their beauty.
- ✓ Crowns made of mostly jasmine flower buds are used in some marriages for adorning the couple.
- ✓ While making garlands, strings, veni, jadai etc., tinting of jasmine is also done for getting varied designs.

Species And Cultivars

A number of jasmine species are grown in India. Commercially grown important species are *J.sambac, J.auriculatum, J.grandiflorum* their brief description all as follows;

***J. sambac*:** Also called Arabian Jasmine. The flowers buds are white, with single or multi-whorled petals, used for garland-making, adorning hair and extraction of perfume. It is a bushy weak-stemmed shrub with pubescent branches.

Important varieties are: Gundu Malli, Single Mohra, Double Mohra, Madanban, Ramabanam, Kasthuri malli.

J. grandiflorum: Also called Royal or Spanish Jasmine, Chameli, Pitchi. It is a large shrub pinnate leaves. Flowers are white, often tinged with purple. Suitable for concrete extraction.

Important clones are: Pin type, Thrum type, J.G.1 (Bangalore), J.G.2 (Coimbatore), J.G.3 (Lucknow), J.G.4 (Tenkasi white), J.G.5 (Thimmapuram), J.G.6 (Triploid), Surabhi, CO_1 Pitchi, CO_2 Pitchi.

J. auriculatum: Also called Jathi Malli, leaves are mostly simple, usually trifoliate. The flowers are star shaped, white-scented blooms, borne in flan cymes. Black type of this is grown in home gardens.

High-yielding varieties are: CO_1 Mullai, CO_2 Mullai, Pari Mullai, Long point, Long round, Medium point, Short round other important species of floricultural importance are;

J. multiflorum: Also called Kakada, Tundam. Resistant species, not scented, very ornamental.

J. arborescens: Also called tree Jasmine, Muta, Bela. Large shrub with fragrant white flowers.

Soil and climate

Well drained loamy or red loamy fertile soil. Jasmine require Warm summer, mild winter, moderate rainfall and sunny days.

Propagation

Semi hard wood cuttings (15 - 20 cm long).

Planting: Jasmine is perennial in nature. The plants remain in the same spot for many years. They are generally planted during rainy season. Pits of 45 cm are dug at least one month before planting, the pits are filled with 2 parts of well-rotten cow dung manure and one part each of fresh earth and coarse sand. In termite – prone all as, dry leaves may be burnt in pits or a handful of BHC may be added to filling minture. Pits should be irrigated to settle the minture. Well-rooted, healthy and strong plants are planted in pits (one in each). Soils with proper drainage and irrigation facilities and sunny condition are ideal.

Planting distance plays an important role in flower yield. To get the highest yield, recommended distances are:

J. auriculatum	: 18 x 1.8 m
J. grandiflorum	: 1.5 x 1.5 m
J. sambac	: 1.2 x 1.2 m

Climbing species are spaced to a wider distance, which depends on the purpose and choice of growers.

Pruning: Pruning is essential to get optimum yields and to keep the bushes within manageable size. The first pruning is done in the year following planting and thereafter once a year. The bushes are pruned during December – January every year. Irrigation is stopped 15 days before pruning and pruned to a height of 75-90 cm. from ground level. After pruning the soil around the bushes is dug up to a depth of 15 cm and a diameter of 60-75 cm all around leaving 30 cm of area close to the bush undisturbed. The dug basins are exposed for a week. After this manures and fertilizers are applied and irrigated sparingly (once in week) at initially and increased after the appearance of flower buds (once in 4 days).

Manuring

Many commercial growers use early organic manure by mining one part each of horse and donkey manaure and tank silt. The manure is applied @ 10 kg / plant / year. A fertilizer doze of 100g : 150g : 100g of NPK over a basal doze of 10 kg FYM / pH / year is ideal for getting minimum flower yield may be obtained if Mg (40 kg/ha), Zn (10kg / ha) and B (5 kg/ha) are applied along with NPK fertilizers. The N_2 doze can be reduced to half (50 g / pH / yr) if applied as foliar spray in equal dozes beginning feem first week of February at fortnightly intervals. In *J. auriculatum,* 120:240:240 g of NPK is recommended / plant / year. In *J. sambac*, 90:120:240 g NPK / pH / year is recommended and most beneficial at Coimbatore. For *J. multiflorum*, 120 g N2 / plant / year is recommended at Bangalore. flowering. During blossoming, the water should be applied twice a week if there is no rain and once a week during out of the months. Seen after the cessation of flowering, watering is to be completely stepped until pruning and fertilizer application. With the advancement of cold weather, the plants begin to shed the leaves. After pruning and manuring, watering is resumed. In *J. sambac* flowers come in phases. Each phase lasts for 7 days during which the blossoms are put forth in perfusion. There is an interval of about a month between one bloom and the commencement of the next with the close of each flowering phase, watering is completely stopped for weeks together till the appearance of fresh flowering buds.

Harvesting

Unopened but fully developed flower buds should be picked in the morning and marketed immediately.

Yield: Pari malli – 10,000 Kg / Ha
Jathi malli – 11,000Kg / Ha
Gundu malli – 6200 Kg/ Ha

Lec no. 10 - Importance & Scope of Medicinal plants – Isabgol – Importance – Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.

Medicinal plants are those plants rich in secondary metabolites and are potential sources of drugs. These secondary metabolites include alkaloids, glycosides, coumarins, flavonoids, steroids etc.

These plants form the main base for the manufacture of drugs of Indian systems of medicine (ayurveda, Unani, Siddha) and Homeopathy. These plants are found in various parts of the country in different environmental and climatic conditions. Plants which grow wild in forest regions, classified as minor forest produce, supply a substantial amount of raw material required for the indigenous drug industry.

Importance and scope for cultivation of medicinal plants in India.

1. India is one of the few countries where almost all the known medicinal plants can be cultivated in some part of the country of the other. Among the various plants in great demand in the country and abroad are Opium poppy, tropane alkaloid bearing plants, sapogenin bearing yams, senna, psyllium husk and seeds, cinchona and ipecac.
2. The ancient Indian System of Medicine (ISM) is predominantly a plant-based material medica making use of most of our native plants. It caters to almost the entire rural population of our country mainly because of the scarcity of modern allopathic health care in our villages
3.ISM offers most appropriate or first line therapy against many diseases like jaundice, bronchial asthma, rheumatoid arthiritis, diabetes etc, for which allopathic medicines have as yet no cure. It is well known that most allopathic medicines have as yet no cure. It is well known that most allopathic medicines produce many morbid side-effects. It is for this reason that more and more people in the western societies are showing increasing interest and preference for organic drugs and their preparations.
4. India has about 2,000 species of medicinal plants and a vast geographical area with high production potential and varied agro-climatic conditions. Most of these plants can subsist under stress conditions and are thus suited even for rainfed agriculture. Cultivation of medicinal plants offers considerable scope for rural employment and export for foreign-ex-change earnings.
5. India is already a major exporter of medicinal plants. It is estimated that rupees 86 crores worth of raw materials and drugs from medicinal plants are exported from India. It holds monopoly in the production and export of **psyllium and senna** and is second largest exporter of **Opium latex**.
6. Many of the medicinal plants required by the trade are gathered mainly from the wild growth thus depleting the vegetation of its valuable medicinal plant wealth (eg: *Rauvolfia, Dioscorea*). On account of this practice, many species of medicinal plants in our country have become extinct or endangered. This should be prevented and herbal gardens and gene-banks covering important medicinal plants should be established to conserve them.

ISABGOL

Botanical name**:** *Plantago ovata*
Family : Plantaginaceae
Origin : *Persia and west asia*
Plant part : Seeds and husks

Importance

Isagbol or Psyllium is important for its seed and husk which have been used in the indigenous medicine for many countries.It has the property of absorbing and retaining water (40-90%) and therefore it works as an anti- diarrhoea drug. It is beneficial in chronic dysenteries of amoebic and basillary origin.The seed has also cooling and demulcent effect and is used in ayurvedic, unani and allopathic medicines. The husk yields a colloidal mucilage consisting mainly of xylose, arabinose and galacturonic acid. Isabgol improves digestion and relives constipation . It cleanses colon, relives from acidity, cures piles and fissures. It helps in weight management and lowers risk of cardiovasular diseases. Isabgol also helps in lowering blood cholesterol and blood pressure. It controls diabetes.

Varieties

Gujarat Agricultural University has released two improved varieties viz., Gujarat Isabgol – 1 and Gujarat Isabgol -2 which have a yield potential of 800 – 900 kg and 1000 kg per ha respectively.

Climate and soil

It requires cool and dry weather and hence in India, the crop is grown in winter *i.e*. from November – December to March-April. Humid weather at maturity results in shattering of seeds. A light well drained sandy loam to rich loamy soil with a pH of 7 – 8 is ideal.

Propagation

Isabgol is commertially propagated by seed. The seed rate varies from 4 – 6 kg and is sown after pretreatment with thiram @ 3 g per kg of seed to protect the seedlings from the possible damage of damping off.

Fresh seeds from the preceding crop season should be sown for getting high per cent germination. The seeds, being small and light are mixed with sufficient quantity of fine sand before sowing. The seeds are sown broadcast and are swept lightly with a broom in one direction to cover them with some soil. For uniform germination care should be taken not to bury the seeds deeply in the soil.

Irrigation

Immediately after sowing light irrigation is essential. First irrigation should be given with light flow of water. The seeds normally germinate in 6 – 7 days. If the germination is poor, second irrigation may be given. Later on, irrigations are given as and when necessary. Last irrigation should be given at the time when maximum number of spike reached the milk stage.

Manuring

25 kg N/ha and 25 kg P/ha are applied as basal dose at the last ploughing and another dose of 25 kg N/ha is top dressed 30 days after sowing.

Inter cultivation

Timely weeding is important to encourage good growth of the plants. After 20-25 days of sowing, first weeding is done and 2-3 weedings are required within 2 months of sowing.

Harvesting

The crop will be ready in about 110-130 days after sowing. When mature, the crop turns yellowish and the spike turns brownish. At the time of harvest, the atmosphere must be dry and there should not be any moisture on the plant. The seeds may be marketed whole or the husk may be sold separately. The husk: seed ratio is **25:75** by weight.

Yield:

The average seed yield is 800-1000 Kg per hectare

Lec No. 11: Ashwaghandha & Periwinkle - Importance – Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.

ASHWAGHANDA (Indian Winter cherry)

Botanical name: *Withania Somnifera*
Family : Solanaceae
Origin : *India and Southeast Asia*
Plant part : Leaves , roots and fruits

Importance

Withaferine-A, Withaferine-B and Somniferine are important alkaloids extracted from the roots. Leaves and roots are used in preparation of ayurvedic and unani medicins. Ashwagandha benefits all parts of the body and can be used as a tonic or in oral form. Ashwagandha stimulates the immune system, combats inflammation, increases memory,

and helps maintain general health and wellness. Ashwagandha is known to increase the production of bone marrow, semen, and acts anti-aging. Patients with anxiety can also benefit from Ashwagandha

Varieties

Jawahar aswagandha -20, poshita, Asgandh-WS-90-134

Climate and soil

Requires subtropical climate, preferably dry weather with an average rainfall of 66-75 cm. The crop needs 1-2 winter rains for full development of roots.

Sandy loam or light red soils with good organic matter are best soil and are easy to dig roots in this condition.

Propagation

Ashwagandha is a seed propagated crop. About 10 – 12 kg/ha of seed is required for broadcasting. For transplanting, seed rate of 5 kg/ha is required. Seeds are directly broadcasting during second week of July.

Nursery raising and planting:

Seedlings are raised in a raised nursery bed with 5 kg seed to provide ha. Seeds treated with fungicide and seeds sown in nursery spaced at 5 cm. Germination in 6-7 days and six week seedlings are ready for transplanting with a spacing 60 x 60 cm.

Manuring

The crop is mainly grown on residual fertility. Hence, no manure or fertilizers are recommended.

Irrigation

The crop requires 2-3 irrigations during cropping period.

Interculture

Directly sown crop thinned 25-30 days after sowing to maintain a population of 20,000 to 25,000/ha

Harvesting and Drying

Harvest from January to March at 150-170 days after transplanting. Drying of leaves, change of berry colour to orange red were the maturity indices. Entire plant uprooted and roots separated by cutting 1-2 cm above crown, transversely cut into smaller pieces 7-10cm for drying and occasionally roots dried as whole. Berries plucked from dried plants threshed to obtain seeds

Yield:

Average yield 300-500 kg/ha dry roots and 50-75 kg/ha- seeds.

PERIWINKLE

Botanical name : *Catharanthus roseus*
Family : Apocyanaceae
Origin : *Madagascar*
Plant part : Leaves, seeds, roots

Importance

Periwinkle is a perennial ornamental herb found throughout India on waste lands and sandy tracts.It has medicinal importance owing to the presence of indole alkaloids raubasin (ajmalicine) and serpentine in its root which have anti-fibrillic and hypertensive properties. The leaves contain two alkaloids viz., Vinblastine and Vincristine which form the constituents of patented cancer drugs and vincristine alkaloids are distributed in different parts of the plant but the roots contain the maximum (0.75 t to 1.20%) followed by the leaf (0.60 to 0.65%).

Varieties

There are no recognized varieties but there are three local types based on the colour of the flowers viz*., C.alba* with white flowers, ***C. roseus*** with pink rose coloured flowers and ***C.ocillata*** with white flowers having rose purple spot in the center. 'Nirmal' and 'Dhawal' are the released cultivars of white flowered type.

Climate and soil

It is suited to all types of soil and tropical climatic conditions. Well distributed annual rainfall of 100 cm or more is ideal for cultivation. It is also suitable for raising as a rainfed crop.

Propagation

The crop is propagated from seeds. Fresh seeds are preferable as they lose viability on long storage. Seeds can be sown directly in the filed or the plants raised in the nursery and transplanted later on.Crop is sown during beginning of monsoons.

Seed rate

Direct sowing – 2-3 kg/ha

Transplanting – 500g/ha

Spacing

Direct sowing: 45 X 25-30 cm

Transplanting: 45 cm x 30 cm or 45 cm x 45 cm

Irrigation

The crop, do not require much water as the pants have drought resistant capacity. In areas where monsoon is restricted, 4 to 5 irrigations are required during the life of the plant to get good yield.

Manuring

They are not generally manured, however, for getting a good yield of both leaves and roots, farm yard manure at about 15 tonnes per ha should be applied and a fertilizer mixture of N (50 Kg), P_2O_5 (75 Kg) and K_2O (75 Kg) per hectare is applied as a basal dose.

Interculture

The crop requires two weedings, the first one about 60 days after sowing or transplanting and the second one in another 60 days.

Harvesting

Two leaf strippings can be taken, the first one after 6 months and the second after 9 months of sowing. Third stripping of leaves can also be taken when the whole plant is harvested after one year.

For seed collection, uproot the plants, dry them in shade and thereafter thresh lightly for seeds or matured fruits are hand picked and dried in shade and threshed lightly. For harvesting of roots whole field is copiously irrigated and ploughed and the roots are collected. The roots are washed well and dried in shade and later made into bundles for marketing.

Yield

Under rainfed conditions about 0.75 tonne of roots, 1.0 tonne of stems and 2 tonnes of leaves (all dry basis) may be obtained from one hectare. But under irrigated conditions, 1.5 tonnes each of roots and stems and 3 tonnes of leaves per ha can be obtained.

Lec No. 12 - Aloe & Tulasi - Importance – Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.

ALOE

Botanical name : *Aloe vera and Aloe barbadensis*
Family : Liliaceae
Origin : Eastern and Southern Africa
Plant part : Leaves, seeds, roots

Importance

Two major products from leaves 1. Yellow bitter juice specialized cells , beneath epidermis yields drug aloe. 2. Parrenchyma tissue of centre of leaf contain mucilaging gel yield aloe gel obtained from A.barbdensis. Aloe gel used in preparations of burn, first aid medicines also used in laxative preparations.

Varieties: *Aloe vera var chinensis* is commonly cultivated one.

- Lace aloe : Plant is long and flowers in cold temperature.
- Short leafed aloe: Short variety and bushy in growth.
- Rubble aloe : Plant is red in colour and flower shaped.
- Golden toothed aloe: The spines are whitish yellow colour and flowers in summer.
- Soap aloe : Salt resistant plant and suitable for coastal regions.
- African aloe : Grows in desert areas.
- Climbing aloe : Climber type and grows very fast.

Climate and soil

Wide adaptability, hence cultivation possible throughout country and prefers warm humid dry climate with 150-200 cm to 35-40 cm yearly rainfall. Hardy and grown on variety of soils,does well in sandy coastal and loamy soils with pH upto 8.5. Water logged and problem soils not suitable.

Propagation

Root suckers or rhizome cuttings are used for propagation.

Planting

The suckers are dipped in 0.1 % Carbendazim for five minutes and planted in the field. Planting should be done during June-July. 15-18 cm long root suckers, rhizome cuttings are planted with a spacing of 60 x 30 cm or 60 x 45 cm and buried 2/3 portion under the ground.

Manuring

Incorporate 10 t/ha of FYM during last ploughing. For fertile soils manuring is not required at all. But for low fertile soils, apply 30 kg/ha of Nitrogen + 120 kg/ha of Gypsum during field preparation. In addition, 30 kg N can be applied after 20 days of planting.

Irrigation

Immediately after planting needs one irrigation required. It is mainly grown as rainfed crop. During summer months 4-5 irrigations are required.

Interculture

In order to facilitate healthy soil atmosphere, soil works like spading, earthing up, etc. are required in aloe plantation. Weeding at regular intervals are some important intercultural operations.

Harvesting

The crop comes to harvesting 8-10 months. The maured leaves are harvested for every 3 months. Commercial yield from second year to upto five years.

Yield

Fresh weight 12-15 t/ha.

The cost of cultivation is Rs.15000-20000/- per acre and the net profit is Rs.40,000/- per acre

TULASI

Botanical name : *Ocimum sanctum*
Family : *Labiatae*
Origin : India

Plant part : Leaves, seeds, roots

Importance

Plant contains phenols, Aldehydes, tannins, saponin and fats, essential oil components – Eugenol (71%) eugenol methyl ether (20%) also isolated terpeneurobsolic acid having anticancer properties.

The fragrant leaves and flowers, in the form of tincture, tea or decoction are considered to be stomachic and expectorant, used in treating coughs, bronchitis, skin diseases, and diarrhea. These preparations are considered to be prophylactic against epidemics including cholera, influenza and malaria. The tulsi seeds, taken mixed in water, juice or cow's milk, are antioxidant, nourishing, mucilaginous and demulcent. They are used in treating low energy, ulcers, vomiting and diarrhea or as an overall tonic. The powder of the dried root, taken in milk, ghee or as a decoction, is recommended to treat malarial fever as an analgesic application to the bites and string of insects and also to increase sexual stamina and prevent premature ejaculation. The herb improves resistance to stress and has a normalizing influence on blood pressure and blood sugar imbalances. Tulsi is likely to prove prophylactic against the negative effects of environmental toxins, including cancer. The plant is also richly endowed with bioavailabel antioxidants, vitamins A and C and calcium. It has marked insecticidal activity against mosquitoes.

Varieties

Two types of *O.Sanctum* Green type (Sri tulsi) second (Krishna tulsi) purple leaves.

Climate and soil

The crop flourishes well under high rainfall with humid conditions. Long days and high temperatures favours good growth and higher yields. Ocimum can be cultivated in wide variety of soils from rich loam to poor laterite soils , saline, alkaline, slightly acidic. Well drained soil suitable for good growth and higher yields.

Propagation

The crop can be propagated **through seeds**. For propagating through seeds, they are to be sown in the nursery beds. For sowing of one hectare about 300g of seeds are required. The nursery should be located preferably in partial shade with adequate irrigation facilities. Soil is worked upto a depth of about 30 cm. well rotten farm yard manure is applied to the soil and prepared to a fine tilth and seed beds of 4.5x1.0x0.2 m size are prepared. As the seeds are minute, the required quantity of seeds are mixed with sand in the ratio of 1:4 and sown in nursery bed, 2 months in advance of the onset of monsoon. They germinate in 8-12 days and seedlings are ready for transplanting in about 6 weeks time at 4-5 leaf stage.

Vegetative propagation:

Tulsi can also be propagated by vegetative method using terminal cuttings with about 90-100 per cent success when planted during October-December months. For this purpose, cuttings with 8-10 nodes and 10-15 cm length are used. They are so prepared that except for the first 2-3 pair of leaves the rest are trimmed off. Later, they are planted in the well prepared nursery beds or polythene bags. In about 4-6 weeks time the rooting is complete and they are ready for transplanting into the main field. The plants are transplanted at a spacing of 40 cm between the row.

Spacing : 40 x 40 cm 40x 50 cm and 50 x 30 cm

Manures

The plant requires about 15t/ha of FYM which is to be applied as basal dose at the time of land preparation. Regarding the inorganic fertilizers application of 120:60:60 kg/ha of NPK is recommended.

Irrigation

In summer 3 irrigations/ month and totally crop needs 12-15 irrigations.

Intercultivation

1st weeding at 30 DAT, 2nd weeding 60 DAT. Depending on the growth and spread of branches, apply fertilizers after weeding.

Harvesting

Harvesting at full bloom stage and first harvest 90-95 after planting and after 65- 75 days intervals. Cut 15-20 cm from ground level.

Yield

About 5 t /ha twice or thrice year and whole herb contain 0.1-0.23% essential oil. Oil yield 10-25 kg/ha.

Lec no. 13: Importance & Scope of Aromatic plants – Lemongrass – Importance - Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.

Importance and scope of Aromatic plants

Aromatic plants: Plants which possess essential oils in one or more plant parts.
Essential oil: Complex mixture of odoriferous steam volatile compounds, which are deposited by plants in sub- cuticular spaces, granular hairs, cell organelles, excretory cavities, canals and heart wood.

Essential oils are produced in plants to attract pollinating agents, to repel animals or pest etc. and to give competitive advantage. Essential oils are secreted in oil glands.

Uses of aromatic crops:

1. Used in food industry for flavoring
2. In perfumery, soap, cosmetics and ice-creams, aerated waters disinfectants, tobacco etc.
3. In Pharmaceutical and drug industries.
4. To manufacture pesticides, disinfectants due to antifungal, antiseptic and insecticidal properties.
5. In paint industry – as solvents.
6. Distilled wastes are used in manufacture of card boards, cheap paper, packing material.

Essential oil industry in India:

In India it is a cottage industry. India is the traditional producer of essential oils such as sandal wood, palmarosa, lemon grass. Indians use the plants and products in rituals, ceremonies. Some aromatic plants find place in ***material medica***, sandle wood, mint and fennel etc.

Distillation process was mentioned in ***charaka*** and ***sushrita samhita*** (written over 3000 to 4000 years ago). India is endowed with various agro-climatic conditions, suitable for growing different aromatic plants.

Essential oil industry is not strong in India because:

1. Farmers are not aware of the significance and profitability.
2. Lack of marketing facilities.
3. High initial investment.
4. Price fluctuation
5. Competition for land domestically.
6. Lack of scientific knowledge on cultivation.
7. Deadly diseases like spike disease of sandal wood or fusarial wilt of Geranium1

8. Lack of germplasm collection and maintenance.
9. Risk, as the produce is priced on the basis of the principle.
10. Larger quantities are required.
11. Lack of testing facilities.
12. Cheaper synthetic substitutes.
13. Dearth of trained personnel.

LEMONGRASS

Botanical name : *Cymbopogan flexuosus*
Family : Graminae
Origin : South-east Asia
Plant part : Leaves

Importance

Lemon grass is a perennial grass species which grow upto 3 meters height. The leaves are like paddy with 125 cm length and 1.7 cm width. The crop was first introduced to India in Malabar region. It is a tropical crop and grown scientifically for oil extraction in some parts of Kerela, Uttar Pradesh and Andhra Pradesh.

Chief constituent of the oil is **Citral**, which is used in the manufacture of **vitamin A** tablets. The oil also contains Myrcene, Terpinene, Beta Terpinelol, Alpha Trpineol, Triphenyl Acetate, Bomeol, Gerainol, Farnesol. Oil has bactericidal, insect repellent, mosquito repellent and medicinal uses. Used in soap and detergent making. Spent grass is good cattle feed and used in making silage. Spent grass is used for preparing card boards, paper and fuel.

Important species of Cymbopogan under commercial cultivation are:

1. **East Indian lemon grass:** *Cymbopogan flexuosus*
   It is indigenous to Kerala. Its oil is known as Cochin oil.
2. **West Indian lemon grass:** *Cymbopogan citrates*
   It is cultivated In Guatemala, Haiti and West Indies.
3. **Jammu lemon grass:** *Cymbopogan pendulus*
   It is cultivated in Jammu and Kangra valley.It is resistant to frost. Growth period is 8-9 months. Period of dormancy begin from December to February.

Varieties

1. OD – 19: released by MAPRS, Odakkali. Belong to East Indian lemon grass. Herbage yield 50-55 t per ha.Oil yield 80-85 kg per ha.Oil recovery 1.2 – 1.5%. Citral content is 80-85 %

2. RRL – 16: Released by RRL, Jammu. Belong to Jammu lemon grass. It is frost and drought resistant.

3. SD - 68: Released by CIMAP, Lucknow. Herbage yield 50-55 t per ha. Oil yield 80-85 kg per ha. Oil recovery 1.2 – 1.5%. Citral content is 80-85 %.

Climate and soil

Tropical plant. Loves hot and humid climate, plenty of sun shine. Rain fall 150 - 300 cm with uniform distribution. Grown mainly as rainfed crop. Lemon grass can also be cultivated as intercrop in coconut and other orchards where 80% of sunlight available.

Hardy and drought resistant crop can be grown on loamy to poor laterites pH 4.5 to 7.5. This crop has soil binding nature, hence useful as vegetative cover.

Propagation

Both by seeds and vegetative means through slips. Slip propagation is better in Andhra Pradesh. Seed propagation covers larger area.

Seed rate: Direct sowing: 20-25 Kg/ha, Nursery : 3-4 Kg/ha.

Seed propagation:
Seeds are formed in November – December.
Seeds are collected in January – February.
Seedlings are to be raised in nursery and transplanted during June – July or October – November.
Slips: Mature clump is divided. Slips are treated for rooting. Rooted slips are used for propagation.

Planting

Land is thoroughly ploughed, leveled. Land laid into ridges and furrows. Planted with the onset of monsoon at 30X30 cm with plant density of 1,11,000 per ha. Wider spacing of 60 x 45 cm or 90 X 60 cm is recommended for over fertile irrigated lands under North Indian conditions. 2-3 seedlings or slips are planted per hill.

Manuring

FYM 25 t/ha and N:P:K @ 50: 45: 35 kg per ha should be incorporated into soil. After every cutting nitrogen @ 60kg/ha is applied as basal per year is adopted.

Irrigation

High rainfall (well distributed) areas does not require irrigation. In dry and low rain fall areas, irrigate the crop at 7 – 10 day interval.

Interculture

Keep the field weed free during the initial 3-4 months and after one month after each harvest. Crop have to be weeded, earthed up, ploughed between rows and fertilized after every harvest. Flowering which occurs during February has to be pinched off.

Harvesting

First harvesting is done in 5-6 months under Hyderabad conditions. 90-100 days (3 months) under Kerala conditions. Subsequently cuttings are given within 3-4 months. The crop is cut 10-15 cm above the ground. Delayed or early harvest reduces citral and oil content. Discard flower stalks from time to time. Three cuttings are taken in the first year. 5-6 cuttings are taken in the subsequent years. Lemon grass is perennial, yield well from 2nd to 4th year. Plantation is economical for 5 – 6 years.

Yield

Herbage : 20-30 t/ha
Oil yield :

First year -- 25 Kg/ha
Second year onwards -- 80-100 Kg/ha

Distillation: Distilled by steam distillation. Either fresh grass is directly distilled or it is first shade dried for 72 hours and then distilled after chopping. The later method was found to be better.

Lec No. 14 : Citronella & Palmarosa – Importance - Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.

CITRONELLA

Botanical name: *Cymbopogan winterianus* – Java citronella
Cymbopogan nardus – Ceylone citronella
Family : Graminae
Origin : Srilanka
Plant part : Leaves

Importance

Java citronella is a perinnial grass. The crop was introduced first in India by National Botanical Research Institute, Lucknow. Citronella oil is raw material for production of geraniol, citronellol, hydroxyl citronellol etc. These are used in perfumery, soaps, cosmetics Used in pharmaceuticals. Used in flavouring industries. Used as a ingredient in mosquito repellent creams. Used in mosquito repellent creams.

Crop is extensively cultivated in Assam particularly in tea gardens, Karnataka and Tamil Nadu. Due to high alcohol content Java citronella have high demand and was found to be the best source of citronella oil.

Varieties:

1. **RRL – Jor – 3 – 1970 :** RRL, Jorhat. Oil has 46.2% citronellol; 28.5% gernaiol.
2. **NBPGR, Delhi** released two strains in Java citronella viz., IW 31243, IW 31245.
3. Bidhan Chandra Krishi Viswa Vidyalaya, Kalyani has developed a selection namely **KS – CW – SI.**

Climate and soil

Thrive well under tropical and sub-tropical conditions. Require humid climate, abundant sunshine, well distributed rainfall of 200 – 250 cm. Long drought spells or excessive rainfall are harmful. Does not like shade, under shade growth is poor, leaf blade become hard and yield less oil. Susceptible to frost**.** Grow well in plains and hills with 1000 -1500 m above MSL.

Humus rich sandy loams are the best. Heavy clay and light textured soils are not good. Calcareous and water logged soils are unsuited. Soil pH 5.0 to 7.5 (optimum 6.0 to 6.5)

Propagation:

Due to irregularities in **Meiosis**, viable seeds are not formed. Therefore citronella is propagating through **slips**, obtained by dividing healthy mature clumps. Each slip should have 2-3 tillers. At the time of planting trim fibrous roots and leaves. One ha citronella produce enough planting material *i.e*. slips for planting in 20 ha of main field.

Land preparation

By ploughing, discing or harrowing, land prepared to fine tilth. FYM plus insecticidal dust, Endrin/ Heptachlor 5% dust @ 50 kg per ha is incorporated in the last ploughing. Apply a mixture of 2,4 – D and Grammoxone @ 25 kg per ha leave for a fortnight to check weeds. Land is laid out into beds with irrigation channels.

Planting

Best time is during South West monsoon. In our state, planting is done during July- August. Spacing adopted is **60 x 60 cm** requiring **28,000 slips** per ha. If climate and soil support luxurious growth **90 x 90 cm** is followed as in the upper Assam. Slips are planted vertically in 10 cm deep pits either on ridges or flat beds. As it is extremely sensitive to water logging, plant on ridges.

Irrigation

Irrigate immediately after planting. Keep the soil moist for 3 -4 weeks, within which

it gets established. Java citronella is grown as irrigated crop in Karnataka and A.P and as a rainfed crop in High rain fall areas like Assam. 16-20 irrigations are required at 7-10 day interval.

Manuring

It is a soil exhausting crop therefore requires liberal application of manures and fertilizers. Apply 10 t/ha FYM . Apply 200 kg Nitrogen, 80 kg P and 40 kg K per hector. Nitrogen is given in 4 splits in North, 5-6 split doses of Nitrogen is given in South. The split doses of Nitrogen are given first one month after planting and the remaining after each harvest at an interval of 3-4 months.

Interculture

Check weeds up to 3-4 months after planting and after each cutting. 3 -4 weedings are required per year. Manual weeding or weeding by running a cultivator is done. Weeding has to be done after every harvest. Earthing up has to be done if roots are exposed out. Flowers have to be pinched off.

Harvesting

The leaves are ready for first cutting is taken **4-7 months**. In Assam and Bengal first cutting is taken in **3-4 months**. Subsequently harvested at 2-3 month interval. In A.P., first cutting is taken **6-7 months** after planting (due to low rainfall and less growth). Three cuttings are taken per year. Possible to take four cuttings per year under good management. Should not be harvested too soon or too late affects the quality of oil adversely. Optimum interval between two cuttings is 90 days; if delayed leaves are partially dried and oil content declines. Leaves are cut 10-15 cm above ground in morning. Only leaf blade should be cut leaving leaf sheath, as leaf sheath contains only little and poor quality oil. Crop is economical for 4 to 5 years. Once in a year clumps are cut close to ground to remove dry leaves and to maintain height.

Yield

Maximum yield is recovered from 2nd to 3rd year. Later it declines. Oil content varies with age, climate, soil fertility and method of distillation.

Year	Herbage	Oil
I	15-20 t	100-120 kg
II	20-25 t	150-200 kg
III	18-20t	150 kg
IV	13-15 t	100 kg

Distillation: Oil is extracted by steam distillation from herbage. Distill soon after harvest. Semi dried leaves are chopped into bits. Delay in distillation affects aroma and colour of oil.

PALMAROSA

Botanical name: *Cymbopogan martini var motia*
Family : Graminae
Origin : India
Plant part : Tender stems, leaves and flower stalks

Palmarosa also known as **East Indian Geranium**. Grows wild in forests A.P, M.P, Maharashtra, Karnataka. It is a perinneal grass which grows 2.5-3 m height.

Importance

The oil obtained from other species ***Cymbopogan martini var sofia*** is known as the **ginger grass oil.** Essential oil from (**Rusha or Rosha**) palmarose is used to extract Geraniol and also used for inscenting soaps, perfumes, tobacco. The oil imparts rose like aroma hence heavy demand. The palmarosa oil occupies 3rd place in the export of essential oil.

Climate and soil

Hardy and drought resistant plant. It grows well in areas receiving 100 – 150 cm annual rainfall. Winter should be less severe. Exposure to sunlight is essential. It does not perform under shade.

Light loamy soils with good water infiltration are ideal. Can be grown in poor sandy to heavy fertile soils, saline, marginal soils also. Prefers well drained soil with P^H 6-7. In soils with P^H above 8.5 the yield decreases.

Varieties

- ✓ IW 31244 : released by NBPGR
- ✓ RRL (B) - 77 and RRL (B) 71: released by RRL, Bhubaneswar.
- ✓ **Trishna** : Hybrid developed by CIMAP, Lucknow. Give 40% more oil and has 93% Geraniol.

Propagation

Palmarosa can be propagated by seed and rooted slips.

By seed: First a nursery is raised. Beds are raised well prepared and well manured. Seeds @ 2.5 kg per ha is sown at 15-20 cm spaced lines. Sowing is done during May – June. Nursery beds are irrigated daily. Germination will be completed within 2 weeks and seedlings ready in 30-40 days (15-20 cm height). Per cent of establishment is higher with seedlings.

By Slips: Slips are collected from elite clump. They are separated and planted during April – May. Ready for transplanting after 3 months during June- July or August - September. Oil yield is higher with clonal propagation.

Land preparation

Plough 3-4 times. Land is laid out into ridges & furrows spaced at 60 cm.

Planting: Planted during June- July at 45 cm apart on ridges. Irrigate immediately.

Irrigation

If rainfall is more than 150 cm, the crop can be grown as rain fed crop. If rainfall is less than that, irrigation has to be given at 7 – 10 day interval. When the crop is fully grown, irrigate at 15-20 day interval. Yields reduced if field becomes dry. Irrigation should be stopped before harvesting.

Manuring

If grown on fertile soils, do not manure during the first year as it promote vegetative growth and reduce oil yield. In less fertile soils, basally 10 t FYM; 20 kg N; 50 kg P and 40 kg K per ha are to be applied. Top dressing with 40 kg Nitrogen each time for three times starting from 45 days after planting is to be done. Application of Zinc @ 12.5Kg increases the yield.

Intercultivation

After every irrigation, soil should be loosened for improving infiltration of water and earthed up.

The crop should be kept free from weeds by regular weeding and hoeing. Two weeding cum hoeing operations are recommended, first 40 days after transplanting and the second 30 - 40 days after the first weeding. Among herbicides, Diuron @ 1.5 kg ai/ha or Oxyfluorfen @ 0.5 kg ai/ha are effective for weed control.

Harvesting

First harvest is taken in 4-5 months after planting. Harvest 15-20 cm above the ground at the time of flowering to early seed formation stage. Subsequently the crop is harvested at 2 ½ to 3 months interval for 3-4 years.

Yield

Herbage - 20 - 30 t/ha/year

Oil : yield increases up to 4 th year.

1st year: 20 kg oil per ha
2nd year: 60 kg oil per ha
3rd year: 70 kg oil per ha
4th year: 70 kg oil per ha

Distillation: Oil is extracted by steam distillation. Herbage is shade dried for 24 hours and chopped for distillation. Oil recovery is **0.3 to 0.4%**. It takes 4 hours for complete recovery of the oil.

Lec No. 15: Vettiver & Mint - Importance - Varieties- Propagation –Planting – Irrigation – Manuring –-Intercultural operations- Harvesting – Yield.

VETTIVER

Botanical name : *Vetiveria zizanioides*
Family : Graminae
Origin : India and Srilanka
Plant part : Root

Importance

The vetiver oil is extracted from the **roots** of grass. Vetiver oil, enjoys world wide reputation, being one of the finest oriental perfumes. Use of vetiver oil is known in India, through several centuries. Vetiver is found wild throughout plains and lower hills (1250 m) in India, Burma, Srilanka. Vetiver is cultivated in Kerala, Tamil Nadu, Rajasthan, Uttar Pradesh and Andhra Pradesh.

Oil from roots is used for soap making, perfumes and attars. Roots are used to make mats, brooms, screens, mattresses along with bamboo. Roots used in pharmaceuticals. Leaves are used as roofing material and for mulching.

Climate and soil

Vetiver survives under any agro climatic conditions. It prefer mild climate for the best performance. It is cultivated in 100-200 cm rainfall in South India, as well as in Bharatpur area in Rajasthan receiving scanty rain. Under temperate or warm winter hilly areas growth is stunted. Shade has unfavorable influence on root growth. It stands well against winds and storms.

Vetiver thrive well in the dry lands of West and sandy soils of East. It grows well in marshy areas of Bharatpur. It can withstand prolonged dry spell as well as water stagnation. Loose sandy soils are most suited. Roots can be easily pulled. Compact heavy soils restrict root growth and pulling out of roots is difficult.

Varieties

Basically there are 2 main types in vetiver viz.,

1. **Seeding type:** They grow wild in North India. Oil from some of the North Indian types has superior aroma. **Ex.** Akhila, Bharatpur, Musanagar.
2. **Non seeding type:** They grow in South India.

IARI developed **three selections**, which give double root yield,Two hybrids Hybrid 7 and 8 superior in root and oil yield.

In Kerala – ODVI 3 hybrid is a superior variety than the local type Nilambur

Propagation

Vetiver can be propagated through tillers and slips. Tillers take long time, hence slips are preferred. Collect slips from previous crop. Plants are cut at 25-30 cm above ground and dug out for preparation of slips. The culms are divided into slips with 2-3 tillers. These slips are jabbed into ground like seedling. Although the growth may be slow initially, the plants develop quickly once roots are established. The plant responds to fertilizers and irrigation with massive tillering, and each tiller can be broken off and planted. From an average sized clump about 20-30 healthy slips can be obtained.

Planting

After division into slips the fibrous roots are also removed leaving 5-8 cm from the base of the root. Slips of 15-20 cm length are planted in lines at 45 x 30 cm spacing. Flat bed planting followed by ridging (after 30 days of planting) produces higher roots and essential oil. Planting is done in holes 5-8 cm deep. The soil around the slips is pressed firmly and leveled. One-hectare area requires about 75,000 slips when planted at 45 x 30 cm spacing.

Best time is June- July, after the monsoon showers. Planting should be done when there is adequate soils moisture.

Land preparation

Plough repeatedly in all directions to achieve fine tilth up to 60 cm. All vegetation, roots, tubers are thoroughly removed. Level the field, lay out into beds of 100 square meters. In these beds, ridges and furrows are laid out.

Manuring

Apply Ground nut cake, wood ash etc, which enhance root yield and and oil yield. Fertilizer requirement per crop cycle (18 months)/hectare is as following:

Basal application
Urea 90 kg
Single super phosphate (SSP) 250 kg
Muriate of potash (MOP) 67 kg
Top-dress (after 4 months of planting)
Urea 45 kg
In second year
During June Urea 87 kg

Irrigation

Irrigate immediately after planting. Give irrigations up to 10-15 days till slips establish.

Inter culture

Weed control is the most important. Weed roots intermingle with crop roots and yield and quality is affected. 3 to 4 weedings are necessary in the first year.2-3 weedings are taken up during second year.

Earthing up after weeding is beneficial to the crop. Earthing up encourages root growth at the crown due to better rhizospheric environment provided to the growing plants.

Shoot cutting

The cutting of aerial portion with commencement of winter (November) increases tillering and consequently gives more roots per plant. Shoot cutting is done twice during the crop cycle. First shoot cutting is done at 30 cm height in planting year to achieve regeneration for second year, while second time cutting is done at 15-20 cm height before harvesting to facilitate digging of roots.

Harvesting

Roots for distillation will be ready for harvesting 18 months after planting. Roots expose to hard surface when the skin is peeled off, thick, hard long and wiry. Give better taste when chewed, will give more oil. Young tender thin roots give poor quality oil. Oil from the old thicker well developed roots is of better quality and darker colour.

Oil content and yield are less during rainy season as the oil is diffused into soil. Plant produce new roots during rainy season oil synthesis is reduced. Harvesting roots during **dry periods** is more preferable.

Above ground portions are cut to 15 to 20 cm above the ground. Clumps are uprooted by digging forks. Soil is dug up to 30 to 40 cm to get 50% roots.Clumps are beaten to remove adhering soil and roots separated from the stem portion with sharp knife. Clean the roots thoroughly in running water and send for distillation.

Yield

4-5 tonnes of roots per ha. It gives 15 to 16 kg of oil and 1 to 1.5% oil on dry weight basis. The oil contains 65 to 75 per cent Veteverol.

Distillation

Oil is extracted by steam distillation. Herbage is steeped in water for 12 hours, chopped to 5-10 cm long bits and distilled.

MINT

Botanical name : *Mentha arvensis*
Family : Lamiaceae
Origin : Mediterranean regions
Plant part : Leaves

Importance

Japanese Mint (*Mentha arvensis var piperascense*) is an aromatic perennial herb, grown as an annual in sub-tropical parts of north India. Mint (foliage) on distillation yields an essential oil, containing high (75 – 80%) menthol content. The oil has a bitter cooling taste, harsh odour and is the principal source of menthol. It is used in combating cold, used as an ingredient in cough drops and related pharmaceuticals, cosmetics, mouth washes, scenting of tobacco products and flavouring of beverages. Its essential oil contains many components phenolic, aldehydes, ketones, and carbohydrates.

Species and varieties

The four most commonly cultivated species are:

1) **Japanese Mint/Menthol Mint (*M.arvensis*):** Japanese mint is a primary source of menthol. The fresh leaves contain .4-6.0% oil. The main constituents of the oil are menthol (65-75%), menthone (7-10%) and menthyl acetate (12-15%) and terpenes (pipene, limonene and comphene).

Varieties :

i) Himalaya (MAS0-1): It is a selection released by the CIMAP Lucknow which contains 0.8 to 1.0% oil (FWB) with 81% methol content and a low congealing point.

ii) Kalka (Hyb-77); It is a tall, vigorous variety evolved by the CIMAP Lucknow.

iii)Shivalik: It was introduced from China and released by the CIMAP, Lucknow.

*iv)*Ec-41911: This is a progeny selection of an interspecific cross between *M.arvensis x M.piperita*.

2) **Peppermint (*M.piperita*):** The fresh herb contains essential oils ranging from 0.4 to 0.6%. The constituents of peppermint oil are almost similar to Japanese mint oil.

However, the menthol content is lower in peppermint oil and varies between 35-50%. The other constituents are menthyl acetate (14-15%), menthone (925%) menthoufuran and terpenes like pinene and limonene.

Varieties:

i)Kukrail: This is a high yielding variety developed and released by the CIMAP Lucknow.

3) Spearmint (*M. spicata*): The principal constituent of spearmint oil is carvone (57.71%) and the other minor constituents are phellandrene, limonene,L-pinene and cinelole. The oil is used mostly as a flavouring in toothpastes and as food flavouring in pickles and spices, chewing gum and confectionery, soaps and sauces.

Varieties:

i)MSS-1: This is a selection from the spearmint cultivars inteoduced from USA. This variety was released by the CIMAP, Lucknow.

ii)MESS-5: It is a selection from MSS-1 made at the CIMAP,Lucknow.

iii)Punjab spearmint-1: This variety is a clonal selection made at the CIMAP, Lucknow

iv)Arka and Neera are the recently released variaties from CIMAP, Lucknow.

4) Bergamot mint (*M. citrata)*

Linalool and linalyl acetate are the main constituents of Bergamot mint oil. The oil is used directly in perfumes. Cosmetic preparations like scents, soaps, after-shave lotions and colognes also contain this oil.

Varieties:

Kiran: The variety produces 239 kg of oil with 48% linalool, over 172 kg and 39% linalool over parent cultures.

Climate

Japanese mint can be grown in all tropical and subtropical areas under irrigation. However, it does not tolerate damp winters which cause root-rot. A temperature of 20-25ºC promotes vegetative growth, but the essential oil and menthol are reported to increase at a higher temperature of 30ºC under Indian conditions. Peppermint and spearmint cannot be grown profitably in tropical and sun tropical areas, especially those areas with very high summer temperatures (41ºC) and the ideal yield is obtained only in humid and temperate conditions like in Kashmir and the hills of Uttar Pradesh and Himachal Pradesh. Open, sunny situations without excessive rains during the growing period are congenial for the good growth and development of the oil. Bergamot mint can be grown both in temperate as well as subtropical area. However, the yield is higher in temperate climates.

Soil

Medium to fertile deep soil, rich in humus is ideal for the cultivation of mint. The soil should have a good water-holding capacity but water-logging should be avoided. A pH range of 6-7.5 is best.

Propagation

Mints are propagated through the creeping stolons or suckers. In the case of peppermint and bergamot mint, even runners are planted. Stolen are obtained from the previous year's planting. A hectare of well-established mint, on an average, provides

enough planting material for ten hectares. About 400 kg stolons are required for planting one hectare of land. The best time for obtaining stolons is during the months of December and January.

Planting

The stolons are cut into small pieces (7-10 cm) and planted in shallow furrows about 7-10 cm deep with a row-to-row distance of 45-60 cm, manually or mechanically. While planting on ridges, the stolons are planted half-way down on the inner sides of the ridges. The plot is irrigated immediately after planting.

Land Preparation

Mints require thoroughly ploughed, harrowed, fine soil. All the stubble of weeds should be removed before the crop is planted. Manuring may be done at the time of land preparation by adding FYM @ 25 to 30 t/ha. Green manuring may also be done before the mint is planted. Sun-hemp (*Crotalaria juncea* L.) is an ideal green manure crop. Mints are planted on flat land or ridges. Hence, flat beds of convenient sizes or ridges are made according to the spacing recommended.

Irrigation

The water requirement of mint is very high. Depending upon the soil and climatic conditions, the crop is irrigated 6-9 times before the first monsoon. The crop requires three irrigations after the monsoons during September, October and November. Sometimes another irrigation is required during winter, if the plant is dormant and there are no winter rains to encourage proper growth of the underground stems. Experiments conducted at Pantnagar have revealed that fifteen irrigation are required to get the maximum herb and oil-yield in Japanese mint. When mints are grown in temperate climates, only 3-4 irrigation during the period from July to October are required.

Manures

Mint responds very well to a heavy application of nitrogenous fertilizers. The increase in herbage by the application of phosphorus is not as remarkable as in case of nitrogen. Generally, nitrogenous fertilizers @ 80-120 kg P and K at 50 kg P_2O_5 and 40 kg K_2O/ha is required for a good crop of mint. However, in M.arvensia an increase of up to 160 kg N/ha and, in M.piperate, 125 kg N/ha has given increased fresh herbage and essential oil-yield. An amount of 100-120 kg N/ha is recommended for producing the optimum herb and oil-yield in *M.citrata* under Pantnagar conditions. A split application of 75 kg N/ha in combination with P at 60 kg P_2O_5/ ha is recommended under Kodaikanal conditions. Potassium application has no significant effect on herb and oil-yield. In *M.spicata*, the maximum herb-yield is obtained with the application of 100-120 kg N/ha. Nitrogen may be applied in three split doses at 1, ½-2 and 3 months after planting and the third dose after the first harvest of the crop.

Intercultivation

Uninterrupted weed growth causes about 60% reduction in herb and oil-yields. Hence, mints require weeding and hoeing at regular intervals in the early stages of crop growth. One hand-weeding is required after the first harvest. Combining organic mulch with a combination of 0.5 kg/ha of Oxyfluorfen herbicide and weeding or application of Pendimethion herbicide at 1 kg/ha and weeding are found to give excellent weed control throughout the crop growth.

Harvesting

Japanese mint is generally harvested after 100-120 days of planting, when the lower leaves start turning yellow. If the harvesting is delayed the leaves start falling, resulting in loss of oil. Further, harvesting should be done in bright sunny weather. Harvesting consists of cutting the green herb by means of a sickle 2-3 cm above the ground. A second harvest

is obtained about 80 days after the first harvest and the third one after about 80 days from the second harvest. Whereas, in peppermint, spearmint and bergamot mints which are grown in temperate climates, the first crop is ready by the end of June and the second in September or October.

Yield

A good crop of Japanese mint can give as high a yield as 48 t/ha of fresh herb. However, the average yield of mints from three cuttings is 20-25 t/ha. The fresh herb contains 0.4% oil.

Distillation of Oil

Mint oil is obtained by distilling either the fresh or the dry herb. The distillation is done both in primitive and modern stills; in the former the principle of water and steam-distillation is followed. While in the later steam generated in a separate boiler is employed. The stems are removed from the dried material prior to distillation, because they constitute 30 to 50% of the material and contain only traces of the oil.

The average yield of oil is 50-70 kg/ha. Although bergamot mint as well as Japanse mint give an average yield of 70-100 kg/ha, the yield of peppermint oil is lower with an average of 50 kg/ha.

Storage of Oil

Mint oil is a light and golden-coloured, motile liquid and it should be completely free from moisture before storage. It is stored in large steel, galvanized steel or aluminium containers, filled up to the brim to protect against any air remaining inside and placed in a cool storage godown, away from light and humidity.

Lec No. 16 : Geranium & Davanam - Importance - Varieties- Propagation –Planting – Irrigation –Manuring –-Intercultural operations- Harvesting – Yield.

GERANIUM

Botanical name	: *Pelargonium graveolens*
Family	: Geraniaceae
Origin	: Cape province in South Africa
Plant part	: Leaves

Importance

It is the source of the one of the most important and **costliest** essential oil. Oil possess strong rose like odour. Chief constituent are Geraniol 68 to 75% and Citronellol (23 – 40%). Geranium oil is widely used in expensive soaps, perfumes and for the production of Rhodnol etc. Demand of oil is 40 to 50 t per year. Internal production of oil is only 20 tonnesfrom about 1400 ha.

Types of geraniums

There are two types of geraniums

1.Rose geranium: *Pelargonium graveolens*

In rose geraniums there are two types.

i)Algerian or tunician: Plant is slender, produce dark pink flowers. It is mostly cultivated. Not suitable for wet soil conditions. Grown in Nilgiri hills.

ii) Bourbon or Reunion: Sturdy plant, produce light pink flower.Suitable for wet soil conditions. Oil quality is superior. Grown in Nilgiris and Annamalai hills.

2.Ornamental geranium: Differ from rose geranium which do not possess essential oil and used as ornamental purposes.

Varieties

Kodaikanal 1: released by HRS, Kodaikanal (TNAU) give high herbage (45.2 t per ha) and oil yield (54 kg) oil contains 60 % of geraniol

Climate and soil:

Can grow in temperate, sub- tropical and tropical climates. Flourish best in Mediterranean type of mild climate. Rainfall 1000 – 1500 mm. Sensitive to frost. Prefers sheltered warm situation. Best temperature is 20-25^{0}C.In India it is cultivated from 1000 – 2700 m. It is grown in the hills of shevroy, Palni, Nilgiri and Annamalai hills and low altitudes of Karnataka.

The crop comes up well in well drained deep, porous soil rich in organic matter.

Slightly calcareous soil with a pH range of 5.5 to 6.0. It is a shallow rooted crop. It is prone to waterlogging as it aggravates disease.

Propagation

Does not set seed in India. Hence propagated through rootedstem cuttings.

Stem cuttings: Terminal stem cuttings are taken from healthy, vigorously growing plants during November. Cuttings are defoliated except top 3-4 leaves. Slant cut is made just below a node. Bottoms of cuttings are dipped in 0.3% Benlate or Bavistin 0.1% and then in Seradix powder. Planted with at least two nodes buried in the soil at a spacing of 5x5cm. Beds are hand watered after planting. As they are sensitive to hot sun, temporary shade is to be provided. Cuttings root in 30-40 days and ready for planting within 60 days after planting. 80 m x 80 m nursery is sufficient for one ha.

Land preparation

Select land on a gentle slope. Crop Stands for 3 - 10 years, hence have a thorough preparation of land. Ploughing, harrowing and planking are to be done thoroughly for preparation of land. Manures, P and K are applied at the last ploughing and incorporated. The land is laid out into ridges and furrows.

Planting: Select sturdy, healthy disease free Rooted stem cuttings with well developed root system and a crown of leaves.

On hills: plant during May – June; **On plains:** December – January.

Dip the cuttings in 0.1% Bavistin and plant on ridges 60 x 60 cm. Irrigate on alternate days for a month and later at weekly intervals. Plants establish within two months.

Irrigation

The crop is raised as an irrigated crop. It is a shallow crop hence needs frequent irrigations.

Manuring

10-20 t of FYM; 35-40 kg N, P2O5 and K2O are applied as basal dose. Top dress with 30 and 40 kg N per ha is recommended at 30 and 90 days after planting. 35 kg Nitrogen per ha is applied at the end of each harvest. Altogether Nitrogen is given in 6 splits per year. The above dose is repeated again.

Intercultivation

Keep the field weed free during the first 2-3 months after planting and up to one month after every harvest. Weed with minimum soil disturbance and for root. From second year, soil should be worked to provide aeration and induce plants to produce more root suckers.

Harvesting

Geranium comes to first harvest in **4-5 months** after planting. Later harvesting is done at the beginning of flowering season. Harvesting is done when the leaves turn light green in colour. Lemon like odour changes to that of rose.

Subsequently the crop is harvested once in 3-4 months for 3-4 years. Tender twigs and terminal portions are harvested for oil extraction. After each harvest spray 0.1% Bavistin or Benomyl, fertilized and irrigated immediately.

Yield

Yield depends on total population in the field. A minimum of 25,000 plants must be maintained in a hectare area. Herbage yield is 30-40 tonnes per ha per year. Oil

yield is 30-40 kg per ha per year. Oil content ranges from 0.1 to 0.15 %. on fresh weight basis. Oil content is influenced by stage of crop and period of harvest. Oil content is higher during summer (April to June). High humidity and rains at harvest lower the oil yield.

Terminal portion with 6-12 leaves contain more oil than the middle or basal portions.

Distillation: Oil can be extracted by Steam distillation of freshly harvested terminals.

Davanam

Botanical name : *Artemesia pallens*
Family : Asteraceae
Origin : India
Plant part : Tender stems with flower panicles

Importance

It is an aromatic herb. It is grown traditionally in India to include tender shoots in garlands. It is less known to the perfumer because of high price of oil (Rs. 15000 – 18000 per kg). The chief chemical constituent of Davanam oil is **Davanone**. **India** is the only country where Davanam is under cultivation. Only in Karnataka it is grown for essential oils. In A.P., it is grown in Krishna, Cuddapah, Chittoor and Guntur districts.

Varieties

CIM-Arogya: Developed through marker assisted breeding. Herb yield is 450-475 q/ha. Artemisinin content is 0.8-1.0%

CIM- Jevanrekha: Developd through selection. Herb yield is 42q/ha. Artemisinin content is 0.5 – 0.6%.

The local varieties are mostly used for cultivation.

Climate and soil

It requires bright sun shine, moderate rainfall, winter without fog. It prefers a temperature range of 20 to 30^0C with least diurnal differences. Cool weather is preferable for oil production (November to March). It can be rationed upto April. At blooming / harvesting, there should not be any showers/ cloudy weather, otherwise oil yield is adversely affected.

It comes up well in rich loams. It can be grown in sandy, red, alluvial soils. Fertile alluvial soils are the best.

Propagation

It is propagated through **seed**. Seeds are very minute 1 gram weighs 6000 seeds. Seeds from current crop are selected for sowing. One year old seeds are more preferable, but seeds more than one year do not germinate. They are non- viable.

Nursery

Raised beds of 2 m long and 1 m width are preferred. FYM @ 10 kg per bed is mixed well in the soil. Seed rate is 1.5 kg per ha in 500 m^2 nursery. High seed rate is to allow losses due to poor germination, damping off, ants and to select healthy seedlings.

Seeds are mixed with sand in 1:11 ratio. Seed bed is kept moistened in a moist cloth for 2-3 days 48-72 hours. Pre germinated seeds are sown on the beds. Beds are dusted with 5% BHC powder against ants and termites, flooded with water, seeds sown evenly on the wet beds. Beds lightly covered with fine sand to avoid washing off.

Irrigate twice a day till the completion of germination and once a day afterwards. Beds covered with dry grass during the day and removed in the evenings. Seeds germinate within 3-4 days. When the seedlings are 2-3 cm long, shade is discontinued and beds watered once in a day. 6 to 8 week old seedlings of 10-15 cm height are transplanted on wet beds at 15 x 7.5 cm.

Time of sowing

Season is unimportant when grown for garlands in which case harvested at 2 months age. Season is important when crop is meant for oil, in which case, harvested at flowering i.e. 4 months age. At this stage flower stalks contain maximum oil.

For oil purpose the crop is sown in September – Octber and transplanted during November – December. By February- March, crop is harvested and ratoon extends upto April – May.

Irrigation

It requires frequent irrigations. Soil should not become dry, otherwise oil yield is affected. Irrigated one day in advance of planting. Beds are irrigated every day for the first 10 days and thereafter once in 2 days.

Manuring

As basal dose 50-60 tonnes of FYM, 40 kg of P2O5 and K2O each per ha Nitrogen @ 160 kg per ha in three splits is to be top dressed. Nitrogen @ 30 kg per ha is applied at 10 days after transplanting for ratoon crop. For the main crop first split is given 10 days after transplanting (DAT), Second split is given 15 DAT,Third split is given 15 DA second split.

Intercultivation

Since close spacing is adopted, crop do not allow weed growth. Two weedings for the main crop once at 10 days after transplanting and the second before the crop covers interspaces. In case of ratoon, remove weeds after 10 – 15 days after harvesting.

Harvesting

First flower bud appear, 2-3 months after transplanting by the end of January. Crop is harvested for obtaining good yield at maximum flowering and quality oil. This stage is normally reached by the end of Februay. Harvest the crop with sickle at 10 cm height from the ground level. Fresh sprouts appear and one more crop i.e. ratoon is taken up after two months i.e. April – May.

Yield

Herbage yield is 10 t per ha.
Oil yield is 10 kg per ha

Oil extraction: Herbage is shade dried for 2-3 days and extracted by steam distillation.