HOR 411 Production Technology of Flowers, Medicinal and Aromatic Crops 2+1

Unit I: Scope, importance and fundamentals of floriculture

Fundamentals of Floriculture – Loose flowers and cut flowers - Classification – scope – area and production – Domestic and export potential of commercial flowers –protected cultivation - propagation – nursery practices – special practices like pinching, training and pruning – role of growth regulators

Unit II: Production and post harvest technology of Loose and cut flowers

Loose flower: rose, jasmine, chrysanthemum, tuberose, crossandra and marigold – Cut flowers - rose, carnation, cut chrysanthemum, gerbera, lilium, anthurium and tropical orchids – Macro and micro climate - varieties – planting methods – nutrient, water and weed management – Irrigation and fertigation — harvest - post harvest management practices – grading and packaging – export standards of loose and cut flowers –flower arrangement.

Unit III: Landscape gardening and lawn making

Ornamental Horticulture – importance of gardening — components of gardening – basic principles of landscaping – Lawn and Lawn making – use of important trees, shrubs ,climbers, plams – annuals – biennials and herbaceous perennials in gardening -designing garden

Unit IV: Production technology of medicinal crops

Medicinal crops- importance and scope – classification -conservation — Good Agricultural practices - organic production and certification - soil and climate – varieties – propagation– planting methods – nutrient, water and weed management – harvest – post-harvest handling – storage, packaging of senna, periwinkle, glory lily, ashwagandha, medicinal coleus, aloe, Isabgol, poppy,– extraction of secondary metabolites.

Unit V: Production technology of aromatic crops

Aromatic crops - importance and scope - classification - soil and climate - varieties - propagation- planting methods - nutrient, water and weed management - harvest - post-harvest handling - storage, packaging of ocimum, davana, Japanese mint, lemon grass, citronella, geranium, rosemary, palmarosa and vetiver - distillation of essential oils.

Lec 1 - Fundamentals of Floriculture – Loose and cut flowers – Classification – Scope – Domestic and Export potential of commercial flowers

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

branch of horticulture which deals with **cultivation of ornamentals**, **annuals**, **biennials** and **perennial plants** including potted ones and also their marketing.

India has a long tradition of floriculture. As it is an ancient creative skill with imagination and an advanced science that played a very important role in the course of human civilization and its social development.

In most part of the country, flower growing is carried out on small holdings and commercial floriculture has assumed importance only in the recent past. Traditionally, flowers have been grown in India in the open fields, where they have been exposed to both biotic and abiotic stresses. Hence, the quality is not up to the standards. However, in the era of globalization, the produce has to be of International quality and globally competitive, as there is lot of demand for different floricultural products in the export market. The modern floriculture will meet the above demand of the present day

The floriculture business is growing in the world at around 6-10 % per annum.

In spite of a long tradition of floriculture, **India's share** in the International market for these flowers is negligible (at present it is < 0.70 %).

During the last few years, taking an advantage of the incentives offered by the Government of India, a number of Floriculture units were established in India for producing and exporting flowers to the developed countries.

Karnataka and TN are the leaders in floriculture (Loose flowers – Tamil Nadu , Cut flowers – West Bengal Combined - Karnataka)

The country's first and the only Digital Flower Auction Centre is located in Bengaluru, running by Karnataka Agro Industrial Corporation (KAIC) at Hebbal.

Floriculture industry

- Cut flowers
- Loose flowers
- Nursery industry
- Seed industry
- Natural dye industry
- Perfume industry
- Dry flower industry

Scenario of floriculture

Global level

- Traditional centres USA, Japan, Italy, Netherland & Columbia
- > New production centres Latin America, Africa & Asia

India

- Huge opportunity sector
- > 38 per cent of the global floriculture area
- ➤ Growth rate of 24 % per annum

Tamil Nadu

- Production 2,01,905 tonnes of loose flowers in an area of 24,750 ha
- Export Sri Lanka, Singapore, Malaysia and Middle East countries & USA

Cut flowers industry

- Flowers with long stem cut individually from the plants with long vase life used for making bouquets and flower arrangements.
- Cultivation of cut flowers is a fast emerging venture.
- Potential money spinner in the floriculture industry.
- Provides more returns per unit area
- Increase in demand for cut flowers in the domestic area is due to the advanced culture, festivals, development of superior varieties and awareness for use of flowers.
- **Total area under flower crops** 2,33,000 hectares, which included traditional flowers marigold, jasmine, aster, rose, chrysanthemum, tuberose and cut flowers carnation, rose, gerbera, gladiolus, anthurium.
- More than 50% of the floriculture units are based in South zone Karnataka, Andhra Pradesh, Tamil Nadu.
- West Bengal, Maharashtra, Rajasthan have large areas under floriculture.

• Returns from floricultural products were estimated at Rs.205 Crores, which included Rs.105 Crores from traditional and Rs. 100 Crores from modern flowers.

IMPORTANCE OF FLORICULTURE IN INDIA

1. ECONOMIC POINT OF VIEW:

- Floriculture is a **fast emerging major venture** in the world, especially as a potential money-spinner for many countries in world.
- Many flowers and ornamental plants are being grown for domestic as well as for export market will provide more return/unit area than any other agricultural/horticultural crops.
- For example in markets such as Delhi and Mumbai and other metros a single spike of gladiolus and gerbera cutflower may sell upto Rs. 3-5 in *Kharif* and Rs. 5-10/spike in Rabi/Summer.
- Gestation period of flower crop is very less compared to other crops.
- Modern-day floriculture refers to the production of high-value cut flowers such as rose, gladiolus, carnation, mums, orchids, tuberose, anthurium, lilium, gerbera etc,
- Now days, growing of these 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 sale of loose flowers of Jasmine, Crossandra, Marigold, China Aster, Chrysanthemums, Berlaria and Gaillardia etc., are a roaring business in south India.
- The present trend in floriculture is for making dry flowers, extraction of natural colours and essential oils and demand for good quality flower seeds and ornamental planting materials.
- At present the global ornamental crop industry is worth about US\$ 70 billion.
- The global consumption of the flowers is about US\$ 35 billion.
- Presently more than 145 countries are involved in flower production on commercial scale.
- More than three lakhs hectare area is under flower production in different countries of the world.
- Floriculture generates **self-employment opportunities** round the year. The employment opportunities in the field are varied such as.

One can join the floriculture field as farm/estate managers, plantation experts, supervisors and project coordinators and so on. Teaching, Research and Extension scientists/ teachers are some other avenues of employment in all SAUs and NARS. Marketing of Floriculture products for different ventures is emerging as a potential segment of this field. Besides, one can also work as consultant, landscape architect etc with proper training. One can also work as entrepreneur and offer employment to others. In addition to these careers which involve research and actual growing of crops. Floriculture also provides service career opportunities which include such jobs like floral designers, grounds keepers, landscape designers, architects and horticultural therapists. Professional qualification combined with an inclination towards gardening and such other activities produces efficient floriculturists and landscaping professionals all over the globe.

2. AESTHETIC POINT OF VIEW:

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

Horticultural therapy - is the new dimension of horticultural sciences to heal the psychic debility and the science is to use garden, landscape plants, parts of plants, growing activity as tools to work. The bio-force of plants offer a permanent solution to the problems of bio force of human thus, bio aesthetic horticulture is emerging as a new occupational therapeutic tool to restore the lost rhythm and harmony back to human self or inner environment. It is being utilized in psychiatric hospitals, general

hospitals and physical rehabilitation centers, homes for elderly, prisons and schools. The patients can achieve higher level of personal development and satisfaction.

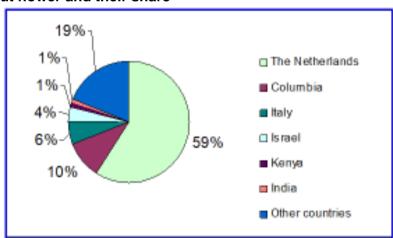
3. SOCIAL POINT OF VIEW:

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

Major International markets

- The Netherlands (59 %)
- ❖ Columbia (10 %)
- ❖ Italy (6 %)
- USA
- ❖ Australia
- France
- Germany
- UK

Countries dealing cut flower and their share

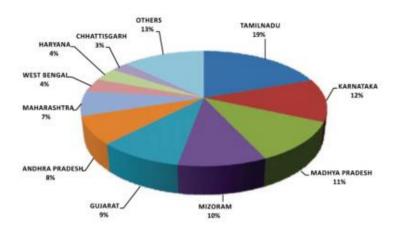


New markets: Japan, Northern America, South East Asia and Gulf countries **Area and production of flowers in India (2013-14)**

Year	Area	Proc	duction		
	(in 000' HA)	Loose (in 000' MT)	CUT (Million flower)		
2007-08	166	868	43654		
2008-09	167	987	47942		
2009-10	183	1021	66671		
2010-11	191	1031	69027		
2011-12	254	1652	75066		
2012-13	233	1729	76732		
2013-14	255	2297	540 (in '000 MT)		

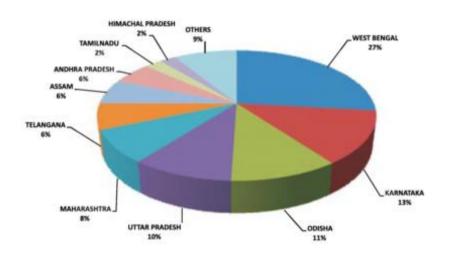
Source: Indian Horticulture Database, 2015

LEADING LOOSE FLOWER PRODUCING STATES IN INDIA (2013-14)



Source: Indian Horticulture Database, 2015

LEADING CUT FLOWER PRODUCING STATES IN INDIA (2012-13)



Source: Indian Horticulture Database, 2015

Seven floriculture zones of Tamil Nadu

Zones	Loose Flowers							
Hosur zone	Jasmine, Marigold, Chrysanthemum, Tuberose, Gomphrena							
2. Hill area zone	Chrysanthemum, Marigold							
3. Coimbatore zone	Jasmine, Scented rose, Tuberose, Chrysanthemum, Crossandra, Marigold, Gomphrena, Celosia							
4. Madurai zone	Jasmine, Scented rose, Tuberose, Crossandra, Marigold, Gomphrena, Nerium							
5. Chennai zone	Jasmine, Crossandra, Marigold, Tuberose							
6. Kanyakumari zone	Jasmine, Scented rose							
7. Trichy zone	Jasmine, Scented rose, Crossandra, Tuberose							

Nursery industry

- Increasing demand for horticultural crops more particularly fruit and ornamental ones in both urban and rural area of India
- The demand for good quality planting materials has gone up.

- Nursery business has developed rapidly in the recent years in our country.
- Nursery product is no longer restricted to orchards or large parks and gardens. It has entered into high rise buildings, officers, factories, business houses, hospitals, hotels, backyards, roadsides in cities, roof tops, etc. for decoration purpose.
- Heavy demand is observed during festive seasons and seasons of fairs and meals
- Ornamental nursery business has therefore come up in a large scale in areas near city and towns.
- 50000 nurseries propagating different ornamental plants engaging about 1500000 people in the nursery business.
- More than 85% of the nurseries are in urban areas.
- Many firms such as AV Thomas, SPIC Biotech, Growmore Biotech etc. are involved in the micropropagation of internationally leading cut flowers and exporting them to the countries involved in their production.

Seed Industry

- Seed is a vital input
- India having favourable climatic condition for seed production
- Indian seed industry 6th position
- In India, Punjab occupy first place in flower seed production
- Private and public sector companies/corporations are involved in the seed production
- The private sector companies around 150 seed companies, which include national and multinational companies and other seed producing/ selling companies.
- In India, we produce the open pollinated seeds in bulk particularly in the surrounding areas of Ludhiana, kalimpong, Ranchi, Bangalore, Ooty and Kashmir Valley.
- Around 60 per cent of the total seed production is from Ludhiana.
- Rest of the production comes from Srinagar, Kullu Valley, ranchi, Kalimpong and Terai areas.
- At present, the Tamil Nadu government is considering setup of a flower seed production centre in the Nilgiris of Tamil Nadu.

Perfume industry

- Jasmine, Tuberose, Scented rose, Michelia champaca, Pandanus odoratissimus, Artabotrys odoratissimus.
- Uttar Pradesh & Pujab Rose oil, rose attar, rose water and gulkhand
- Coimbatore & Madurai jasmine concrete

Trade of essential oil at Global level

- India is the second largest producer of essential oil in the world after USA.
- Largest exporter of jasmine in the world accounting for over 40 per cent of total world exports in jasmine oil.
- The leading export markets for Indian jasmine oil are France, accounting for 36 per cent of total jasmine oil exports from India, followed by UAE, USA, Germany and UK.
- Rose oil commands highest price in the international essential oil markets closely followed by jasmine oil.

TANFLORA

- Hosur (Krishnagiri Dt.)
- Tamil Nadu Industries Development Corporation (TIDCO) & CCL Flowers Pvt. Ltd., Bangalore
- APEDA 348.66 lakh
- Total area of the park 80 ha
- Growing area 50 ha
- Model units 30 ha

Challenges before the Indian Floriculture Industry

India's share in world floriculture trade has been negligible compared to some other countries the reasons being

- 1. Quality parameters are high internationally, like output free from diseases, proper handling at various stages of transport etc. anything less than this will not be tolerated.
- 2. Availability of dedicated cold storage facility at airports, farms are very low, airlines too prefer less volume cargo making things more difficult for exporters.
- 3. Size of farms in India is quire small as compared to some countries thereby there is no royalty this increases cost of planting materials.
- 4. Most of the farmers depend on seeds imported from other countries for which they pay royalty, this increase cost of planting material.
- 5. One of the major issue is environmental cost, use of chemicals in cultivation which affect the final output and health of workers is also major cause of concern.

Suggestions for improving fortunes of Indian Floriculture Industry

- Improvement in infrastructure facilities for transport of flowers for export market, increase in cold storage facilities for preserving flowers.
- Workshops on floricultural skills, introduction of new cultivation techniques, a strategic alliance with tourism industries.
- Promotion of floricultural products by local and national governments with targeted marketing to new customers (e.g. government departments, hotels, tourists etc.,).
- Postharvest production, information and management.
- Genetic improvement of cut flowers varieties.
- Research priorities at flower research institutions throughout Asia could be directed towards developing innovative solutions which supported global sustainability.
- In addition to above measures, unifying the image of flowers produced in Asia to create an identity of Asian floriculture would be bold step. Then, this could be implemented by introducing an Asian calendar of floral holidays which indicated particular flowers and how they are used in association with these holidays.
- For example, in China, on a certain day in the autumn, the moon and all things associated to be round like the moon are appreciated.

SCOPE TO ENTER FLORICULTURE INDUSTRY IN INDIA

- India is blessed with varied and dynamic agro-climatic condition, good quality soil and water made suitable for floriculture.
- Geographically India is well located between two major markets i.e., Europe and East Asia.
- Winter is being very mild and hence there is lot of scope to export Indian flowers to temperate countries during the winter season, when the demand is in peak because of important winter festivals like Christmas, New Year Day and Valentine's Day.
- Labour cost is very low in India, nearly 10-15 times cheaper than that of similar employees in the Netherlands, Israel and Japan.
- The Government of India has identified floriculture as "Extreme Focus Thrust Area" for export during IX plan.
- With the implementation of GATT agreement European nations has brought down the import duty on floricultural products, which at present is 15 %.
- The International market is growing @ 8-10 % annually. The International demand is around Rs. 90,000 crore/ year and domestic market at 20-25 %. Hence, the scope to enter floriculture industry in India is unlimited.
- The Govt. of India has setup the infrastructure for floriculture industry in major cities like New Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Pune etc.
- APEDA is giving financial assistance to some extent for various activities connected with export of floriculture products.
- Easy bank financing for hi-tech floriculture.
- 100 per cent export oriented units (EOU"s) are located in and around Andra Pradesh, Tamil Nadu, Karnataka, Haryana, Maharashtra and West Benghal
- For 100 % EOU"s the government has allowed to sale 50 per cent of produce in domestic markets. 100 per cent tax exemption has given on implements / raw materials used in greenhouses. The rules and regulations related to import and exports have been minimized.
- Singapore is the nearest International standard flower auction centre, helpful for Indian exports.
- Floriculture products posses 25-30 time more foreign exchange earning ability than cereals or any other agricultural/horticultural products.

- Floriculture is capable of attracting and retaining large number of progressive farmers / entrepreneurs.
- Due to ample sunlight and optimum temperature during winter, it does not require artificial lighting or heating for green house production of cutflowers.
- The Government of India has identified product specific zones for selective research and development (Table-1) of floriculture.
- APEDA and GOK have established four flower auction centers including one in Bengaluru, Noida (UP), Mumbai and New Delhi.
- APEDA also has setup a marketing center at Aalsmeer (The Netherlands) to promote Indian produce.

Product specific floriculture zones in India

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

PROBLEMS / CONSTRAINTS FOR FLORICULTURE INDUSTRY IN INDIA

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

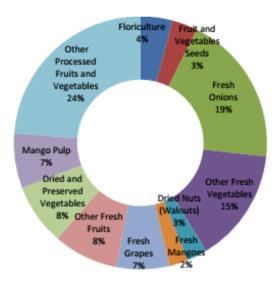
- Lack of knowledge about importing and exporting countries.
- Lack of quality consciousness of the produce. This affects the floriculture industry as a whole.
- Lack of sale promotion activities in India.
- Lack of market intelligence regarding leading varieties, selling price, etc.

AREA AND PRODUCTION OF FLOWERS IN THE STATE AND THE COUNTRY

- India ranks 2nd next to China with an area of 1, 91,000 hectare and produces 1031 thousand metric tons of loose flowers and 66,671 lakh cut flowers annually (2010-11).
- Tamil Nadu is a leader in flower production; it occupies 31,970 ha followed by Karnataka (25, 100 ha), West Bengal (21,940) ha and Andhra Pradesh (21,400 ha).
- Floral products exported: Cut flowers, pot plants, cut foliages, seed bulbs, tubers, rooted cuttings, dried flowers or leaves.

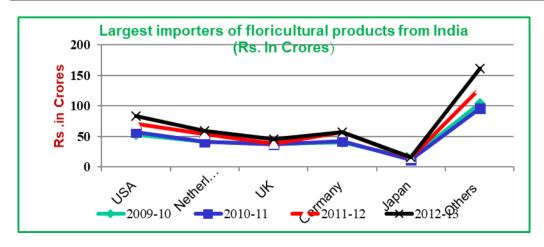
Commodity wise share of exports of Horticultural products from India 2012-13

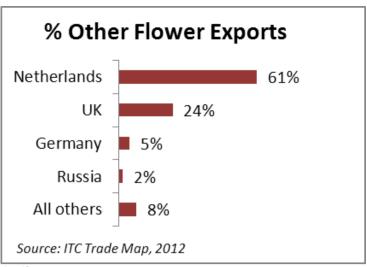
India's total export of floriculture: Rs. 455.90 crores (2013-14)



Largest importers of floricultural products from India (Rs. In Crores)

Country	2009-10	2010-11	2011-12	2012-13
USA	53.06(I)	56.87(I)	71.29(I)	83.87(I)
The Netherlands	41.18(II)	41.62(III)	54.13(III)	59.70(II)
UK	37.88(IV)	37.62(IV)	38.56(IV)	45.68(IV)
Germany	40.65(III)	42.81(II)	57.53(II)	56.75(III)
Japan	15.59(V)	11.52(V)	14.72(V)	15.67(V)
Others	105.10	96.01	129.09	161.79
Total	294.46	296.0	365.32	423.4





Cut Rose Export from India

- India is the largest supplier of roses to USA, Australia, Singapore, Japan, Malaysia and Gulf Countries.
- 4 crore flower stems produced by small, medium and big farmers have been exported for Valentine's Day this year (2014).
- Apart from Valentine's Day, demand peaks around Christmas, New Year's Day, Mother's Day and Father's Day.
- Demand increased by 20 to 30 per cent every year.
- Export prices per stem Red rose varieties Taj Mahal Rs 25 to Rs 30; Grand Gala Rs 20 to Rs 25 and First Red Rs 15 to Rs 20.
- Area of cut-flower cultivation in the Hosur district increased from 150 hectares to 170 hectares in 2014 (40 % of total area under cultivation)
- Corporate houses in the floriculture business in Pune and Bangalore, the countries major rose growing areas, are gearing up to export lakhs of roses to world markets

Export of Jasmine flowers

- ✓ Exported to : Gulf countries, Singapore, USA, France etc.,
- ✓ Reason : Due to large Indian population settled in abroad.
- ✓ Need : Religious functions and weddings

Export of xanthophyll from marigold in India

- Promotion of larger area cultivation through contract farming
- Industries / Organization involved
- M/s AVT Natural Products Ltd., Sathyamangalam, Erode; M/s Olive Life Sciences Pvt. Ltd., Bangalore, Karnataka

Applications

- Oleoresin
- Natural lutein
- xanthophyll

Export potential of potted plants from India

- Major importers U.K, USA and Germany
- Major markets Europe, South East Asia, Japan, Hong Kong and Singapore
- Popular potted plants Begonia, Yucca, Chrysanthemum, Poinsettia and Dieffenbachia
- Demand for Ficus, Dracaena, Azalea and Kalanchoe

Dry flower export from India

- Have good demand in Indian and international markets.
- Exported to countries like USA, Japan and Europe.
- India stands first in dry flower export availability of variety of plants.
- Export of dried flowers and plants from India is about Rs 100 crore per year.
- Industry exports 500 varieties of flowers to 20 countries.
- Widely used to make

- handmade paper,
- lampshades,
- candle holders,
- iute bags.
- photo frames,
- boxes, books,
- wall quilts,
- topiary,
- cards and several gifts.
- Export of dried flowers from Tuticorin & Trichy Rs 60-80 crore worth exports annually.

EXPORT MARKET FOR INDIAN PRODUCTS

- Traditional flowers like jasmine and tuberose are being exported as fresh flowers to Malaysia,
 Singapore,
 Sri Lanka and Gulf countries from India.
- The international market price for Jasmine concrete and absolute oil is around 30,000/- and 60,000/- per kg, respectively. The exported flowers fetch 30 crores to 40 crores foreign exchange annually.
- Extracting essential oils from flowers is another major industry in India.
- The rose petals are also used to prepare rose water and gulkand. These products are being exported to UK, France, Germany and Middle East countries.
- Tuberose flowers are used for extraction of oils and it is considered as the high value concrete in the world market.
- Tissue cultured plants of jasmine; scented rose etc. can also be propagated and supplied to Taiwan, Korea and Japan.
- All these floricultural products can be sold in the International market at Singapore.
- The varied agro climatic conditions prevailing in the country with ample sunshine can maintain regular supply of any floricultural commodity throughout the year.
- India"s geographical location particularly its proximity to the developing Far East, offers tremendous competitive advantage.

WORLD FLORICULTURE TRADE:

- The Global trade in floriculture products is recorded in terms of live plants and bulbs, cut flowers and cut foliage.
- World imports cut flowers and foliage together accounts for a share of 51 to 55 % whereas, live
 plants and bulbs accounts for 45 to 49 %. Floriculture industry has been the monopoly of a few
 countries (mainly Netherlands),
- Netherlands is the largest trader of floricultural products, with a lion"s share of 70% followed by Columbia 12% and Israel with 6% share of the global floriculture trade.
- India"s share in the total world export being less than 1%. The new markets for Indian flowers may be Japan, Northern America, South East Asia and the Gulf countries.

TOP TEN CUT FLOWERS AND POT PLANTS IN THE WORLD TRADE

- Cut flowers Rose, Chrysanthemum, Tulip, Lily, Carnation, Gerbera, Freesia, Cymbidium, Alstroemeria, Limonium
- Pot plants Ficus , Dracaena , Kalanchoe , Chrysanthemum , Begonia, Hedera , Azalea , Saintpaulia , Hydrangea , Spathiphyllum

INDIAN SCENARIO

- In India, floriculture industry comprises, Flower trade, Production of nursery plants and potted plants, Seed and bulb production, Micro propagation and Extraction of essential oils and natural pigments.
- Major Import Markets For Floriculture Product Europe is the largest market for floricultural products. Among the major importing countries Germany, USA, France, U.K and Netherlands together accounts for nearly 64 % of the world imports.

- Germany is the single largest market accounting for nearly 25 % of the world imports.
- (APEDA) and National Horticulture Board (NHB) have also helped for export promotion.

INSTITUTIONAL ASSISTANCE TO FLORICULTURE HI-TECH PROJECTS:

- 1. NABARD Soft Loan Assistance:
- 2. NATIONAL HORTICULTURE BOARD (NHB):
- 3. APEDA SCHEMES TO ASSIST EXPORT ORIENTED FLORICULTURE
- 4. Nationalized banks viz., State Bank of India, Canara Bank etc.,

Questions

Part A.

- 1. India's share in the International market for these flowers is ------(< 0.70 %).
- 2. ----- is the largest trader of floricultural products.(Netherland)
- 3. India stands first in -----(Dry flower export) with of variety of plants.
- 4. The international market price for Jasmine concrete and absolute oil is around -----(30,000/- and 60,000/- per kg).
- 5. -----(Singapore) is the nearest International standard flower auction centre, helpful for Indian exports.

Part B.

- 1. Write top 10 cut flowers that are exported
- 2. What are the major components in floriculture industry?

Part C.

- 1. Write in detail about scope of floriculture industry in India
- 2. Write in detail about Horticulture therapy
- 3. Wrtite about SWOT of floriculture in Tamil Nadu.

Lec 2. Propagation and nursery practices and special practices like pinching, training and pruning

Propagation and Nursery Practices

Nursery is a place where seedlings, cuttings and grafts are raised with care before transplanting. It acts as a temporary home for young plants until they are eventually planted in a permanent garden.

Advantage of raising seedlings in nursery

- 1. It is very convenient to look after the tender seedlings
- 2. It is easy to protect the seedlings from pests and diseases
- 3. Economy of land usage (duration in the main field is reduced)
- 4. Valuable and very small seeds can be raised effectively without any wastage
- 5. Uniform crop stand in the main field can be maintained by selecting healthy, uniform and vigorous seedlings in the nursery itself.

Selection of site

- 1. The nursery area should be nearer to the water source
- 2. Generally, the location should be partially shaded i.e. under the trees. If not, artificial shade is to be provided
- 3. It should be well protected from animals
- 4. Proper drainage facilities should be provided.

Selection of soil

A medium textured, loam (or) sandy loam soil is preferred. Soil should be rich in organic matter. Soil depth should be preferably by 15-25 cm.

Types of nursery bed

- a) Flat bed b) Raised nursery bed.
- Preparation of raised nursery bed

Selected soil should be worked well to break the clods. Weeds, stones and stubbles should be removed. Height of the raised bed should be 10-15 cm with a width of 1 m and length may be according to the requirement and conveniences. Two parts of fine red earth, one part of sand and one part of FYM can be incorporated to each bed to improve aeration and fertility of the soil. Before preparing the bed, the soil should be drenched wit 4% formaldehyde or 0.3% copper oxy chloride to kill the pathogenic spores in the soil.

Advantage of raised nursery bed

- 1. Water movement will be uniform and drainage of excess water is possible (In the case of flat bed water moves from one end to the other and there is possibility of washing away of seeds).
- 2. Germination percentage of seeds is normally high. Operations like weeding and plant protection measures are easy.

Seed treatment

The seed should be treated with Captan (or) Thiram (2g) or Carbendazim @ 1 g per kg of seeds 24 hours before sowing to control the seed borne pathogens. Micro organism inoculants like Azospirillum or Phosphobacteria can be mixed with rice gruel @ of 250 ml per packet of Azospirillum or Phosphobacteria, seeds treated and dried under shade before sowing. Normally two packets (400g) are needed for treating the seeds required for one hectare. These inoculants are helpful in getting healthy vigorous seedlings in the nursery itself so that the correct population can be maintained in the main field.

Sowing of seeds

The surface of the bed should be leveled by using a wooden plank. Straight lines are made across the bed at a spacing of 10 cm and to a depth of 1-2 cm; Seeds are sown in the lines and covered with sand or fine soil or powdered FYM. Line sowing of seeds facilitates easy weeding; drenching of chemicals and removal of disease infected seedlings. Depth of sowing determines the rate of emergence. If it is too shallow, the seeds come up and dry out early. If it is too deep, the seedlings emergence is much delayed. So, a thumb rule is followed sow the seeds approximately at a depth of 3-4 times the diameter of the seed. After sowing the seeds, the bed is covered with paddy straw and watered using a rose can so as to avoid packing of the soil and washing away of seeds. Watering should be done twice daily till the seeds germinate. Mulches should be removed after germination and watering once a day will be sufficient. A week before transplanting the seedlings should be exposed to full sunlight and the number of watering should be reduced so that the seedlings become hardy to bear the shock of transplanting in the main field.

COMMERCIAL FLOWERS										
S. No.	Flowers	Botanical Name	Family	Propagation method						
1.	Rose	Rosa sp	Rosaceae	budding						
2.	Mailigal	Jasminum sambac	Oleaceae	Ground layering/cutting						
3.	Mulial	Jasminum auriculatum	Oleaceae	Ground layering cutting						
4.	Jathimaili	Jasminum grandiflorum	Terminal outtings							
5.	Crossandra	Crossandra Infundibuliformis	Acanthaceae	Seeds/suckers						
6.	Chrysanthemum	Chrysanthemum Indicum	Asteraceae	Suckers, Termina cuttings						
7.	Tuberose	Pollanthes tuberosa	Amaryllidaceae	bulbs						
8.	Marigold	Tagetus sp.	Asteraceae	Seeds						
9.	Anthurium	Anthurium andreanum	Araceae	Suckers & TO Plants						
10.	Orchide	Dendroblum sp.	Orchidaceae	Off-shoots (Ke kis)						
11.	Asiatic IIIy	Lillum asiatica	Lilliaceae	Bulb 10-12, 12-14 cm						
12.	China Aster	Callistephus chinensis	Asteraceae	Seeds						
13.	Statice	Limonium sinuatum	Plumbaginaceae	Seeds						
14.	Limonium	Limonium latifolium	Plumbaginaceae	TC Plants						
15.	Alstroemeria	Aistroemeria aurantiaca	Alstroemeriaceae	Rhizomes						
16.	Lislanthus	Eustoma grandiflorum	Gentianaceae	Seeds/TC plants						
17.	Gypsophila (Baby's breath)	Gypsophila repens	Caryophyllaceae	TC Plants/ Seeds						
18.	Bird of paradise	Strelitzia reginae	Strelitziaceae	Suckers/ seeds						
19.	Calla IIIy	Zantedeschla aethiopia	Araceae	Rhizomes						
20.	Snap dragon	Antirhinum majus	Plantaginaceae	Seeds						
21.	Freesla	Freesia alba	Iridaceae	Seeds/suckers						

Special Practices And Intercultural Operations In Flower Crops

A. LOOSE FLOWERS

Rose

1. Pruning

Need for Pruning

- 1. To balance the vegetative growth with floriferousness
- 2. To improve flower production
- 3. To improve the flower quality
- 4. To remove the diseased and unproductive growths and develop clean strong shoots.
- 5. To thin overcrowded canes and open up the canopy
- 6. To facilitate cultural operations
- 7. To rejuvenate older/ aged plants and improve plant vigor,

- Pruning Season

Under protected conditions, roses are pruned approximately 45 days prior to the requirement of flowers. Pruning is done during March and October for garden roses under open conditions depending on the growth and climatic conditions.

- Intensity of pruning

Based on the intensity, pruning is of three types

- a. Light pruning: After thinning out, the healthy shoots are cut at 2ndor 3rdbud
- immediately below the flower bearing point. Strong and vigorous plants are pruned light.
- b. Moderate pruning: Cut back the ripe main shoots and laterals of previousyear growth at an outward growing eye at about ½ the length of the growth.
- c. Hard pruning: Weak plants are hard pruned keeping only 3-4 shoots of last

year and heading them to 3-4 eyes from the base. Basal pruned shoots produce vigorous shoots.

- Method of pruning

Generally cutting back the vigorous past season shoots to half the length is advised. During pruning, remove unproductive, overcrowded and diseased shoots. Cut back the stems to be retained based on the requirement. It is necessary to cover the cut ends with fungicidal spray or paste immediately after pruning.

- Rejuvenation Pruning

After 5-6 years, the plants are to be rejuvenated to develop vigourous shoots. Cut back all the main branches at 15-20 cm from the base. Apply Bordeaux paste or Copper oxychloride + Carbaryl 50 WP over cut ends to prevent diseases and insect damage.

2. Pinching

Removal of part of terminal growing portions is known as pinching. It is mainly done in young budded plants to promote laterals. The maturity of flower bud is also delayed by pinching. If the blind shoots that appear healthy are pinched then it may induce flowering.

3. Disbudding

Young vegetative buds in the leaf axils of basal and lateral shoots are disbudded to encourage branching and to obtain long terminal shoots to develop long stemmed quality blooms. Undesirable buds are removed keeping only the central bud intact. The flowers produced due to this operation are of bigger size and best quality. In Hybrid Teas, often there are 2-3 small buds along with the terminal flower bud. These side buds should be removed to develop showy blooms

4. Deshooting

This is mainly done in hybrid teas. The young vegetative shoots developing from leaf axils of basal and lateral shoots are removed. If deshooting is not done, the entire plant gets crowded, becomes unhealthy and unproductive. This also increases the yield up to 50-75%.

5. Defoliation

Defoliation is the removal of leaves during pinching manually (or) using chemicals. This improves the flower production. When the uppermost axillary bud fails to grow after flower harvest removal of subtending leaf resulted in bud growth.

6. Removal of faded and mature flower

Earlier removal of faded flowers encourages strong laterals with good quality flowers. If these are not removed, then it may form _Hips' (rose fruit) which ultimately affects the growth and flowering. Faded flowers also serve as a dwelling point for pathogens.

7. Removal of root suckers

Sometimes suckers arise from roots. These root suckers should be removed periodically whenever they appear.

Jasmine

1. Pruning

Pruning is a crop regulation practice that influence growth, flower bud formation, flower bud differentiation and flower production. By pruning the balance between vegetative growth and reproductive growth is achieved. Pruning also helps to remove unwanted and diseased shoots and direct the growth and development of remaining shoots.

- Time of Pruning

In jasmines, irrigation is withheld for about 10 days before pruning and all the past season shoots are to be removed. Leaves are stripped off and the cut ends after pruning are smeared with Bordeaux paste. Pruning can be done at a height of 45 cm from ground level. The pruning season varies with the species as given below.

Species	Pruning height	Pruning season
Jasminum sambac	50 cm (From the ground level)	Last week of November
Jasminum auriculatum	45 cm (From the ground level)	Last week of January
Jasminum grandiflorum	45 cm (From the ground level)	Last week of December

Chrysanthemum

1. Pinching

- After planting, the growth of the plant is upward with very little branching.
- To arrest such tall growth, a simple procedure called _pinching' is used. It is also called _stopping'.
- Only soft vegetative shoot tips 1.5 to 3 cm long are removed.
- Pinching is one of the most important cultural operations.
- Pinching is most essential for small flowered chrysanthemum.
- Pinching increases the number of flowering stems in each plant; it can indirectly control flowering date and bloom quality; and the number of stems to a plant can easily be controlled.
- (a) Soft pinching: By this pinching the top soft tips of the shoot along with 2-3 openleaves are removed;
- (b) Hard pinching: It means removing a longer portion up-to hard shoot.

2. Disbudding and De-shooting

This is performed for large flowering and decorative type chrysanthemums.

- Standard types are disbudded in which the largest terminal bud is reserved and all axillary buds are removed.
- Disbudding of spray types is very easy because in this case only the large apical bud is removed and the axillary buds are allowed to develop.

For taking three blooms per plant, three lateral strong shoots are allowed to grow and others are removed. Lateral buds and side shoots are removed at their early stage of growth from time to time.

For taking one bloom per plant no pinching is done. Only the main stem is allowed to grow.

Removal of undesirable lateral buds and shoots are done. De-shooting is practiced to reduce the number of branches for improving the size and form of the flower.

3.De-suckering

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

Staking of plants

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

Marigold

1. Pinching

Removal of apical portion of shoot is called pinching. In case of tall cultivars of marigold, the plants grow straight upwards to its maximum potential height and later develop a terminal flower bud. Early removal of terminal portion of shoot promotes large number of lateral shoots resulting in well shaped bushy plant and more number of good quality uniform flowers. This is due to the breaking of apical dominance and sprouting of auxiliary buds. Pinching is done on 40 days after transplanting.

B. CUT FLOWERS

Cut Rose

1. Disbudding:

Varieties produce some side buds below the center bud. These side buds have to be removed or disbudded. The disbudding must be done regularly and also as soon as possible in order to avoid large wounds in the upper leaf axil.

2. Dead shoot removal:

In the old plants the dead shoot or dried shoots on plants will serve as the host for fungi. So regularly these have to be removed.

3. Bending:

Leaf is a source of food for every plant. There should be balance between Source (Assimilation) and sink (Dissimilation). After planting, 2 to 3 eye buds will sprout on main branch. These sprouts will grow as branches and these branches in turn form buds. The mother shoot is bend on 2nd leaf or nearer to the crown region. The first bottom break or ground shoot will start coming from the base. These ground shoots form the basic framework for production and thereon the ground shoots should be cut at 5th five pair of leaves and medium ground shoots should be cut at 2nd or 3rd five pair of leaves.

4. Defoliation:

The removal of leaves is known as defoliation. It is done mainly to induce certain plant species to flower or to reduce transpiration loss during periods of stress. Defoliation may be done by removal of leaves manually or by withholding water. The shoots are defoliated after pruning.

Carnation

1. Netting

Carnation crop has the tendency to bend unless supported properly. Hence the crop needs support while growing. Good support material is metallic wire woven with nylon mesh. At every two meters the wire should be supported with poles. The poles at both the ends of bed should be strong. Metallic wire is tied around the bed along the length with the support from supporting poles. Across the bed, nylon wires are woven like net. For an optimum support, an increasing width of the meshes can be used bottom net can be of 10x10cm, then two nets of 12.5x12.5cm and the upper most can be 15x15cm.

2. Pinching

Pinching refers to breaking out tip of budding and encouraging growth of side shoots. Depending upon the need of crop spread

- a) Single,
- b) Pinch and half and
- c) Double pinches are given.

Ideal time for pinching is morning. When the plant attains 6 nodes, the first pinch is given. This is referred as _single pinch'. This would give rise to six lateral shoots. With a _one and half pinch', 2-3 of these lateral shoots are pinched again. For the _double pinch', all the lateral shoots are pinched off.

(1) Single pinch

In this method, the top of the main or leader shoot is removed leaving 5 pairs of leaves. This leads to development of 4-5 lateral shoots. These lateral shoots will produce flowers at the same time. This method is particularly applicable to cultivars which produce higher proportion of quality blooms like the hybrid standard carnations.

(2) Pinch and-a-half

This method is followed to regulate the supply of flowers throughout the year. It involves the removal of main stem tip to induce 4-5 lateral shoots. When these lateral shoots develop 5-6 pairs of leaves, only half the number

of the lateral shoots are pinched. This method provides steady supply of flowers but reduces the quantity of the first crop.

(3) Double pinch

In this method the main shoot is pinched once followed by pinching of all the lateral shoots arising from the first pinch when they are about 6-8 cm long or develop 56 pairs of leaves. This method produces larger number of flower bearing shoots but produce weak shoots and poor quality flowers. So this method is not commonly followed.

3. Disbudding

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

4. Calyx banding

Calyx banding is the practice of tying a rubber band or plastic tape around the calyx of the flower bud when it just begins to open. It helps to minimize the occurrence of calyx splitting which is a physiological disorder in carnation.

Ouestion bank

Part A.

- 1. -----(4% formaldehyde or 0.3% copper oxy chloride) is used to kill the pathogenic spores in the soil.
- 2.Micro organism inoculants used for seed treatment is-----(Azozpirillum/Phosphobacteria)
- 3. Removal of part of terminal growing portions is known as----
 - **a. pinching** b.disbudding c.bending d.pruning
- 4. -----(Calyx banding) is the practice of tying a rubber band or plastic tape around the calyx of the flower bud

Part B.

- 1. What are the advantages of raising seedlings in nursery?
- **2.** What is rejuvenation pruning?

Part C.

- 1. What are the special inter cultural operations in marigold and chrysanthemum?
- 2. Explain about training and pruning in Rose

LEC 3 – ROSE VARIETIES – PACKAGE OF PRACTICES (BN – Rosa spp, F- Rosaceae, O – Asia and Europe)

INTRODUCTION: It is one of the Nature's Beautiful Creations". Hence, it is universally acclaimed as the Queen of flowers. Rose is considered as National flower of England. It is the largest traded flowers in the world, worth 1.5 billion dollars globally. The Holland alone 500 million dollars and is growing 7-8% annually.

IMPORTANT ROSE IMPORTERS AND EXPORTERS:

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

USES:

- 1) Garden display:
- 2) Standard roses (Hybrid Tea roses):
- 3) Climbers
- 4) Hedges or Edges

- 5) Rockeries
- 6) Pot plants
- 7) Hangers
- 8) Loose flowers
- 9) Cut- Flowers
- 10) Perfume and Allied Products:

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

Rose oil (Rose perfume): It is also obtained from rose petals, sweet fragrance; medicinal properties; used in Ayurveda. Bulgarian **rose otto** is largely used in perfuming soaps & cosmetics. Used in flavoring soft drinks and alcoholic liqueurs. **Species suitable are:** Rosa damascena, R. borbouniana, R. centifolia, R. alba & R. gallica. In India R. damascena and R. borboniana are cultivated for rose oil. **Gulkhand:** Rose petals are also preserved for direct consumption prepared by beating equal proportion of petals and sugar – considered as tonic and laxative. R. damascene, R. chinensis, R. gallica, R. pomifera & some other scented roses like Edward roses are commonly used.

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

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

As a source of vitamins: Rose hips (Fruits of rose) are very good source of ascorbic acid (Vit. C).

12) Other uses: In Europe, roses are also used for preparation of pot-pourri, conserves, rose vinegar and rose petal wine.

CLASSES OF PRESENT DAY GARDEN ROSES:

- 1) Hybrid Tea: A cross between hybrid perpetuals and Tea roses; most popular rose. Bears large & highly centered flowers. Eg: "La France" (1867) First cultivar of hybrid tea group.
- 2) Floribunda (Hybrid polyanthas): A cross between a Hybrid Tea x Polyantha. They combined the beautiful forms of the Hybrid Teas with the perpetual flowering habit of the Polyanthas. Flowering in clusters with small size and open centre.
- 3) Hybrid perpetuals They are the immediate forerunners of Hybrid Teas.
- 4) Teas: Also called "Tea scented China roses" they derived their names from their distinct aroma
- **5) Grandifloras:** Mainly obtained from crosses between Hybrid Tea and Floribunda type.
- **6) Polyanthas:** Dwarf with small flowered polyanthas is the forerunner of Floribundas. Blooms for several months.
- 7) China roses, 8) Miniature / Button Roses, 9) Climbers and Ramblers, 11) Bourbon rose, 12) Cabbage roses, 13) Moss Roses, 14) French roses, 15) Albas, 16) Musk roses, 17) Noisette roses, 18) Rugosas19) Austrian briars

Important Species and varieties: Edward Rose (Paneer rose) - *Rosa bourboniana* and Andhra Red Rose (*Rosa centifolia*) and Button rose are found mainly under cultivation. At present there are more than 20,000 cultivars of roses, differing widely in form, shape, size, colour, fragrance and flowering habit.

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

CLIMATE: The most important factors are light (photoperiod, intensity and quality), temperature (aerial and root zone), humidity, CO2, ventilation, etc. **LIGHT INTENSITY:** 6000-8000 ft candles. In general rose requires bright sunshine for the whole day. It should be free from shades of trees and protected from the strong winds. **TEMPERATURE:** It is another imported factor regulating growth and flowering of roses. It affects both quality and quantity of flowers. Mild temperature is very important about 15.5°C is ideal for its cultivation because of this reason in winter we get good crop. On sunny days 25-30°C. Whereas on cloudy day it must be 18-20°C. However a maximum of 28°C in day and 15-18oC in the night will be ideal for rose production. **HUMIDITY:** RH is very important with respect to pests and disease incidence especially mildews and black spot as they are closely associated with high RH in

greenhouses as the high humidity results in condensation of water on flowers and leaves. About 60% RH is the most ideal for rose production.

PROPAGATION OF ROSES:

Methods: Seed propagation and vegetative propagation:

Vegetative propagation: **1. Cutting:** Propagation of roses by cuttings normally done to raise root stocks for grafting or budding. Also for multiplying vigorous types of cultivars. Climbers, ramblers, polyanthus and miniature roses respond quite well to this method.

- **a. Stem cuttings:** Easiest and least expensive method. Each shoot should be cut clean just below the node and lower leaves are removed. Cuttings may be single, double or triple-eyed bellow for rooting. The cuttings are are dipped in IBA or IAA @ 500 ppm.
- **b. Budding:** The most commercial method for hybrid cut roses. Provides larger number of plants than cuttings, layering or grafting, as a single shoot of the desired scion furnishes a number of buds for budding. T-budding or shield budding is commercially practiced.

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

ROOT STOCKS:

- 1. Rosa bourboniana (Edourad rose
- 2. R. canina inermis (Dog rose)
- 3. R. indica var.odorata: Tolerent to powdery mildew & other insects. Resistance to extreme soil conditions.
- 4. R multiflora var. inermis Briar Root stock

SEASON - June - July , Hot summer, heavy rains - planting avoided **SPACING**

- Essential oil extraction 2 x 1 m
- Vigorously growing cultivars: 60 x 75 cm / 75 x 75 cm
- Pit size: 45cm³
- · Immediately after planting stake the plants.

IRRIGATION: Adequate soil moisture is very much essential throughout the vegetative and flowering stages of roses. Water logging condition is not good for rose cultivation. The frequency of irrigation depends on stage of crop growth, soil texture/ type of media, climate and type of production-field or pot culture. Normally the lighter soil requires more frequent irrigation than heavy soils. In general water the rose beds once in a week or 10 days in winter and twice a week during the summer season. Drip irrigation is ideal for roses.

MANURES AND FERTILIZERS:

FYM - 20 kg/plant

Biofertilizers

Soil application of 2 kg each of Azospirillum and Phosphobacteria per ha at the time of planting. It is to be mixed with 100kg of FYM and applied in pits.

Macro nutrients

NPK - 6:12:12

Vigorous cultivars - 12:24:24g/plant

Application in 2 splits:

- (1) After pruning in Oct
- (2) July

Foliar nutrition - Micro-nutrients

MnSO₄ (20g) + MgSO₄ (15g) + FeSO₄ (10g) + Boron (2g) per litre of water - bright colour

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

WEED CONTROL: Weeds pose very serious problems in rose cultivation. Manual method is effective, if it is done properly and frequently. However, chemical method is economical, convenient and efficient in eradicating weeds by one or two applications. Eg: 2, 4-D @ 2 kg 1600 liter per hectare (before flowering) controls broad leaved weeds.

PRUNING:

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

The pruning consists of two operations:

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

OBJECTIVES OF PRUNING:

- i. To remove the unproductive growth, because rose plant bears flowers on a new shoot.
- ii. To ensure production of large number of strong and healthy shoots.
- iii. To improve the flower production with quality.
- iv. Pruning will force the eye bud to produce the strongest shoot.
- v. It keeps the rose bush in proper shape and size.
- vi. To allow light and air to reach the centre of the rose bush.
- vii. To facilitate various cultural operations like hoeing, weeding, soil scraping, sterilization, manuring so also harvesting the long and straight stems.
- viii. To rejuvenate the old plants. Cut off the old plants from the base to get strong shoots.

TIME OF PRUNING:

- The most usual time for pruning is during October-November after rains are well over and the cold season is approaching.
- The staggering of pruning at weekly interval from September end to October end will provide a regular supply of flowers throughout the winter.
- In some regions pruning is practiced twice a year, i.e. in May and October for monsoon and winter flowering, respectively.

WHERE AND HOW TO PRUNE? Every rose stems has eyes (buds) alternating on opposite sides in the leaf axils (usually outward and inward). The basic rule in pruning is always to make the cut about half a centimeter above a vigorous bud that finds in the direction one desires the new shoot to grow. While making the cut care should be taken not to make it too high above the eye (bud) as there may be chance of die back of shoot. On the other hand if the cut is very nearer to the bud, it may die due to want of sap flow. So cut one inch above the bud. It is absolutely necessary to cut the sharp end clean because the broken tissues, bruises or hanging shreds of bark will invite for infestation of pests & diseases. All the cut ends should be pasted with cane sealer (copper fungicide) against the attack of fungus and cane boring insects. Within a fortnight after pruning new flush of growth will start and within 45 days of pruning new flowers are ready for harvesting.

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

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

١. ا						

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

2. Moderate pruning:

☐ Healthy shoots are pruned back to 45-60cm from the base.

- Continionly practiced in nonbundas and tri 10363.
3. Hard pruning:
☐ Here keeping only three or four shoots of the last year growth and heading back at about three or
four eyes from the base.
□ Practiced for rejuvenation of old bushes and weak plants
□ Pruning is done by leaving 10-30cm from the bud joint.

SPECIAL CULTURAL PRACTICES TO IMPROVE THE QUALITY OF ROSES:

Commonly proceed in floribundes and UT recognition

- 1. **Thinning:** Removal of the undesirable growth like inward growth, weak stems, blind shoots, crowded growth.
- 2. **De-suckering:** The operation of removal of suckers from root stock i.e. the shoots produced below the bud union on rootstocks is called de-suckering.
- 3. **Pinching:** Removal of a part of terminal growing portion of stem is called pinching. It is done to reduce the plant height and to promote auxiliary branching. Pinching of blind shoot is beneficial to increase flowering.
- 4. **Disbudding:** Removal of undesirable buds is known as disbudding. Keeping only the central bud and removal of others cause development of a quality bloom. It is done in standard/HT roses to reduce number of flowers.
- 5. **Removal of young vegetative shoots:** This practice is also known as **de-shooting.** It is generally followed in HT roses. Young vegetative shoots developing from the axils of leaves of basal and lateral shoots are removed to allow only one terminal shoots. It is important from the point of stalk length.
- 6. **Defoliation:** Under special conditions it is followed, but it has reported that removal of leaves from rose plants will increase number of blind shoots, It will force the plants to produce growth and flowering during desired period.
- 7. **Use of growth substances:** To some extent some growth regulators like GA3 and retardants like CCC are used to get more number of flowers with good quality. GA3 @ 250ppm has been found to increase the stalk length, flower size and reduce number of blind shoots.
- 8. **Removal of faded flowers:** If the opened blooms are not removed in time, there is chance of developing fruits bearing seeds. Once the hips are formed and reach the advanced stage of development, growth and flowering are severally reduced during the season; Cutting of faded flowers will force to produce strong lateral shoots which will produce good quality flowers.

HARVESTING:

Flowering: 1 st year onwards Economic yield: 2nd – 10th year

Harvesting stage: For loose flower - when flower bud is half open, For concrete - fully open flowers

- Flowers are plucked daily in the early morning hours before sunrise when they have higher concentration of oil.
- These are transferred to well aerated bamboo baskets before processing
- These are distributed to the market in bamboo basket which should be covered under moist muslin cloth.
- ❖ PH handling: flowers are cooled down to 2-4°C for 5-6 hrs.

Yield: 7.5 t/ha, Oil recovery: 0.025 – 0.030%, Oil yield: 0.80 – 1.00 kg/ ha, Concrete: 0.35 – 0.45%, Absolute: 0.15- 0.20%

Part A		
	1.	Dried rose petals are known as(pankhuri)
		Rose hips (Fruits of rose) are very good source ofa.Vitamin A b.Vitamin.B c.Vitamin C. d.Vitamin D Number of cultivars in rose are(20,000)
	4.	(GA3 @ 250ppm) has been found to increase the stalk length, flower size and reduce number of blind shoots.
Part B		
	1.V	Vhat is Gulroghan and how it is used?
	2.V	Vhat are the types of roses?

Part C

- 1. What are the special cultural practices to improve the quality of roses?
- 2. Write in detail about types and steps in rose pruning

LEC 4 - JASMINE - VARIETIES - PACKAGE OF PRACTICES

BN - Jasminum spp. F- Oleaceae , O- Originated from Asia, Africa, Afghanistan, Persia, China, Malaysia

INTRODUCTION - Jasmine (*Jasminum* spp.) is one of the oldest fragrant flowers. Jasmine being one of the important commercial flower crops is cultivated in India. As many as forty species of their genus are known to be in India.

IMPORTANT SPECIES

- 1. Jasminum sambac: Gundu malli /Malligai / Arabian jasmine / Tuscan jasmine
- 2. Jasminum auriculatum: Mullai / Vasantha Mallige
- 3. Jasminum grandiflorum: Jathimalli (or) Pitchi (or) Spanish Jasmine
- 4. Jasminum pubescens (multiflorum) Kakada / Star jasmine

USES AND IMPORTANCE

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

Distribution - In India it is being grown in 8000 hectare area. India exports – to Sri Lanka, Singapore, Malaysia and Gulf countries

COMMERCIALLY IMPORTANT CULTIVARS: (Refer manuals)

- 1. Jasminum auriculatum (Malligai /Vasantha mallige) Cultivars- Parimullai, CO 1 and CO 2
- 2. Jasminum grandiflorum (Spanish jasmine) Cultivars- CO 1, CO 2 and Arka surabhi.
- 3. *Jasminum sambac (Gundu mallige)* Cvs : Ramanathapuram, Gundumalli, Khoya and Arka Aradhana, Ramabanam madanban, Single mogra, Double mogra, Soojimalli, Kasthurimalli

CULTURAL REQUIREMENTS:

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

PROPAGATION AND PLANTING MATERIAL: Jasmines are commercially propagated by cuttings and layering. Growth regulators. IAA (or) IBA treated at 1000 ppm for terminal cuttings and 2500 ppm for semi-hard wood cuttings.

- J. sambac Semi-hardwood cuttings.
- J. auriculatum Semi-hard wood
- J. grandiflorum Terminal cutting

Best rooting medium is sand: Vermiculate: moss at 1:1:1 ratio.

PLANT SPACING, DENSITY AND SEASON

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

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

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

NUTRITIONAL REQUIREMENT

Species	Fertilizer dose					Intervals	
Jasminum sambac	FYM	10	kg	and	NPK	at	Two split dose
	60:120	0:120	g/p	olant			
Jasminum auriculatum	FYM	10	kg	and	NPK	at	Bimonthly interval

	120:240:120 g / plant						
Jasminum grandiflorum	FYM		•	and	NPK	at	Two split dose
	120:240:240 g / plant						

FOLIAR NUTRITION: Spraying of zinc 0.25% and magnesium 0.5% before flowering increases the yield of flowers. Spray FeSO4 at 5g/lit. at monthly intervals until the chlorotic symptoms disappear.

IRRIGATION: Plants are irrigated by flooding once in a week. Sufficient amount of moisture in the soil is necessary for proper growth and flowering. Jasmines can be irrigated once in ten days depending on the soil and climatic conditions.

Special practices (Refer manual also) PRUNING

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

Species	Pruning height	Pruning season
Jasminum sambac	50 cm (From the ground level)	Last week of November
Jasminum auriculatum	45 cm (From the ground level)	Last week of January
Jasminum grandiflorum	45 cm (From the ground level)	Last week of December

WEEDING: Commonly done manually but is expensive. Chemical weed control is effective and economical.

Spraying with Oryzalin 1 or 2 applications is effective. Mulching also reduce weed population.

HARVESTING: Jasmine gives economic yield only from the third year and up to 12-15 years and then starts declining in their yield. The stage of harvest depends on the purpose of flowers to be harvested. For fresh flowers, fully developed unopened flower buds are picked in the early morning, while for extraction of concrete only fully opened fresh picked flowers are required. Picking of flowers after 11am will considerably reduce the yield and quality of the concrete. Pluckers collect the flowers in a bag. Care should be taken to see that the flowers are not badly handled. Wrinkled and damaged during harvest and transit will affect fresh flowers and concrete recovery will be affected and the entire product may be unmarketable. The contamination will reflect in the quality of the concrete. While picking and transporting care should be taken not to damage the flowers. The damaged flowers yield concrete with more percentage of unwanted wax and other plant materials. The flowers harvested should be stored in a cool atmosphere and processed within a maximum period of two hours.

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

POST HARVEST HANDLING - Lesser shelf life- Problems faced by the farmers- during the peak season of the flowering. Fully developed flower buds soaked in the chemicals viz., Boric acid 4% keeps the flowers fresh for two days without losing its fragrance

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

YIELD: Flower and concrete yield in jasmines vary considerably according to the species and cultivars and management practices.

Species	Flower (kg/ha)	yield	Concrete recovery (%)	Shelf flowers	life	of
J.auriculatum	4636 – 9022		0.28 to 0.36 (13.44 to 28.24 kg/ha)	28-30 hrs	;	

J.grandiflorum 4329 – 10144 0.25 to 0.32 (13.85 24 hrs

to 29.42 kg/ha)

J. sambac 739 – 8129 0.14 to 0.19 (1.18 28-30 hrs

to 15.44 kg/ha)

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

FLOWERS: For extraction of concrete, only freshly picked fully opened flowers are required. Jathimalli flowers open in the evening between 5-7 p.m. The fully opened flowers have to be picked in the early morning preferably before 9.30 a.m., Delay in picking flowers after 9.30 a.m. results in gradual reduction of concrete yield. Picking the flowers after 11.00 a.m. will considerably reduce the yield and quality of concrete especially in the hot climate. Therefore, it is essential to pick the fully opened flowers in the morning before it becomes hot. The flowers should be harvested and transported in clean baskets or cloth bags. The flowers should be picked in such a way that at the time of picking, the sweat, dirt etc., of the picking personal do not contaminate them.

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

PROCESSING: Processing of jasmine flowers involves two steps.

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

STEP I

SOLVENT TREATMENT: Flowers are soaked in Food Grade Hexane (Having Boiling point of 70oC). Mixing Hexane 2 litres / kg of flowers for 30 minutes Rotate the container slowly for 20 minutes in the rotary type of extractor. Perfume substance along with wax and pigments dissolved in Hexane.

STEP II

EVAPORATION: Perfume laden solvent is led into the evaporator Evaporation at a constant temperature of 75oC Vapour of the solvent condemned into liquid for recycling Liquid (Perfume, wax & pigments) is distilled in a vacuum distillation unit for complete removal of solvent in the still Floral concrete settled in the still in the form of molten wax Cooled and Stored in glass (or) aluminum containers

Based on the above principle, Tamil Nadu Agricultural University, Coimbatore has designed a pilot plant for extraction of floral concrete. It has essentially four steps viz.,

(1) Extractor (2) Evaporator (3) Condenser and (4) Vacuum Distillation Unit.

MAJOR CONCRETE EXTRACTING UNITS

- Pushpak Fragrance Nilakottai
- Hindustan Essential oils Nilakottai
- ENCEE Aromatics Mettupalayam
 Flavors and Fragrances Coimbatore

OFF SEASON FLOWERING

- No continuous or uniform supply of flowers to the market round the year because of the peculiar flowering habit.
- Peak production- 8 to 9 months
- Peak flowering dose not coincide with the greatest demand
- Effect of pruning and the GR application like CCC, MH and Alar for the induction of off season flowering

- GA₃ spray at 10 ppm Early stage improves vegetative growth, longer shoots, increase flowering
- CCC- 1000 ppm induce more lateral shoots and flowering & SADH- retards growth
- GA₃ 100 ppm induces longer shoots and delay flowering
- Removal of water shoots
- · Looks healthy and unproductive
- It will utilize the nutrients and water from the plant

Question bank

Part A

- 1. Scientific name for Spanish jasmine is----
- a.J.grandiflorum b.J.sambac c.J.multiflorum d.J.pubescens
- 2. Jasmines are commercially propagated by -----(cuttings and layering).
- 3. Spacing for planting *J. sambac* is ---- (1.25 m x 1.25 m)
- 4. -----(Boric acid 4%) keeps the jasmine flowers fresh for two days without losing its fragrance.
- 5. Pruning time for *J. auriculatum* is -----(Last week of January)

Part B

- 1. What are the foliar nutrients employed in jasmine flower production?
- 2. What are the parameters considered in grading of jasmine flowers

Part C

- 1. Write in detail about Jasmine concrete extraction
- 2. Explain about off season flower induction in Jasmine

Lec 5 - CHRYSANTHEMUM - VARIETIES - PACKAGE OF PRACTICES

Common Name : Chrysanthemum

Scientific Name : Dendranthema grandiflora Tzvelev

Family : Asteraceae Origin : China

Plant type : Chrysanthemums are <u>herbaceous perennial plants</u>.

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

IMPORTANCE AND USES

- ✓ In India too, chrysanthemum occupies a place of pride both as a commercial crop and as a popular exhibition flower.
- ✓ It has a wide range of type, size and colour and also "forms".
- ✓ Short day plant 'Photo sensitive' (10 hours day light)
- ✓ The erect and tall growing cultivars are suitable for background planting in borders or for cut flowers.
- ✓ The cultivars with the dwarf and compact growing habit, on the other hand, are suitable for front row plantation or pot culture.
- ✓ The decorative and fluffy bloomed small-flowered cultivars are ideal for garland making and hair decoration.
- ✓ The extra-large-bloomed cultivars for their exhibition value.
- ✓ Tall growing type suitable for background planting in borders.
- ✓ Dwarf growing for flower beds and pot culture (pot mums)
- ✓ Loose flowers garland, veni, worship etc.
- ✓ Long stem flowers cut flowers for Bouquet, Vase etc.
- ✓ Chrysanthemum morifolium is also an important source of essential oil and sesquiterpenoid alcohol.
- ✓ The species like *Chrysanthemum cinerariifolium* and *C. coccineum* are also being cultivated as sources of pyrethrum and an important insecticide.

Varieties

There is large number of cultivars in chrysanthemum. Most of the varieties of chrysanthemums are short day plants, some are day neutral in their response. The chrysanthemum varieties can be classified into different groups as mentioned below.

Based on usage: field mums, cut mums and pot mums etc : Several colour forms and numerous cultivars are available for different usages

Examples:

For exhibition: Snow Ball (white); Chandrama (Yellow); Bravo (red) For pot culture: Topaz (yellow); Sharad shoba (white); Alison (mauve)

For cut flower: BirbalSahni (white), Flirt (red), Nanako (yellow); Reagen series

(different colours)

For field production as loose flower: CO 1, MDU 1 For bedding and borders: Eg. CO 2; Indira, Usha Kiran

CLASSIFICATION

Classification is made based on the size, shape of flower, arrangements of florets and purpose used

I. Small flowered mums / type

1. Single

Ray florets are arranged in a single row with prominent central disc.

Ex : Potomac

2. Semi double

Ray florets are arranged in more than one row with prominent central disc.

3. Anemones

Prominent centrally raised hemispherical cushiony disc florets surrounded by short rounded or flat or twisted or quilled ray florets.

Ex. Golden sands. White sands



3. Korean single

Small flowers with a prominent central disc, ray florets are flat, number of whorls or ray florets are five and less than five.

Ex: Cardinal, Gul-e-Sahir, Chairman



4. Korean double

The number of whorls of ray florets is more than five and the central disc is open.

Ex: Flirt, Man Bhawan



5. Spoon

The outer ray florets are tubular with a spatula or spoon like opening at the tips.

Ex: Anokha



6. **Decorative**

Fully double flowers with flat petals and central disc is generally absent or not seen, ray florets are long.

Ex: Elegance, Blue chip, Dolly



7. Quill

Ray florets are tubular, straight and not coiled.

Ex: Golden crystal, Snow crystal



8. Button

Very compact, small flowers (2 - 3 cm in diameter).

Ex: Golden dust



9. **Pompon**

The flowers small, freely opened, compact, hemispherical or ball shape, the central disc is concealed or absent, florets neatly arranged.

Ex: Apsara, Jayanthi, Lameo, Dandy, Eve



II. Large flowered mums/types

1. Incurved regular

The outer ray florets curve upwards and inwards towards the disc florets to form a globular shape.

Ex: Snow ball, Sonar Bangla, Chandrama



2.Incurve irregular

The outer ray florets incurve loosely and irregularly and do not form a ball as in case of regular.

3. Refluxed

The outer ray florets curved outwards and downward away from the centre so that only their upper surface is seen.

Ex: Cresta, City Beauty, Golden Rule, Day dream, Peach blossom, Sweet Heart

4.Intermediate

The inner florets incurved and outer florets are refluxed, they are intermediate in shape to incurved and refluxed.

Ex: John Reid, Lady Hope town

5.Spider

The outer ray florets are large, elongated, tubular and curved to form a hook or coil like structure at the tip of the petals.

Ex: Rupasi Bangla, Mahatma Ganthi

6.Quill

The outer ray florets are elongated, straight and tubular like a quill with tips open but not flattened.

7.Exhibition

The outer florets are refluxed and inner florets incurred. Ray florets are generally twisted, irregularly overlapped each other and look attractive.

8.Ball type

Ray florets are straight and radiated in all directions to give a complete ball shape.

besides the above, there are 10 classes in small flowered chrysanthemums such as Anemone, Buttons, Single Korean, Double Korean, Decorative, Pompon, Semi quilled, Quilled, Stellate and Cineraria.

The descriptions of some of the classes are given below:

Buttons: Small compact flower heads (not more than 3 cm), with hemispherical florets radiating. Single Korean: blooms flat with visible disc; strap like ray florets arranged in 5 or less whorls Double Korean: blooms flat with visible disc; strap like ray florets arranged in more than 5 whorls.

Stellate: flowers like single Korean, florets reflexed; may or may not be twisted

Cineraria: flat Korean type with size not more than 3 cm.

B. Based on the temperature sensitivity to flowering

- i. Thermo-zero cultivars: varieties which flower at any temperature between 10-27°C and most consistently at 16°C night temperature. They are capable of flowering in wide range of temperatures and not highly sensitive.
- ii. Thermo-positive cultivars: Flowering is inhibited by low temperature. A minimum of 16°C required for initiation and at 27°C there will be rapid initiation but delayed flowering.
- iii. Thermo-negative cultivars: Flowering is inhibited by high temperature. Bud initiation occurs at low or high temperature between 10°C and 27°C but continuous high temperature delay bud development.

In some varieties, the temperature and light levels may interact and affect the flowering and seasonal production

C. Based on duration

Early varieties: blooms in 90 days from final transplanting Medium varieties: take 100-110 days to bloom from transplanting









Late: Requires more than 110 days to bloom from transplanting

Varietal descriptions

Brief descriptions of the some of the important varieties developed at different research institutions are given below:

Indian Institute of Horticultural Research (IIHR), Bangalore

- **a. Chandrakant**: Flowers are decorative; white; 124 days to flower; dwarf; plant height of 39 cm; flower diameter 4.7 cm; flower weight ~ 1.85 g; It is floriferous; 149 flowers/ plant; yield 272 g per plant; can be used as loose flower.
- **b. Kirti**: It is a hybrid between Angela x G.P.1; early (88 days); white; double Korean type of flowers which fades to pink tinge; suitable for bedding and potting; can be used for floral decoration.
- **c. Chandrika**: A white flowered hybrid obtained by crossing Angela x G.P.1; decorative; can be used as cut flower in flower arrangement, bouquets and as loose flowers for Pooja and floral decoration.
- **d. Indira**: A cross between an open-pollinated seedling of 'Lord Doonex' numbered LD14 (imperial purple) and a hybrid seedling of 'Flirt' x 'Valentine' numbered FxV-1 (beet root purple); ideal for cut flower purpose, religious offerings, wreaths, bedding and potting.
- **e. Arka Swarna**: A cross between 'Nanako x CO 1'; Pompon yellow flowers; suitable for cut flower and loose flower purpose.
- **f. Ravi kiran**: One of the hybrid produced by crossing cultivars 'Flirt' x 'Valentine'. Flower colour is greyed-red fades to greyish-orange; suitable as cut flower and can be used in flower vases or in bouquets; vase life of 12 days.
- **g. Red Gold**: A cross between 'Flirt' (Current red) x 'Valentine' (Amethyst violet); flowers in 120 days; for cut flowers; bedding, potting, and wreaths and for religious offerings.
- **h. Yellow Gold**: Yellow flowered; induced mutant of the red flowered variety 'Flirt' obtained by gamma irradiation; ideal for loose flower and suitable for cut flower (spray type) purpose
- i. Arka Ravi: It is a cross between Mundial and Hybrid 87-17-1; can be used for cut flower.
- **j. Arka Ganga**: A cross between Flirt and Red Gold; takes 127 days for flowering; produces 143 flowers per plant; white colour with pink tinge; vase life of 11 days; suitable for loose flowers and as cut flower.
- **k. Usha Kiran**: An induced mutant from Kirti; takes 121 days for flowering; suitable for bedding /potting and loose flower purpose
- **i.Arka Pink Star:** It is half sib selection from cv.Punjab Gold.It takes 63 days to flower.produces 318 flowers per plant. Flowers are attractive pink with semi double flowers.Suiatble for bedding and pot plants.
- **j.Nilima**: It is hybrid between Flirt X Valentine. It takes 115 days to flower and produces 144 flowers per plant. Flower yield per plant ranges from 281 -300g.suitable for cut flower and floral decorations.
- **k.Pankaj**: It is hybrid between Lord Doomex X -14 (Flirt X Valentine)s. It takes 115 days to flower and produces 114 flowers per plant. Flower yield per plant ranges from 350-360g.suitable for cut flower and floral decorations.
- **I.Rakhee**: It is open pollinated seedlings of Lord Doonex. It takes 124 days to flower and produces 124 flowers per plant. Flower yield per plant ranges from 150 -160g.suitable as pot plant.
- **m.Yellow Star**: It is hybrid between Flirt X Valentine -22. It takes 140 days to flower and produces 150 flowers per plant. Flower yield per plant ranges from 270 -280g.suitable for garland making and bouquet preparations.

Punjab Agricultural University, Ludhiana

- **a. Baggi**: Produces flowers in November December; takes 137 days for flowering; plants are 64 cm tall and show upright growth; flowers are decorative type, snow white in colour.
- **b. Birbal Sahni**: Produces flowers in October November; takes about 121 days for flowering; flower vield is 13.2 t / hectare.
- **c. Punjab Gold**: An early flowering hybrid of 'Flirt' x Gul-e-Sahir'; dwarf, golden—yellow; suited to pot culture.

National Botanical Research Institute, Lucknow

- **a. Shanti:** Small-flowered, white decorative; profusely branching, long, erect stem; 99 flowers / plant, floret colour white.
- b. Y2K: It is a small-flowered, white Anemone type mini chrysanthemum; floret colour white.
- **c. Kargil '99**: It is a small-flowered, spoon-shaped, single whorl ray florets with yellow disc, purplish mauve florets with snow-white variegation of leaves; most attractive for 'mini culture'. 215 flowers /plant, red coloured florets.
- **d. Appu**: Open-pollinated seedling selection from an Original Dwarf Double (no Pinch No State type), dwarf and early blooming; purple flowers, compact buttons and suitable for mini culture.
- e. Bindiya: Flowers dark Crimson, double Korean type; for mini culture.

No pinch no stake mini chrysanthemums

Year round cultural operations are required for chrysanthemum cultivation. Existing cultivars (large and small flowered) require lot of additional care like 'pinching' and 'staking' which are expensive and time consuming. Mini varieties developed at NBRI, are genetic selections with dwarf, bushy, compact, round shaped, profuse blooming habit. The plant habit and shape is most attractive. Due to their mini growth habits they can easily be transported in small containers. Some examples of mini varieties developed at NBRI are 'Bindiya', 'Mother Teresa', 'Dina'.

NBRI golden jubilee year varieties

- 1. **NBRI Indiana:** It has been developed by crossing 'Little Darling' (orange) as female and 'Nanako' (yellow) as male parents. It is a small flowered, yellow, pompon type, suitable for mini and pot culture. It is a profusely branching, long, erect stem, green leaves, uniform bloom, opening in late November, easy to multiply by suckers and cuttings. Plant height 33 to 36 cm, 135 to 150 flower heads/plant, 16 flowers/stem.
- 2. **NBRI Kusum:** It has been developed by crossing 'Haldighati' (yellow) as female and 'SharadKanti' (yellow) as male parents. It is a small flowered, yellow open disc, single Korean type chrysanthemum good for pot culture. It is a bushy compact with profuse blooming habit in late November. The plant habit and shape is most attractive for exhibition. Plant height 45 to 50 cm, 255 flower heads/plant, 22 flowers/stem.
- 3. **NBRI Little Darling:** It has been developed by crossing 'White Charm' (white) as female and 'Jubilee' (bronze) as male parents.i, It is a small flowered, terracott pompon type mini chrysanthemum. It requires neither 'Pinching' nor 'Staking'. It is a unique genetic strain with dwarf, bushy, compact round shape, profuse blooming habit in early December. The plant habit and shape is most attractive for 'mini culture'. Plant height 32.5 cm, 260 flower heads/plant, 26 flowers/stem.
- 4. **NBRI Mini Jessie:** It has been developed by crossing 'Cameo' (pink) as female and 'Jessie' (purple) as male parents. It is a small flowered, cineraria type mini chrysanthemum. It requires neither 'Pinching' not 'Staking'. It is a unique genetic strain with dwarf, bushy, compact round shape, profuse blooming habit in early December. The plant habit and shape is most attractive for 'mini culture'. Plant height 34.4 cm, 267 flower heads/plant

TNAU Varieties

Varieties

CO 1

It is a selection made from a bulk population introduced from Hosur. Flowers are medium sized (2.5 gm) and are attractive canary yellow in colour. The flowers have thick sturdy stalk and hence easy for making garland and other decoratives. Average yield is 16.7 tonnes per hectare. It flowers early by 15 - 20 days and flowers also last longer when compared to other local cultivars.

CO₂

Clonal selection from germplasm introduced from NBRI, Lucknow. It gives higher yield than CO 1 and MDU 1. It is of a novel new purple colour (Rhodamine Purple) and the flowers are large with a long stalk and invisible disc which is preferred in the trade.



MDU 1

It is a selection from germplasm type. It comes to flowering in 104 days as against 120 days in local types. The flowers are large and attractive sulphur yellow in colour with a diameter of 3.90 cm. Yield up to 30 tonnes per hectare in a year in two crops.

TNAU varieties - CO 1 (yellow coloured flowers), CO 2 (rhodamine purple coloured flowers), MDU 1 (light yellow coloured flowers)

Soil & Climate: Well drained red loamy soil with pH of 6 to 7. Tropical and subtropical climatic conditions are ideal. Best day temperature is 20-28°C and night temperature is 15-20°C.

Season: Chrysanthemum is a short day plant, planting should be done such that flowering coincides with short day conditions. Under Tamil Nadu conditions, it is planted during April-May so that it flowers during September - December.

PROPAGATION

☐ Chrysanthemum can be propagated both by vegetative and sexual methods.

☐ Maintain the purity of cultivar seeds are used to develop hybrids.

VEGETATIVE PROPAGATION

- 1. **SUCKERS:** Suckers arise from the underground stem and these are separated and planted in prepared nursery beds during January for stock plants. Regular pinching is performed in these plants for vigorous and profuse branching. Some of these stock plants are used for preparation of cuttings. The first pinching is performed in April, followed by monthly pinching up to June. After 3rd pinching in June, cuttings are taken from these mother plants.
- 2. CUTTINGS: Terminal Cuttings: Cuttings of 5-7 cm in length are taken form healthy stock plants in June. The cuttings are prepared removing basal leaves and reducing the leaf area of remaining leaves to half. The basal portions (less than half inch) of cuttings are dipped rooting hormone (1000 ppm solution of IBA) for better rooting. Sometimes the lower portion of cuttings is treated with some copper fungicide to avoid fungal growth. These rooted cuttings are ready for planting in the field.

3. Micro propagation

Spacing: 30 cm x 30 cm

Irrigation: Irrigation is done twice a week in the first month and subsequently at weekly intervals.

Weeding: Weeding should be done as and when necessary.

Manuring: 25 t FYM and 125: 120: 25 kg NPK/h . Basal application - half of N + entire P and K; top dressing - half of N applied 30 days after planting. Apply 2 kg each of Azospirillum and Phosphobacteria per ha at the time of planting. It is to be mixed with 100kg of FYM and applied.

Micronutrients: Foliar spray of ZnSO₄ 0.25% + MgSO₄ 0.5%.

Special practices – Refer manual

Pinching: Pinching is one of most important operations in chrysanthemum culture. The operation of removal of terminal growing portion of stem pinching reduces plant height and promotes axillary branches. Time and severity of pinching depend on the type of chrysanthemum and the desired objectives. After planting, the growth is mostly upward with very little branching. To arrest such tall growth, a simple procedure called "pinching" is used. It is also called "stopping". Only soft vegetative shoot tips 1.5 to 3 cm long are removed. Pinching is most essential for small flowered chrysanthemum. First pinching is done when the plants reach a height of 15-20 cm with 3-4 pairs of leaves. A second pinching may be necessary if the plants make straggly and lean growth. Pinching increases the number of flowering stems in each plant; it can indirectly control flowering date and bloom quality; and the number of stems to a plant can easily be controlled. Two types of pinching are performed:

- (a) **Soft pinching:** By this pinching the top soft tips of the shoot along with 2-3 open leaves are removed;
- (b) **Hard pinching:** It means removing a longer portion upto hard shoot.

Pinching is done 4 weeks after planting to induce lateral branches. To get head type flowers – Allow the main stem to grow and pinch the laterals and to get spray type flowers – Allow the laterals to grow and pinch the main stem.

DISBUDDING AND DE-SHOOTING - These operations are mostly performed for large flowering of decorative type chrysanthemums. Many of the standard type varieties are disbudded in which the largest terminal bud is reserved and all auxiliary buds are removed. Disbudding of spray varieties is very easy because in this case only the large apical bud is removed and the auxiliary buds are allowed to develop

For taking three blooms per plant, three lateral strong shoots are allowed to grow and others are removed. Lateral buds and side shoots are removed at their early stage of growth from time to time. For taking one bloom per plant no pinching is done. Only the main stem is allowed to grow. Removal of undesirable lateral buds and shoots are done. De -shooting is practiced to reduce the number of branches for improving the size and form of the flower.

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

STAKING OF PLANTS -Staking is necessary to keep plants erect and to maintain proper shape of plants and bloom. Stakes are prepared mostly from bamboo sticks.

WEED CONTROL:

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

HARVEST AND YIELD:

Loose flowers - Maturity Index and Harvesting: Harvesting of the flowers starts from 3rd month onwards at 4 days interval. **Harvesting is done at 3/4th to fully open stage for nearby markets and 1/2 open stage for distant markets.** The duration is 6 - 8 months for main crop and 4 months for ration crops.

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

Question bank

Part A

- 1. Origin of chrysanthemum is -----
- a.India b.Japan c.Australia d.China
- 2. Chrysanthemum is the national flower of -----country
- a.India b.Japan c.Australia d.China
- 3.---- (Apsara and Eve) are the varieties of pompon typed chrysanthemum
- 4.----(Kargil 99) is the chrysanthemum variety released by NBRI, Lucknow
- 5. -----(Chrysanthemum morifolium) is also an important source of essential oil and sesquiterpenoid alcohol

Part B

- 1.Write about disc and ray florets
- 2. Write about classification of chrysanthemum based on usage

Part C

- 1. Write in detail about classification of chrysanthemum based on size and shape of the flowers
- 2. What are the intercultural operations / special practices in chrysanthemum cultivation

LEC 6 - TUBEROSE - VARIETIES - PACKAGE OF PRACTICES

CN – Tuberose (The word tuberose is derived from the plant is being the tuberous hyacinth and distinguishes from the bulbous hyacinth). **B.N -** *Polianthes tuberosa* **L.; F- Amaryllidaceae, O – Mexico)**

INTRODUCTION

It is essentially a florist's flower and one of the leading commercial crops because of its multifarious uses. The predominant characteristics of this crop are its lingering, delightful fragrance and excellent keeping quality. It has a great economic potential for cut flowers trade and essential oil industry.

☐ Due to their great demand it is being cultivated in most part of the tropical and subtropical countries.

IMPORTANT AND USES

The flowers remain fresh for pretty long time and stands long distance transport. They are used for making artistic garlands, floral ornaments, bouquets and buttonholes. The long flower spikes are excellent cut flowers for table decoration. The variegated ones with beautiful golden stripes on foliage margins are very attractive and suitable for garden display. The fleshy, white, tubular flowers emit a strong odour and hence are cultivated on a large scale in some parts of the world for the extraction of highly valued natural flower oil, the tuberose oil. The tuberose flower oil of commerce is one of the most sought after and expensive raw materials in perfumery. The fresh flowers give a concrete yield of 0.08 to 0.11 %, of which nearly 18 to 23% constitutes the alcohol-soluble 'absolute'. The essential oil is used in only the highest grade perfumes. Sometimes, the oil is used in flavouring candy, beverages and baked food.

DISTRIBUTION

It is grown largely in the southern states of America, Italy, France, Morocco, South Africa, Taiwan, Egypt and many other tropical and subtropical areas in the world.

In India, tuberose is cultivated on a commercial scale in West Bengal, Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra.

SPECIES AND VARIETIES:

There are about fifteen species under the genus *Polianthes*, of which twelve species have been reported from Mexico and Central America. Of these, nine species have white flowers, one is white and red and two are red. Except *Polianthes tuberosa* L., all the others are found growing wild.

Tuberose is categorized based on number of rows of tepals each flower posses.

Single: The cultivar with one row of tepals is designated as single

Semi double: This cultivar bears two - three rows of tepals.

Double: This cultivar bears more than three rows of tepals is called double

COMMERCIAL CULTIVARS

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

1. Single

Flowers with one row of corolla segments
Flowers are extensively used for essential oil extraction
Loose flowers are used for making floral ornaments
Single types are more fragrant than double
Seed setting is also high in single type
Floral buds are greenish white, flowers are pure white
Concrete content has been observed to be 0.08 to 0.11 per cent
Varieties:Rajat Rekha, Calcutta Single, Shringar, Single
Mexican, Prajwal, Arka Nirantara

2. Semi double

White flowers with 2-3 rows of corolla segments on straight spikes

Used as cut flowers also

Varieties: Vaibhav





3. Double

Flowers with more than three rows of corolla segments on long and sturdy spikes

Used as cut flower as well as loose flower
Used for extraction of essential oil
Concrete recovery has been found to be 0.06 %
Flower colour is white and/or also tinged with pinkish red
It does not open well and is not commercially viable

Varieties: Swarna Rekha, Suvasini, Pearl Double



VARIETIES/ HYBRIDS Single flowered type

1. Rajat Rekha

It is released by NBRI, Lucknow.Silvery white streak all along the middle of the leaf bladelt is a mutant evolved by irradiating bulbs of single type cultivar.Concrete content has been found to be 0.089 %

2. Shringar

It is released by IIHR, Bangalore Developed form a cross between Single x Double It bears single type of flowers on sturdy spikes The flower bud is slightly pinkish tinged Florets are bigger than Calcutta Single

It is resistant to *Meloidogyne incognita* nematodeLoose flowers are ideal for making garland Spikes can be used as cut flowerYield of loose flowers is about 1500 kg/ha per year Concrete content of the Hybrid is at par with Mexican Single It is preferred by farmers and perfumery industries



3. Prajwal

It is a hybrid developed from Shringar x Mexican SingleIt bears flowers on tall stiff spikes It is released by IIHR, Bangalore The flower buds are slightly pinkish in colour, flowers are white The individual flowers are large in size compared to Local Single It yields twenty per cent more loose flowers than Shringar It is recommended for both loose flower and cut flower purpose

4.Arka Nirantara

It is released by IIHR, Bangalore White, single flowers with prolonged blooming

- **5. Phule Rajini:** It is a cross between local single x shringar. This cultivar was released by MPKV, Rahuri. This cultivar has appropriate spike length with well distributed 46-58 florets on the spike. Therachis length is more than 50% of the spike length.
- **6.Calcutta Single:** The flower buds are slightly pinkish in colour while the open flowers are white. The average length of spike are 130 -140 cm and number of florets/spike is around 35-40 respectively.
- **7. Mexican Single:** Pure white in colour at full opening stage, however on open florets are greenish white in colour. Among all traditional cultivars, it gives the highest quality of essential concrete recovery.



Semi double flowering type

1. Vaibhav

The hybrid is derived from the cross Mexican Single x IIHR 2 It is released by IIHR, Bangalore It bears semi double flowers on medium spikes The flower buds are greenish in colour Flowers are white Spike yield is 50 % higher compared to Suvasini It is suitable for cut flower

Double flowering type

1. Swarna Rekha

Double type with golden yellow steaks along the margins of leaflt is released by NBRI, Lucknowlt is a gamma ray induced mutant, in which mutation occurred in chlorophyll synthesis resulting in change in leaf colour Concrete content has been found to be 0.062 %

2. Suvasini

A multi whorled variety developed form the cross between Single x Double. Pure white flowers are bold and big, borne on a long spike .Spikes are best suited as cut flower. Suvasini recorded 25% more yield than cv. Double

- **3.Pearl Double:** The florets of this cultivar have more than three rows of petals, which are white in colour, but tinged with pinkish red before opening. It does not bear seeds. No anthers or gynoecium are present in the sterile double forms of tuberose.
- **4. Calcutta Double:** flower colour is white at opening and tinged with pinkish red. The length of spike and weight of spike are reported about 87 cm and 144 g repectively.



SOIL AND CLIMATIC REQUIREMENT:

SOIL: Tuberose can be grown on wide variety of soils from light, sandy loam to a clay loam with a soil pH of 6.5 - 7.5. The soil should be at least 45 cm deep, well drained, friable, rich in organic matter and nutrients with plenty of moisture in it. The crop can be grown even in high saline-alkaline soils with better agronomical practices.

CLIMATE: The crop is best suited for cultivation in tropical to subtropical and temperate climates. The crop is reported to flower profusely throughout the year, if the climate is mild and free from extremes of high and low temperature. A temperature range from 20-30°C is considered ideal for this crop. If the temperature is above 40°C, the spike length and quality of the flowers are affected. Very low temperature and frost will damage the plants and flowers. Tuberoses grow well in a sunny situation.

SEASN OF PLANTING:

Tuberoses are generally planted in February-March in the plains and April-May in the hills.

LAND PREPARATION:

The land is ploughed deep, twice, to a depth of 45 cm. At the time of the second ploughing apply FYM @ 20-50 t/ha and incorporate into the soil. Then the soil is brought to a fine tilth by breaking the clods and removing the weeds. The field is laid out into plots of convenient sizes with irrigation channels, ridges and furrows at the recommended spacing.

CULTIVATION: PROPAGATION:

- Tuberoses are propagated by bulbs, bulblets and seeds.
- Multiplication by bulb-segments and in vitro micro propagation from scale stem-sections is also possible.
- Propagation by bulbs is the most common method practiced for the commercial multiplication of tuberoses.

- The bulbs remain dormant for 30 days and in winter months in places where the temperature is low
- If early planting is desired, the dormancy can be successfully broken by dipping the bulbs in 4% Thiourea solution for one hour.
- Spindle-shaped bulbs with a diameter of 2.6 to 3 cm size and 30 g weight are used for planting.
 Large bulbs are cut into 2-3 vertical sections, each containing a bud and part of the basal plate.
- Each of these sections is treated with copper fungicide and planted vertically with their tips just showing above the surface.
- About 8 to 9 tons of bulbs are required to plant an area of one hectare.

PLANTING:

The density of planting markedly influences the yield and quality of the flowers. The planting distance varies with the soil and climatic conditions. About 1, 00,000 to 2, 00,000 bulbs are required for planting one hectare of land. A spacing of 15 x 20 cm (Maharashtra), 25 x 25 cm (West Bengal), 30 x 30 cm (Lucknow), 30 x 22.5 cm (Bangalore) and **20 x 20 cm (for other part of South India)** have been recommended for this crop. While planting, the bulbs are planted at the recommended plant-spacing, 3.5 cm deep on the sides of the ridges. The plots are irrigated immediately after planting.

FERTILIZER APPLICATION:

100 kg N, 60 kg P2O5 and 40 kg K2O /ha is recommended for tuberose production. For achieving increased essential oil content in flowers and for the maximum recovery of concrete, a fertilizer dose of 80 kg N, 60 kg P2O5 and 40 kg K2O/ha has been recommended. Of the full recommended dose of fertilizers, half the N, the full dose of P and K has to be applied at the time of planting and the remaining half of N is given as a top-dressing after 45 days of planting. Apart from N, P and K, calcium, magnesium, sulphur, iron, zinc, manganese, aluminium, boron and copper have also been found to influence the growth and flowering in tuberoses.

IRRIGATION:

Irrigation is given immediately after planting. Subsequently, the crop is irrigated at 5-7 days intervals depending upon weather conditions. In the summer months, irrigation is recom-mended twice a week.

INTERCULTURE:

- In order to keep the plots free of weeds and to avoid the exposure of bulbs, the plots are weeded and earthed-up once a month.
- Earthing-up enables the spikes to grow erect, despite strong winds and rains.
- The application of Atrazine (@ 3 kg/ha) as a pre-emergent weedicide keeps the plots weedfree.
- A pre-emergent treatment of Gramaxone (@ 3 kg/ha) followed by three post- emergent sprayings at intervals of 110 days in between the rows also keeps the crop weed free.
- Mulching the plots with strips of black polythene, dried grass and chopped straw is effective in controlling weeds.
- The flower-spikes should be supported by stakes after about 2 1/2 months of planting.

HARVESTING AND YIELD:

- Flowers are ready for harvest in about 3 to 3 1/2 months of planting.
- August-September is the peak period of flowering.
- Depending on the purpose, harvesting is done by cutting the fully-opened spikes from the base (cut flowers) or single flowers are harvested as they open (loose flowers and concrete extraction) by day; the picking of individual flowers should be completed by 8.00 a.m.
- The flowers have a shelf-life of 3 days.
- Flowers yield up to 17-18 t/ha can be expected from a well-maintained crop.

HANDLING AND PACKING OF FLOWERS

- Loose flowers are transported in poly bags to the nearby whole sale market.
- The flower spikes are graded according to spike length, length of the flowering zone and quality of individual flowers

- Bunched in round bundles each having about 50-100 spikes
- The stem portion of the bundle has to be wrapped with news paper.
- To avoid damage of the flowers and buds, the whole bundle may be wrapped with soft, white tissue paper or polythene.
- Bundles have to be packed in card- board boxes for long distance transportation.

STORAGE OF FLOWERS -The fresh flowers can be stored at 10oC.

EXTRACTION OF ESSENTIAL OIL

- About 150 kg of flowers are required to produce 1 kg of the brown, semi-solid absolute of Enfleurage.
- The extracted flowers will contain some natural perfume and are treated with petroleum ether to obtain the absolute of chassis as a valuable by-product (yield 1.2-1.5%).
- In recent years, the process of Enfleurage has been partly replaced by solvent extraction, which requires much less labour though the yield of the absolute reduces considerably.
- The extraction of the tuberose flowers with petroleum ether yields 0.08-0.11 % of concrete, which gives 18-23% of absolute on treatment with alcohol and contains 3% steam distillate.
- The concrete yield is about 17-18 kglha which gives 3.5 kg absolute and 0.8 kg distillable oil.

RATOON CROPPING:

After harvesting the main crop, the flower stalks are headed back (cut to the base) and the plots are manured and irrigated. About 3-4 ration crops can be taken from a single planting.

LIFTING, CURING AND STORAGE OF BULBS:

- Bulbs reach maturity at the cessation of flowering when the leaves become yellow and dry during winter (February-March) in North India.
- At this stage, irrigation is withheld and the soil is allowed to dry. The leaves are cut off at the groundlevel and the bulbs are dug out.
- After digging, the bulbs are lifted out and the adhering earth shaken off neatly and thoroughly.
- The offsets are then separated out by hand, which are used as seed-stock for the next season.
- The bulbs are the graded based on the size into mature (> 1.5 cm diameter) and immature (< 1.5 cm diameter).
- Cleaned and graded bulbs are placed on sheaves to dry or cure.
- To hasten curing, artificial heat of 270 to 350 C may be applied.
- The bulbs must be stirred or have their position changed every few days to prevent fungal attack and rotting.
- An ambient air temperature of at least 18oC for four to six weeks or exactly six weeks at 30oC stimulates the yield of commercial sized bulbs.
- Longer storage at 30oC advances flower spike yield but the quality of spike deteriorates and the bulb number decreases.

Lec 7 CROSSANDRA - VARIETIES - PACKAGE OF PRACTICES

<u>VARIETIES</u> - Crossandra varieties show a remarkable range of colours, varying from orange, pink, red, yellow and double coloured blue types with white throat. Recently white, light green and violet types

Common Name : Crossandra / Fire cracker plant Scientific Name : Crossandra infundibuliformis

Family : Acanthaceae

Origin : India

Plant type : It is an erect, evergreen shrub growing to 1 m with glossy, wavy-margined

leaves and fan-shaped flowers, which may appear at any time throughout the year. Flower colours range from the common orange to salmon-orange

or apricot, coral to red, yellow and even turquoise green.

have become popular. Important varieties of crossandra are as follows.

a. Orange: Orange crossandra is tetraploid (2n=40) and produces bright orange flowers in profuse number.

- **b. Delhi Crossandra:** Delhi Crossandra is triploid (2n=30) and bears deep orange attractive flowers. It does not set seeds and **is propagated by cutting**.
- **c. Lutea yellow:** It is a tetraploid variety bearing orange yellow colour flowers. It is good for planting in pots, front line of shrubbery and hanging basket. It provides an impressive view when planted in pockets.
- **d. Sebacaulis Red:** It is a tetraploid variety tolerant to nematodes.
- **e. Mona Wall Head:** Plant is compact, upto 50 cm tall. Leaves are lustrous and vivid green while flowers are deep salmon to pink.

IIHR varieties - Arka Ambara, Arka Kanaka

Soil & Climate: Well drained sandy loam and red soils with pH of 6 - 7.5 are ideal. Soil is to be tested for nematodes before planting. It requires a temperature of 30 - 35°C for growth. It is shade tolerant to some extent but susceptible to low temperature and frost.

Season: July – September and October – November are best planting seasons.

Preparation of field: Land is ploughed thrice and FYM at 25 t/ha is incorporated. Ridges are formed 60 cm apart. Dip the roots of seedlings in Carbendazim (1 g/l of water) and plant on one side of the ridge at 30 cm spacing.

Spacing:

Tetraploid: 60 x 30 cm / 60 x 60 cm (for seed production).

Delhi Crossandra: 60 x 40 cm

Nutrition:

- a. Tetraploids: Apply FYM 25 t/ha as basal and NPK at 75, 50 and 125 kg/ha as top dressing three months after planting. Repeat NPK application at the same dose at half yearly intervals for two more years (Instead of applying N at 75 kg/ha, N at 60 kg/ha + *Azospirillum* 2 kg/ha can also be applied).
- b. Delhi Crossandra: 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.

For both Tetraploids & Delhi Crossandra:

Biofertilizers: Soil application of 2 kg each of *Azospirillum* and Phosphobacteria per ha at the time of planting. It is to be mixed with 100 kg of FYM and applied.

Growth regulators: Spray Ascorbic acid 1000 ppm (1 g/lit of water) before flowering.

Irrigation: Once in a week depending upon the weather conditions.

Plant protection

Pests -Aphids: Spray Dimethoate 30 EC @ 2 ml/l.

Nematode: Avoid planting crossandra in nematode infested fields. To control nematodes, apply of Phorate or Carbofuran 3 G @ 1 kg a.i./ha a week after planting and the same may be repeated siz months after planting.

Diseases -Wilt: Soil drenching with Carbendazim 1 g/lit or Triflooxystrobin + tebuconazole @ 0.75 g/litre

Crop duration: 3 years including ration crop.

Harvest: Flowering will start a month after transplanting. Fully opened flowers are picked once in two days.

Maturity index and Harvesting: Flowering will start a month after transplanting. Flowering appears on spike from base to top and diagonally opposite flowers open. Well developed fully opened flowers are picked once in two days. Crop stands in the field for 3 years including ration crop.

Yield:

Tetraploid varieties: 2 t/ha/year Delhi Crossandra: 2.8 t/ha/year.

Value addition: Flowers though has no perfume has a good shelf life of 2-3 days, flowers throughout the year and are light in weight. Hence they are used in garland and veni making

Lec 8 MARIGOLD – VARIETIES – PACKAGE OF PRACTICES (BN - *Tagetes* spp., F- Asteraceae O - Mexico) (African marigold – *Tagetus erecta*, French marigold – *Tagetes patula*)

IMPORTANCE

- Marigold has gained popularity amongst gardeners and flower dealers on account of its easy culture and wide adaptability.
- Free flowering and short duration.
- Wide spectrum of colour, shape, size and good keeping quality.

USES:

- Used for garland, veni and other decorations.
- It is highly suitable as bedding plant, in an herbaceous border, also as shrubbery in landscaping.
- French marigold is ideal for rockery, edging, hanging baskets and window boxes.
- Have medicinal properties to cure boils and carbuncles.
- Floral extract is used as a blood purifier and cure for bleeding piles.
- Good remedy for eye diseases and ulcers.

- The Pigments (Xanthophylls) are used as a natural colour to intensify yellow colour of egg yolk and broiler skin, flesh and also for fish. Xanthophylls are the major carotenoid fraction in the flower petals.
- Lutein accounts for 80 90% of total xanthophylls content. Used for colouring the food stuffs, textile industries and pharmaceuticals.
- The oil has a pronounced odour and acts as a repellent to flies.
- Trap crop -It is highly effective in reducing the population of nematodes under control and also attracts the fruit borers in many vegetables, fruits and ornamental plants.

SPECIES There are about 33 species of the genus *Tagetes*. Some of the important are as follows 1. *Tagetes erecta* (African marigold): Plant is hardy, annual, upto 90 cm tall, erect and branched. Flowers are single to fully double and large sized with globular heads. Flower varies from lemon yellow to yellow, golden yellow or orange.

2. *Tagetes patula* (French marigold): A hardy annual, about 30 cm tall, bushy type. Foliage is dark green with reddish stem. Flowers are small, either single or double. The flower colour varies from yellow to mahogany red.

CLIMATIC REQUIREMENT: Marigold requires mild climate for luxuriant growth and profuse flowering. It ceases to grow at high temperature thereby flower quantity and quality is adversely affected. During severe winter including frost plants and flowers are killed and blackened. Sowing and planting is carried out during rainy season, winter and summer season. Hence, flowers of marigold can be had almost throughout the year.

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

PREPARATION OF SOIL: Land should be well prepared by ploughing 2-3 times and 50 tones of well decomposed farmyard manure should be well mixed. Beds of convenient size are made to facilitate irrigation and other cultural operations.

PROPAGATION: Marigold is propagated by both methods *i.e.*, Seeds & Cuttings.

TRANSPLANTING OF SEEDLINGS: Marigold seedlings will be easily established after transplanting in the field without much mortality. At the time of transplanting, seedlings of one month old with 3-4 true leaves have to be selected for proper establishment and higher yield.

SPACING: In general *Tagetes erecta* requires wider spacing than *T. patula*.

Tagetes erecta 1) 40 x 40cm, 2) 45 x 30cm **Tagetes patula** 1) 20 x 20cm, 2) 30 x 30cm

MANURES AND FERTILIZERS: To get highest flower yield, 100 kg N, 100 kg P2O5 and 100 kg K2O should be mixed at the time of preparation of land. Remaining 100 kg N per ha should be applied in 2 splits @ 30 and 40 days after transplanted.

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

IRRIGATION: It takes about 55-60 days to complete vegetative growth and to enter into reproductive phase. Season of planting determines the frequency of irrigation. If rainfall is normal and well distributed, irrigation is not frequently required, but if the rain is scanty irrigation is needed frequently. From April to June, frequent irrigation at the interval of 4-5 days is required.

SPECIAL OPERATIONS

PINCHING: In tall varieties of *Tagetes erecta*, emergence of side branches and their flowering is influenced by the presence of apical dominance. Due to which the plants of marigold grow straight upwards to their final height and develop into terminal flower bud. However the apical portion of the shoot is removed at the early stage to get more number of axillaries which in turn produces more flowers.

☐ Pinching the plants at 40 days after transplanting enabled the plants to yield more flowers.

FLOWERING -In summer season crop, - commences by the middle of May with maximum intensity in the month of June and continues till the onset of rains. Rainy season crop - by the middle of September and the flowering will continue till December. Flowering in winter crop - by the middle of January and will continue till March.

HARVESTING AND YIELD:

- Marigold flower should be plucked when they attain the full size depending upon the variety.
- Plucking of flowers should be done in cool hours of the day *i.e,* either in the morning or evening.
- Field should be irrigated before harvesting so that, flowers keep well for longer period after plucking.
- Plucked flowers should be covered with moist gunny bags if kept overnight before taking to market.
- Productivity of plants increases considerably by regular plucking of flowers.

YIELD

African marigold - 11 – 18 t/ha French marigold - 8 – 12 t/ha

Marigold Flower Polysaccharide (MFP):

- MFP can be extracted from the meal with warm (50-55oC) water.
- Petals were separated from the rest of the flower and extracted in a Soxhlet apparatus with methanol.

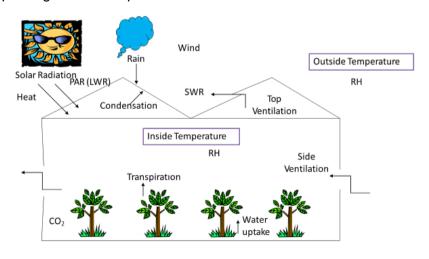
Lec 9 PROTECTED CULTIVATION OF CUT FLOWER CROPS IN TAMIL NADU

Protected Cultivation

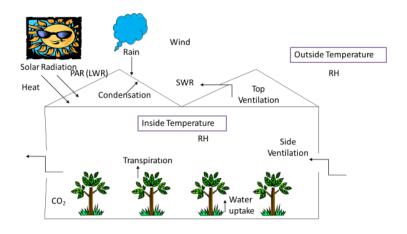
- Creating suitable environment for growing exotic cut flowers
- Low volume high value crops Promising commercial agriculture venture Protection from natural elements
- Labour and input efficiency

Why a Greenhouse?

- 1. To grow crops out of season
- 2. To grow crops not adapted to the locality
- 3. To speed up the growth of crops



PROCESS DIAGRAM IN GREENHOUSE ACTIVATED BY SOLAR RADIATION



PROCESS DIAGRAM IN GREENHOUSE ACTIVATED BY SOLAR RADIATION

Major cut flower producing districts in Tamil Nadu

Crops	Location
Rose	Hosur
Carnation	Nilgiris, Kodaikanal
Liliums	Nilgiris
Gerbera	Coonoor, Kodaikanal, Yercaud
Cut Chrysanthemum	Kotagiri, Yercaud
Anthurium	Yercaud
Dendrobium orchid	Chennai, Villupuram & Kanyakumari

SWOC analysis

Strength

- Rich in natural resources
- Conducive climate and soil
- Year round production good sun light
- Heating of greenhouses not required
- No heavy rains during export season

Weakness

- Lack of cost effective greenhouse technology/PHT
- High cost quality planting materials
- Lack of coordinating agency-growers and sellers
- Limited cargo space & higher air freight
- High import duty
- High input cost

Opportunities

- Large demand for cut flowers International and domestic markets
- Global market size above Rs. 1, 00, 000 crores
- Indian growth rate: 20-24%
- International growth rate: 17%
- Production and project costs steadily increasing developed countries
- Floriculture declared as focus export thrust area by GOI
- India located between Europe and East Asia

Challenges

- Perishable nature of the product
- High incidence of pests and diseases
- High rate of import duty by the EEC
- Increasing competition African and South American countries
- Foreign exchange rates influence project cost
- Delay in transport loss of quality
- Strict quarantine and phytosanitary regulations

Types of greenhouse

Lean type, Dome type, Tunnel type, Quonset type, Gothic arch, A-type, Saw tooth type

Types based on climate control

- Naturally ventilated Polyhouse
- Fan & Pad
- Fan & Pad with Atomization

Saw tooth type (Aerodynamic)

- Natural ventilation
- Long life span (10-15 years)
- Withstand strong wind
- Cost Rs. 700/m²

Low cost wooden structure

Merits

- Constructed with locally available materials (casuarina, bamboo, eucalyptus, silver oak)
- Low cost

Demerits

- Prone to wind
- Shorter life span

Cladding or covering material

Character	Clear film	Diffused film
Film usage	GH - Cover	GH – Cover
Width	Up to 15 m	Up to 15 m
Thickness	200 micron	150 micron
Length	As required	As required
Light Transmission in PAR (Photo active radiation)	82 %	82 %
Diffused light transmission in PAR	22.5 %	55 %
UV-blocking	99 /350 (%/nm)	96/350 (%/nm)
Thermicity*	63 %	58 %

5 layer films

- UV blocker
- Antivirus
- Anti Sulphur
- Anti drip
- Thermicity - ability of the film to withstand light in the greenhouse during night

Insect proof nets

• 40 to 50 mesh – Aphids, Red spider mites, Thrips

Fogger

- Consistent control use of Humidistat
- Heat rise across the greenhouse is controlled

Shade net house with rain shelter (Anthurium & Orchids)

Standard Colour	Green	White	Black
Standard Length	50 m	50 m	25 m
Standard width	3.0 m		5.3 m
Standard Shade Factors	35 % 50 %		
	75 %		

Pros of Greenhouse

- Apart from protection, it also helps to improve the growing environment for crops
- It provides humid and warm environments for plants. All types of plants love such conditions.
- Since there is a growing environment, the plants are able to grow robustly.
- The greenhouse helps retain the water and heat within the room. As the result, the plant grows faster healthier. It results in more production as well.

Advantages

- Protection from excess rainfall, wind current, scorching sunlight and extreme cold conditions
- It can be erected on unproductive soil
- Under minimum space one can have maximum production of crop plants
- Humidity is maintained
- Efficient use of CO2
- Minimum labor requirement
- Minimum use of water and fertilizers
- Maximum use of space
- A single person can have control over thousands of plants
- Diseases and pests can be controlled easily
- Water can be used economically
- Production of crop throughout the year
- Protection from birds, animals and human
- Labor cost is reduced
- Quality of product is best

Cons of greenhouse

- Its difficult to find the weakness of greenhouse cultivation. The ventilation and temperature management can be a daunting task for beginners.
- Its important to properly set up the temperature levels. If it exceeds the required level, the plants will die due to the excessive heat. On the other hand, insufficient heat during cold seasons can lead to frozen crops.
- some farmers need to practice regarding the issue. Otherwise they are not able to adjust the temperature correctly. They can learn from customized greenhouse solutions, though.
- The farmers should perform a regular inspection in order to deal with those pests.

Crops under protected cultivation in Tamil Nadu

- Carnation Grown in ooty, coonor, kotagiri, kodaikanal
- Rose Grown in hosur, yercaud, suitable for mild tropical regions
- Gerbera Grown in hosur, yercaud, nilgiris, dindigul
- Chrysanthemum Grown in hosur, yercaud, kotagiri & kodaikanal
- Anthurium Grown in yercaud, kodaikanal, Kanyakumari, kolli hills & lower pulney hills
- Orchid Grown in coastal regions, Eg. Dendronbium, oncidium, phalenopsis, vanda, cymbidium
- Lilium Grown in the Nilgiris

Protected cultivation of loose flowers

- Marigold are cultivated in polyhouse in some regions of Tamil Nadu. It enhances yield.
- Tuberos is cultivated under tunnels in North India during winter months. It advances flowering.

Question bank

Part A

- 1.---- (Lilium) flowers are produced in Nilgris which fetches higher foreign exchange
- 2. -----(Protected structures)Creating suitable environment for growing exotic cut flowers.
- 3. -----(Thermicity) ability of the film to withstand light in the greenhouse during night

Part B

1. Merits of protected cultivation Uniform in growth and less labour intensive

Part c

1. Write in detail about glading cover material GH – Cover - UV filtration

LEC 10 – CUT ROSE – PACKAGE OF PRACTICES – VARIETIES HYBRID OR CUT ROSE CULTIVATION

TYPES OF GREENHOUSE REQUIRED:

- Under mild climatic conditions (Bangalore and Pune) roses can be successfully cultivated under Naturally Ventilated Polyhouses.
- However, under warm and high temperatures (Hyderabad and Delhi) it needs forced ventilation system (Cool-Cell Pad) to get quality flowers.

IMPORTANT VARIETIES: Varieties:

Red - First Red, Grand Gala, Red Corvette, Tajmahal.

Yellow - Aalsmeer Gold, Gold Strike, Skyline.

Pink - Noblesse. Flirt. Vivaldi.

Orange - Movie Star, Miracle, Tropical Amazon.

White - Ice Berg, Polo, Holly Wood, Avalanche, Tineke, Aloynica, Biyanka.

CULTIVATION PRACTICES:

Climate and soil - Ideal day temperature -25° C to 28° C . Ideal night temperature- 15° C to 18° C.Rose is a sun loving plant. Light hours required not less than 12 hours. Light intensity up to 100000 Lux . Optimum relative humidity to be maintained - 60-70%. Low temperature & high RH can cause a high incidence of diseases. Powdery mildew in hot and downy mildew or black spot in the cold. Good air circulation (ventilation) is ideal . Ideal CO_2 concentration is 1000 - 1500 ppm

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

Spacing:

Protected cultivation: 40 X 15 cm (7 plants/m²).

Open field cultivation: 60 x 60 cm (27,777 plants/ha) to 60 x 75 cm (22,222 plants/ha).

MEDIA: Both soil and soil-less substrates (rockwool, peat, sphagnum moss, vermiculites, perlite, leaf mould, Coco peat, rice husk, etc.,) . pH 5.5-6.8 . 30-40cm deep well drained, porous, rich in organic content.

PLANTING: 6-18 months old budded plants may be planted during May-June. The soil should be loose and humid but not too wet nor muddy. Planting may be in 2-row system. Per compartment of 6.40 metre 6 rows of plants can be planned. The distance between the plants in one row varies around 15-20 cm. Accommodates 7 to 8 plants per metre square (Depending upon cultivar and cultivation system).

MANURING:

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

IRRIGATION: The first week watering has to be done with sprinklers or hose pipe 5-8 times a day. 3-4 weeks after planting drip irrigation may be employed for uniform watering. Each plant has to be watered @ 0.75 -1.0 liter/plant/day. A drip irrigation system is recommended as each plant receives the equal amount of water.

CROP MAINTENANCE AFTER PLANTING:

BENDING IN ROSES: After planting, shoots will develop quickly. Only after the flower bud becomes clearly visible the shoots are bend-out towards the path and the flowers are removed, this process is known as bending.

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

SPECIAL OPERATION:

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

HARVESTING AND YIELD:

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

POST HARVEST TECHNOLOGY:

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

- 1. **Pre-cooling:** In a cold storage at the temperature of 4.4 to 7.2oC the flowers have to be kept immediately after harvesting to remove field heat which enhances the keeping quality of flowers
- 2. **Pulsing:** Treating of cut flowers with 2-4% sucrose solution for 3-4 hours. This intern makes the cut flower very hardy and turgid to improve the quality of cut flowers, also have lees neck bending.
- 3. **Grades:** The flowers which are in uniform stem length and developing flower buds should be grouped together at the time of cutting and kept them in separate container. For easy handling the basal foliage and thorns may be removed up to 20 cm at the time of cutting of the flowers. It is necessary to dispatch the flowers within 24-30 hours after harvesting.

Packing:

- The graded cut blooms have to be packed in corrugated cardboard boxes (CCB).
- A box of 100cm length x 32.5cm width and 6.5cm height will accommodate 80 roses of 65-70cm long stem.
- The inside area of the box is lined with thin polythene film and very fine newspaper. Moist tissue papers are spread out end to end of the box to provide a cushion to blooms.
- The blooms are generally packed in bundles of 20 each and bundles are tied with string or rubber band
- The upper portion of the each bundle having flower buds and are wrapped in a corrugated paper which is fixed with an adhesive tape or rubber sheet.
- The labeling of cultivars is made on the paper. The lower half of the bundle is wrapped with tissue paper.

INTERNATIONAL QUALITY STANDARDS OF ROSE CUT FLOWERS:

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

VASE LIFE: Pre-cooled and pulsed flowers stored better in general. However some of the preservatives like 8HQC @ 300ppm, 8HQS @ 150pm, AgNO₃ @20-30ppm, citric acid @ 200ppm have been found to be good for prolonging the vase life of cut roses.

Question bank

Part A

- 1. Spacing of rose in open field is ----(40 x 15 cm)
- 2.Bending is the operation done in rose for increasing -----(flowers)

Part B

- 1. What is bud capping nylon covering
- 2.Post harvest handling in rose -8 HQC,HQS,STS etc

Lec 11- Carnation – Varieties – Package of Practices - Post harvest management

Carnation (Divine flower), BN - Dianthus caryophyllus L. - Family - Caryophyllaceae. Origin - Eurasia

INTRODUCTION

- It is one of the important cut flower crops in the International flower market.
- It is more preferred to other cut flowers due to its large array of colours,
- Excellent keeping quality,
- Wide range of forms
- Ability to with stand long distance of transportation,
- As well as remarkable ability to rehydrate after continuous shipping.
- Carnations in general are grown only under protected cultivation of carnation.
- Cultivated in Italy, Spain, Colombia, Kenya, Sri Lanka, Canary Islands, France, Holland, Germany and USA.

• In India the major carnation producing centers are located in and around Bengaluru, Pune, Delhi, Trivandrum, Andhra Pradesh and HP.

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

Important 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, dianthine, Mignon or micro types

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

1. Standard types:

Produces single large blooms with longer flower stalks.

2. Spray types:

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

SOIL/GROWING MEDIA AND PREPARATION OF BEDS

- Soil should be ploughed upto 80-100 cm deep.
- A rich sandy loam or loamy soil is considered to be the most ideal with soil pH of 6.0 to 7.0
- Media have to be sterilized with methyl bromide@ 25-30g / formaldehyde @ 3-7% (7.5 to 10.0 l/100/sq.mt or Basamid (Dazomet) @30-40g/m2
- Bed size: 30 cm height; 1.05 m wide; length varies as per the length of the protected structure.
- Spacing between beds : 30 cm

CLIMATE:

- Mild climate with a temperature ranging from 5-18°C is considered to be the ideal for the crop.
- Day temperature : 28°C & Night temperature : 16-18°C
- Quantitative Long Day plant (long days promote flowering)
- Critical photoperiod: 13 hours and light intensity is 10 15 foot candle.
 Co2 enrichment in greenhouse: upto 500-1000 ppm improves the flower quality.
- RH: 50 -60 %; (Beginning: 80-85%; at full growth: 60-65 %)
- High day & night temperature during flowering leads to abnormal flower opening & Calyx splitting

PROPAGATION

- Using soft terminal cuttings is the common method of multiplication used by commercial growers throughout the world.
- Cuttings of 10-15 cm with 3-4 nodes weighing around 10g are ideal for multiplication.
- Rooting hormone such as IBA at 500ppm is used prior to planting of cuttings for rooting.
- Terminal cuttings give rise to good plants. Cuttings can be stored at 0oC before planting for several weeks.
- Cuttings are spaced at 5 cm apart and intermittent misting should be used for good rooting.
- Cuttings normally develop good root system within 21 days.
- MICRO-PROPAGATION Almost all parts of the plant may be used as explants in carnation except the root.

PLANTING AND AFTER CARE

- Carnation plants are planted in different spacing normally, 30-45 plants per sq m is considered to be ideal.
- Different spacing 15x8cm, **15x15cm**, 15x20cm and 15x10cm, are followed.
- Alternate normal method of transplanting wherein the plants are planted firmly to soil, carnation,

a. SUPPORT MATERIAL/ NETTING - Carnation crop has the tendency to bend

- Shallow planting is followed. Deep planting should be avoided.
- Shading should be given in the beginning of the crop for few days.
- Care should be taken to maintain the humidity to prevent plants from drying.

SPECIAL CULTURAL PRACTICES

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

b. PINCHING - Pinching refers to breaking out tip of budding and encouraging growth of side shoots. Essential for Standards. 4-6 well grown laterals are allowed. At six pairs of leaf first . pinching has to be done. First pinching done 3 - 4 weeks after planting. (Refer practical notes – Important)

Depending upon the need of crop spread it is classified into,

- Single.
- One and half and
- Double pinches.

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

- **2. ONE AND HALF PINCH -** After single pinched shoots flower, half of side shoots are pinched off. 2-3 of these lateral shoots are pinched again.
- **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.

<u>MANURING</u> - No inorganic fertilizers in first 3 weeks after planting. Fertilizer application of 40g N, 20g P and 10g K, in addition to 5kg of well decomposed FYM /m2 will increase the yield of flowers. OR 250: 80: 200: 125: 400 g / m2 / yr N, P2O5, K2O, Ca, Mg application in 24 splits once in 15 days.

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

Water requirement: 4 -5 I / m²/ day

PHYSIOLOGICAL DISORDER CALYX SPLITTING:

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

HARVEST AND POST HARVEST:

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

STANDARDS:

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

SPRAYS:

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

TIME OF HARVEST: 15 – 20 weeks after single pinching

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

POST HARVEST OPERATIONS:

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

Question bank

Part A

- 1.--- types carnation comes up well in warm conditions (spray type)
- 2. For micropropagation of carnation -----part is not used (root)

Part B

- 1. What are the types of carnation? (Standard and spray types)
- 2.what is pinching? (removal of terminal buds)

Part C

1. What is calyx splitting and remedies for them? (too many petals – rubber band)

LEC 12 - CUT CHRYSANTHEMUM - VARIETIES - PACKAGE OF PRACTICES

Varieties:

Standard types: Bonfire Orange, Bonfire Yellow.

Spray types: Reagan Yellow, Reagan White, Nanako, etc.,

Climate: Cut chrysanthemums are grown under polyhouses with the following environmental conditions.

Temperature: 16 - 250C, Relative humidity: 70 - 85 %, CO2: 600 - 900 ppm

Photoperiod: Long day conditions with 13 hours light & 11 hours darkness during vegetative stage (upto 4-5 weeks from planting) and short day conditions with 10 hours light & 14 hours darkness during flower bud initiation stage.

Soil: Well drained sandy loam soil with good texture and aeration or growing medium made of 1: 1: 2 of soil, compost and cocopeat with pH of 5.5 to 6.5.

Propagation: Terminal cuttings and tissue culture plants are used. Terminal cuttings are widely used for commercial cultivation. Cuttings of 5-7 cm length are taken from healthy stock plants and are induced to root by treating with IBA (1000 ppm).

Planting: Beds of 1 m width, 0.3 m height and convenient length are formed. Nets (with cell size depending on the spacing adopted) are placed on the beds and planting is done.

Spacing: 15 x 15 cm (45 plants/m 2) or 10 x 15 cm (67 plants/m²).

Irrigation: Drip irrigation with 8-9 litres of water/m²/day.

Nutrition:

Basal application of DAP - 50 g/m²

Weekly schedule - from 3rd week after planting

,			
Fertilizer	Quantity (g/m²)		
	Monday	Wednesday	
19-19-19	3.0	1.0	
KNO ₃	3.0	1.0	
CAN	2.0	1.0	
Ammonium nitrate	2.0	1.0	
MgSO ₄	2.0	1.0	

Special practices (same as loose flowers)

Pinching: First pinching - 3 weeks after planting; 2nd pinching - 5 weeks after planting. **Disbudding:** In spray varieties, only the large apical bud is removed and the lateral buds are retained. In standard varieties, the lateral buds are removed and only apical buds are allowed to develop.

Light regulation: Chrysanthemum is very much influenced by light and hence photoperiod should be regulated. (Photoperiod should be regulated as detailed under 'climate')

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

Weed management: Weeding and hoeing are done manually as and when required.

Harvest index:

Standard types - Flowers are harvested when 2 - 3 rows of rays florets are perpendicular to the flower stalk.

Spray types - When 50% flowers have shown colour for distant markets; when two flowers have opened and others have shown colour for local markets.

Yield:

Standard types: 67 flower stems/m2 Spray types: 260 flower stems/m2

POSTHARVEST TECHNOLOGY GRADING

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

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

STORAGE - Chrysanthemum cut flowers can be wrapped in plastics and stored dry for 6 to 8 weeks at a temperature of 0.5oC. Temperature for truck shipments across the country ranged between 20 and 4oC. The stems in the buckets (after grading) are given a cut using sharp blade and pre cooled at 1°C minimum of 2 hours before packing. Chrysanthemum can be stored for 3-6 weeks period at 0-3°C.

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

Physiological disorders

Blindness:

- It occurs when the night temperature is too low and the days are short at the time when flower buds are forming.
- A rosette type of growth
- Center petals fail to develop & flowers may fail to open.
- This can be reduced by properly regulating the light and temperature.

Crown Bud

- Bud development is severely retarded and invloucral bracts become grossly enlarged.
- This is observed in plants grown in long days after receiving a few short days
- Quilling of florets Boron deficiency
- Spray Borax @ 3g/l (or) 25 to 75 ppm

- Bleaching of petals cause bronze and pink coloured cultivars due to high temperature during floral development
- ▶ Pink colouration in white petals low night temperature during flower development
- **Doubleness –** transfer of plants to long days during floret formation
- Singleness transfer of plants to short days during floret formation

Question bank

Part A

- 1.Rooting hormone employed in chrysanthemum is -----(1000 ppm IBA)
- 2.----(Bonfire yellow) belongs to standard type of chrysanthemum

Part B

- 1. What is disbudding? (Removal of apical bud)
- 2. What is blindness? (Cool temperature)

Part C

- 1. Harvest index for chrysanthemum (standard and spray)
- 2.Post harvest handling of chrysanthemum (harvesting, pulsing)

LEC 13 – GERBERA – VARIETIES – PACKAGE OF PRACTICES

BN - Gerbera jamesonii, F- Asteraceae, O- South Africa

INTRODUCTION:

- Gerbera is commonly known as Transvaal Daisy, Barberton Daisy or African Daisy.
- It is an important commercial flower crop grown throughout the world in a wide range of climatic conditions.
- It is ideal for beds, borders, pots 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.

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.

VARIETIES

Species

Gerbera jamesonii is the only cultivated species.

The other species are

Gerbera asplenifolia Gerbera kunzeana Gerbera aurantiaca Gerbera viridifolia

Cultivars

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

Yercaud -1

Gerbera is a clonal selection from seedling from a mixed open pollinated seeds collected from germplasm of gerberas. It is a dwarf, herbaceous perennial growing to a height of 39cm. The flowers are double in form with cherry red colour. Flowers are large (9.11cm diameter) with moderately prominent disc. Petals are dense, compact and arranged in concentric whorls. Flowers are borne on long (47-79 cm) and thick stalk. Free from the disorders like bent neck, petal necrosis (during vase life) and temporary wilting in field are absent. Plants flower earlier (within in 45 days after planting) and produce about 60 flowers per plant per year. Flowers have a retentivity of 8 days on the plant with a vase life of 7 days. The variety is suitable for use as cut flower, raising as borders in garden and for pot cultivation. It is suitable for growing in the hill ranges of Tamil Nadu situated at an altitude of 1000 – 2000m.

Yercaud -2

It is a cut flower variety selected from among the germplasm collection at Horticultural Research Station, Yercaud. It blooms throughout the year with peak flowering during May – June. The flowers are attractive, rosy pink coloured, borne on long stalk without bend. The

flowers have a vase life of 15 days in hills and 10 days in plains. The variety yields about 80 flowers / clump in a year and suitable for cultivation in hilly regions of Tamil Nadu.

IIHR Varieties

Arka Krishika

It is selection from half sib from Acc.GJ4.It produces 3.6 flowers per plant per month with stalk llength of 39 cm.Flowers are double type and it can be grown in open conditikn.Flower colour is vellow.

Arka Ashwa

- It produces flower diameter (10.85 cm), flower stalk length (61.06 cm), flower stalk diameter (6.42 mm) and 3.23 numbers of flower/month.
- · It is suitable for cut flower and flower arrangement

Arka Nesara

- It produces flower diameter (10.43 cm), flower stalk length (61.11 cm), flower stalk diameter (5.63 mm) and 2.89 numbers of flower/month.
- It is suitable for cut flower and flower arrangement

PROPAGATION

- Gerbera is propagated by seed, by cuttings of side shoots and suckers.
- VEGETATIVE PROPAGATION:
- Side shoots, with some amount of heel, is utilized for.
- Divisions/ suckers, cuttings are also used.
- **MICRO-PROPAGATION**: Following are the plant parts used as explants for micro propagation.

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

SOIL AND CLIMATE

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

SOIL: Soil pH should be between 5.5 to 6.5 or it should be maintained at this level to get maximum efficiency in absorption of nutrients. The soil should be highly porous and well drained to have better root growth and better penetration of roots.

DISINFECTION OF SOIL: (For all cut flowers suitable)

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

- 1. Steam: Not economically feasible for Indian conditions.
- 2. **Sun**: Cover the soil with plastic for 6-8 weeks. Sunrays will heat up the soil, which will kill most fungi.
- 3. **Chemical sterilization**: Use of formalin @ 7.5-10 lit/100sqm. This pure chemical should be diluted 10 times in water and then sprayed/drenched on beds. Cover the beds with plastic sheets for 7 days. Then flush the soil approximately with 100 liters of water per sqm to drain the traces. After sterilizing, subsequent washing out of the soil. It is advised to wait for 2 weeks

before plantation. Other chemicals that can be used are, Methyl Bromide : @ 25 - 30g/sqm , Basamid (Dazomet) : @ 30 - 40g/sqm

BED PREPARATION:

- In general, Gerberas are grown on raised beds to assist in easier movement and better drainage. The dimensions of the bed should be as follows:
- Bed height: 1.5 ft (45cm), Bed Width: 2 ft (60 cm), Pathways between beds: 1 ft (30 cm)
- The beds for planting should be highly porous, well drained and airy.
- Gravel/sand can be added at the bottom for better drainage.
- While bed preparation, add Single Super Phosphate (0:16:0) @ 2.5 kg per 100 saft for better root establishment and
- Magnesium Sulphate @ 0.5 kg per 100 sqft to take care of deficiency of Mg.

PLANTING: While planting Gerbera plants, the crown of plants should be 1-2 cm above soil level.

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

IRRIGATION: Avoid excessive watering to gerbera. Immediately after plantation, irrigate the plant with overhead irrigation for four weeks to enable uniform root development. Thereafter gradually change to drip irrigation. Drip irrigation is mainly for correct doses and fertilizer application. Generally, one dripper per plant is required. The aim is to provide sufficient irrigation in the 2nd year for extra foliage. The water requirement of Gerbera plant may be approximately 700 ml per plant per day. In hot summer foggers can be utilized to maintain the humidity of the air. Until the first flowers are produced, watering can be done as overhead irrigation. Thereafter irrigation is through drippers. The R.H. of air should not exceed 90 - 92%, as it will lead to deformity of flowers. As a thumb rule, the soil should be moderately moist-however never having excessive water.

FERTILIZATION:

- Irrigate and fertilize frequently in small quantities for optimum results. However, always take care to fulfill the crop requirement.
- Micronutrients should be given weekly or fortnightly as per the deficiency symptoms (preferably chelated source).
- 25-75 t/ha of well decomposed organic manure is required.
- 150:137:190 g NPK/m2 (40:40:40 g, three months at monthly interval)
- For the first three months after planting, application of 20:20:20:N:P:K @ 1.5 g/l of water every two days during the vegetative stage encourages better foliage.
- o Once flowering commences N:P:K 15:8:35 at the rate of 1.5 g/l water/day.
- Boron deficiency causes base of young leaves to turn black coloured.
- Zinc deficiency symptoms can be identified with the C-shaped leaf structure caused by chlorosis on one half of the leaf blade which ceases to expand, while the other half of the leaf is normal.

Special practices – Hand weeding is done whenever necessary. Remove the flower buds up to 2 months and then allow for flowering. Rake the soil once in 15 days to facilitate easy

absorption of water, fertilizer and to provide air to the roots. Remove older leaves to facilitate new leaf growth and good sanitation.

CROPPING PATTERN AND HARVESTING OF FLOWERS:

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

POST HARVEST HANDLING OF FLOWERS

- o Cut the heel of the stem by giving an angular cut.
- Pack the flowers in a box with following dimensions.
- Immediately after harvesting, flowers put in water and kept for four hours at 7 to 8oC
- The cut flowers can be stored dry at 2oC in moisture proof retentive boxes for two days
- If stored wet at 4 to 5oC, the flowers can be kept for 5 to 7 days.
- Always add 7 10 ml commercial bleach/Sodium Hypochlorite solutions in one litre water i.e. 1% solution.
- It has a maximum vase life of 7 to 8 days.
- Frequent re-cutting of stem ends is suggested.
- The flowers are relatively insensitive to ethylene.
- A good flower has stalk length of 45 55cm, and diameter of flower is 10 12cm.
- o Gerbera Cups The packaging solution to protect the gerbera flower

Physiological disorders

- Pre-harvest stem break High root pressure and high humidity in the air. Regular watering and ethyelene spray
- Premature wilting of Gerbera flower Cloudy weather followed by bright sun or carbohydrate depletion.
- Bushiness An abnormality characterized by numerous leaves, short petioles and small laminae, which gives some cultivars of gerbera a bushy appearance known as bushiness. Nodes are not clearly distinguished and no internode elongation is seen.
- Double-faced Gerbera flower A physiological disorder caused by imbalance of nutrients. Too much growth too little flower buds.
- Non-uniform flower blooming Physical injury to flower stem/pest damage/phytotoxicity.
- **Short stem length** High salinity level, moisture stress, low soil temp.
- **Bend Neck** Inappropriate harvest and insufficient stem maturation

Question bank

Part A

- 1.Gerbera is also called as ----- (African daisy)
- 2.(G.Jamseonii)----is the only cultivated type.

Part B

- 1.Write cropping pattern in Gerbera (Age of crop, yield etc)
- 2.What is bend neck? (insufficient stem maturation and harvest)

Part C

1. Write in detail about post harvest handling of Gerbera (Harvest, yield, pre harvest ,pulsing etc)

PACKAGE OF PRACTICES OF LILIUM

Botanical Name – lilium spp – family – Liliaceae - Origin – Asia Varieties: Hybrids

a. Asiatic hybrids: Orange, red and Yellow in colour

Dreamland (yellow), Brunello (orange), Novona (white), Pollyanna (yellow), Yellow Giant (yellow), Vivaldi (pink), Black Out (Deep red)

Oriental hybrids: White, Pink flowers - Mostly fragrant types - late flowering
Star Gazer (Pink & white), Nerostar, Siberia, Acapulco (cyclamen pink) and Casablanca
Eastern lily (L. longiflorum): Flowers are large, white, fragarant, funnel shaped Elegant
Lady, Ace, Snow Queen, White, American, Croft and Harbor

Difference between Asiatic Lily and Priental Lily

Asiatic Liliy	Oriental Lily
Early Bloomers	Late Bloomers
Non Fragrant	Heavily Fragranced
Rapid Multiply	Slow Multiply
Greater Colour Range, flower shape	Large flowers , Raised papillae in the petals
variance more	

Climate: Liliums are best grown in green houses. Day temperature of 18-22°C and night temperature of 10-15°C are ideal. Relative humidity should be 80-850 C

Soil: Well drained sterile medium (preferably leaf mould, cocopeat and FYM in equal parts) with pH 5.5 to 6.5 is ideal. Fumigate the beds with Dazomet @ 30g/m².

Propagation: Liliums are commercially propagated through bulbs / bulblets A 6 and 8 week cold storage period at 2°C to 5°C is needed to break dormancy for Asiatic and Oriental lily respectively. Bulbs can be stored at - 20C up to one year.

Spacing: 20 x 15 cm, 15 x 15 cm or 15 x 10 cm (plant density varies between 30 and $60/m^2$ depending on cultivar and bulb size). The bulbs are planted at a depth of 15 cm.

Irrigation: 6-8 litres/m²/day during summer and 5 - 6 litres/m²/day during winter

Nutrition:

The following fertigation schedule can be adopted.

Nutrients	Quantity (g/m²/week)	
	Asiatic	Oriental
Calcium Nitrate	2.5	2.5
19:19:19	0.5	0.5
Potassium Nitrate	2.2	2.3
Micronutrient mixture	1.2	1.2

Crop support: Supporting plants with nylon mesh is advisable. One plastic net layer at 15 X 25 cm is put over the bed after planting and the is raised as plant grows

Physiological disorders – Leaf Scorch (Fluoride toxicity), Flower Blasting (ethylene gas release), Stem Pull – (Physical removal of daughter meristem).

Harvest: Harvesting is done when lower most bud shows colour (colour breaking stage) but is not open. Cut the stem at 8-10 cm above the ground level. The stems are graded according to number flower buds per stem, length and firmness of the stem. During bunching remove 10 % foliage from the end of the stems and subsequently sleeve the b stems. The bunches are placed in cold storage at 2-4 $^{\circ}$ C. To increase vase life 2 % sucrose and 100 ppm GA₃ are added as preservative. To maintain temperature liliums are transported in perforated boxes.

Crop duration:

Asiatic hybrids : 8 - 10 weeks Oriental hybrids : 14 - 16 weeks

Yield: The average yield is 30 - 40 flower stems/m²

Question bank

Part A

- 1.Origin of lilium is ----(Asia)
- 2.Slow rate of multiplication is found in -----(oriental) lily
- 3. Dormancy period of lilium bulbs is -----(4-6 weeks)

Part B

- 1. Physiological disorder in lily (Fluride toxicity, ethylene release etc)
- 2. Vase life enhancement in lilium (2 % sucrose and 100 ppm GA3)

LEC 15 - ANTHURIUM - VARIETIES - PACKAGE OF PRACTICES

Derives its name from Greek language "Anthos" means 'flower" and ''Oura" means, "tail" indicating the flower with a tail.

(BN - Anthurium spp, F- Aracea, O - Tropical America)

INTRODUCTION - *Anthurium* is an evergreen, tropical herbaceous plant cultivated for its colourful spathe and unusual attractive foliage. The genus *Anthurium* has 600 species, which are distributed worldwide. Among the number of species available, the most popular and economically important species are *Anthurium andreanum* and A. *Scherzerianum*, which posses" attractive long-lasting inflorescence.

Several other species like A. magnificium, A. digitatum, A. crystallinum, A. watermaliense, A. clarinervium and A. hookeri are grown for their excellent foliage.

PRODUCTION - WORLD SCENARIO

- Presently, the Netherlands is the world's leading producer and exporter.
- The preferred colours in Dutch markets are orange and red followed by white and pink.
- Germany is the single largest importer of Dutch Anthuriums followed by Italy and France.
- Mauritius is the second largest producer and exporter of Anthuriums.
- Anthurium is also produced commercially in Indonesia, Japan, South Korea, Thailand, Sri Lanka, Singapore and Taiwan.
- In India, Anthurium cultivation, which was mainly a hobby, is transformed into a commercial business by enterprising coffee and tea planters, who were initially responsible for bringing many exotic varieties into India.
- The coastal belts of south India, Eastern and Western Ghats and North-East hilly regions are potential area where Anthurium cultivation can be taken up on a large scale.
- Anthurium cultivation on commercial scale is also concentrated around Pune, Nashik, Mumbai, Trivendrum, Cochin, etc..

PLANT MORPHOLOGY

Anthurium andreanum a perennial with creeping, climbing or arborescent stems with lots of aerial roots. The attractive colourful plant that is traded is actually a **modification of the leaf**, which is botanically called '**spathe**'. A **cylindrical fleshy spadix** originates from the same junction and produces a number of bisexual flowers (150-250 flowers) which are arranged in concentric whorls. The female part of the flower matures first (protogynous), which can be noticed by nectar like secretions in the form of shining droplets on the flowers. The anthers dehisce at a later stage forcing the flowers to cross pollinate. 3 to 8 flowers per plant per year can be expected.

AVAILABLE GERMPLASM

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

FLOWERING TYPE Anthurium andreanum, A. seherzerianum, A. omaturm, etc. **FOLIAGE TYPE** A. clarinervium, A. corrugatum, A.crystallinum, A. digitatum A. holtanianum, A. leuconerum A. magnificum, A. pentaphyllum A. pedetoradiatum, A. olfersianum, A. hookeri, A. veitchii A. warocqueanum, A. watermaliense etc.

- **1. STANDARD:** They have the most common heart shape, the spathe lobes often overlap. Sizes range from 12x11cm to 20x18cm. Colour range includes red, orange, pink, Coral, white and green.
- **2. OBAKE:** Popular for their two-tone coloration usually a bi- colour pattern of green and a major spathe colour. Sizes vary from 8x7cm miniatures 28x23cm large varieties.
- **3. TULIP:** They have up right cup shaped spathe with a straight and erect spadix. The spathe size ranges

from 10x6cm. Tulip types are mostly hybrids with more than one species as their parents.

GROWING ENVIRONMENT

Diurnal temperature, light and humidity play a major role in the growth and flowering of *Anthurium*s.

DIURNAL TEMPERATURE - For a **luxuriant growth** the cultivated *Anthurium* required **18.3°C** during **night** whereas , a **higher night temperature of 21.2 to 23.9 °C** is essential for **initiation of flowering.** *Anthurium* cannot tolerate freezing temperature. At the same time *Anthurium*s do not prefer temperatures above 35 ° **C**. If the temperature exceeds 35 degree centigrade coupled with low relative humidity leaf scorching is common.

LIGHT -*Anthurium* is basically a shade loving plant. During summer where the light intensity is more, *Anthurium* plants are provided with 75 to 80% shade allowing only 20-25% of light to reach the plants. The range of light intensity that suits *Anthurium* cultivation is 20,000 to 25,000 lux.

RELATIVE HUMIDITY -Anthurium thrives well in areas having high relative humidity levels, which are common in coastal areas of Kerala, Tamil Nadu, Andhra Pradesh and Maharashtra, high rainfall areas of Western, Eastern Ghats and North Eastern hilly regions. The optimum relative humidity levels range from 50 to 85% and at humidity levels less than 50%, the vegetative growth is slower and the flower development is poor.

GROWING STRUCTURES - Depending upon the area of cultivation, the growing structures can be modified to suit the local climatic conditions. Commercial scale *Anthurium* cultivation can be taken up in

- o Low cost polyhouses,
- o Shade houses or
- o Climate controlled green houses.

LOW COST POLY HOUSES - In areas where the relative humidity levels are low and the temperature levels are high, low cost poly houses are more suitable for commercial cultivation of *Anthuriums*. By creating a protected climate by cladding UV stabilized polythene, the relative humidity levels can be easily maintained and by providing top or side ventilation, the hot air can be easily expelled. Inside the poly house, the top portion can be provided with layers of two shade nets (50% and 25%). If the light intensity is very high a thin film of calcium chloride or lime can be sprayed on the external surface of the poly house to reduce the incoming radiation.

SHADE HOUSES -In many of the commercial *Anthurium* growing areas, shade houses are the most popular structures because of the simplicity of construction and low cost. The shade houses can be constructed by taking the support of existing tree trunks if the *Anthurium*s are grown in multistoried plantation cropping. In open areas wooden, granite or pillars can be

erected at regular intervals connected by GI wires as a mesh on top. Shade net can be covered on the top to provide the required shade 75%, (ie., 50 +25%, shade nets). Provision can be made for installing overhead sprinkler/misters/fogging systems by running GI wires from one end to another end.

CLIMATE CONTROLLED GREEN HOUSES -The capital investment and the level of sophistication is more in climate controlled greenhouses than the previous two structures. Climate controlled greenhouses can be adopted for growing *Anthurium*s in areas where conditions of growing are not so congenial or to produce top quality blooms exclusively for export markets. Unless it is warranted it is not advisable to go for such capital intensive structures.

PHYSIOLOGICAL PROBLEMS -

- 1. Flower abortion,
- 2. Folded ears,
- 3. Sticking,
- 4. Jamming,
- 5. Cracks .

The symptoms are as related to the name of the disorder and are mainly due to varied climatic conditions and varietal characters.

6. Excess light - Symptoms – Leaves appear bleached in the centers and may have brown tips.

Control – Increase shade so as to reduce light level to 1800-2500 foot-candles.

- **7. Over fertilization Symptoms** Lower leaves become yellow and develop brown tips, which gradually enlarge . **Control** Reduce fertilization and leach soils thoroughly. Check roots for damage and possibility of secondary infection by fungus or bacteria.
- 8. Lack of flowering Symptoms Mature plants produce many leaves but few flowers. No flowers on the lateral shoots. Control Increase light level to 1800-2500 footcandles. Maintain higher light intensity as long as leaves do not develop symptoms mentioned in 1) above.

GROWING MEDIA - *Anthurium* requires a highly organic, well aerated medium with good water retention. However, the secret of success for commercial cultivation is to have good drainage in the medium used.

An ideal medium for pots or ground potting should have the following properties like good water holding capacity, high porosity, adequate drainage, good aeration, good structure and good texture with low salt concentrations

CULTIVATION:

- **A). IN POTS** *Anthurium* especially the miniature type, *A. scherzerianum* and its hybrids have to be grown in pots to use them as potted plants.
- **B) IN BEDS** When planting is done in soil, the plants have to be grown in 1.00meter wide raised beds

with gentle slope, which facilitates good drainage. The beds have to be raised approximately 30cm in height which gets compressed due to frequent irrigation and other cultural practices. The beds are prepared by digging about 2 feet deep and filling the pits with the chosen growing medium. The dug out soil is thoroughly mixed with chosen growing medium and is used as top layer to create the raised beds.

PROPAGATION: Seeds, cuttings, suckers, tissue culture. Anthuriums are highly amenable for in-vitro propagation using different parts as explants.

PLANTING - Avoid planting during seasons with high temperature and high rainfall. Make sure the

bed/medium is evenly moist but not wet. Dip the roots in a fungicide solution before planting (@ 0.1% Bavistin). Plant them in rows in cross wise pattern. Plant at an optimum depth (15cm deep so that new aerial roots appear above the planting surface. Do not prune the leaves immediately after planting, allow the plants to establish and cut down to three to four leaves.

PLANTING DENSITY / spacing - The optimum spacing for commercial cultivation of *Anthurium* is 45 x 45cm, which accommodates 5 plants/m2. A closer planting of 30cm apart is also recommended to accommodate 7 to 10 plants/m2 (61,750 plants/ha).

IRRIGATION - Anthurium requires generous watering and should be irrigated at least twice a day in summer months. In field grown plantations besides ground level irrigation, the plants can also be watered using overhead sprinklers. Irrigation can be accomplished by flooding beds or by installing micro-sprinklers at the plant level.

NUTRITION -*Anthurium*s prefer smaller doses of fertilizers at frequent intervals rather than larger doses in longer intervals. For pot cultivation it is advisable to apply 5g of any complex fertilizer in 500ml of water (1%) once in a month. *Anthurium*s can also efficiently take up nutrients thorough foliage. Foliar application of 0.1% urea at monthly intervals is found to be beneficial. Adequate levels of calcium and magnesium are also necessary for optimum yield. Deficiency of calcium often results in color break in the spathes. Application of 5g of CaNo3 at monthly intervals stabilizes the spathe color.

HARVESTING

Anthurium flowers are harvested when the spathe is completely unfurls and the spadix is well developed. Development of true flowers on the spadix is also used as a criterion for harvesting the blooms. When one third of the flowers on the spadix mature, change of colour can be observed that moves from base to tip of spadix at that stage the flowers are harvested.

Harvesting has to be done during cooler parts of the day i.e. early morning or late evening. The flowers are cut below leaving 2cm stem on the plant & kept in the bucket containing water. Flowers are graded according to the length of the stalk and diameter of the spathe. The flower stalk length varies from 25 to 50cm. Depending upon the cultural practices, planting density and variety, 5 to 10 flowers can be obtained per plant per year. Average price of Anthurium in Europe is US \$1.50 per flower. In the India cities, prices vary from Rs.15 to Rs.30 per flower in florist shops, while growers get Rs.6 to Rs.10 per flower.

POST HARVEST HANDLING

- 1. PACKING -Dutch packing puts few *Anthuriums* in a box to make sure that the *Anthurium* spathes do not bruise. Within each box flowers are of a uniform grade and generally of the same colour. Individual flowers are packed with water vials filled with water with preservative solution. Flowers are packed so as not to touch each other or the ends of the box. White foam rubber cushions are used to support the spadix. If flowers are layered, 4cm thick plastic sheeting is inserted between the layers. White cellulose shredding is used around the ends, particularly in the winter, when foam peanuts or other white foam pieces may be included in the box for insulation.
- **2. PACKAGING -** *Anthurium* packaging is into boxes of white surfaced corrugated cardboard, the lids which have been printed with 3-colour logos and lettering. European Carton Sizes-100x20x10cm, 100 x 40 x 12 cm and 100 x 40 x 14.5 cm

STORAGE AND VASE LIFE -*Anthurium* can be easily stored at 13oC for 2-3 weeks. The flowers, which are harvested when ³/₄th of the length of the spadix colour changes, last longer than the other flowers which are harvested either early or late. The average vase life depends upon life of flowers ranges between 12-24 days depending upon the cultivars.

POST HARVEST QUALITY REQUIREMENT -The size, shape, colour and texture of the spathe gets prior consideration. A heart-shaped symmetrical spathe with overlapping or fused lobes is desirable.

The spathe should be free from any kind of damages and infestation. Straight and sturdy flower stems with shorter internodes are preferred.

Pulsing – Pulsing is a short term treatment given to cut flowers immediately after harvest to increase the longevity.

Question bank

Part A

- 1.origin of Anthurium is ---- (America and Mexico)
- 2.Anthurium is cultivated in ---- (Yercaud) of Tamil Nadu
- 3.----(A.crysalinum) is the foliage typed anthurium

Part B

1. What are the types of Anthurium? (standard, obake and tulip)

Part C

1. Physiological problems in Anthurium (Flower abortion, sticking, jamming and cracks)

LEC 17 - IMPORTANCE, COMPONENTS OF GARDEN AND BASIC PRINCIPLES OF LANDSCAPING

Importance of gardening

The importance of gardening is realized by every individuals now in the globe.

- The gardens serve the purpose of public recreation and education
- They serve to refresh the body and the mind
- Gardens have become essential to modern civilization
- Home gardening is an integral part of family life and it lends itself for the family to relax and enjoy the nature and beauty of garden
- It helps to develop 'skill' in floriculture industry
- It also helps to develop some useful hobby
- Landscape architecture has come to play a vital role in the developments of home, public institutions, public places.
- Landscaping on the roadsides provide shade and beauty to that area

Scope of ornamental gardening and landscaping

Gardening which was only an art and science in the earlier days has now emerged as a huge industry. With the importance and need of gardening in improving and conserving the environment being strongly felt now, the concept of landscaping and gardening is growing rapidly. Ornamental gardening and landscaping has expanded as a multi-faceted industry encompassing activities such as propagating and rearing ornamental plants, landscaping, production of growing media, pots and other accessories, etc., generating huge employment Opportunities and simultaneously promoting activities that would improve the environment.

BIO-AESTHETIC PLANNING

- The term bio-aesthetic planning, a concept of **Prof. Lancelot Hogben**,
- This means the proper utilization of the available flora and fauna in the beautification of the surroundings.
- In India, the theme of bio-aesthetic planning gave a practical shape to it in planning **Chandigarh City** along with the famous architects **Le Corbusier** and **Pierre Jeanneret**.
- The aim behind this concept is to plant ornamental flowering trees all along the roads, in parks, house compounds, public places and also to develop national parks where non- carnivorous animals and beautiful birds will find sanctuary along with beautiful flora. This term also includes landscape gardening though in a wider sense.
- Bio-aesthetic planning should run hand in hand with town planning.
- Our new townships should not be allowed to grow as mushrooms in dung-heaps as our older towns are.
- The roads in town and cities should be broad, planted with flowering and shade trees, and there should be spacious parks along with conservatories for harmless animals and birds.
- The older congested cities and towns also should be retrieved from their present state by bio-aesthetic planning.
- One way of doing this is to acquire by compulsion the ugly areas of the towns in some centrally located pockets and to convert them into parks.
 - The displaced persons may be accommodated in multi-storey buildings which occupy less land.
 - But many planners are against vertical growth in our towns; a compromise must be found somewhere.

- In some of the most congested cities such as Kolkata, Kanpur, Mumbai etc., it may be really impossible to get land in the city proper for bio-aesthetic planning.
- In such cases "garden suburbs" should be developed on the outskirts of the city with easily approachable by vehicles or even bicycles.
- The real estate value of any property goes up if it has a compound properly landscaped and planted with trees.

LANDSCAPE FOR POLLUTION FREE ENVIRONMENT

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

LANDSCAPE ARCHITECTURE:

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

OR

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

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

The scope of the profession includes:

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

Plant and Non plant components

A. Plant components

- a. **Carpet beds** The art of growing ground cover plants closely and trimming them to a design or alphabetical letters is called a carpet bed. Colourful foliage edge plants are found more suitable for this purpose. Eg. *Alternanthera*
- b. **Ground cover** -When a dicot plant, which is of straggling nature is used to cover the ground surface, it is called ground cover. Eg. *Vedalia, Verbena, Portulaca*
- c. **Shrubs** -Shrubs are very important in the garden as flowering shrubs produce beautiful flowers at eye level. They display their varied beauty by way of richly coloured flowers, handsome foliage and their shape. They form the frame work of garden as they are semi permanent in character.
 - Purpose of a shrub
- * Enhance the beauty of surroundings.
- * Act as garden's boundary wall.
- * Planted for screening purposes to hide unwanted places of garden.
- * Planted to divide the area of garden into different segments.
- * Actually the fillers of the garden at eye level.
- d. **Hedges -** When shrub is planted on boundary for fencing, it is called as hedge. It may be ornamental or protective or both. For selecting an ideal shrub for a hedge, it should have following characteristics:
- * It should have thick texture and quick growth.
- * It should stand trimming to shape.
- * It should be easily propagated through seeds or cuttings.
- * It should withstand drought conditions.
- * It should not attract reptiles or other animals.
- e. **Edges -**When low growing perennial plants are grown on the border of plots or bed, they are called as edge plant or an edge. These plants hardly grow upto 20-30 cm. These are propagated through terminal cuttings. Eg. *Eupatorium cannabium*, *Iresine* sp., *Alternanthera* sp., etc.

- f. **Trees -** Planting trees as avenues were planted by Buddhist and Emperor Ashoka. They bring change in skyline due to their variation in their height, shapes, foliage texture and flower colour. Trees are planted both for aesthetic and functional purposes. They act as specimen, avenue plantation, wind break and screening of less pleasing sites, and offer privacy, as sound barrier and reduce noise and dust blown by speeding traffic. Trees provide shade and shelter and also reduce heat during hot summer. Arboretum is growing of different species of trees in one place is called 'Arboretum'.
- g. **Topiary -** It is an art of training plants into different shapes i-e. of birds, animals etc. It is an old art and now-a-days it is becoming common in city parks to provide passive recreation to the visitors specially children. Eg. Hills *Cupressus macrocarpa*, *Pinus patula*; Plains *Casuarina* sp., *Bougainvillea* sp.,
- h. **Trophy** -It is the arrangement of colourful potted plants in different tiers around a central structure which may be a tree trunk, lamp post or a pillar.
- i. Ornamental Climbers -Climbers are an important group of ornamental plants. The beauty of any garden can greatly be enhanced by carefully selecting and planting them in suitable places. Plants which have special structure to climb on supports are defined as climbers
- j. **PALMS** -Palms are the princess of vegetative kingdom and are tropical plants that tall, unbranched trunks topped by a crown of fan-shaped or feathery fronds which are sculpturistic in nature. Eg. *Caryota urens*, *Oreodoxa regia*, Areca palm
- k. Cacti And Succulents -These are group of plants which have developed a special capacity to store water in thick fleshy leaves or stems. They thrive best in sunny situations and are light loving. They need little care except when actively growing. All the cacti are succulents on account of storing water but all the succulents are not cacti. There is a clear cut distinction between both. Cactus is characterized by the presence of areoles, which often look like wooly cushions carrying spines, hairs and the flowers arise from or near the areoles.
- I. **Ferns** -Ferns are foliage plants that do not produce flower and seeds but to reproduce by means of spores.
- B. Non -Plant components / Hardscapes are non-living garden components (adornments) which can be made with aesthetic sense to add additional beauty to the garden. This includes Pathways , garden seats , Bird Baths , Ornamental tubs, urns , vases , planter boxes , window boxes , statues , cascades , fountains , bridges , Japanese lanterns , lighting lamps, name boards, aesthetic dust bins , Ornamental stones , fence , arches , pergolas , arbours , Sun dials , Floral clocks , trellis , gazebos , garden walls , Plant stands , conservatory , swings etc.,

STYLES OF GARDENING

History and development of gardening in India

It is believed that the gardening in India is as old as its culture. Five to six thousand years before Christ, gardening was in vogue. It is understood that Indians were the first to choose gardening as the proper atmosphere for meditation.

Gardening has been mentioned in classical literature of India. Gardening is considered as a source of peace and solitude. From 6 to 10th Century gardening received a great deal of encouragement from Indian kings. These types of gardens are **informal gardens**.

1. Informal gardens - Imitation of nature and improvement over nature were considered as a primary goal in these types of gardening. Asokavana of Ramayana was believed to be established with trees, shrubs, ponds, etc. The use of 'brindavan' (landscaped city) and 'Raja-vanam' (large park where kings go for hunting) did find very frequent mention in ancient literature. Many trees were considered, 'sacred' to Hinduism e.g. Ficus religiosa, Saraca indica, Aegle marmelos and Mimusops elengi. During Bhuddha's period (about 563 B.C.) gardening received further encouragement. King Asoka could be considered as the Father of road side avenue planting as he was the first king to order planting of road side avenue trees in India. During the time of King Somadeva (11th Century) and King Hamira (13th Century) gardening developed into a fine art. **The** 'Vanas' and 'Ashrams' gave way to gardens established by kings and nobles and gardening became virtually and monopoly of the feudals.

Features of informal gardens

- Naturalistic effect and asymmetrical
- Plan is made according to the land available
- Smooth and curvaceous outlines
- Water bodies and rockeries irregular
- Group planting without trimming
- 2. Formal gardens The period between the beginning of the 14th Century to the end of 16th Century showed sudden change in the style of gardening due to influence of Moghul emperors who ruled India during these centuries. King Feroze Shah and King Baber brought with them the finest art of gardening from their country and the Mogul style gardens were established in Delhi, Hyderabad, Agra, Kashmir, Lahore and Pinjore. Some of these gardens are still famous to this day. Some examples are Garden at Fatepur Sikri (U.P.) by King Akbar, Shalimar Bagh at Lahore by Shah Jahan, Taj Mahal garden in Agra. These Mogul gardens had a distinct style and are called as formal gardens. They were laid out near river, or rivulets, slope of a hill or river bank. Features of formal gardens:

- Plan made on paper and land selected
- Symmetrical with enclosure and boundaries at right angles
- Garden may be square or rectangular
- Flower beds in geometric designs
- Trees and shrubs kept in shape by training and trimming
- Water bodies symmetrical
- 3. <u>British style:</u> During the 16th Century when British came to India they introduced the styles of gardening of England and continental Europe. The first style developed by the British was the formal or symmetrical style of gardening. By 18th Century, this style became monotonous and then informal style or natural gardens began to develop. The modern gardens, developed during 19th and 20th Centuries, involved the combinations of the formal and informal styles. The important features in English gardens are lawn, rockery, mixed borders of herbaceous perennials, annuals, shrubs, etc. Lal Bagh at Bangalore, Government Botanic Garden at Ooty and Coimbatore, Sims park at Coonoor and Bryant park at Kodaikanal are examples of gardens established in British style.

THE MAJOR GARDEN STYLES -

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

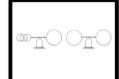
Out of these, the **Mughal, Persian, Italian and French styles are Formal Gardens**, whereas, **English and Japanese gardens** are classified as **Informal Style of gardening**.

- {1} ENGLISH GARDENS The main features of gardens during this period were curved paths, informal groups of trees, rivulets or streams, artificial waterfalls and clipped hedges. The flowering annuals, the main stay of an English garden, came into prominence during the nineteenth century which subdued the architectural features. The main features of an English garden are the lawn, mixed border especially of herbaceous annuals, as well as herbaceous perennials, shrubbery, and rock gardens.
- **(2) ITALIAN GARDENS -** The Italian garden style came into existence at the time of **Renaissance.** The most prominent features associated with Italian gardens was the massive flight of stairs, generally of marble, complete with balustrade to connect the different levels in the garden. Decorative urns, fountains generally in combination with stone sculptures or rather the fountains themselves used to emerge from one part or the other of the statues, are the other equally important features of the Italian gardens.
- (3) FRENCH GARDENS The moral of French garden style of Le Notre seems to teach the lesson "How to Think Big".
- (4) PERSIAN GARDENS Persian garden style is one of the oldest. The Persian garden style and the Japanese style both were based on their respective ideas of heaven. Except this similarity the two styles differ widely from one another. The Persian styles are strictly formal and symmetrical. They used for their gardens all crafted materials such as masonry, carved and pierced marble stones, and highly polished stones. The Persian gardens were laid out by cutting terraces on the hill slopes. They also tapped some natural spring to create a straight water-course through the gardens and manipulated the water-course to undertake different movements along its run. So the main stay of a Persian garden design was *nahars* (Flowing canals) of water the concept of Persian Paradise, "where cooling water flows". The fruit trees represented the symbol of life while Cypress symbolized death and eternity.
- **(5) MUGHAL GARDENS -T**he gardens laid out during the rule of Mughal Emperors in India are known as Mughal gardens. The main features of Mughal gardens, which are largely borrowed from the Persian style, are: (a) site and style of the design, (b) walls, (c) gates, (d) terrace, (e) nahars or running waters, (f) baradari, (g) often a tomb or a mosque, and (h) trees.
- (6) JAPANESE GARDEN STYLE A most important teaching of the Japanese garden is possibly that "unless a garden has an air of peace it is not worth a place visiting. It should be a place where the mind finds rest and relaxation." Another strong basis of the Japanese garden is its immutability, i.e., except some seasonal changes in the deciduous trees the Japanese garden hardly goes through any other strong visible changes during different seasons. A Japanese garden tries to capture natural scenery or to imitate a landscape. The three elements most important to achieve these objectives are water, stone, and plants. Low sculptured bushes and trained dwarfed trees look very attractive in a Japanese garden. The Japanese gardens are further classified based on positions, shape and purpose. The important types are Hill garden, Flat garden, Tea garden, Passage garden, and Sand gardens.

PRINCIPLES OF GARDENING

Basic principles of Gardening

- Unity
- Balance
- Proportion
- Rhythm
- Transition
- Focal point
- Mobility
- **Unity-** Unity means all parts of the composition or landscape go together. All components blend with the entire landscape. Unity can be achieved by using mass planting and repetition.
- **Balance** Balance refers to the equilibrium or equality of visual attraction.
 - Symmetrical balance Formal styles Symmetrical balance is where there are more or less equally spaced matching elements in gardens design like mirror image and it need high maintenance to keep both side similar
 - Assymmetrical balance Informal styles Total mass of plants need to be balance left and right and need not be mirror image. It differs from left to right giving curiosity ,movement and feels alive. Asymmetrical balance cannot be boring.



- Proportion Proprtion refers to Size of different components in relation to each other.
 Simply refers to the size of elements in relation to each other than its Scale. Ex. Size of trees in relation to building
- **Rhythm** Rhythm is achieved when the elements of a design create a feeling of motion. Rhythm reduces confusion in the design. The Components can be repeated in regular fashion to attain rhythm in landscape design.
- **Transition** Transition is arrangement of objects with varying textures, forms or sizes in a logical sequential order.
- Focal Point Focal point is the centre of attraction and is focused as a point of attraction . In a landscape focal point can be used to direct attention to a point in an area.
- **Mobility** Mobility include components like Moving water, Moving branches, Birds in ponds, Butterflies, Swing of climbers, Sway of shrubs, Gait of trees, Curves of roads

Other principles include

- Background in a garden, whether a wall, tall trees or a hedge should be neutral in nature; that is to say this should not become a distracting feature over the main features of the garden.
- **Contrast:** The design should be such that it should break monotony. To achieve this, a variation in form, texture, or colour has to be brought through contrast
- Open Centre: The central area of the garden should be left out of any items of major interest. The best way to achieve this is to have a lawn, which also gives an effect of largeness to the property. A specimen shrub in the centre of the lawn is unsuitable as this counters the principle of spaciousness, but a tree branching at higher levels from the ground could be planted.
- **Repetition:** The repetition or duplicating some features of a garden helps achieve rhythm, balance, and unity. In a formal garden, generally the same feature is repeated.

But for an informal design this need not be so. Here one may repeat the colour tone without disturbing the texture, form, or quantity. If there is a circular path this can be repeated by having two or three consecutive circular shaped beds of annual flowers, hedges, and shrubbery border. Thus, though the shape is repeated, the variation in texture, colour, and form ensure that the design does not look monotonous.

• Variety: To break the monotony in a garden, variety is essential. This is achieved by contrast of colour, form, and texture. Planting of different seasonal flowers all in red colour, does not necessarily mean variety.

Question bank

A.Multiple cho	ice questio	ons						
1. Bio esthetic	plan was o	develop	ed by		_			
a.Gregor Meno	del k	b.P.P.Pa	aul	c.H.P.Si	ngh	d. Prof. L a	ncelot Ho	gben
2 are c	onsidered	d as lu	ngs of th	ne cities	6			
a.Corporation	building		b.Lakes	s and p	onds	c.Bird san	ctuary	d.Parks
3. When low gas	growing p	erenni	al plants	s are gr	own on	the border	of plots or	bed, they are called
a.Hedges	b.Edges	s	c.Shrub	os	d.Flow	er beds		
4. Arrangeme be a tree trun		•	•			t tiers arou	nd a centra	Il structure which may
a.Trophy	b.Topiaı	ry	c.Groui	nd cove	er	d.Ferns		
5. Arrangemo	ent of obj	ects w	ith vary	ing text	tures, fo	orms or siz	es in a log	ical sequential order i
a.Proportion	b.Rhyth	m	c.Focal	point	d.Tran	sition		
B.Answer the 1.What are th 2.Write the im	ie non pla	nt com					e? (dols,sta	atues etc)
C.Brief the fo	•	netic pl	anning					

2. Write in detail about landscape for pollution free environment

3. Differences between formal and informal garden

d.Explain about major garden styles e.Write principles of gardening

Lec 18 LAWN AND LAWN MAKING

A lawn is an area where grass is grown as a green carpet for a landscape and is the basic feature of any garden. It serves to enhance the beauty of the garden, be it larger or smaller. Proper lawn maintenance plays a crucial part in any landscape design. A beautiful well maintained lawn can make the entire landscape look good, whereas a lawn that is not maintained can completely ruin it's beauty.

Site and soil

The ideal soil pH should be 5.0 to 5.6. If it is very acidic, lime should be added and to clayey loam or alkaline soil, gypsum may be added. After choosing the site, the next important factor for consideration is the size and shape of the lawn.

Land preparation

The preparation of site includes digging, levelling and enriching the soil with organic manures or by amending with fertile soil. If the soil is very heavy, coarse sand may be added by removing subsoil to a depth of 20 cm.

Provision of drainage for excess rain water should be made if the ground is not sloppy. The site should be thoroughly levelled with spade. Pebbles and weeds are hand picked. The soil is rolled with roller. Weeds especially nut grass should not be allowed to grow and should be removed with roots for at least 2 to 3 times.

Methods of lawn establishment

- **a. Seed sowing:** If grass roots and cutting are not available, seeding is the best method. Seeds are broadcasted on well-prepared land by mixing with double quantity of sand or soil of moist and pass garden rake lightly in two directions for better mixing of the seeds. Then the ground is rolled with a roller to level the soil and irrigate well with rose can or a pipe fitted with rose head. Seeds germinate within 3-5 weeks. Seed rate is 500 gm per 200 m² area. This method takes long time of lawn establishments nearly one year.
- **b. Dibbing:** Well matured rooted or non-rooted cuttings are used for dibbling at a pacing of 7-10cm. It is a cheaper but time consuming method. Here the lawn establishes within 5-6 months.
- **c. Turfing:** Turf is a piece of earth of about 5 cm thick with grass grown on it. Usually turf is available in one foot. Turf is made closely to each other like bricks in all ready prepared ground and make firm by a beater and in this method lawn is quickly established but costly. Usually this method is used for preparation of lawns in exhibition and flower shows.
- **d. Turf plastering:** A paste is prepared by mixing garden soil (1 basket), fresh cow dung, water (1 basket) and bits of chaffed grass (2 baskets). Spread this paste uniformly on soil and cover this paste with 2 cm thicker soil. After 2-3 hours irrigate the ground. By this method lawn is established in about 2-3 months.
- **e. Astro Turf** It is synthetic lawn popularly used in developed countries in roof gardens as well as in play grounds. It dispenses the normal maintenance usually required for normal lawns.

Constant sprinkling of water is one of the prime requisite to bind the synthetic fibre to provide the surface akin to lawn carpet.

Maintenance of lawn: If lawn is not properly maintained, it becomes useless. Therefore one has to follow certain important practices to maintain the lawn in good condition.

- **Weeding:** As soon as the lawn is established, weeding has to be carried out regularly. Remove all annual and perennial weeds along with their roots.
- Rolling: It helps the grass to anchor itself securely and also to keep surface leveled by pressing down small stone and pebbles. Rolling should not be done in moist soil.
- Mowing: When grass is about 5 cm tall, it is clipped with garden shear for one or two times, later on lawn mower is used for cutting the lawn grasses evenly at correct
 - height. Frequency of mowing varies with season and purpose of lawn maintained.
- Sweeping: Sweeping lawn thoroughly after each mowing is essential to clean cut grasses that might have fallen from lawn mower box. Sweeping is also required to
 - remove dried fallen leaves, debris, waste material etc.
- **Irrigation**: Lawn grasses are shallow rooted and requires frequent but light irrigation. No over flooding or no missing while irrigation is important. Sprinklers irrigation is the best for bigger areas and pipe fitted with rose head for smaller area.
- **Scraping:** Old lawns get matted due to continuous rolling and mowing which makes the lawn ugly. The lawn grass is scrapped at ground level with spade or Kurphi
- **Manuring** The lawn grass is top-dressed mildly three times in annually with 2 % urea or ammonium phosphate @ 1lit per m² areas.

Description of lawn grass species

Botanical Name	Common name	Texture	Situation
Cynodon dactylon	Hariyali (or) Arugu	Medium	Suitable for open sunny location;
	(or) Doob grass	fine	drought resistant
Stenotaphrum	St. Augustine grass	Coarse	Suitable for shady situation;
secundatum	or Buffalo grass	texture	requires frequent watering
Sporobolus	Chain grass (or)	Fine	Suitable for saline soils and open
tremulus	Upparugu		sunny locations
Poa annua	Annual blue grass	Medium	Suitable for acid soils and suitable
		fine	for higher elevations
Pennisetum	Kikuyu grass	Rough	Grow well in acids soils, suitable for
clandestinum			higher elevations.
Zoisia japonica	Japan grass	Coarse	Suitable for poor sandy soil; open

			sunny situation, slow in growth
Z. matrella	Manila grass	Medium	Suitable for open sunny situation
Z. tenuifolia	Korean grass or	Fine	Suitable for open sunny situation
	velvet grass or		
	carpet grass		
Cynodon sp.	Bermuda grass (or)	Fine	Suitable for open sunny situation,
	Hyderabad grass		needs mowing
Cynodon sp.	Dwarf Bermuda	Medium	Suitable for open sunny situation
Festuca sp.	Fescue grass	Coarse	Shade tolerant, survive on inferior
			soils
Paspalum	Paspalum grass	Medium	Suitable for open sunny situation
vaginatum			

Bottle necks in lawn	Symptoms	Control
maintenance Problem		
Chlorosis	Grass turns yellow with the	Iron
	deficiency of magnesium and	Spray Ferrous sulphate 25 g
	iron	dissolved in 10 litres of water
		/ 100 m2.
		Magnesium - Spray MgSO ₄
		100g in 10 litres /100 m ²
Dog urine	Dead grass in the lawn	Re-plant grass in a circular
		manner
Fertilizer burn	Grass browns especially in	Drench the lawn in injured
	hot weather	areas to leach excess fertilizers
		deep into the soil.
Improper mowing	Lawns cut too closely turn	Mow enough to remove not
	yellowish and often look	more than 1/3rd height of the
	diseased or dried	grass at a time. Keep mower
		blades sharp.

Plant Protection Pest	Symptoms	Control
White ants	Form small mounds around	Apply Lindane 1.3 % dust
	the entrance to their nests	
Cut worms	Eat away grass stems near the	Apply Lindane 1.3 % dust
	surface of the soil causing	
	dead spots	
Grubs	Eat away the roots of grasses	Apply Lindane 1.3 % dust
	creating brownish dead	
	patches	
Leaf hoppers	Suck the juice from grass	Spray Dimethoate @2 ml/l
	blades causing stripped white,	

	then yellow and finally brown	
	leaves.	
Nematodes	Affect the roots, lawn takes a	Apply Carbofuron @ 40 g
	bleached out appearance	/m2

Question bank

A.MCQ

1.Ideal PH for making lawn is

a.6.5 - 7.5

b.5.0 - 5.6

c.7.5 - 8.5

d.4.5 - 5.5

2. Seed rate for sowing lawn seeds in 200 m2 area is

a.250 g

b.500g

c.750g

d.100g

3.Common method of establishment of lawn is

a.Dibbling

b.Turfing

c.Seed sowing

d.Turf plastering

4. Mowing of lawn could be done when lawn reaches a height of

a.5cm

b.10cm

c.7.5 cm

d.15cm

5. Grass suitable for shady areas is

a.Hariyali grass

b.Buffallo grass

c.Korean grass

d.Japan grass

6. Reclamation for chlorosis in lawn is by application of

a.FeSo4@25 g

b.Fe@20g

c.MgSo4@25g

d.ZnSo4@20g

B.

- 1. Write about methods of lawn establishment (turfing, plastering, seeding)
- 2. Write about scarping in lawn maintenance
- 3. What are the common grass species employed in lawn making? (Mexican grass, Korean grass, buffalo grass)

C.

- 1. Write about major pests affects lawn and management (ants, termites)
- 2. Write in detail about methods of lawn making

Lec.20 ANNUALS, BIENNIALS AND HERBACEOUS PERENNIALS

Annuals

Annuals are plants that complete their life cycle in one season or one year (eg.) Balsam and Cosmos. Annuals are a group of plants which attain their full growth from seed, flower and die in one year or one season. Mostly they complete their life history in 3 to 6 months. They comprise of several of the most beautiful and easily grown plants widely varying in form, habit of growth and colour.

Annuals are classified into rainy season annuals, cool season or winter annuals and warm weather annuals.

Annuals can be used for multipurpose as hereunder.

- 1. Flower beds of simple design can be laid out on the outskirts of lawn, along the base of buildings, in the path leading to entrance of horses and on sides of foot steps
- 2. Certain annuals are useful as edging (e.g. Dwarf marigold, Alyssum and Candytuft)
- 3. Certain annuals are useful in hanging baskets (eg. Petunia, Verbena and Alyssum)
- 4. Certain climbing annuals are useful to cover trellis work (e.g. Tall Nasturtium and *Cobaea scandens*)
- 5. Some annuals are useful for massing in beds (e.g., Aster, Phlox, Salvia, Zinnia and Verbena)
- 6. Few other annuals are useful for planting in shrubberies in vacant spaces; they are Sunflower, Hollyhock, tall growing species of Amaranthus, Tithonia etc.
- 7. They serve as perennial sources of supply of cutflowers for indoor decorations.

Hints for raising annuals

- 1. The seeds are sown in seed pan or raised beds. Thin sowing is necessary to get good sized vigorous seedlings. In the seed pan, a pot mixture consisting of two parts of well sifted soil, two parts of leaf mould and one part of sand may used.
- 2. Fine seeds may be mixed with 3 to 4 parts of sand before sowing.
- 3. Annuals which do not stand transplanting like Calendula and Antirrhinum are sown broadcast in beds.
- 4. Watering the nursery may be done with rosecan.
- 5. After the seeds germinate completely, over crowded seedlings are thinned out.
- 6. As transplanting often results in heavy casualities the seedlings are pricked before transplanting. Pricking is the practice of transplanting young seedlings into small pots individually or in the nursery beds with richer soil giving wider space (10 to 13 cm). Pricking is normally done when the seedlings have produced 2 to 4 leaves. This help to increase the fibrous root system and to develop vigorous plants.
- 7. One month after planting when the seedlings have produced six to eight leaves, they can be transplanted into main beds.
- 8. Generally a spacing of 30 X 30 cm may be given for most of the annuals.
- 9. Tall growing annuals like Hollyhock may be provided with stakes.
- 10. The terminal buds of seedlings are pinched-off after they establish and when they are about 25 to 30 cm high. This encourages lateral growth and a more bushy shape.

Biennials

Biennials are plants which grow in one season, flower, fruit and die in the next season. Generally, the period of growth is 6 to 9 months. Biennials are grown in the same way as annual and can be used similarly. Examples of biennials are canterburry bulb, *Gladiolus* etc.

Herbaceous perennials

Herbaceous perennials are those perennial plants with soft succulent stems (as compared to shrubs which have woody stems). They are propagated by seeds, cuttings, offset and slips. They are useful as herbaceous or mixed borders or for pot culture. The following .are the examples for herbaceous perennials.

- 1. **Chrysanthemum:** Flowers are single or double available in attractive colours. Perennial species include *C. frutescens* and *C. maximum* and its varieties. Propagated easily by suckers.
- 2. **Solidago:** Popularly known as 'golden rods' producing erect feathery rod-like trusses crowded with pretty golden yellow flowers. They are suitable for mass planting in beds and borders in and adjoining lawn. They are raised by suckers.
- 3. *Gerbera:* Stemless perennial herbs with radical stalked leaves, flower heads are solitary, large and sterile with varying colours. Propagation by division of clumps or from seed.
- 4. *Gazania splendens:* Perennial plant about 20 cm high, with pointed leaves with silver, and bearing beautiful daisy like flowers, in yellow orange shades; useful in beds, borders for edging and carpet bedding and on rockeries, propagated by seed or suckers.
- 5. **Perstemon:** It has a large erect spikes of tubular, open-mouthed, gloxinia like flowers, which are available in several shades of colours, a good bedding plant, propagated by seeds, cuttings or division.
- 6. *Pelargoniums*: It is commonly known as geraniums, a popular herbaceous perennial pot plants grown for the beauty of their flowers which are borne in large trusses propagated by cuttings or from seed.

DESCRIPTION OF ANNUALS

DESCRIPTION OF ANNUALS			
Name of Plant & Family	Colour of flowers	Method of propagation	Remarks
Ageratum (Floss Flowers) (Compositae)	White Blue	By Seeds	Floss Flowers – Full blooming useful for edging, massing in beds and for mixed border – Ageratum means "ever young"
Althaea rosea (Hollyhock) (Malvaceae)	Various colours	By Seeds & Transplanting	Large single or double flowers – Useful for screens, borders and for background suited to hills
Amaranthus (Amaranthaceae)	Various colours	By Seeds & Transplanting	Foliage or blooms are different coloured Foliage types: <i>A. tricolor, A. salicifoliu, A. melancholiusruber</i>
Antirrhinum (Snap-dragon) (Scrophulariaceae)	Various colours	By Seeds & Transplanting	Bedding or pot or border plant. Pink, rose, apricot, orange, crimson, white yellow flowers.
Aster (Compositae)	Rose like and variegated	By Seeds & Transplanting	Can be grown throughout the year. Suited for borders also.
Balsam (Balsaminaceae) (Impatiens balsamina)	Rose like and variegated	By Seeds & Transplanting	Can be grown throughout the year. Suited for borders also.
Culliopsis spp. (Coreopsis) (Compositae)	Yellow brown or Crimson brown	By Seeds & Transplanting	Flowers profusely single or double yellow; orange and crimson flower – Excellent as borders and in flower beds.
Celosia spp. (Cock's Comb) (Amaranthaceae)	Fascinated flowers of varying colours	By seeds	Pretty annuals with terminal fascinated flowers or varying colours. Useful for borders and mixed borders.
Chrysanthemum spp. (Compositae)	Yellow white	Seeds and suckers	Hardy annual or perennial single or double flowers, white and yellow, scent – Spacing 1 ft. – 2 ft. Well drained loamy soil is best. Flowers are used for Puja, garlands and head dress, useful for mixed border for bedding and pot culture.
Cosmos spp. (Cosmos bipinnatus)	White, crimson, rose & purple	Seeds	Popular rainy season annual with graceful foliage. It can be grown throughout the year.
Dianthus spp. (Pinks and Carnations) i) Indian Pink or Chinese Pink ii) Sweet William (D. barbatus)	Various colours	Seeds	Popular rainy season annual with graceful foliage. It can be grown throughout the year. Useful for pots and borders also.
iii) Carnation Pink (D. caryophyllus) (Caryophyllaceae)	Pink, white, crimson & others	Seeds and cuttings	Suited for pots particularly, Carnation – Margurite is the most successful in plains
Gaillardia spp. (Compositae) Blanket Flower G.pulchella var. picta var. loranziana	Red yellow	Seeds	Single or double flowered heads.

Gomphrena globosa (Globe Amaranthus or Bachelor's Button; Amaranthaceae)	Pink, Purple & Orange	Seeds	Suitable for beds, borders and as cut flowers. Thrives well in all garden soil.
Gerbera (Compositae)	Various colours	By divisions or suckers	Suited for beds and borders.
Helianthus sp. (Sunflower) (Compositae)	Yellow with brown (dark) colour	Seeds & Cuttings	Staking the plants is essential in the case of tall and unbranched varieties.
Helichrysum (Compositae)	Various colours	Seeds	Suited for pots and borders – Everlasting flower.
Kochia (Chenopodiaceae)	Minute Brownish Pink	Seeds	Suited for pots and as ornamental leaves. Green in open sunny situations.
Lathyrus odoratus (Leguminaceae) Sweet Pea)	Sweet fine colour	Seeds	Grown in open sunny situations. Suited for hills
Tagetes erecta (Marigold) (Compositae)	Bright yellow, orange	Seeds	Suited for beds and borders
Michaelmas daisy (Aster lamellus) (Perennial Aster) (Compositae)	White, rose, blue	Clumps and suckers	Low growing plants – Best during cold and rainy seasons.
Pansy (Violaceae)	Violet, blue, yellow, white	Seeds	Suited for borders and pots – Pretty brilliant coloured flowers.
Petunia sp. (Solanaceae)	Various colours	Seeds	Suited to flower beds, mixed borders, pot plants, window borders and hanging baskets.
Phlox (Polemoniaceae)	Various colours	Seeds	Suited for beds, pots
Pimpinella monoica (Lady's Lace)	Small lacy white flowers	Seeds	Coriander like smell of leaves – Small lacy white flowers – Suited for medium high elevations.
Poppy (Papaveraceae)	Various colours	Seeds	There are four species useful for cut flowers – Suitable for high attitudes.
(Portulaca grandifiora) (Portulacceae)	Various colours	Seeds	Trailing stem with short thick leaves – Resembles roses – Suited as an edge plant.
Salvia splendens (Labiatae)	Scarlet blue Purple pink	Seeds	Can be grown throughout the year – Suited for beds and borders – Pinching back the shoots in early stages builds up better plants
Schizanthus (Solanaceae) (Poor Man's Orchid) (Butterfly flowers)	Various colours	Seeds	Cold season annual, pretty foliage of green colour, orchid like flowers of various colours.
Solidago (Golden Rod) (Compositae)	Golden yellow flowers	Seeds	Herbaceous perennials, erect feathery, rod like, trusses, crowded with pretty golden yellow flowers suitable for mass planting in beds and borders
Tagetes sp. (Marigold) (Compositae)	Yellow orange variegated	Seeds	Tall and erect growing annuals, single or double flowers, effective in beds and mixed borders.

			Flowers are grown on commercial scale also.
Tithonia speciosa (Mexican sunflower; Compositae)	Reddish orange flowers	Seeds	Reddish orange flowers on long inflated stalks, can be grown throughout the year, valuable for planting in long borders and in shrubberies.
Verbena (Verbenaceae) V. Hybrida Vvenosa V. erinoides	White, Purple & Pink	Suckers, cuttings layers	Garden verbenas are trailing plants, annuals and perennials useful in shrubberies, hanging baskets, rockeries, flower beds and in pot culture.
Vinca (Apocynaceae) V. rosea	Pure white red	Suckers, cuttings layers	Attractive foliage, smooth green leaves, Tamil "Sudukadu Mallikai". The plants should be cut back every month. Useful for flower beds, plants, borders, rockeries, etc.
Zinnia elegans (Youth and old age; Compositae)	Various colours	Seeds	Hardy, flowers in profusion for a long period, single or double flowers borne on long stalks. Attractive in borders and beds. The first flower bud should be nipped off for allowing the plants to grow bushy and bear numerous flowers.
Z. linearis	Golden orange	Seeds	Hardy flowering perennial – Linear leaves- Beautiful small golden orange flowers – Useful for low bed, edging, hanging baskets and rockeries.

LEC 21 ORNAMENTAL PALMS

Palms are a special group of plants used extensively in landscape gardening, due to their beautiful trunk, leaf colour, shapes, plant structure and growth habits. Palms include about 200 genera and three thousand species. Their roots, trunks (stems), fronds (leaves), flowers and fruits are different and distinct in appearance and structure from others of the plant kingdom.

Ornamental palms are important components of tropical, subtropical, and even warm temperate climate landscapes. In colder climates, they are important interiorscape plants and are often a focal point in malls, businesses, and other public areas. As arborescent monocots, palms have a unique morphology and this greatly influences their cultural requirements. Ornamental palms are overwhelmingly seed propagated, with seeds of most species germinating slowly and being intolerant of prolonged storage or cold temperatures. They generally do not have dormancy requirements, but do require high temperatures (30-35°C) for optimum germination. Palms are usually grown in containers prior to transplanting into a field nursery or landscape. Because of their adventitious root system, large field-grown specimen palms can easily be transplanted. In the landscape, palm health and quality are greatly affected by nutritional deficiencies, which can reduce their aesthetic value, growth rate, or even cause death. Palm life can also be shortened by a number of diseases or insect pests, some of which are lethal, have no controls, or have wide host ranges. With the increasing use of palms in the landscape, pathogens and insect pests have moved with the palms, both between and within countries, with some having spread virtually worldwide.

Based on the trunk and its different manifestation, palms can be divided in to four groups viz..

- 1. Solitary palms- single erect trunk (eg. Cocos, Phoenix, Elaseis)
- 2. Clumping plams- multiple trunks arising from at or just below the ground level (eg. Areca lustescens, Raphis)
- 3. Branching plams- branching can occur above ground (eg. *Hyphaene indica*) or below ground (eg. Nipa fruticans)
- 4. Trunkless palm- have very much reduced trunk called acaulescent (eg. *Phoenix acaulis*)

The leaves of the palms called 'fronds' vary in form. They may be grouped into 'fan leaved type' and 'pinnate leaved type' palms.

Use of palms in landscape garden

- 1. Palms are well suited as single specimens in lawn (eg. Areca triandra)
- 2. Palms are excellent specimens for avenue planting in the gardens (eg. Roystonea regia)
- 3. They are also suitable for decoration of conservatories, verandahs, stair-cases, for indoor decorations as potted plants.

Classification

The large family of palms (Palmae) is pre-eminent in the plant world for their grandeur, which is especially remarkable in regions where palms grow naturally to their full luxuriance. Linnaeus appropriately styled them" Princes of the vegetable kingdom." There are some 1,150 species of palms known and more doubt less still remain to be discovered. They may be divided into two main classes: (I) feather or pinnate leaved and (2) fan or

flabelliform leaved. About two thirds of the species come under the former class. Most palms have upright, straight, unbranched stems, many reaching a great height. Some are bushy, throwing out numerous stems from the base. E.g., *Chrysalidocarpus, Ptychosperma*, species of *Licuala*, etc. while others as *Chamaedorea*, are dwarf, flowering and fruiting at a height of but a few feet. A few are naturally branched or forked, as the Doum Palm (*Hyphaene*). Some have bent stems, as in coconut; others are enormous climbers, e.g. *Calamus*. Palms are either wind or insect pollinated or both. Some are dioecious e.g. Date palm, Palmyra, Lodoicea and Phytelephas and others monoecious, as the Coconut and Oil palm.

Pinnate leaved palms

T IIIIIato Ioaroa paililo	
Acanthophoenix crinita	Thorny stems
Acanthoriza aculeata	30-40 ft. Spiny aerial roots on stem
Acrocomia sclerocarpa	Macaw Palm. Stout erect stem, 40-50 ft. Very spiny; spines 3-4 in
	long.
Archontophoenix	Handsome sp., flowers in large white panicles
alexandrae	
A. cunninghami	40-50 ft.
Areca catechu	Arecanut; Betel palm
A .concinna	Ceylon. Small slender stem
Arenga saccharifera	Gomuti- or Sugar-palm. Leaves up to 25 ft. or more in length; pinnate,
	2-3 ft. by 3 in. broad. Very large, handsome species
Astrocaryum rostratum	Petioles very spiny
Attalea cohune	Cohune Palm. Honduras. 50-60 ft. Bears very large spadix
Bactris (Guilielma) utilis	Peach nut; Pejibaye; Pewa; Pupunha. Slender stems; whole
	palm spiny, 30-40 ft. Fruit in clusters, reddish-yellow, eaten boiled with
	salt or roasted
Bentinckia condapanna	Slender sp. about 30 ft. high
Calyptrocalyx spicatus	30-40 ft. Bright red berries on long spikes

Feather leaved palms

Caryota cumingii	Handsome genus with bi-pinnate leaves
C. urens	Toddy Palm. Handsome, bi-pinnate leaves; 50-60 ft. Flowering
	spadices 7-9 ft. long, in huge bunches
Chamaedorea	Dwarf, single stem; flowers when 2-3 ft. high
elegans	
Chrysalidocarpus	Cane Palm. Many stems; handsome, fine, feathery leaves
lutescens	excellent for pot culture
Cocos flexuosa	30-40 ft. Handsome feathery leaves
C. nucifera.	Coconut Palm Handsome palms, 40-50 ft.
C. plumosa and	
C. schizophylla	
C. weddelliana	Small elegant sp. with fine pinnate
Cyrtostachys renda	Sealing wax palm; Pinang-rajah. Bright red leaf-sheaths, numerous
	stems
Desmoncus major	Climbing palm, very spiny; small, round, red fruit
Diplothemium	Very handsome, small palm. 10-12 ft
caudescens	
Elaeis guineensis	Oil Palm
Euterpe edulis	Tender stem tops edible, used as a vegetable in Brazil, etc
Guilielma speciosa	Peach palm; Pejibaye

Hydriastele wendlandiana	Slender palm; small round, scarlet fruit
Kentia (Howea) australis; K. belmoreana; and K. forsteriana	Single stem, handsome pinnate leaves; favourite palms for pot culture in Europe, etc.
Manicaria saccifera	Bussu Palm
Metroxylon Rumphii	Prickly sago palm
Myrialepis Scortechnii	Strong growing climber, spiny leaves and stem
Nephrosperma	Erect, slender stem
vanhoutteana	
Nipa fruticans	Nipa; Water palm. See sugar palms
Oncosperma	Nibung palm. Many stems; handsome, drooping pinnate
fasciculate,	
O. filamentosa	
Oreodoxa oleracea	Palmiste. Cabbage Palm. 80-100 ft., very stately, cylindrical stem; effective in avenues. Top part edible
O. regia	Royal palm; Bottle palm. Stem usually barrel-shaped. Tender top portion edible, commonly used as a vegetable
Phoenix dactylifera	Date palm
Wallichia disticha	Fan-shaped feathery Palm
Rhopaloblaste hexandra	80-100 ft., single, slender stem; narrow pinnate, ornamental in small state

Fan Leaved Palms

Borassus flabellifer	Palmyra palm	
Copernicia cerifera	Carnauba wax palm	
Corypha umbraculifera	Talipot palm	
Hyphaene thebaica	Doum palm. One of the few branching palms. 30-40 ft. Fruit edible	
Latania Commersoni	40-50 ft. L. purplish, glaucous	
Licuala elegans	Small sp. with many stems; petioles prickly	
L. gracilis	Bushy, 5-7 ft	
L. (Pritchardia) grandis	Single stem. 6-8 ft. Leaves almost circular, pleated fan like; very	
	elegant.	
Livistona altissima	60-80 ft.; petioles prickly; berries scarlet	
Stevensonia	40-50 ft., single stem; leaves. spiny, reddish tint when young	
grandifolia		

Sub tropical palms

oub tropical paints		
Brahea dulcis	Fan leaved, dwarf sp	
Chamaerops fortunei	Fan leaved	
(Trachycarpus excelsus).		
C.humilis	Fan leaved, dwarf sp., only European palm	
Nannorhops ritcheana	Small bushy palm. Leaves used for fans, baskets, etc.	
Rhapis flabelliformis	Small slender palm, numerous stems; used for walking sticks	
Rhopalostylis(Areca) sapida	Nikau palm. Small, pinnate leaved	
Trachycarpus excels	Fan leaved, dwarf sp.	
Washingtonia filifera	Handsome fan leaved; copiously furnished with long, creamy	
_	white, filiform threads. elegant, fan leaf margins	

Hints to grow palms

- 1. Palms can be propagated from seeds or division of clumps (eg. Raphis)
- 2. Palm seeds are to be harvested at fully ripe stage and are to be immediately sown in raised beds having more proportion of sand.
- 3. Depending upon the species, the seeds start geminating from 3 months even continue upto 2 years in certain cases.
- 4. The seedlings may be lifted at first pair of leaf stage and potted off simply in small pots.
- 5. Palms generally refer pot bound condition and thrive even in undersized pots.
- 6. Repotting to the next large sized pots may be done at the stage when the roots increase and fill the pots fully, almost forcing the pots to open or crack.
- 7. Liquid manuring with oil cakes and Ammonium sulphate may be given to the palms once in fifteen days.
- 8. Regular watering especially on alternate days is essential for the palms grown in the pots.
- 9. Potted palms intended for keeping indoors should be acclimatized sufficiently before keeping them indoors, so that they retain their fresh appearance and lusture.

Some attractive palms for the garden

- 1. Areca triandra: an elegant single trunked palm
- 2. Caryota urens: Toddy palm, produces a long drooping flower spike
- 3. *Hyphaene indica*: Indian doum palm unique- branching habit.
- 4. Livistona decipiens: Solitary, fan shaped leaves with stout thorns on their leaves.
- 5. *Pritchardia pacifica*: It has ornamental large broad flabellate plaited leaves, often 10m, broad
- 6. Raphis excelsa: Dwarf-rattan like palms, slender stem and fan shaped leaves, produce large number of suckers.

Question bank

A.MCQ

1. Total number of species in palms are ----

a.3000 b.300 c.2000 d.1000

Part b

1. Sub tropic palm types (Brahea dulcis, Rhopalostylis(Areca) sapida)

Lec 22 - SCOPE AND IMPORTANCE OF MEDICINAL & AROMATIC CROPS-CONSERVATION METHODS

Importance and scope of medicinal plants

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

These plants form the main base for the manufacture of drugs of Indian systems of Medicine (ISM) (Ayurveda, Unani and Siddha) and Homeopathy. These plants are found in various parts of the country in different environmental and climatic conditions. Plants which grow wild 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

- The ancient Indian System of Medicine (ISM) is predominantly a plant-based materia medica, making use of most of out 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.
- 2. World Health Organization (WHO) has listed over 21,000 plant species used around the world for medicinal purpose and in India 8000 species listed is available. ISM uses nearly 2500 plant species belonging to more than 1000 genera. Of the nearly 800 species used in the industry, 25% are cultivated.
- 3. India is one of the few countries where almost all the known medicinal plants can be cultivated in some part of the country or 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
- 4. ISM offers most appropriate or first line therapy against many diseases like jaundice, bronchial asthma, rheumatoid arthritis, diabetes etc. for which allopathic medicines have as yet to 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.
- 5. India has a vast geographical area with high production potential and varied agro-climatic condition that it is possible to grow any medicinal plant. 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-exchange earnings.
- 6. India has nearly 9500 registered herbal industries and a multitude of unregistered cottage level herbal units which depend on the continuous supply of medicinal plants for manufacture of herbal medical formulations based on ISM.

- India is already a major exporter of medicinal plants. It holds monopoly in the production and export of psyllium and senna and is the second largest exporter of opium latex.
- 8. Though India ranks in number two in terms of export of medicinal plants, it occupies only sixth position interms of value as we are exporting only raw material and not the finished drugs.
- 9. 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 (e.g. 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. Deforestation, shifting cultivation, over grazing and over exploitation are the other main human activities posing a threat to biodiversity and medicinal plant wealth in this country. GOI has banned export of 52 medicinal plants in order to conserve them in nature and semi-wild conditions.

10. World Conservation Union (IUCN) has identified following categories.

Category	Brief description	Plant to this category
Extinct	The last remaining member of the	Myristica malabarica
species has died or is presumed beyond reasonable doubt to have been dead.		Ravoulfia serpentine
Extinct in the wild	Captive individuals survive, but there is no natural population	Plectranthus vetiveroides
Critically endangered	Faces an extremely high risk of extinction in the immediate future.	Adhatoda beddomei
		Janakia arayalpathra
Endangered	Faces high risk or extinction in the immediate future	Nilgirianthus ciliates,
		Nervilia aragoana
Vulnerable	Faces high risk of extinction in the medium term	Farcinia indica,
		Adenia hondala
Rare	Not available plenty in nature	Vernonia anthelmintica,
		Commiphora mukul

11. This warrants conservation and sustainability of the plant species for present and future generations. One approach is resorting to in-situ conservation by establishing bioreserves, national parks, wild life sanctuaries, sacred grooves and other protected areas. The second approach is to establish ex-situ conservation i.e. cultivating and maintaining these plants outside their natural habitat in botanical gardens, institute gardens, gardens maintained by NGOs etc.

Importance and scope of aromatic plants

Aromatic plants are defined as those plants which possess essential oil in them. These essential oils are the odoriferous steam volatile constituents of the aromatic plants. They are mainly a complex mixture of acyclic and or cyclic monoterpenoids. These terpenoids are basically secondary metabolites and they have no apparent function in the plants primary metabolism. These essential oils are used in perfumery, cosmetic and pharmaceutical industries where as the essential oils obtained from spices and condiments which impart the flavor and improve the taste of the food are used in several flavor industries. Some of the special attributes of these plants are:

- 1. They are usually present in the aerial parts of plants such as flowers, fruits and leaves. Occasionally, they also accumulate in roots and wood (eg. Sandal wood).
- 2. The nature and proportion of the various monoterpenoids in the essential oil is a characteristic not only of the genus but also of species as well.
- 3. Most of the commercial essential oil bearing plants belongs to the families Labiatae, Myrtaceae, Compositae, Rosaceae, Umbelliferae, Graminae and Pinaceae.
- 4. The essential oil accumulation in a plant depends upon the developmental stage of the concerned organ/ plant part. In most of the aromatic plants, it is associated with early growth period.
- 5. The composition of the essential oil also varies greatly with the developmental stages of the plants eg. In *Menta arvensis* young leaves contain more of manthone which matured leaves contain more of menthol in the oil.
- 6. Essential oil content and its composition are influenced by climate or season. In geranium, for example the oil content is more (0.09 to 0.12%) during summer months (April to June), and low (0.06 to 0.07%) during winter months.

Some of the important features of essential oils industry in India are:

- 1. Current production of essential oil is about 16,000-18,000 tonnes in India as against the world production of 80,000 tonnes.
- 2. The turnover of all perfumes in India is about Rs. 3000 million annually while the market size of Indian cosmetics is around Rs. 4,5000 million. Market growth in India is expected to around 1.5 per cent compared to 5-7% in America or Europe.
- 3. India ranks 28th in import and 14th in export of global trade in essential oil.
- 4. India is the largest producer of mints and basils.
- 5. China, Brazil and Indonesia are stiff competitors fir India with the pharmaceuticals.

Aromatherapy is a form of alternative medicine that uses volatile plant materials and other aromatic compounds for the purpose of altering, a persons mind, mood, cognitive function or health. Nowadays, it is gaining importance among the tourist and rich segment of society and its overall benefit to human health. World consumption in aroma therapy is still small (200 – 300 tonnes) but is expected to grow if combined with the pharmaceuticals.

Importance of essential oil industry in India

- 1. Use of aromatic plants and their products is as old as our history that distillation of rose flowers is mentioned in Charaka and Sushrita Samhitas believed to have been written in India 1000 years B.C.
- The aromatic plants and aroma chemicals contained in them play a vital role in our day to day living. More and more common and middle class people are using perfume and perfumed products, which were previously used by affluent and rich people only as these are falling with the reach of more and more.
- 3. India has varied climate conditions and suitable soil exists in one or other parts of the country. Hence it must be possible to grow almost any type of essential oil bearing plant. Historically, India has enjoyed a pre eminent position as the supplier of natural perfumes to the world over. This is still true in the case of sandal wood oil, lemon grass oil, palmarosa oil, vetiver oil and cedar wood oil.
- 4. Though more than a thousand of Indian flora have been reported to contain odoriferous materials, only half a dozen have been systematically studied and cultivated.
- 5. Our country is earning a foreign exchange of Rs. around 130 crores per annum by way of export of aromatic essential oil. However, tis contribution in world export is only 1.1% and in import 0.7%.
- 6. India ranks28th position in import and 14th position in global trade of essential oil.
- 7. India's share of essential oil in the world market can be improved greatly if some of the bottlenecks that prevails now are removed. They are
 - a. Adoption of age old technology is still being followed in essential oil production.
 - b. Wide fluctuation in quality and price.
 - c. Availability of low priced synthetic substitutes.

Question bank

Part A

- **1.** World Health Organization (WHO) has listed over ----(21,000 plant species) used around the world for medicinal purpose
- 2. India has nearly -----(9500) registered herbal industries

Part B

1. Features of essential oil industry (production, share in foreign exchange)

Part C

1. Classification of medicinal plants based on World Conservation Union (extinct sp)

Lec 23 - Good Agricultural Practices and Organic production and certification of medicinal and aromatic crops

Organic production of medicinal and aromatic crops

The medicinal plants are necessarily to be cultivated organically and there is no other option. The medicinal plants were collected so far from the forest where there was no cultural intervention and plants have grown luxuriously in nature. Such wild gathering phase was over by now and many of the commercially important herbs are to be grown under cultivation owing to its increasing demand. Eg. Senna, Gloriosa, Coleus forskohlii, and Aswagandh.

Microflora Management

Soil microbes are the entities which give life to the soil. They thrive in humus and cause ionic degradation to release the elements for plant growth. The soil devoid of microbes are supposed to be sterile one. The root growth and the canopy growth are the directly influenced by the extent of microbes present in the soil. Few microbes aid in digestion and fermentation of organic matter applied to the soil, some acts against many of the damaging fungi or bacteria and many help to build up the soil.

Bio inputs in organic production and other versions of organic farming

Bio manures

Bio manures though contain less quantity of essential nutrients, they help to build the capacity of the soil to generate its own nutrients. They help to enrich the humus, sustain microflora, accelerates soil dynamics. They help the plants to become sturdier and tolerant to pests and diseases. Farm yard manure is a universally accepted bio manure while goat manure is supposed to be superior but its availability is limited. The poultry manure is available in bulk but should be used after an year without complete degradation.

Bio fertilizers

Many of the fungi and bacteria are useful to upgrade the soil quality and helps for maximum root ramification and absorption of elements by plants VAM (Vascular Arbuscular Mycorhizae), phosphobacteria, rhizobial cultures, azospirillum, blue green algae and azolla are few bio inputs which are largely in use whether organic cultivation is practiced or otherwise.

Bio control agents

Herbal pesticides are made out of plant extracts. The plants which are non-browsable by animals are best source of herbal pesticides. The leaf or whole plant or urine extracts acts as a pesticide. Calatropis, Prosopis, Aloe, Clerodendron, Vitex, Neem are few examples. The

composition and quantity may vary for each kind of pest and disease. Further, some of the fungi (Trichoderma viride and Pseudomonas fluorescence, Pseudomonas harzianum) can act against many of the harmful fungi and bacteria and safeguard the soil environment.

Bio promoters

Panchagavya, a product combination of cows dung, urine, curd, milk and ghee acts as a growth promoter as well as immunity booster.

Bio dynamic farming

Organic farming system when extrapolated with plants and stars became biodynamic farming. Moon and Saturn are taken into account as moon influence the water (90% of plants and human consists of water only) and Saturn governs the agriculture. The crop operations which are (-) ve in nature like, cutting, pruning, harvesting, etc can be done during the waning phase of moon, while the crop operations which are (+) in nature viz., planting or sowing, application of manures etc can be performed during the waxing phase of the moon. There is an agricultural almanac developed for this purpose taking into account the stellar movements.

Agnihotra

System advocates inclusion of sound waves in a particular frequency through mantras which they say purify the environment and ensures cosmic flow on the field for better expression of crops. The essential feature of organic cultivation is that the farming should be made viable without any extra input from outside. The farm waste, farm animal waste are to be recycled in such a way that the crops enjoy all the comfort from soil and atmospheric environment and derive nourishment continuously over years from the revitalized soil and atmosphere.

Organic certification

As the public becomes increasingly concerned about the negative effects of industrial and high input intensive agriculture on the environment and on their health, the demand for safe food is increasing day by day. In this context, organic horticulture offers a bright light in the troubled future of farming community by providing an economically and environmentally healthy alternative for their survival.

The reports on organic agriculture showed that, most of the farming communities from the developed countries have already switched over to organic farming system and now having organic produces of many crops and allied activities. Now the organic growers were in the stage of selling their products with premium prices through some measures. In this context, organic

certification becomes an important and inevitable step to be implemented to sell their products in the domestic or in global market.

Organic certification in Horticulture especially in medicinal plants provides transparency in certification and improves the images of organic agriculture. The organic certification by any agency includes the following programmes:

- i. Certification Carried out by the certification manager
- ii. Inspection Done by inspection manager well trained in organic standards
- iii. Adopting standards Carried out by the quality control manager

The certification programs vary with country or regions and the certification label is very particular to the country. All the standard used in certification was developed early by IFOAM and is reviewed every two years by the General Assembly of IFOAM. IFOAM has established an accreditation programme for supervising the international trade of organic products.

Various Organic standards

The standards are indicated as directions of sustainability and should be looked upon at global level. The standards acknowledge measure of comparison of or qualitative or quantitative value for degree or level of requirement of excellence or attainments and rules of production.

The organic standards were defined as minimum production practices and requirements, which must be followed strictly if the agricultural products to be labeled as organic. The standards may be of

Global standards :

- Mandatory Standards Abide by law and regulations and passed by government or regulatory bodies. eg. CODEX standards – are set by world level organizations like FAO and WHO at global level. These are reference standards for any dispute or problems.
- Voluntary standards These standards influence the organic farming at world level. Eg. IFOAM standard. The major advantages were It can influence the mandatory standard It includes new techniques and various types of innovations.
 It recognizes the traditional standards in a continuous manner.
- Regional standards Developed by mandatory standards eg. EU regulations

National standards

National programme for organic products (NPOP, 2000) India

It provides a means for certification programme in our country to establish their equivalence to regulatory requirements worldwide in the organic production, processing and trade. The main aim is to develop National Standards to prepare specific standards, to institute a logo "Indian Organic", and to approve certification bodies.

Certification standards

It is developed by certifying bodies through committee meeting and each agency has its own standards. Organic standards were defined on the minimum production practices and handling requirements which must be followed for the resulting agricultural products to be labelled as organic. There are many standards viz., Soil Association Standards (SA), European Commission regulations (EU), CODEX Standards IFOAM Standards etc. Each standard has its own production practices and all have similarities and dissimilarities.

Both EC and SA standards request 3rd party recognized certificate for export

Emphasizing on audit

Request annual inspection

Accreditation

Defines conversion plans

Emphasis on sustainable organic farming.

Requirement for organic certification

The requirements for organic certification are outlined in much detail in the legislation that is used as the basis for certification. Summarised briefly, the main requirements of regulation for the producers of agricultural crops are:

- Soil fertility has to be maintained by means of crop rotation, adapted cultivation techniques and nutrient cycles. Pest attacks need to be minimised by means of a healthy soil, natural enemies and adapted crop varieties. Only those farm inputs (fertilizers, pesticides, etc.) that are listed in the regulation may be used in organic farming.
- Only certified organic seeds should be used.
- 3. All farm or processing activities needs to be carefully documented on every level, thus ensuring a full traceability of the product flow.

- 4. If there is also a conventional unit, organic unit has to be clearly separated from the inorganic unit and the same product may not be produced in both units. Conventional and organic products may not be mixed at any stage.
- 5. Farms that are converting to organic farming have to undergo 2 (annual crops) or 3 years (perennial crops) of transition period. After the first 12 months, the products can be marketed as "organic in conversion".
- 6. Organic products need to be labelled as "organic" or "organic in conversion" throughout the whole chain of harvest, transport, storage, processing and export.
- 7. Specific requirements apply for organic livestock and honey production.
- 8. Every farm, processor or exporter producing or handling organic produce need to be inspected and certified once in a year by an accredited certification agency.

Indian certification agencies

Government of India through Director General of Foreign Trade, New Delhi, allowed the export of organic products only if they are produced, processed and packed under a valid organic certificate issued by a certification agency accredited by one of the accredited agencies designated by the Government of India. The Government of India has already recognized the agencies viz, Agricultural and Processed Food Product Export Development Authority (APEDA), Spice Board, Coffee Board and Tea Board as Accreditation agencies. The organic market in India has not yet taken off as it is in other countries. There are very few domestic Inspection and certification agencies.

In India, the first indigenous agency received accreditation from the Spice Board is M/s. Indian Organic Certification Agency (INDOCERT), Cochin during 2003. It is supported by two International Organizations viz, M/s FIBL, (Research Institute of Organic Agriculture) and M/s Bio.inspecta, an internationally accredited Swiss Organic certification Agency. FIBL support INDOCERT in planning, management, consultancy, assistance in developing structures, procedures, documents, technical training of the staff and also support in obtaining accreditation requirements. M/s Bio.inspecta assists to start inspections for the export market right from the beginning to co certification.

Tamil Nadu government has created a new department by name 'Department of Organic Certification' accredited by APEDA to certify the organic production system in Tamil Nadu.

Steps in organic certification

The following are the steps to be followed strictly in certification.

- 1. A preliminary enquiry by the Operator for information
- 2. Certifier sends the applications which requests for the basic data on farm, livestock details,
- 1. processing units etc.
- 2. Operator fills the application and sent to certifier
- 3. Application is to be screened by the certifier
- 4. Sending invoice for certification and inspection cost
- 5. Certification contract
- 6. Inspection visit
- 7. Assessment of inspection report
- 8. Certification decision
- 9. Issue of certificate.

Good Agricultural Practices for Medicinal Plants

Introduction

- In this production process including cultivation and collection of medicinal plants, postharvest processing and good quality of the raw material produce.
- Keep as free as contaminants and residues such as pesticide.

In order to produce high quality raw materials:

- Materials should be well washed in case of possible contaminants.
- The skin of the material should be peeled.
- This guideline serve as the standard for the level of microbial contamination in the production of raw materials for crude drugs.

Objectives

Within the overall context of quality assurance, the WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants are primarily intended to provide general technical guidance on obtaining medicinal plant materials of good quality for the sustainable production of herbal products classified as medicines. They apply to the cultivation and collection of medicinal plants, including certain post-harvest operations. Raw medicinal plant materials should meet all applicable national and/or regional quality standards. The guidelines therefore may need to be adjusted according to each country's situation.

Identification/authentication of cultivated medicinal plants

 Selection of medicinal plants - Where applicable, the species or botanical variety selected for cultivation should be the same as that specified in the

- national pharmacopoeia or recommended by other authoritative national documents of the end-user's country.
- Botanical identity The botanical identity scientific name (genus, species, subspecies/ variety, author, and family) - of each medicinal plant under cultivation should be verified and recorded.
- Specimens In the case of the first registration in a producer's country of a
 medicinal plant or where reasonable doubt exists as to the identity of a botanical
 species, a voucher botanical specimen should be submitted to a regional or
 national herbarium for identification.
- Seeds and other propagation materials Seeds and other propagation materials should be specified, and suppliers of seeds and other propagation materials should provide all necessary information relating to the identity, quality and performance of their products, as well as their breeding history, where possible.
- Cultivation Cultivation of medicinal plants requires intensive care and management. The conditions and duration of cultivation required vary depending on the quality of medicinal plant materials required.
- Site selection Medicinal plant materials derived from the same species can show significant differences in quality when cultivated at different sites, owing to the influence of soil, climate and other factors.
- Ecological environment and social impact The cultivation of medicinal plants may affect the ecological balance and, in particular, the genetic diversity of the flora and fauna in surrounding habitats.
- Climate Climatic conditions, for example, length of day, rainfall (water supply) and field temperature, significantly influence the physical, chemical and biological qualities of medicinal plants.
- Soil The soil should contain appropriate amounts of nutrients, organic matter and other elements to ensure optimal medicinal plant growth and quality.
- Irrigation and drainage Irrigation and drainage should be controlled and carried out in accordance with the needs of the individual medicinal plant species during its various stages of growth. Water used for irrigation purpose should comply with local, regional and/or national quality standards.
- Plant maintenance and protection The growth and development characteristics of individual medicinal plants, as well as the plant part destined for medicinal use, should guide field management practices. The timely operations such as topping, bud nipping, pruning and shading may be used to control the growth and development of the plant, thereby improving the quality and quantity of the medicinal plant material being produced.
- Harvest Medicinal plants should be harvested during the optimal season or time period to ensure the production of medicinal plant materials and finished herbal products of the best possible quality. The time of harvest depends on the plant part to be used.

Post-harvest processing

Inspection and sorting

Raw medicinal plant materials should be inspected and sorted prior to primary processing.

The inspection may include: Visual inspection for cross-contamination by untargeted medicinal plants and/or plant parts;

Visual inspection for foreign matter;

Organoleptic evaluation, such as: appearance, damage, size, colour, odour, and possibly taste.

- **Primary processing** Appropriate measures of primary processing are dependent on the individual materials. These processes should be carried out in conformity with national and/or regional quality standards, regulations and norms.
- Drying: It should not be kept in direct sunlight. The building should be constructed so as to protect the crop from birds, insect, farm and domestic animals. Drying racks should be kept clean and regularly maintained. Dried crops should be inspected, winnowed or sieved to remove discoloured, mouldy, stone.
- **Packing:** After removal of foreign matters the dried crop should be packed in clean, dry sacks, bags or boxes, preferably new.
- **Storage and Transport:** Fumigation to control pests should be applied only where necessary, trained personnel should be carried out. Vented containers are used for transport.
- **Personnel:** Personnel handling the material should be in hygiene.
- **Documentation:** Keeping records of fertilizer, pesticides and herbicide used on each batch of harvested material is highly desirable.
- **Training and Education:** Managing the material require appropriate techniques highly recommended. It can be achieved by local agricultural institutes.
- Quality Control: It should be checked by regular inspection visits by the
 producer's and the buyer's representatives with expertise in good agricultural and
 hygiene practice. Specifications for herbal materials should be agreed between
 the producer and the buyer, these may include active principles and
 characteristic constituents, heavy metals and pesticide residues.
- Collection: Collection of medicinal material should be away from raw material processing unit. Person should know about the character and taxonomy of the medicinal plant.
- Threatened and endangered species Medicinal plants that are protected by national and international laws, such as those listed in national "red" lists, may be collected only by relevant permission according to national and/or international laws. The provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) must be complied with. Endangered medicinal plant species must be sourced only in accordance with national and/or regional legislation. When medicinal plant materials from threatened, endangered or protected medicinal plant species are obtained through cultivation, they should be accompanied by appropriate documentation in accordance with national

and/or regional regulations, to certify that no such medicinal plant materials collected from the wild are included.

Question bank

- 1.Explain about bio dynamic farming?2.Procedures for registering in GAP

Lec 24 - Senna, periwinkle – varieties – soil and climate – propagation – sowing and planting, nutrient, water and weed management – harvest and processing – post harvest handling

SENNA

Importance and chemical composition

- Senna (Cassia angustifolia Vahl.) belonging to the family Caesalpiniaceae, is a perennial shrub, but grown as an annual in the rainfed areas, mainly for its medicinal properties particularly for its laxative principle.
- This crop is cultivated significantly in Gujarat (Anand), Rajasthan (Jodhpur) and Maharashtra (Pune district) and Tamil Nadu.
- It is extensively cultivated as a rainfed crop in wastelands of Tirunelveli district of Tamil Nadu, by which attains the popular name as "Tinnevely Senna".
- The species was reportedly introduced first in Tirunelveli district during the mideighteenth century from Europe and hence the Indian produce as a whole is referred as "Tinnevely Senna".
- A major part of the produce is exported in the form of leaves, pods and sennoside concentrates.
- Senna is being exported mainly to countries like USA, Germany and Japan. Other senna importing countries are Spain, France, China, Hong Kong, Thailand, Australia and Singapore. Nearly 75 % of senna produced in India is exported, especially through Tuticorin port.
- The available statistics on area of cultivation of senna is around 6,000 ha located in various regions of India and in southern districts of Tamil Nadu, which dominates in commercial cultivation.
- Of late, Gujarat and Rajasthan are emerging as potential suppliers of senna in India. o The leaves and pods of senna contain sennosides A, B, C and D, which are well known for the preparation of laxatives and purgatives all over the world.
- The drug is used as the most reliable and least harmful laxative agent. o Senna pods and leaves are also used in the form of decoction, powder and many other herbal preparations. It is popular in European countries for its use along with 'herbal tea'.

Origin and distribution

- 1. There are two sources of senna drug namely, *Cassia angustifolia* Vahl, and *C. acutifolia* Del., *C. angustifolia* commonly called Thirunelveli senna, is indigenous to Somalia, southern Arabia, part of Sindh and Kutch area of Gujarat.
- 2. *C. acutifolia* commonly known as Alexandrian senna is indigenous to Sudan and Sinai. It is commonly cultivated in Sudan and Egypt. *C.italica* and *C.obavata* also posses a fair percentage of Anthraquinone compounds.

Description of the plant

Senna is a small perennial under shrub; leaves are large, compound and pinnate and emit characteristic fetid smell when crushed. The flowers are bright yellow in color and pods are slightly curved, 3.5 to 6.5cm long and 1.5cm broad.

Varieties

- 1. ALFT-2 The Gujarat Agricultural University, under the All India Co-ordinated project on Medicinal and Aromatic Plants at Anand, has released a late flowering type 'ALFT-2' through selection, which remains in vegetative stage till 100 days and is suitable for growing as leaf crop.
- 2. Sona CIMAP, Lucknow has released a high yielding variety named 'Sona'.
- 3. KKM Sel 1 It is a selection from Thenkalam local, high yielding recording 38.5 per cent higher leaf yield and 69.88 per cent higher pod yield than local. This is highly suited for all soils of Tirunelveli and Tuticorin districts and ideal for rainfed cultivation. The plants are spreading and bushy with 7-8 branches attaining a height of 80-100 cm. The plant has good rejuvenation capacity and suitable for stripping at an interval of 30 days with crop duration of 135-140 days. It yields 918 kg/ha of leaves and 352 kg/ha of pods. The total sennoside content is 2.54 per cent. The dried leaves and pods have good export potential and the medicinal property is utilized in the preparation of laxatives.

Cultivation

Soil - Senna is a hardy plant and thrives on a variety of soils ranging from sandy loam to lateritic soils. In southern Tamil Nadu, the crop is grown on poor and marginal lands under rainfed condition. The soil type in this region is sandy to red sandy soil, with a pH of 7-8.5. In areas of Ottapidaram, Vilathikulam, Sattur and Virudunagar, senna is cultivated traditionally under black cotton soils.

Climate - Generally, the crop requires an all-round warm and dry weather conditions. It is very sensitive to heavy rainfall, especially at the time of seed sprouting to young seedling stage. Temporary water logged conditions due to continuous rain and low temperature besides, inclement weather at harvest are unsuitable for its cultivation.

Propagation - Senna can be cultivated both as rainfed and irrigated crop, however, in most parts of southern districts, rainfed cultivation dominates and as such, there are two growing seasons, which coincide with the monsoon rain. The first commences with the onset of south west monsoon in June-July and the second during November-December, receding with North east monsoon rain. Wherever irrigation facilities are available, senna can be raised during January-February as irrigated crop.

Seed treatment and sowing - The crop is raised from seeds. Since the seeds have a hard and tough seed coat, a certain amount of abrasing of its surface is necessary to induce germination. This is achieved by pounding the seeds lightly with coarse sand in a mortar. A traditional method of seed treatment for removing the hard seed coat is mixing the required

quantity of seeds with dry and pure sand in the ratio of 1:3 and is gently beaten. Later the seeds are soaked in water for 10-12 hours and then used for sowing. This practice gives about 90 % germination. The seeds exhibit dormancy for 2 months. The land should be thoroughly ploughed, at least two times, and properly leveled for ensuring good drainage. The farmers usually divide the land into small fields enabling for draining the excess rain water and then broadcast the seeds for raising the rainfed crop. Under irrigated condition, a uniform spacing of 45x30 cm is recommended. Small beds are first prepared and shallow straight lines are formed at 45 cm apart and seeds are dibbled at a depth of 1-2 cm. The seeds start germination in 5-7 days and complete germination in 15 days after sowing. The seedlings are thinned to have a spacing of 30 cm in between plants within 20-30 days after sowing.

Manures and fertilizers - A basal dose of 25 tonnes of FYM, 50 kg N, 25 kg P2O5 and 40 kg of K2O/ha can be applied. Top dressing of 25 kg of N can be applied 40 days after sowing and another 25 kg N after 80 days of sowing. 4-6 irrigations can be given during the cropping period. Continuous rain, water stagnation and excess moisture are not suitable for senna growing.

Crop rotation and intercropping - Senna is grown after the paddy and grown as intercrop between rows of cotton, sesamum, chillies, brinjal, okra, mustard and coriander.

Irrigation - Senna can be economically grown under rainfed conditions. However, when it is grown as semi irrigated crop, the yield increases considerably and excess irrigation is injurious to the crop.

Pests and diseases

Pest The leaf eating caterpillar feed on the green senna leaves and spraying of carbaryl (4g/l) controls the infestation. The pod borer is also reported to attack the pods and can be controlled by spraying chlorpyriphos 1000 ml/ha **Diseases** 1. Leaf spot and leaf blight: The crop is sprayed with 0.1% benlate at about 70-80 days after sowing. 2. Damping off: Drenching with 0.2% brassicol or 0.5-0.15% rhizoctol. 3. Seedling blight: Spraying with 0.2% Mancozeb at forthnightly intervals.

Harvest and Yield - The leaves can be harvested in 2 months period. The second harvest is made at 30 days interval and the third harvest 40 days after second harvest. The harvested leaves should be shade dried for 7 to 10 days.

Yield - Yield/ha Leaves (kg) Pods (kg) Rainfed 1000 150-200 Irrigated 2000 400 It has been shown that young leaves and pods contain more sennosides than the mature ones; however, bluish green, matured leaves are preferred in the market and they also fetch better price. Even though, the produce are sold by weight, leaves containing about 2.0-2.5 % and pods having 2.5- 3.0 % of total sennosides are acceptable in the industry.

Post harvest handling and storage - The harvested leaves should be spread in a thin layer under open sun for 6-10 hours to reduce the moisture content. Further drying of the produce is done in well ventilated drying sheds. It takes 3-5 days to dry the produce in the

sheds by frequently turning them all over. A well dried produce should have 7-8 percent moisture and should maintain light green to greenish yellow colour.

Grading - One of the serious limiting factors in senna trading is lack of grading. High degree of variation in sennoside is experienced due to mixing of small, medium, large and extra large leaves. In the market, three or four grades of senna are recognised based upon size of leaf and colour.

- Grade A / first grade: The extra large and bold leaves and pods having yellowish green colour
 - Grade B /second grade: Produce having brownish leaves and pods
 - Grade C /third grade: Smaller and broken leaves and pods

PERIWINKLE

Importance and chemical composition

- Periwinkle (*Catharanthus roseus*) belonging to the family Apocynaceae, is one of the few medicinal plants which have found mention in the folk medicinal literature as early as 2nd BC.
- Modern investigations have shown that periwinkle contains more than 100 alkaloids, distributed through out the plant.
- It has medicinal importance owing to the presence of alkaloids like ajmalicine (raubasin), serpentine and reserpine in roots, which is well known for their hypotensive and antispasmodic properties.
- It gained further importance after the isolation of vincristine and vinblastine alkaloids from leaves, which have importance in cancer therapy.
- Vincristine sulphate is being marketed under the trade name ONCOVIN, which is used against acute leukemia and vinblastine sulphate as VELBE to cure Hodgkin's disease

Origin and distribution

- The plant is native of Madagascar and from there, it has spread to India, Indonesia, IndoChina, Philippines, South Africa, Israel, USA and other parts of the world.
- In India, it is being grown in Tamil Nadu, Karnataka, Andhra Pradesh, Madhya Pradesh, Gujarat and Assam in an area of about 3000 ha.
- Farmers prefer it because of its wide adaptability and its ability to grow in marginal lands and its drought tolerance.
- The presence of alkaloids all over the plant confers immunity to cattle browsing and crop loss due to pilferage.

- The USA is the world's largest user of this plant as raw material. A single firm which has the patent to manufacture Vinblastine and Vincristine sulphate has been consuming more than 1000 t of leaves annually.
- West Germany, Italy, Netherlands and the UK are interested in the roots. The total demand from these countries is more than 1000t of roots annually.

Description of plant

It is a perennial herb which grows up to 90-120 cm tall. It is a diploid with the chromosome number 2n = 16.

Types and varieties







Three variants in periwinkle, those with (i) rose purple flowers, (ii) white flowers and (iii) white flowers with a rose purple spot in the centre. The first type is being cultivated because of its higher alkaloid content. Recently, two white flowered varieties named "Nirmal" and "Dhawal" have been released by the CIMAP, Lucknow, which although equal in active principles are reported to yield a higher biomass.

Cultivation

Soil - The crop is hardy and grows well on a wide variety of soils, except those which are alkaline or waterlogged. Deep sandy loam to loam soils of medium fertility are preferred for its large scale cultivation because of better development of roots and also easy to collect at harvest time.

Climate - The distribution of the plant shows that there is no specificity in its climatic requirements. It comes up well in tropical and subtropical areas. However the growth in tropical areas is better than in the subtropical areas, where its growth is slow due to the low temperature in winter. It can be successfully grown up to an elevation of 1300 m above sea level. A well distributed rainfall of 100 cm or more is ideal for raising this crop on commercial scale under rain-fed conditions.

Propagation -The plants can either be propagated by seeds or vegetatively through cuttings. Since plants propagated by cuttings flower earlier than the plants from seeds, it is recommended that for drug production the plants should be grown from seeds and for seed production from cuttings.

Propagation by seeds - Fresh seeds collected a few months in advance are preferred for sowing as they lose viability on long storage. The seeds can either be directly sown in the field or a nursery can be raised and the seedlings are transplanted.

Direct Sowing - This method is best suited for large areas where labour is expensive as it reduces the cost of production. The land is ploughed twice and brought to fine tilth. Weeds, stubble and pebbles are removed. The field is divided into plots of convenient size and the soil is mixed with the recommend dose of manures and fertilizers. The seeds at the rate of 2.5 kg/ha are broadcasted at the onset of monsoon in June – July, in lines spaced 30-45 cm apart and lightly covered. Since the seeds are very small, for ease in handling and distribution, they are mixed with sand about 10 times their weight. Germination takes place after about 7-8 days. After germination is complete the seedlings are thinned at a spacing of 30-40 cm within the row. The flowering starts 40-45 days after sowing.

Nursery preparation and transplanting -When seed supply is short this method can be followed. The other advantage of this method in comparison to direct sowing is that healthy and vigorously growing seedlings can be selected and the inferior ones can be discarded. The seeds are sown in well prepared, raised nursery beds in March – April in rows spaced at 8-10 cm apart and about 1.5cm deep. About 500 gm of seeds will be enough to raise seedlings to cover 1 ha area. After two months of germination, the seedlings are ready for transplanting into the field. The seedlings are transplanted at a spacing of 45×30 cm in the field. A population of 74, 000 plants per ha may be accommodated. Vegetative propagation To raise plants by this method, soft wood cuttings obtained from the lateral shoots have proved better than either hard or semi hard wood cuttings. Cuttings of about 10-15 cm length with a minimum of 5-6 nodes are ideal and result in about 90% rooting. Soaking the cuttings over night in NAA solution of 25 or 50 ppm concentration has been found to further improve rooting to the extent of 96%. This method can be profitably used for multiplying the clones which have high alkaloid content and also where seed alone is to be produced.

Manures and fertilizers -FYM is applied at the rate of 10 – 15 t/ha to obtain good growth and yield. If irrigation is available, green manure crops can be raised and ploughed into the field at the time of flowering. In case organic manure is not applied it is advisable to apply a basal dose of 20 kg N, 30 kg P2O5 and 30 kg of K2O per hectare per year. In addition, a top dressing with 20 kg nitrogen can be given in two equal split doses during the season.

Irrigation -In places where rainfall is evenly distributed throughout the year, the plants do not require any irrigation. However in areas where rainfall is restricted to a few months in a particular period, about 4-5 irrigations will help the plants to give optimum yield.

Weed control -The crop requires two weedings in the initial stages of its growth. The first weeding may be done after about 60 days of sowing and the second at 120 days of sowing. Mulching the field with cut grass or rice straw will also minimize the weed growth. Pests and diseases o Plant is hardy hence devoid of pest and diseases. Occasionally they suffer from little leaf due to infection by mycoplasma resulting in stunted growth. This can be effectively checked by uprooting and destroying the affected plants. o Die back / Twig blight/top rot is reported during monsoon. Control measure is spraying Mancozeb at an interval of 10 -15 days.

Harvest, processing and yield -

Harvesting and processing -i. Leaves, stem and seeds: For leaves, leaf stripping twice, first after 6 months and the second after 9 months of sowing can be taken. A third leaf stripping is also obtained when the whole plant is harvested. After the plant is harvested, it is dried in the shade.

ii. Roots: The crop is harvested 12 months of sowing. The plants are cut about 7.5 cm above the ground level and dried for the stem, leaves and seeds. The field is then copiously irrigated and when it reaches proper condition for digging, it is ploughed and the roots are collected. The roots are washed well and dried in the shade. For seeds, it has to be collected from matured pods 2 to 3 months before the harvest of the whole plant. The aerial part of the plant between 7.5cm and about 25 cm above the ground level is taken as the stem for the purpose of marketing.

Yield -Under irrigated conditions, about 4t/ha of leaves, 1.5t/ha of stem and 1.5t/ha of roots, on air dried basis may be obtained. Whereas, under rainfed conditions, the yield will be about 2 t/ha of leaves and 0.75t/ha each of stem and roots on air dried basis. The total alkaloid content in the leaf varies from 0.15 to 1.34 % of which the average content of Vinblastine is 0.002% while that of Vincristine is 0.005%

Question bank

Part A

- 1. Senna is being exported mainly to countries like -----(USA, Germany and Japan)
- 2. -----(Vincristine sulphate) is being marketed under the trade name ONCOVIN

Part B

- 1. Processing of senna
- 2. Alkaloids present in periwinkle with uses (vincresin, vinblastin etc)

Lec – 25 Ashwagandha and Poppy – varieties – soil and climate propagation – sowing and planting nutrient, water and weed management – harvest and processing – post harvest handling

ASHWAGANDHA

Importance and chemical composition

- Aswagandha (*Withania somnifera*) is commonly known as 'winter cherry' and Indian Ginseng in English. Several types of alkaloids are found in this plant, out of which, withanine and somniferine are important. In addition the leaves are important to contain five unidentified alkaloids. The total alkaloid content in Ashwagandathe roots of Indian types has been reported to vary between 0.13 -0.31. The drug is mainly used in Ayurvedic and Unanic preparations.
- Withaferin A- contains antibiotic and antitumor properties. It is used for curing carbuncles in the indigenous system of medicine. The paste prepared out of its leaves is used for curing inflammation of tubercular glands and that of its roots Fruit for curing the skin diseases, bronchitis and ulcers. It is used as aphrodisiac, remunerative tonic, Diuretic, Hypnotic, Sedative and restorative, useful in rheumatism, cough debility from old age, dropsy and general weakness. In addition to alkaloids, roots are reported to contain starch, reducing sugar, hentriacontane, glycosides, dulcital, withaniol acid and a neutral compound. The free amino acids identified in the roots include aspartic acid, glycine, tryosine, alanine, proline, tryptophan, glutamic acid and cystine.
- Berries contain milk coagulating enzymes, esterases, free amino acids, fatty oil, essential oil and alkaloids. The amino acids present are proline, hydroxy-proline, valine, tryoline, aspartic acid, glycine, asper agine, cystine and glutamic acid.

Origin and distribution

Aswagandha is found wild in grazing grounds in Mandsaur and the forest lands in the Bastar district of Madhya Pradesh, all over the foothills of the Punjab and Himachal Pradesh and Western Uttar Pradesh, in the Himalayas. It is also found in the wild in the Mediterranean regions in North Africa. The crop is cultivated in an area of about 4000 ha in India, mainly in the drier parts of Manasa, Neemach and Jawad tehsils of the Mandsaur district of Madhya Pradesh, in Punjab, Sindh, Rajasthan and South India. In Karnataka, its cultivation has been reported in the Mysore districts. Area and production Aswagandha is cultivated in 5000 hectares in India predominantly in Madhya Pradesh. The estimated annual production is 2500 metric tones of dry roots.

Varieties

 A variety named Jawahar Asgandh (WS-20) has been released from a single plant selection from the Jawaharlal Nehru Krishi vishwa Vidhyalaya, Regional Agricultural Research Station, Mandsaur. This variety has recorded the highest dry root yield, consistently over the others. 2. A high root and alkaloid yielding variety 'Poshita' is released from CIMAP, Lucknow.

Cultivation

Soil and climate - Ashwagandha grows well in sandy loam soil, in slightly alkaline soil with good drainage condition. It grows better in 600-1200m altitude. The semi-tropical areas receiving low rainfall are suitable for cultivation of this crop. The crop requires dry season during its growing period. Temperature between 20oC to 35oC is most suitable for cultivation. Late winter rains are conducive for the proper development of the plant roots.

Land preparation - Ashwagandha is usually grown in fields which are not well covered by the irrigation systems. The field on which food crops cannot be grown profitably because of low rainfall can be used for ashwangandha cultivation. The soil of the field selected for ashwagandha cultivation is well pulverized by ploughing. The field should be leveled and pressed by using heavy wooden plank.

Nursery raising and planting - The crop can be sown either by broad casting or in lines. Line to line method should be preferred increased root production and also helps in performing intercultural practices in required by farmers. The seeds are usually sown about 1-3 cm deep during June- July in nursery. A light shower after sowing ensures good germination. About 5-12 kg seeds are sufficient for one hectare field. The seedling of 25-35 days old can be transplanted in the fields marinating 30 x 30 cm. spacing between the plants & the rows. As Ashwagnadha is a rainy season Kharif crop, the time of its sowing should be decided by date of arrival of monsoon in area of cultivation.

Thinning and weeding - The seeds sown by broadcasting or in the line should be thinned out by hand at 25-30 days after sowing to maintain a plant density of about 30-60 plants per square meter (about 20,000 to 25,000 plants/hectare). The plant density to be used may depend on the nature and fertility of the soil. On the marginal land the plant population should be kept high. One weeding at an early stage is sufficient to enable the Ashwagandha plants to take over the growth.

Manures and fertilizers - The ashwagandha crop does not require heavy doses of manure and fertilizers. In Madhya Pradesh, where it is grown on a commercial scale, no fertilizers are applied and the crop is cultivated on only residual fertility. Studies at the Indore Research Station have showed no effect of nitrogen and phosphorus on its root yield.

Irrigation - Light shower after transplantation ensures establishment of seedlings. There is no need of irrigation if rainfall is at regular intervals. Excessive rainfall/water is harmful to the crop. Only life saving irrigations may be applied, if required to ashwagandha. This is to be noticed that ashwagandha is a dry land crop and do not need much water.

Pest and disease management - Seed rotting, seedling blight and leaf blight are common diseases affecting ashwagandha. Their incidence can be minimized by spraying Dithane M-45 @ 3g/ I at the interval of 7-10 days.

Harvesting, processing and grading - The plants start flowering and bearing fruits from December onwards. The crop is ready for harvest in January- March at 150 to 180 days after

sowing. The maturity of crop is judged by drying out of leaves and yellow red berries in the plant standing in the field.

Processing- The entire plant is uprooted for roots which are separated from aerial parts by cutting the stem 1-2 cm above the crown. The roots are then either cut transversely into small pieces (7 to 10 cm) or dried as it is, in the sun. About 350 kg fresh roots can be obtained from one acre of land. On drying, it comes to 180 kg. Berries should be hand plucked separately. They are dried and crushed to take out the seeds. The dried roots, entire or transversely cut into smaller pieces, have to be further cleaned, trimmed and graded. The roots are beaten with a club which removes adhering soil and breaks off the thin, brittle lateral rootlets. Lateral branches, root crown and stem remains on roots are carefully trimmed with the help of knife.

Grading - The entire produce (dried roots) is then carefully hand sorted into following 4 grades.

- 1. Grade A: Root piece 7 cm long, diameter 1 to 1.5 cm. Roots should be brittle, solid and pure white from inside. 2.
- 2. Grade B: Root pieces 5 cm, diameter 1 cm, roots brittle, solid and white from inside.
- 3. Grade C: Root pieces should be solid, 3 4 cm long, diameter less than 1 cm.
- 4. Lower grade: Small pieces of root, roots are somewhat hollow, yellowish from inside.

POPPY

Importance and chemical composition

- Opium poppy (*Papaver somniferum*) is an annual herb belonging to the family, Papavaraceae.
- It grows up to a height of 60-120 cm. It is an important medicinal plant, the source of over 40 alkaloids including psychoactive agents, a great boon to psychiatry for the treatment of mental and nervous diseases and to medical research.
- The commercial product 'Opium' is an addictive narcotic obtained from the latex of capsules of the opium poppy, the source of a number of very valuable alkaloids like morphine, codeine, narcotine, papaverine and thebain.
- Other minor alkaloids include aporeine, codamine, cryp¬topine, guoscopine, hydrocotarnine, laudanine, narcotoline, neopine, oxynarcotine and papayeramine.
- The seeds do not contain any alkaloids, but are also reported to contain a high percentage of linoleic acid which lowers blood cholesterol in the human system.
- The alkaloids, morphine and codeine, are widely used as sedatives to relieve pain and induce sleep, in addition to their use against cough. Opium is a very valuable but dangerous drug.
- It should be used in very limited quantities and under the strict supervision of a physician.
- In India, this plant is mainly cultivated for its latex (opium) and the seeds come as a byproduct.

- These seeds are quite a rich source of fatty oil and protein and, in many countries of Europe, employed as a major source of cooking oil.
- The seed is also an important culinary item in India.
- It is extensively used in the preparation of native confectionery, pastries and bread.
- In some places, the young plants are also consumed as a leafy vegetable.
- Its cultivation has to be done under the strict control of the Central Excise Department and it cannot be cultivated everywhere.
- It can be grown only in those areas specified by the Government of India.

Origin and distribution

Opium poppy is supposed to have originated in the western Mediterranean region and from there it has spread through the Balkan peninsula to Asia Minor and India. Since antiquity, its cultivation has been in vogue in Italy, Greece and Asia Minor. It was during the 15th century that the herb was introduced in India. First, it was cultivated along the sea coast and later penetrated into the interior of the peninsula.

Area and production

The 1953, the United Nation's Opium Conference Protocol (still in effect) for limiting and regulating the cultivation of opium poppy plants asserts that Bulgaria, Greece, India, Iran, Turkey, the USSR, Egypt, Czechoslovakia, Poland, Germany, Holland, China, Japan, Argentina, Spain, Hungary, Portugal and Yugoslavia are the countries that may legally produce opium. The only country where substantial amount of opium is now produced for export is, India which amounts to 1,465 t annually and forms over 90% of the world production. In India, all the opium of commerce is now grown mainly in the states of Uttar Pradesh, Madhya Pradesh and Rajasthan covering an area of 18000 ha. The control and regulation of all aspects of the cultivation of poppy and wholesale trade has been under the purview of the Government of the India since 1773. After the partitioning of the Indian subcontinent in 1947, the essentials of the present system of narcotics control, which derived from the system instituted by the British in the 1857 Opium Act, were retained with few changes. The Government of India is able to effectively license farmers to grow opium. This is highly organized so as to allow elimination of those growers whose yield of opium is poor.

Description of the plant

The poppy is a small, erect, scarcely branched (towards the top) herb attaining a height of 120 cm with large, serrated leaves and attractive brightly coloured (white, pink, purple, red and variegated) flowers. The main shoot and branches terminate into large, oblong to globose capsules, filled with small white, flat seeds. The seeds, whitish-yellow, grey-brown, reddish-brown or black, and richin oil. Varieties The most popular varieties grown in the country remain in the field from 140 to 160 days. The following are some of the important varieties of which Talia, Ranghatak and Dhola Chota Gothia are

Popular varieties recommended for heavy black soils.

(i) Talia It is sown early and it remains in the field for 140 days. Its flowers are pink and have large petals. The capsule is oblong, ovate, light-green and shiny (waxy).

- (ii) Ranghatak It is a medium-tall variety, maturing for lancing in 125-130 days after sowing. It bears white and light-pink flowers. It produces medium-sized capsules (7.6 cm x 5.0 cm), which are slightly flat-tened on the top. It yields opium of a comparatively thin consistency that changes to a dark-brown colour on exposure.
- (iii) Dhola Chota Gotia It is a dwarf cultivar (85-90 cm), bearing pure white flowers and light¬ green capsules which are oblong-ovate in shape. It is ready for lancing after 105-115 days of sowing and matures for seed in 140 days.
- (iv) MOP-3 This variety has been developed at the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Mandsaur, recently. It bears pinkish-white flowers comprising of large non-serrated petals. Its capsules are ready for lancing 120 days after sowing and the variety is recommended where adequate irrigation facilities exist in the later part of the season.
- (v) MOP-16 This is another promising selection made at the Jawaharalal Nehru Krishi Vishwa Vidyalaya, Mandsaur. The plant bears white flowers with serrated petals and round, flat-topped capsules. This is comparatively drought tolerant and is ready for lancing 105-110 days after sowing. It is recommended where an early maturing crop is preferred.
- (vi) Shama This variety was released by the CIMAP, Lucknow during the year 1983. The main alkaloids like Morphine (14.51-16.75%), Codeine (2.05-3/24%), Thebaine (1.84-2.16%), Papaverine (0.82%) and Narcotine (5.89-6.32%) in this variety are reported to be on higher side than the existing commercially cultivated variety. It yields 39.5 kg of latex and 8.8 kg/ha of seeds.
- (vii) Shweta This variety was also released by the CIMAP, Lucknow, along with Shama. However, it is reported to be superior to Shama in the content of the main alkaloids-morphine (15.75-22.38%), codeine (2.15- 2.76%), thebaine (2.04-2.5%), papaverine (0.94-1.1%) and Narcotine (5.94-6.5%). It gives an average yield of 42.5 kg of latex and 7.8 kg/ha of seeds.
- (viii) BROP 1 (Botanical Research Opium Poppy-I) (NBRI-3) It is a synthetic variety developed at the National Botanical Research Institute, Lucknow, by crossing selections from Kali Dandi, Suyapankhi and Safaid Dandi. This variety is highly adaptable to varied agroc1imatic conditions and gives a higher yield than national checks. It is moderately resistant to diseases. It yields about 54 kg/ha of opium and 10-13 q/ha of seeds. The morphine content is 13% and above pose a problem, since they remain wet during the rains and are too difficult to cultivate in the dry period.
- (ix) Kirtiman (NOP-4) It was developed at the Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad, through selection from local races. The variety is moderately resistant to downy mildew. It yields 35-45 kg/ha of latex and 9-10 g/ha of seeds. The morphine content is up to 12%.
- (x) Chetak (U.O.285) This variety was developed at the Rajasthan Agriculture University, Udaipur. It is moderately resistant to diseases. The opium yield is up

to 54 kg/ha and the seed-yield is 10-12 q/ha and contains up to 12% morphine. In general, the crop needs long cold season (20°C) with adequate sunshine in the early season for a healthy vegetative growth; heavy rains after sowing cause loss in seed germination. Warm, dry weather with a temperature of 30-35°C is required during the reproductive period. Cloudy weather, frost, hailstorms and high gusty winds, particularly during lancing, causes immense damage to the growing crop. Dry, warm weather conditions in February-March favour a good flow of latex and results in higher yields.

- (xi) Jawahar Aphim 16 (JA-16) It is a pure line selection of 10Callandraces developed at the Jawaha¬ralal Nehru Krishi Vishwa Vidyalaya, College of Agriculture, Mandsaur (Madhya Pradesh). It is moderately resistant to downy mildew. It gives 45-54 kg/ha of latex, 8-10 q/ha of seeds and contains up to 12% morphine.
- (xii) Recently, another three varieties:'NBRI-3' of opium, 'Sujatha' an opium-free poppy for the production of oil and seed and 'Shubhra' for high morphine and seed yield have been released from the NBRI, Lucknow, RRL, Jammu and CIMAP, Lucknow.

Cultivation

Soil - The opium crop needs deep clay loam, highly fertile and well – drained soils with a pH range of 6.0 to 7.5. Such soils, containing adequate organic matter, retain moisture and there is no need of irrigation during lancing. However, with adequate manuring and use of fertilizers even light, loam to sandy-loam lateritic soils can give high yields under good management. Heavy clay or fine sandy soils generally sowing for correcting zinc deficiency 12-30 kg/ha of zinc sulphate should be added.

Sowing - Poppy seeds should be sown in a well prepared soil. The field should be given 5-6 cross ploughings followed by planting. The land should be divided into small plots to facilitate irrigation. The seeds should be treated with thiram (405 g/kg of seed) to protect the seeds against soil borne pathogens. The seeds are sown between late October to mid November. After sowing, seeds are covered by a thin layer of soil followed by a light irrigation.

Fertilizer application - The crop requires nutrients required for flowering and capsule formation. A fertilizer recommendation of 90:50:30 kg NPK/hectare is followed.

Irrigation - The first irrigation is given, immediately after sowing, if there is not enough moisture available in the soil. For subsequent irrigations, 7-10 days Irrigation schedule is the optimum depending upon the weather and soil conditions. A total of 10 to 15 irrigations are required for this crop.

Flowering and fruit - set - After about 90 to 100 days of sowing, the plants which are waisthigh begin to flower, i.e., flowering will take place during first week of March, if the crop was sown during the second fortnight of November. Usually after 3 days of flowering, the petals fall off and after another 10-14 days the capsules are ready for lancing.

Pest and diseases - Insects 1. Cutworms (Agrotis suffuse): This insect can be controlled by flooding the field water and dusting the crop with 2% Carbaryl. 2. Weevils (Stenocarus fulginosus-root weevil and Cautorhynchus maculalba – capsule weevil). Diseases • Downey mildew and powdery mildew: This disease can be controlled by the application of Dithane Z-78 (0.4%) • Other diseases: Root rot ,leaf blight, cabbage ring spot virus, beet yellow virus and bean yellow mosaic virus

Lancing and latex collection - The lancing operation is performed by skilled labour (an average of 6 persons to a plot), usually on bright sunny days between noon and 4 p.m. The hottest part of the day is chosen, since the pellicle is said to form on the surface of the freshly exuded latex due to the hot sun, resulting in a greater degree of evaporation and quicker thickening. This also helps prevent the latex from falling off the capsule. The lancing operation is started at the edge of the field and the person works backward to avoid contact with the exuding latex. The hand is quickly passed over a capsule with the exuding latex. The hand is quickly passed over a capsule and a subjective decision is made as to whether it is ready for incision or not. The lancing instrument, called "Nastar" or "Naka", comprises of four lines about the dimension of ordinary needles spaced at 1.5 to 2mm apart and affixed to a holder about 18cm long. The nester is held carefully, as one holds a pencil while writing and the incision is made by a swift downward stroke starting just below the stigmatic rays. The depth of the incision is controlled by the affixation of the lines to the holder, for if incisions are too deep the latex is exuded to the interior of the capsules and is thus lost. If the cut is too shallow the yield of latex will be low, usually, an incision with a depth of 0.4 cm is considered ideal. About 150-200 capsules can be lanced per hour by an experienced worker. Immediately on lancing, the latex exudes; it is initially milky and gets accumulated in the outer wall of the capsule. It quickly darkens and dries during the course of the day and is generally collected the next day before 10a.m. by scraping with a trowel called the Seetoah. The collection may also be delayed for one or two days, depending upon the 'appearance' of the capsules and the vigor after the latex flow. In other words the interval is subjectively determined by the collator. The lancing process is usually repeated twice, making a total of series of vertical incisions. The spacing of the incisions on the capsule is generally even. If the capsules are exceptionally, large, four to five lancing can be done. The air dried latex, which has now become blackish in colour, is scraped from the capsules into small earthenware pots which are lined with polythene sheets. Scraping is carried out by grasping the capsule between the thumb and forefinger of the left hand and including it gently, the scraper is then drawn upwards. The capsule is finally 'cleaned' with the thumb. The semi-dry, blackish latex is then transferred to wooden trays and dried further, upon arrival at the factory, appropriate samples are drawn from each grower's produce and their quality is determined in the laboratory of the Chief Opium Chemist. The material is graded according to morphine content as follows: A = With morphine content more than 12%. D1 = With morphine between 11 an 12%. B2 = With morphine between 10 and 11% B3 = With morphine between 8 and 10%

Question bank

- 1.Extraction methods in senna
- 2. Alkaloids in periwinkle (Vincrestin and vinbalstin) and extraction methods

Lec 26 - Medicinal coleus, aloe – soil and climate – propagation – planting, nutrient, water and weed management – harvest, yield and processing – post harvest handling.

MEDICINAL COLEUS

Importance and chemical composition

Coleus forskohlii Syn. Coleus barbatus, *Plectranthus forskohlii*, belonging to the family Lamiaceae is a well known plant through out the country and one of the most significant medicinal crops for its tuberous roots. The dried roots are found to be a rich source of forskolin and are used for treating hypertension, glaucoma, asthma, congestive heart failures and certain types of cancer. The tuberous roots, resembling a carrot in shape and brown in colour, are the commercial parts. The plant is known as 'Pashanbhedi' in Sanskrit and 'Patharchur' in Hindi. Recent discoveries have indicated that the forskolin is useful against cholesterol and also used in cosmetics. The species came into commercial cultivation after the discovery of forskolin, a unique adenylate cyclase activating drug which is highly useful in activating the cardio vascular system. The dry roots contain forskolin with content ranging from 0.10 to 0.80 per cent. One of the Indian medicinal plants which were very little known until a few years ago has now been raised as a single medicinal crop of international importance.

Origin and distribution

The crop has been distributed all over the tropical and sub tropical regions of India, Pakistan, Sri Lanka, tropical east Africa, Brazil. In India, it is found in the sub tropical Himalayan regions from Kumaon to Nepal. It is cultivated in parts of Rajasthan, Maharastra, Karnataka and Tamil Nadu. In Tamil Nadu, it is cultivated for more than 25 years.

Area and Production

There are about 10,000 ha are under this crop in the country. The annual estimated production is 2000 ton dry roots/annum

Description of the plant

The plants produce thick roots in the form of elongated tubers. Radially spread roots are fasciculate, succulent, tortuous with 1.0 to 3.0 cm thickness and 20 cm length. The inner roots are orange coloured, and has the characteristic pungent odour. The plants have square stems branched where nodes are often hairy. Leaves are pubescent, narrowed into petiole. Though it is a biennial, it is cultivated as an annual.

Cultivation

Soil - *C. forskohlii* thrives better in well drained soils with a pH ranging from 5.5 -7.0. It does not require very fertile soils and can be economically grown under marginal soils.

Climate - Coleus is a crop of the tropics and is found growing well at an altitude of about 2400m under tropical and sub tropical conditions. It grows well under humid climate with a RH ranging from 83-95% and a temperature range between 10-250 C for its successful growth.

Varieties

- 1. Maimul, Manganiperu, Garmai are some of the popular varieties.
- 2. CO1- This variety developed by Tamil Nadu Agricultural University Coimbatore which clonal selection from Periyakulam local. This variety released during the year of 1991. The variety yields 32.89 per cent increased yield over local type with 0.40 per cent forskohlin. Dry tuber yield about 2.5 t /ha. Moderately tolerant to root rot and wilt diseases under field conditions. Field tolerant to nematode and mealy bug infestation.
- 3. A selection, K-8 is reported to give 0.5% forskolin and a higher tuber yield.
- **4.** A new variety 'Aisiri' with forskolin content of 0.7% released from UAS, Bengaluru.

Propagation and planting - Coleus is propagated by terminal cuttings. Normally, 10-12 cm long cuttings comprising 3-4 pairs of leaves are preferred. These cuttings are either rooted in nursery and then planted in the main field or planted directly in the main field. The ideal season for planting Coleus is from June to July with the onset of South west monsoon. Before planting, the field is ploughed deep soon after the receipt of pre monsoon showers and brought to fine tilth. The crop loves high amount of organic manure and about 25 t FYM/ha is applied. Ridges and furrows are prepared at 60 cm spacing. The height of the ridge should be 15 cm from ground level. The cuttings are planted at 30 or 45 cm distance depending on the soil type. While planting, care should be taken to see that minimum of two nodes should be underneath the soil. Watering should be done before and after planting. Under drip irrigation system, raised broad row ridges of 90cm width are prepared at 60 cm interval and planting at 60 cm spacing between rows are planted. The space between two plants should be 45 cm.

Manures and Fertilizers - The crop requires plenty of organic manure. In addition to 25 tonnes of FYM, addition of 1 ton vermicompost, 150 kg of neem cake, 500 kg of gypsum are applied to condition the soil and to improve its fertility by organic means. Many farmers adopt organic farming by avoiding chemical fertilizers and pesticides. 'Panchagavya' 3% organic spray is given along with root drenching. A fertilizer dose of 40 kg N, 60 kg P2O5 and 50 kg K2O per hectare is recommended for Tamil Nadu. Half the dose of N, the whole P and K may be applied as the basal dose followed by the remaining half N, 30 days after planting as top dressing. Irrigation The first irrigation is given immediately after transplanting. In the initial phase, the crop is irrigated once in three days and there after, weekly irrigation is enough to obtain good growth and yield.

Weeding and earthing up - Two or three weedings are given and after the second weeding, earthing up is given. As the roots are shallow, deep digging should be avoided.

Harvesting, processing and yield - The crop is ready for harvest in 180 days after planting. Flowers if any should be nipped-off during the growing period to obtain more root biomass. • The roots are harvested either by ploughing using a bullock or by tractor. The tubers can also be manually dug and taken with least damage. • The roots are cleaned making free of soil and transported for drying. The roots are cut into small pieces using mechanized rotary motors. • The root bits are spread thinly on the cement yard and allowed to dry for 3-5 days. The roots get completely dried and are packed. • On an average, a yield of 1500 kg of dried tubers per hectare is obtained. If proper cultivation practices are followed, a yield of 2500 kg of dried tubers can be expected per hectare. Contract farming • In Tamil Nadu, the contract production system is in practice. • The firms enter into bilateral agreement with the growers and an area of about 4000 ha are being covered under the system. • The major areas in Tamil Nadu include Salem

and Namakkal districts. • The firms offer insurance coverage, timely input supply and technical advise and guarantees buy back.

ALOE VERA

Scientific name: *Aloe vera* Family: Lilliaceae Economic part: Leaves Major: Cathartic anthrax - glycosides as its active principle ranging constituents from 4.5 to 25 % aloin

Uses: Yellow bitter juice consisting of aloin and gel consisting of polysaccharides Havouring liquors Used as active ingredients in laxative and anti-obesity preparation, as moisturizer, emollient or wound healer in various cosmetic and pharmaceutical formulations.

Description

Aloe is a perennial with shallow root and short stem. It grows up to the height of 60 cm. The plants have multiple tuberous roots and supporting roots penetrating into the soil. Aloe does not have true stem but produces bloom stalks. The plants generally grow slowly close to the ground in a typical rosette shape. The fleshy leaves are densely crowded and strongly cuticularized with spiny margin. The flowers vary from yellow to rich orange colour and are arranged in axillary spikes. The ovary is superior, trilocular with axile placentation. The plant does not produce many viable seeds.

Propagation

Rhizomatous cuttings can also be used when the mother plants become much aged (after five years). The stem of the mother plants after harvesting of leaves should be cut into 10 cm length. Each piece should have a minimum of 4-6 nodes. The cuttings are made to root in specially prepared nursery beds with sand as medium. The cuttings should be dipped in a fungicide to prevent damping off disease and planted in the nursery vertically for easy rooting. Cuttings root easily in 60 days, thereupon taken to the field for planting. Care should be taken to water the nursery only to maintain the minimum moisture.

Spacing

Spacing of 60 cm between plants is followed in medium soils. At 60x 60 cm, a plant population of 11,110 plants are accommodated. Fertile soils require a wider row spacing of 75 cm and plant spacing of 60 cm (plant population of 8880 plants /acre).

Inter cultural operations

Cultivated under semi irrigated and rainfed conditions. Soil requires enough organic manures viz., farm yard manure (10 ton/acre) and vermicompost (1 ton/acre) Ridges and furrow method is better for moisture conservation. Ridges at 60 cm spacing is adopted. For a rainfed crop, planting is done during the early rains. Chemical manures are not applied. After every harvesting, the plants are earthed up and manured.

Though it is a drought tolerant crop, limited irrigations should be given in the early stages of establishment. Irrigation during early stages can help in uniform establishment of suckers and rapid root development. During the initial establishment of suckers (first three months), three

irrigations should be given every week. At later stages, irrigation at 20 days interval is recommended for ideal crop growth. Irrigation should be given after every harvest to facilitate new leaf growth. Too much of irrigation during the time of harvest can reduce the quality of leaves. Under contract farming, cultivated under drip irrigation with an extra investment of Rs.25,000/acre.

Harvesting

Leaves attain maturity in eight months after planting. Each leaves weighing 800900 g are only harvested. At a time, only two or three leaves in a plant will attain the harvestable maturity. In the first picking, only two or three leaves can be harvested from each plants. Subsequent harvesting can be made at three months interval, where additional two leaves can be harvested. Maximum of 2 harvests are possible in the first year. Second year onwards, 4 harvests can be made in a year. while harvesting, the leaves should be cut close to the base using a sterilized stainless steel blade or knife. Aloe plantation can be maintained up to 5 years.

Lec 27 - Gloriosa and Isabgol propagation – soil and climate – propagations and planting – standards – pollination – nutrient, water and weed management – harvest, yield and processing – post harvest handling.

GLORY LILY (GLORIOSA)

Importance and chemical composition

Glory lily or the lily flower (*Gloriosa superba* Linn,) belongs to the family Colchicaceae. In Kannada, it is called 'Agnishike',' Indrana huvu', while in Hindi it is called 'Kalihari'. In tamil, it is commonly known as 'Kanvazhipoo', 'Kanvazhikizhangu'. The plant has been used in the Indian system of medicine since time immemorial. Its tubers are reported to have been used as a tonic, antiperiodic, antihelminthic and also against snake bites and scorpion stings. The drug is a gastro intestinal irritant and may cause vomiting and purging. It is sometimes used for promoting labour pains and conversely also an abortifacient. It is considered useful in colic, chronic ulcers, piles and gonorrhea. It is used in local applications against parasitic skin diseases and as a cataplasm in urological pains. The leaves when applied in the form of a paste to the forehead and neck are reported to cure asthma in children. The leaf juice is used against head lice.

- The medicinal properties of the drug are due to the presence of alkaloids, chiefly colchicine and gloriosine.
- Colchicine is used in the treatment of gout; a common disorder in the temperate parts of the world.
- Gout is caused by the deposition of microcrystals of uric acid in the joints.
- In addition, these alkaloids are also used as polyploidizing agents in polyploid breeding in crop research.
- The colchicine content varies from 0.15 to 0.3% in the tubers, and in the seeds it ranges from 0.7 to 0.9%. The crop is grown mainly for its seeds which are in great demand within the country and in the international market.

Origin and distribution

Glory lily is a native of tropical Asia and Africa. The genus derives its name from the Latin word gloriosus referring to the flowers. It is found growing throughout tropical India, from the North-west Himalayas to Assam and the Deccan peninsula, extending up to an elevation of 2120m. In Karnataka, it is commonly found growing all along the Western Ghats. It is also found growing in Madagascar, Sri Lanka, Indonesia and in the adjacent islands. The area under this crop in India is around 3000 ha. The genus Gloriosa is comprised of about 10 to 15 known species. The important species found in India are, *G. superba* and *G. rothschildiana*.

Area and production

Tamil Nadu leads in production of glory lily in India with an estimated area of 3000 hectares with annual production of 1000 ton dry seed.

Description of the plant

• It is herbaceous climbing perennial, growing between 3.5 to 6m in length, but usually trained at 1.5m above ground level.

- The vines are long, weak- stemmed with tuberous roots that support themselves by means of cirrhosed tips.
- The leaves are ovate, lanceolate, acuminate, the tips spirally twisted to serve as tendrils. The flowers are large, solitary.
- In the bud stage, the petals hang down over the ovary and on maturity, they assume an erect position, leaving the ovary with its stigma exposed at right angles.

Cultivation

Soil- It prefers sandy loam soils on the acidic pH with good drainage, for its successful growth. In Southern India, it is found growing luxuriantly in red and black loamy soils which have a good amount of humus with a medium water holding capacity. A soil pH range from 6-7 has been found suitable for raising the crop.

Climate -It is a tropical plant and comes up well in warm humid regions. Under natural conditions, it is found growing up to an elevation of 600m from sea level. An annual rainfall of about 370 cm, well distributed throughout the year, is ideally suited and requires frequent irrigations upto the flowering in dry periods. The temperature favourable for its growth and flowering are 15-20°C at night. The relative humidity should be high. However continuous cloudy weather is congenial for the pathogen Curvularia, which is a very serious threat, resulting in 75 to 80% mortality of the vines.

Propagation -It is commercially propagated from its underground, V-shaped rhizomes or sexually propagated by seeds. The plants raised from seeds take nearly three to four years to flower. Hence, except for experimental purposes, seed propagation is not favoured by the growers. Glory lily produces a bi-forked tuber during the growing season and each of these forks has only one growing bud. Tubers should be handled carefully, as they are brittle and liable to break easily. If the growing bud is subjected to any kind of damage, the tuber will fail to sprout. Since the vigour of the vine and its flowering and fruiting ability depends on the size of the tubers, it should not weigh less than 50-60g. The plants raised from smaller tubers do not produce flowers during the first year. The dormant tubers start sprouting from the month of May. About 2.5 to 3.0t of tubers are required for planting on one hectare. In order to avoid rotting of the tubers before sprouting, only healthy tubers should be selected for planting. The selected tuber pieces should be treated with suitable fungicides, preferably emisan @ 0.08%

Field preparation and planting - The field should be ploughed and harrowed several times until it is brought to fine tilth. All the grass stubbles and roots should be removed. The field must be leveled properly and drainage arrangements made to avoid water logging during the rains. The field is then divided into subplots of convenient sizes. About 15-20t/ha of FYM or compost should be mixed well into the soil. About 30cm deep furrows are opened at a spacing of 45-60cm. The treated tubers are planted at a depth of 6-8cm, keeping a plant to plant distance of 30 to 45 cm, depending upon the type of soil. Closer spacing has been reported to favour cross pollination, thereby improving the fruit set.

Manures and fertilizers - A fertilizer dose of 120kg N, 50kg P2O5 and 75 kg K2O/ha is required for a good crop. Of the nutrients, the whole P2O5 and K2O and one third of N is applied as a basal dose and the remaining two-third of N should be given in the first six to eight weeks after planting. **Irrigation -**Frequent irrigation is required during the sprouting time to keep the surface soft, so that there is no hard-pan formation in order to facilitate easy sprouting and emergence of the growing tip outside the soil. Irrigation should be withheld

until the flowering is over, to prevent rotting of the tubers. Excess watering is harmful to the plants and causes yellow or brown coloured patches on the leaves which fall off prematurely. **Drip and fertigation system-**Application of 150:100:300 kg NPK/ha through water soluble fertilizers is recommended for doubling the seed yield.

Crop monitoring -The provision of support is necessary for successfully growing glory lily. Since the stem is very slender, when the plants are about 30-40 cm tall, they should be staked or tied to wires or allowed to climb on some sort of frame. Various standards are used by farmers. The GI trellis wire support system is the commonly adopted practice.

Pollination -The flowers have deflexed stigma which requires assisted pollination. Hand pollination is done between 7-11 am every day. Pollens are collected using brush and dusted on the just opened flowers to ensure maximum seed set.

Weeding -In the initial stages, the glory lily plantation requires frequent weeding to control the weeds which will otherwise compete with plants for moisture and nutrients and will restrict the growth of the plant. While weeding utmost care should be taken to avoid any damage to the growing tip as once damaged it does not sprout again during the season. Chemical weed control is possible only when there is wide spacing between the rows.

Pests and diseases -Glory lily has few pests and diseases. However, diseases pose a serious threat when they get favourable conditions, causing severe damage. Hence great care has to be taken to control them. Pests Lily caterpillar, Green caterpillar: Controlled by spraying quinalphos @ 1000ml/ha Diseases Leaf blight: This disease is caused by the fungus Curvularia lunata. The disease can be controlled by spraying 0.2% mancozeb. Tuber rot or Basal stem rotting and wilting: Controlled by drenching the soil with carbendazim (0.2%) or Psuedomonas fluorescens @ 0.5% **Harvesting and processing**

- Glory lily is a crop of 180 days duration.
- When planted in June, it starts bearing flowers after 55 days and continues to flower and fruit till October.
- The fruit requires about 105-110 days from the set to reach maturity.
- The right stage of harvest is when the capsule starts turning light green from dark green and the skin of the fruit shows a shrunken appearance and becomes light in weight.
- At this stage when pressed the pod gives a crinkling sound.
- After picking, the capsules should be kept in the shade for 7 to 10 days to facilitate the capsule to open up displaying deep orange yellow coloured seeds.
- The seeds and pericarp are separated manually and dried for a week in the shade, by spreading them over any clean dry floor or any platform specially erected for the purpose. At the later stages, the seeds are dried under sun.
- The dried seeds are then packed in moisture- proof containers and stored until they
 are marketed. Yield The yield of seeds differs greatly, depending upon the size of
 the tubers used for planting and age of the tubers. The average yield is 500 kg dry
 seed /ha. The seed yield gradually decreases in the third year and thereof. Under
 drip and fertigation system, the seed yield is 1000 kg/ha.

ISABGOL

Importance and chemical composition

- Isabgol or Blonde psyllium (Plantago ovata) belonging to the family Plantaginaceae, is important for its seeds and husks which have been used in indigenous medicine for many centuries.
- It derives its name from two Persian words, 'asp' and 'ghol' meaning a 'horse –ear' referring to its characteristic boat-shaped seeds.
- The husk of the seed is economic part and it contains colloidal mucilage mainly consisting of xylose, arabinose, galacturonic acid.
- The husk has the property of absorbing and retaining water and it works as an anti diarrhoeal drug.
- It is beneficial in chronic dysenteries of amoebic and bacillary origin. o It is also used for treating constipation and intestinal disorders as it works as calorie free fiber food, promoting regular bowel movement.
- The seed has also cooling demulscent effects and is used to cure inflammations of mucous membrane of gastro intestinal and urinary tracts.

Origin and distribution

- It is indigenous to the Persia and West Asia, extending upto the Sutlej, Sind and West Pakistan.
- The plant is also acclimatized well in Mexico and in the Mediterranean regions.
- It has been introduced in India and cultivated specially in Gujarat and some parts of Rajasthan.
- At present Isbgol has acquired the place of 'dollar earner' crop of North Gujarat.

Area and production

Isabgol is cultivated in about 50,000 hectares in India, with major areas falling under Gujarat and Rajasthan. The estimated annual production of isabgol is 50 metric ton and India earns foreign exchange valued up to Rs.80 crores every year through export of psyllium husk.

Description of the plant

It is 10-15 cm tall short-stemmed annual herb. Leaves are born alternately on the stem. Flowers in terminal spikes; fruit is a capsule. The flowers are white and minute. Highly self pollinated. The capsule is ovate, 8mm long, releasing the smooth, dull, ovate seeds which are translucent and convex. The seeds are covered with a translucent membrane, known as the husk. The husked seeds are dark red and hard.

Varieties

Gujarat Isabgol-1 and Gujarat Isabgol -2 are the two varieties of this crop released by Gujarat Agricultural University. Another variety, 'Niharika', a mutant has been released by the CIMAP, Lucknow, as a high yielding variety.

Cultivation

Soil -It is an irrigated crop which grows well on light soils. Soil with poor drainage is not conducive for good growth of this crop. A silty-loam soil having a soil pH from 4.7 to 7.7 with high nitrogen and low moisture content is ideal for growth of plants and high yield of seeds.

Climate -Isabgol thrives well in warm- temperate regions. It requires cool and dry weather & is sown during winter months. Sowing during first week of November gives best yields. Early sowing makes the crop vulnerable to downy mildew disease, whereas late sowing provides lesser period of growth in winter along with possibility of shattering of seed due to summer rains in April-May. At maturity, if the weather is humid, its seeds shatter resulting reduction in yield. Heavy dew or even a light shower will proportionately decrease the yield, at times leading to even total loss of the crop. The temperature requirement for maximum seed germination is reported to be 20 to 300C.

Land preparation -Field must be free of weeds and clods. The number of ploughing, harrowing and hoeing depends upon the soil conditions, previous crop and degree of weed infestation. The recommended dose of FYM (10-15t/ha) is applied to the field at the time of last ploughing. The field should be divided into suitable plots of convenient size, depending upon the texture of the soil, the slope of the field and quantum of irrigation. For light soil with even contour, plot size of 8.0 m x 3.0 m will be convenient.

Seed sowing - To obtain high percentage of germination, seed should be taken from the crop harvested at the end of the preceding crop season. Old seeds tend to lose viability under ordinary storage conditions. Seed at the rate of 4-8 kg per hectare is sown after treating it with any mercurial seed-dresser at the rate of 3 g/kg of seed, to protect the seedlings from the possible attack of damping off. The seeds are small and light. Hence before sowing, the seed is mixed with sufficient quantity of fine sand or sieved farmyard manure. The seeds are broadcasted because sowing in lines at different spacing does not increase the seed yield. After broadcasting, seeds are swept lightly with a broom to cover them with some soil. Broom however, should be swept in one direction only, to avoid deep burial of the seed for uniform germination. The sowing should immediately be followed by irrigation. Germination begins in four days after sowing. If delayed, it should be stimulated by another watering.

Manures and fertilizers - The FYM of 1015tonnes /ha is applied during land preparation. Isabgol does not require application of heavy doses of fertilizers. A fertilizer dose consisting of 50kg N, 25kg P2O5 and 30kg K2O/ha gives maximum seed yield. The full dose of P and K along with half of the N is given as a basal dose. The second split of N is applied as a top dressing after one month of sowing.

Irrigation -Immediately after sowing, light irrigation is essential. First irrigation should be given with light flow or shower of water otherwise, with fast current of water most of the seeds will be swept to one side of the plot and the germination and distribution will not be uniform. The seeds germinate in 6-7 days. If the germination is poor, second irrigation should be given. Later on irrigations are given as and when required. Last irrigation should be given at the time when maximum number of spikes shoots up. The crop requires totally 6-7 irrigations for its good productivity in medium sandy soils.

Weeding and interculture - Periodical weeding and hoeing is required. The medicinal plants have to be grown without chemical fertilizers and use of pesticides. Organic manures like, farm yard manure (FYM), vermi compost, green manure, etc. may be used as per requirement of the species. To prevent diseases, bio-pesticides could be prepared (either

single or mixture) from Neem (kernel, seeds & leaves), Chitrakmool, Dhatura, Cow urine, etc.

Pests and diseases

Pests - White grubs and termites damage the crop by cutting off the root which can be controlled by broad casting phorate 10G @10kg/ha. Aphids also attack the crop and can be controlled by spraying 0.2% Dimethoate.

Disease -Downy mildew is the major disease caused by Peronospora plantaginis. The disease appears at the time of spike initiation. The first symptom is small patches on the leaves, completely destroying it and thus affecting the yield. To control it, Bordeaux mixture or Dithane M-45 or any copper fungicide at the rate of 2-2.5g/l can be sprayed.

Harvesting, processing and yield - Blooming begins two months after sowing and the crop become ready for harvest in February-March (110-130 days after sowing). When mature, the crop turn yellowish and the spikes turn brownish. The seeds are shed when the spikes are pressed even slightly. At the time of harvest, the atmosphere must be dry and there should be no moisture on the plant, harvesting will lead to considerable seed shattering. Hence, the crop should be harvested after 10 am only. After two days, they are threshed with the help of tractor during early morning. Water is sprinkled over the heap for easy thrashing and separation.

Yield -Gujarat Isabgol-1, variety yields 800-900 kg of seeds per hectare. The new variety 'Gujarat Isabgol-2' has a potential to yield 1,000 kg of seeds per hectare.

Lec 28 - Methods of extraction of secondary metabolites from medicinal plants <u>EXTRACTION OF MEDICINAL PRODUCTS USING SOXHLET APPARATUS</u>

Extraction, as the term is used pharmaceutically, involves the separation of medicinally active portions of plant or animal tissues from the inactive or inert components by using selective solvents in standard extraction procedures. The products so obtained from plants are relatively impure liquids, semisolids or powders intended only for oral or external use. These include classes of preparations known as decoctions, infusions, fluid extracts, tinctures, pilular (semisolid) extracts and powdered extracts. Such preparations popularly have been called galenicals, named after Galen, the second century Greek physician. The purposes of standardized extraction procedures for crude drugs are to attain the therapeutically desired portion and to eliminate the inert material by treatment with a selective solvent known as menstruum. The extract thus obtained may be ready for use as a medicinal agent in the form of tinctures and fluid extracts, it may be further processed to be incorporated in any dosage form such as tablets or capsules, or it may be fractionated to isolate individual chemical entities such as ajmalicine, hyoscine and vincristine, which are modern drugs. Thus, standardization of extraction procedures contributes significantly to the final quality of the herbal drug.

Methods of Extraction of Medicinal Plants Maceration

In this process, the whole or coarsely powdered crude drug is placed in a stoppered container with the solvent and allowed to stand at room temperature for a period of at least 3 days with frequent agitation until the soluble matter has dissolved. The mixture then is strained, the marc (the damp solid material) is pressed, and the combined liquids are clarified by filtration or decantation after standing.

Infusion

Fresh infusions are prepared by macerating the crude drug for a short period of time with cold or boiling water. These are dilute solutions of the readily soluble constituents of crude drugs.

Digestion

This is a form of maceration in which gentle heat is used during the process of extraction. It is used when moderately elevated temperature is not objectionable. The solvent efficiency of the menstruum is thereby increased.

Decoction

In this process, the crude drug is boiled in a specified volume of water for a defined time, it is then cooled and strained or filtered. This procedure is suitable for extracting water-soluble, heat stable constituents. This process is typically used in preparation of Ayurvedic extracts called —quathll or —kawathll. The starting ratio of crude drug to water is fixed (e.g. 1:4 or 1:16) the volume is then brought down to onefourth its original volume by boiling during the extraction procedure. Then, the concentrated extract is filtered and used as such or processed further.

Percolation

This is the procedure used most frequently to extract active ingredients in the preparation of tinctures and fluid extracts. A percolator (a narrow, cone-shaped vessel open at both ends) is generally used. The solid ingredients are moistened with an appropriate amount of the specified menstruum and allowed to stand for approximately 4 h in a well closed container, after which the mass is packed and the top of the percolator is closed. Additional menstruum is added to form a shallow layer above the mass, and the mixture is allowed to macerate in the closed percolator for 24 hrs. The outlet of the percolator then is opened and the liquid contained therein is allowed to rip slowly. Additional menstruum is added as required, until the percolate measures about three-quarters of the required volume of the finished product. The marc is then pressed and the expressed liquid is added to the percolate. Sufficient menstruum is added to produce the required volume, and the mixed liquid is clarified by filtration or by standing followed by decanting.

Hot Continuous Extraction (Soxhlet)

In this method, the finely ground crude drug is placed in a porous bag or —thimblell made of strong filter paper, which is placed in chamber E of the Soxhlet apparatus. The extracting solvent in flask A is heated, and its vapours condense in condenser D. The condensed extractant drips into the thimble containing the crude drug, and extracts it by contact. When the level of liquid in chamber E rises to the top of siphon tube C, the liquid contents of chamber E siphon into flask A. This process is continuous and is carried out until a drop of solvent from the siphon tube does not leave residue when evaporated. The advantage of this method, compared to previously described methods, is that large amounts of drug can be extracted with a much smaller quantity of solvent. This effects tremendous economy in terms of time, energy and consequently financial inputs. At small scale, it is employed as a batch process only, but it becomes much more economical and viable when converted into a continuous extraction procedure on medium or large scale.

Lec 29 - Ocimum, Davana and Japanese mint – varieties – soil and climate – propagation = planting – nutrient, water and weed management – harvest, distillation of essential oil OCIMUM

Importance and chemical composition

The 'Sacred basil' or 'Holy basil', Ocimum sanctum Linn. belonging to the family Lamiaceae, is commonly cultivated in gardens. The species is worshipped by the Hindus of India and traditionally grown in courtyards and temples. The leaves of this species, on steam-distillation, yield a bright vellow, volatile oil possessing a pleasant odour characteristic of the plant, with an appreciable note of camphor and cloves. The plant contains mainly phenols, aldehydes, tannin, saponin and fats. The essential oil components are eugenol (about 71%, eugenol methyl ether (20%), nerol caryophyllene, selinene, α-pinene, βpinene, camphorcineole, linalool and carvacrol (3%). A terpeneurobsolic acid possessing anticancer properties has also been isolated. The seeds of this plant give a greenish-yellow fixed oil and also contain antistaphlocoagulase which can be extracted with water and alcohol. The plant is also used as a pot herb. Its leaves are used as a condiment in salads, and other dishes. The leaves, seed and root are medicinally useful. The leaves also contain ascorbic acid (83 mg 100 g) and carotene (2.5 mg/100 g). The juice of the leaves possesses disphoretic, antiperiodic, stimulating, expectorant and antipyretic properties. It is used in catarrh and bronchitis, applied to the skin in ringworm and other cutaneous diseases and as drops to relieve earache. An infusion of the leaves is used as a stomachic in gastric disorders of children. If taken internally, it strengthens the liver and heart and is a good appetizer. It cures amenorrhoea and promotes the secretion of milk in lactating women. The leaves, if chewed, give relief from toothache. The leaf-juice is applied to reduce inflammations. A decoction of the root is given as a disphoretic in malarial fevers. The powdered root, if taken twice daily for seven days cures spermatorrhoea. The seeds are mucilaginous and demulcent and are given in disorders of the genito-urinary system. The seeds rubbed in water are given for irritation coughs, gonorrhea, labour pains and dysentery. The seeds rubbed with cow's milk are given for vomiting and diarrhea. The juice of the fresh leaves, flower-tops and the slender roots are considered to be good antidotes for snakebite and scorpion sting. Tribals (Santals) use the plant in cholera, cough, postnatal complaints, hemorrhagic septicemia and dog bite. The volatile oil is reported to possess antibacterial and insecticidal properties. It inhibits the in vitro growth of Mycobacterium tuberculosis and Micrococcus pyrognes var. aureus. It has marked insecticidal activity against mosquitoes.

Origin and distribution

O. sanctum has wide distributions, covering the entire Indian subcontinent, ascending up to 1,800 m in the Himalayas and as far as the Andaman and Nicobar Islands. This plant-occupies a wide range of habitats.

Area and production

There is no published data on commercial production of *O. sanctum* in India. In Tamil Nadu, the crop is cultivated in about 200 hectares with an estimated production of 15 ton essential oil every year. Description of the plant It is an erect, herebaceous, much-branched softly hairy, biennial or triennial plant, 30-75 cm tall. The leaves are elliptic-oblong, acute or obtuse, entire or serrate, pubescent on both sides, minutely gland dotted: the flowers are purplish or crimson, in racemes, close-whorled: the nutlets are subglobose or broadly ellipsoid, slightly compressed, nearly smooth,pale-brown or reddish with small, black markings.

Types and varieties

In India, two types of *O. sanctum* are under cultivation; the green type (Sri Tulsi) is the most common, the second type (Krishna Tulsi) bears purple leaves and is preferred in the trade for its higher potency of the drug. Many new varieties have been released from RRLs and CIMAP, Lucknow. Among them CIM-Angana, CIM-Soumya are important.

Cultivation

Soil - It thrives well on a variety of soils. Rich loam to poor laterite, saline and alkaline to moderately acidic soils are all well suited for its cultivation. Well-drained soils aid in better vegetative growth. Waterlogged conditions can cause root-rot and result in stunted growth.

Climate - The plant can be grown under partially shaded conditions but it yields less oil. It flourishes well under fairly high rainfall and humid conditions. Long days and high temperatures have been found favourable for the plant growth and oil production. Tropical and subtropical climate (at altitudes up to 900 m) are suited for its cultivation. The plant is moderately tolerant to drought and frost. The nursery can be raised in the third week of February and transplanting is generally started in the middle of April. This can be undertaken in the month of March, if the seedlings are raised in beds.

Land preparation - The land is brought to a fine tilth and laid out into plots of convenient sizes for irrigation. It is preferable to add 15t/ha of FYM during the preparation of the land.

Propagation - The plant is propagated by seeds. The seeds are likely to deteriorate in future generations on account of the highly cross-pollinated nature of the crop. Hence, for fresh plantings, the growers have to take fresh seeds from the pedigree stock.

Nursery raising - Raised seed-beds of 15' x 4'x 9" size should be thoroughly prepared and well manured by the addition of FYM. About 200-300 g seeds are enough to raise seedlings for planting one hectare of land. The seeds should be sown 2 cm deep in the nursery-beds. After sowing the seeds in the nursery, a mixture of FYM and soil is thinly spread over the seeds and irrigated with a sprinkler-hose. The seeds germinate in 8-12 days and the seedlings are ready for transplanting in about 6 weeks time, at the 4-5 leaf stage. A spray of 2% urea solution on the nursery plants 15 to 20 days before transplanting helps in raising very healthy plants for transplanting.

Transplanting - It is recommended to plant the seedlings at a distance of $40 \times 40 \text{ cm}$, $40 \times 50 \text{ cm}$ and $50 \times 30 \text{ cm}$ to get high herbage and oil-yield per hectare at Lucknow, New Delhi and Indore, respectively. The plots are irrigated immediately after transplanting. The seedlings will establish well by the time of the second irrigation. At this stage gap filling and replacement of the poor plants is done so that a uniform stand is achieved.

Fertilizer application - The application of 120 kg/ha, 105 kg/ha of P2O5 and K2O is recommended for saline and alkaline soils at Lucknow. The optimum fertilizer dose recommended for this crop is 120 kg N and 60 kg P2O5/ha. Half the dose of N and the entire dose of P2O5 are given as a basal dose. Whereas, the remaining N is applied in two split doses, after the first and second cuttings. The application of the micronutrients Co and Mn at 50 and 100 ppm concentrations, respectively, is reported to increase the oil-yield significantly.

Irrigation - Irrigation depends upon the moisture content of the soil. In summer, 3 irrigations per month are necessary whereas, during the remaining period, it should be done as and when required, except in the rainy season when no irrigation is necessary. Altogether, about 12-15 irrigations years are sufficient.

Weeding - The first weeding is done one month after planting, and the second 4 weeks after the first. After this, no further weeding is required as the plants become bushy, thereby naturally suppressing the weeds.

Interculture - One hoeing, two months after planting, is sufficient. The crop may also be earthed-up at this stage.

Diseases and pests - **Diseases** - The plant is susceptible to powdery mildew caused by Oidium spp., seedling blight caused by Rhizoctonia solani and roor-rot caused by Rhizoctonia bataticola. Powdery mildew can be controlled by spraying wettable sulphur (4 g/l of water), and the latter two diseases are managed by improved phyto-sanitary measures and by drenching the nursery-beds with a solution of mercurial fungicide. **Pests** - Among the insects, the larvae of leaf-rollers sticking to the under surface of the leaves fold them backwards lengthwise, thus webbing them. Malathion (0.2%) may be sprayed to control this insect.

Harvesting, yield and processing - The crop is harvested when it is in full bloom. The first harvest is obtained 90-95 days after planting. Afterwards, it may be harvested at every 65-75 days, intervals. Harvesting should be done on bright, sunny days in order to obtain good quality oil-yield. It is not desirable to harvest the crop if it has rained the previous day. The crop should be cut 15-20 cm above ground-level. The harvested produce may be allowed to wilt in the field itself for 4-5 hours, to reduce the moisture content and the bulkiness. About 5 t/ha of fresh herbage can be obtained twice or thrice a year. **Distillation of oil -** The harvested produce is usually distilled in its fresh form. However, the oil quality and yield do not diminish up to 6-8 hours after harvest, by any further delay may cause considerable loss in yield and quality of oil. Steam-distillation is found to be superior to water distillation. The whole herb contains 0.1 to 0.23% essential oil. The yield of oil varies with the type, season and place of origin. The oil-yield will be approximately 10-23 kg/ha.

DAVANA

Importance and chemical composition

Davana (*Artemisia pallens*) belongs to the family Asteraceae, is an important aromatic herb. The davana herbs are commonly used in garlands, bouquets and religious offerings in most parts of the year. The leaves and flowers contain the essential oil valued for its exquisite and delicate aroma and is used in high grade perfumes and cosmetics. The oil of davana contains hydrocarbons (20%), esters (65%) and oxygenated compounds (15%). The esters are the major constituents responsible for the characteristic smell of davana. The essential oil of davana which is a brown, viscous liquid with a rich, fruity odour has acquired a considerable reputation in the international trade, particularly in USA and Japan where it is being used for flavoring cakes, pastries, tobacco and beverages. India has the monopoly of production and export of davana oil in the world.

Origin and Distribution

The plant grows wild in the temperate Himalayas. It is common in the Kashmir valley, the Shimla and Nainital Hills. Area and Production Davana is commercially cultivated in Karnataka, Maharastra, Kerala, Tamil Nadu and Andhra Pradesh in area of about 1000 ha. with an annual production of 8 ton davana oil. In Tamil Nadu, it is grown in Dharmapuri, Krishnagirii, Cumbum, Bodi regions.

Description of the Plant

Davana is an aromatic, erect herb, about 60cm tall with much divided leaves and small yellow flowers.

Varieties

PKM 1 (AP 7) - Parentage - Acc. No. AP. 7 is a mass selection from the local type (Chinnamanur). The accession AP. 7 has high herbage (16.78 t/ha) and oil yield (20.32 kg/ha) with medium duration. Foliage distinctly silvery green in colour. Profuse branching from the base of the plant. Highly fragrant in nature. First harvest by 40 days after transplanting. Field tolerance to aphids and damping off Duration — 145 to 150 days. Season- June-July / November-December. Average Yield - 17 t/ha (28 % over Nilakottai local). Highest yield - 17.45 t/ha. Area adoption - Theni, Dindigul, Madurai, Salem, Kanyakumari & Virudhunagar

Cultivation

Soil - The crop is found growing on various types of soils from sandy loam to medium black. However, a fertile, well drained sandy loam soil which is rich in organic matter is ideal.

Climate - Season is an important aspect to be considered when davana is grown for extracting essential oil. The oil content in the plant was maximum when the crop was grown during the winter season compared to the other seasons. Thus, when the crop is grown for the production of oil it should be planted during the first week of November. A few light showers with moderate winter conditions and no frost is conducive to the good growth of the plant. High temperature and heavy rains at the time of flowering have not only been found to affect the plant growth adversely, but also reduces the oil content and ultimately the oil yield.

Nursery raising - Davana is propagated by seeds. As the seeds lose viability rapidly only the seeds from the previous season should be used for sowing. About 1.5kg of seed is required to produce enough seedlings to transplant into an area of one hectare. Usually, nursery beds 2m long and 1m width are preferred. The surface of the beds should be clod free. It is then incorporated with finely prepared FYM at the rate of 10kg per bed. Sowing of seeds at the rate of 1g/sq m is desirable. The seeds may be sown either dry or after wetting them along with sand for about 48 hours. In the latter case, the seeds are thoroughly mixed with sand @ 4-5 times their volume. To this mixture, water is added so that the sand is sufficiently wet. It is then tied in a cloth bag and stored in a warm place for 48 hours. This will hasten the sprouting of seeds and radical will emerge at the end of 48 hours. The nursery bed is then flooded with water to make a pool and the sprouting seed and sand mixture is broadcasted all over the bed, homogeneously. This method helps in uniform distribution of seeds. When the seeds have settled down a thin layer of sand is spread over just enough to cover them. The seeds will germinate within 2-3 days of sowing. Hand watering is done till the seedlings establish themselves (7-10 days) after which the beds are irrigated directly though the water channels. While sowing the dry seeds they are mixed with sand and in the ratio of 1: 10 and broadcasted homogeneously all over the bed. A thin layer of sand is then spread uniformly to cover the seeds and the beds are hand watered twice a day. To prevent the ants from carrying away the seeds an application of 10kg/ha of Heptachlor to the soil about 10 days prior sowing has been helpful. Using this method the germination of seeds is observed in about 4-5 days. In areas where there are rains at the time of nursery raising, the seedlings may be grown on raised nursery beds which will also help in reducing the incidence of damping - off disease. As there is very slow growth of seedlings initially, foliar spray of urea (0.1%) at weekly intervals, 3 weeks after sowing may be given to boost their growth.

Transplanting - The seedling will be ready for transplanting in about 6-8 weeks from the date of sowing. At this stage, the seedlings should be about 10cm tall. Before transplanting the field is thoroughly prepared by bringing the land to a fine tilth with repeated ploughings. It is then laid out into plots of convenient size by laying out bunds and channels. The size of the plot depends on the conditions prevailing locally. However, generally, plots of 3-4 m x 1.5-2.0 m size are preferred as it facilitates irrigation, weeding and other intercultural operations. After the preparation of the plots, the soil is incorporated with 6 t/ha of well decomposed FYM or compost. The plots are irrigated a day prior to transplanting. The seedlings are then transplanted at a spacing of 15 cm between rows and 7.5cm between plants. Trials have shown that transplanting davana plants closer together results in higher herbage yield and subsequently, higher oil yield compared to wider spacing, which results in larger plants but lower herbage and oil yield per unit area.

Manures and Fertilizers - Davana responds well to the application of manures and fertilizers. Well decomposed FYM at the rate of 6t/ha is incorporated in to the soil at the time of land preparation. Subsequently, a fertilizer dose of 40kg P and 40kg K /ha is given at the time of transplanting. The N is applied at the rate of 120kg/ha in three equal split doses. The first dose is given at 10 days after transplanting and the subsequent two doses at 15 days intervals thereafter. Irrigation After transplanting, the plots are immediately provided with light irrigation. Later irrigation is provided daily till the seedlings are well established (10-12 days) and, subsequently once in 3-4 days depending on the weather conditions.

Interculture - The field is kept weed-free by regular weeding as and when required. In all about 2-3 hand weeding during the early period of growth will help to keep the weeds down. Growth regulator application Growth regulators have been used to boost the growth and yield in many crops. In davana also, an application of GA at 200 ppm after fives weeks of transplanting has been found to increase the herb and essential oil yield per unit area.

Pest and Diseases - **Insect pests:** No serious attack of insect pests has been reported in davana. However, some insect pests like leaf eating caterpillars, aphids and termites have been observed to affect the crop. Diseases Damping off. The disease is caused by fungus belonging to the Rhizoctonia spp. It is usually severe at the nursery stage, particularly when there is high humidity and cloudy weather conditions resulting in the heavy mortality of seedlings. Controlling the irrigation will reduce the incidence of the disease. Treating the seeds with Emisan @ 0.2% before sowing and then drenching the seed beds with the above chemicals a week after germination controls the disease.

Harvesting and yield - The crop starts flowering after 110 – 115 days of sowing, which will be around the 2nd or 3rd week of February. In order to obtain the maximum essential oil yield, the plants should be harvested when about 50% of them have come to the flowering stage. This is usually at the end of February or in the 1st week of March, about 120-125 days after sowing. Harvesting is done by cutting the plants from base. Although there are reports about the possibility of obtaining a ratoon crop in davana, it is not practical as the main crop is harvested only during the month of March and the ratoon starts sprouting by the end of March or the beginning of April which, due to the high temperatures prevailing during this period, results in poor growth of the plants and mutilated flower buds which may even fail to open. The crop, thus obtained, becomes uneconomical as the flower heads are the major contributors of oil.

MINT

Importance

Mints are a group of perennial herbaceous plants, belonging to the family Lamiaceae; which yield essential oil on distillation. The various species of mints which are commer¬cially cultivated in different parts of the world are: Japanese mint or corn mint or field mint (*Mentha arvensis*) peppermint (*M. piperita L.*), spearmint or lamb mint (*M. spicata L.*) and bergamot mint or orange mint (*M. citrata Ehrh.*).

Origin and distribution

Mint is believed to have originated in the Mediterranean basin and, from there, spread to the rest of the world by both natural and artifi¬cial means. USA is the major producer of peppermint and spearmint. o Bergamot mint is a native of Europe and has been naturalized in eastern USA. It grows successfully in the temperate and subtropical region of India. In India, Japanese mint is grown mainly in the Terai region, extending to parts of the IndoGangetic Plains and parts of Punjab in North-western India. The total area under mint cultivation, which is mostly confined to Uttar Pradesh and the Punjab, is around 10 000 ha.

Area and production

M. arvensis is cultivated in about one lakh hectares in India predominantly in UP, Terai region and the annual production of menthol from India is 8000 ton.

Description of the Species of Mint

M. arvensis (Japanese mint) is a downy, perennial herb, spreading by root-stocks which creep along the ground or just under the surface and root at the nodes. There are three horticultural varieties in this species.

M. piperita spreads by a system of branching, underground rootstocks and grows to a height of 45 to 90 cm (I.5 to 3 ft).

M. citrata grows up to 30-60 cm height, with decumbent branches and erect ends. The leaves are 1.25-5.0 cm long, thin, bronzy-green, petiolate; smooth. *M. citrata* is a hybrid between *M .aquatica* and *M.viridis*. *M. spicata* propagates by stolons, from which 30-60 cm erect, ascending branches arise. The leaves are sessile, smooth above and glandular below, the apex is acute and up to 6.5 cm long. Another variety of spearmint known as scotch spearmint

M. cardiaca . (S.F. Gray Baker)) is cultivated in the USA to a limited extent.

Varieties

- A) Japanese Mint Himalaya (MAS-I): It is a selection released by the CIMAP Lucknow. The yield of oil is around 290-293 kg/ha. This variety is highly resistant to rust, leaf-spot and powdery mildew diseases. Kalka (Hyb-77): It is a tall, vigorous variety evolved by the CIMAP Lucknow, It is highly resistant to leaf-spot, powdery mildew and rust diseases. Shivalik: It was introduced from China and released by the CIMAP, Lucknow. The plant has a compact, bushy growth with thick, leathery leaves. EC-41911: It is less affected by rain, root ¬rot and aphids and is reported to yield 236.5 g/ha of herbage and 12.2 kg/ha of oil, with a menthol contented 70%. Kosi: A leading high yielding variety and cultivated in maximum acarage.
- **B)** Peppermint Kukrail: This is a high yielding variety developed and released by the CIMAP Lucknow. **C)** Bergamot Mint Kiran: This is a mutant selection developed by the CIMAP, Lucknow. It has a high oil content and quality. Yield 239 kg/ha of oil with 48% linalool.

D) Spearmint MSS-I: This is a selection from the spearmint cultivars introduced from USA. This variety was released by the CIMAP, Lucknow. MSS-5: It is a selection from MSS-1 made at the CIMAP, Lucknow. Punjab spearmint-I: This variety is a clonal selection made at the CIMAP, Lucknow.

Chemical composition and uses

Japanese mint (M. arvensis) Japanese mint is a primary source of menthol. The fresh leaves con-tain 0.4-6.0% oil. The main constituents of the oil are menthol (65-75%), menthane (7-10%) and menthyl acetate (12-15%) and terpenes (pipene, limonene and camphene). The menthol content of the oil varies, depending on the climatic conditions. Generally, it is higher in tropical regions. Menthol is used in the flavouring of a large number of pharma-ceutical and oral preparations like toothpastes, dental creams, confectionery, beverages and other items like tobacco, cigarettes and paan masala. Medicinally, it is an' excellent carminative and gastric stimulant. When applied externally, it acts as a mild analgesic. 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 (9-25%) menthofuran and terpenes like pinene and limonene.

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.

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

Cultivation

Seasons -In the plains, planting is done during the winter months, whereas in temperate climates, planting is done in autumn or spring from the last week of December to the first week of March or from the first week of January to the third week of February. Late planting always gives poor yields. **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.

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 20-25°C promotes vegetative growth, but the essential oil and menthol are reported to increase at a higher temperature of 30°C under Indian conditions. Peppermint and spearmint cannot be grown profitably in tropical and subtropical areas, especially those areas with very high summer temperatures (41°C) 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 sub¬tropical areas. However, the yield is higher in temperate climates.

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.

Propagation - Mints are propagated through the creeping stolons or suckers. In the case of peppermint and bergamot mint, even runners are planted. Stolons are obtained from the previous years planting. A hectare of well-established mint, on an average, provides enough planting material for ten hectares. About 400 kg stolons are required for plant-ing 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.

Fertilizer application - Mint responds very well to a heavy application of nitrogenous fertiliz¬ers. 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 are required for a good crop of mint. However, in *M. arvensis* an increase of up to 160 kg N/ha and, in *M. piperita*, 125 kg N/ha has given increased fresh herbage and essential oil-yield. 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 and 3 months after planting and the third dose after the first harvest of the crop. Boron deficiency reduces both the yield of green herb and the essential oil in peppermint. Increased yields of herb, menthol content and essential oil content in peppermint have been obtained by using a combination of boron and zinc fertilizers.

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 irrigation is required during winter, if the plant is dormant and there are no winter rains to encourage proper growth of the underground stems. **Intercultural and weed control** - 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 give excellent weed control throughout the crop growth. In low temperature areas, the plant becomes dormant in November. In order to give a perennial crop (of 3 years only) in peppermint, replanting is done either in autumn (November-December) or in spring (March-April).

Crop rotation - The following crop rotations are in practice in Uttar Pradesh (a) Mint-maize-potato (b) Mint early paddy and potato and (c) Mint-late paddy and sweet pea. Whereas, in Punjab, the farmers practice mint-maize and rape seed/mustard and mint-maize and 'potato or mint and paddy rotation. The recommendation for the Terai region of Uttar Pradesh is a 2-year rotation of mint-summer fallowing or millet (fodder) followed by mint on poor fertility lands and mint-wheat-paddy and mint on medium-fertile lands.

Pests and diseases

Pests - A large number of insect pests attack mints. Among them, the impor¬tant ones are the leaf-roller, pyralid, the hairy caterpillar and termites. The attack of the hairy caterpillar (Diacrisia obliqua Walk) during the months of April-May causes rapid defoliation. This can be controlled by spraying 5% Dipterex. During the dry months, termite attacks are often observed. These can be effectively con-trolled by the application of 3% Heptafan @ 50 kg/ha to the soil before planting. Other pests

like cut-worm (Aulucophora favicollis) also cause damage to the crop. They can be controlled by spraying Thiodon. Nematodes severely damage the foliage yield of mints. The nematodes can be effectively controlled by the application of neem cake @ 250 kg/ha to the soil.

Diseases - Rust, powdery mildew, wilt, leaf-blight and stolon-rot are the five fungal diseases which have been reported to affect mint to a signifi-cant extent under Indian conditions.

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. 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 and storage 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 latter 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 Japanese mint gives 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 aluminum 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 30 - Citronella, Lemon grass - varieties - soil and climate propagation - planting - nutrient, water and weed management - harvest- distillation of essential oil

Importance and chemical composition

Java Citronella (*Cymbopogon winterianus*) is an aromatic grass belonging family Poaceae, which upon as the steam distillation gives an essential oil known to the trade as the oil of Java citronella. This is used extensively as a source of imported perfumery chemicals like citronellal, citronellol and geraniol, which finds use in soap, toiletries, mosquito repellents, perfumery, cosmetic and flavouring industries throughout the world. Citronella oil is classified in trade into two types, i.e. Ceylon citronella oil obtained from *Cymbopogon nardus* a rather inferior type, while the Java citronella oil obtained from *C. winterianus* is considered a superior type. Java citronella oil has higher alcohol content (90-95%) than the Ceylon type (60-71%). Citronella is used as a starting material for further derivatives.

Origin and distribution

CITRONELLA

- Both the Ceylon and Java types of citronella have probably originated from Managrass of Ceylon, which occurs today in two wild forms: C. nardus var. linnael (typicus) and C. nardus var. confertiflorus.
- The Java citronella which is called Mahapengeri in Ceylon is the result of a selection from the Ceylon citronella.
- It is distributed in tropical and subtropical countries like India, Taiwan, Guatemala, Honduras, Malaysia and Brazil.
- The NBRI, Lucknow introduced citronella into India. Area and Production At present, the world production of citronella oil is approximately 2000- 2500 t, the bulk of which is produced in Taiwan, Guatemala, the Honduras, Malaysia and Brazil. India produces about 120t oil annually. The important states in our country growing this crop are Assam, Gujarat, Jammu, Kashmir, Karnataka, Maharastra, Tamil Nadu, West Bengal and Uttar Pradesh

Varieties

- Jorhat- C2, Java -2, and CIMAP- Bio-13 are the high yielding varieties of this crop for Southern and Eastern India.
- Whereas Manjusha and Mandakini are the varieties released by the CIMAP, Lucknow for the North Indian plains.
- An elite mutant clone of Manjusha M3-8 named 'Manjari' which has been found to possess 50- 90% more oil, high citronellol and low elemol content on an average, over the other varieties. Manjari is an erect growing herb with yellowish green leaves and a dark purple stem.
- It is profuse tillering and rapid growing ability hence produces a high herb yield.

Cultivation

Soil - The plant has been found to grown well under varying soil conditions but sandy loam soil with abundant organic matter is the most suitable. Heavy clay and sandy soils are not conducive to the good growth of this plant. Citronella thrives well in a wide range of soil pH ranging from 5.8 to 8.0. However, a pH of around 6.0 is the most suitable. The plants are reported to grow well at altitudes between 1000-1500m.

Climate - Citronella thrives best under tropical and subtropical conditions. It requires abundant moisture and sunshine for its good growth. However the distribution of rainfall is important rather than the total amount. Well distributed rainfall ranging from 200- 250cm and high atmospheric humidity appears to influence the plant's growth, yield and quality of oil favourably. In areas where the rainfall is low the plant can be grown with supplementary irrigation.

Land Preparation - The land is brought to a fine tilth by ploughing and harrowing and the field is laid out in 6m x 6m size beds, providing irrigation channels. Ridges and furrows are made at 60cm intervals.

Propagation - Citronella flowers profusely in South India at higher altitudes and sporadically in the plains of the North and North – eastern regions. Viable seeds, however, are not formed because of irregularities in meiosis and therefore the species can be propagated only by vegetatively. The slips are taken from healthy, vigorously growing young bushes. The bush is gently dug out and separated into a number of slips and each slip contains 1-3 tillers. The fibrous roots and leaves should be trimmed off the slips before planting. It is observed that one year old clump on an average gives about 50 slips.

Planting - The slips are planted in May- June when they establish well in this region. Late planting, particularly after July, sometimes results in heavy casualty. The slips are planted at a distance of 60cm x 60cm apart. However in areas where the soil is very fertile and the climatic conditions support luxurious growth spacing of 90cm x 90cm may be followed. It is better if the slips are planted on ridges to avoid water –logging. The field should be irrigated immediately after planting, if there are no rains within the next 24 hours.

Manures and Fertilizers - In the red laterite soil of Karnataka and other Southern States where the plant grows through out the year 10t of FYM is applied. A fertilizer dose of 80-120 kg N, 80 kg P2O5 and 40kg K2O is given. Nitrogen is applied in 4 equal split doses, the first about a month after planting and then after each harvest at an interval of about 4 months. The CIMAP, Lucknow, has recommended a spray of 0.5% Fe through ferrous sulphate + Citric acid to check the spread of chlorosis.

Irrigation - Citronella requires sufficient moisture for good growth and yield of leaves. In the areas where the annual rainfall is about 200-250cm, well distributed over the year and humidity is high, supplementary irrigation is not necessary. In the drier months, however, irrigation may be provided and this increases the yield. Under Karnataka conditions about 8-10 irrigations are required in the dry period.

Interculture - Citronella plantations should be kept weed –free. When the plants have established themselves and grown into bushes the problem is not that severe. However in newly established plantations and after each harvest, weeds spring up in the inter-row spaces and weeding is essential.

Pests and Diseases

Pests: Termites, mites and thrips are minor pests occurring in the crop. These are controlled by spraying chlorpyriphos termite control formulation (TC)(5 ml/litre). **Diseases:** Leaf blight caused by Curvularia sp can be controlled by spraying Mancozeb at intervals of 10-15 days. Sheath rot disease caused by Rhizoctonia solani is controlled by spraying Hexaconazole 5% Among the insects termites are reported to cause the most damage to the plants. The termite menace can be controlled by the application of 25kg/ha Aldrin to the soil at the time of planting.

Harvesting, distillation and Yield - The crop is ready for the first harvest after about 9 months of planting. Harvesting is done by using an ordinary sickle at about 20-45 cm above the ground. Under Karnataka conditions, the crop is harvested in the month of March, June and September. The crop flowers during October — November and the flowering stalks should be nipped off to discourage flowering. If the flowering stalks are allowed to grow, the plants will tend to age very soon and their life span may be reduced. Generally the crop once planted yields a profitable income for about 3-4 years and should be replanted after this period. Well maintained plantations may thrive longer. The yield of leaves may range from 15-20t/ha in the first year and 20-25t/ha in the second and third years. The yield of oil obtained during the first year is about 100-150 kg/ha and in subsequent years about 200-250 kg/ha oil may be obtained.

LEMON GRASS

Importance and chemical composition

- Lemon grass (*Cymbopogon flexuosus*), belonging to family Poacea, is the source of lemon grass oil obtained from the leaves and shoots of the plant.
- Lemon grass oil is mainly used in the manufacture of perfumes for soaps, hair oils, scents and medicines. It also has antibacterial properties.
- Ionone prepared from the citral present in lemon grass oil was one of the most important raw materials for the preparation of Vitamin A.
- In addition to its use in perfumery, Ionone is used in certain kinds of confectionary and liquors.
- The oil can be used to improve the flavour of some fish and can be used to flavour wines and sauces. It can be used for headache, tooth aches, baths, and as a diuretic agent for fever.

Origin and distribution

The species is considered to have originated in India. It grows wild in many tropical and subtropical parts of Asia, Africa and America. The plant is grown for its oil in the West Indian Islands and also in Central America, South America, Thailand, Bangladesh, the Comoros Islands, Madagascar and China. Although the oil has been known since very

early times in India, the systematic cultivation and distillation of the grass were started in Kerala only about 90 years ago. At present, it is grown commercially in the Northern district of Travancore and Cochin (Kerala), Assam, Maharashtra and parts of Uttar Pradesh.

Area and production

Traditionally, India has been the largest supplier of lemon grass oil to the world market but has ceased to be so any longer. The crop is under cultivation in India in an area of about 2000ha. The production of oil which was 1800t in 1961 -62 has declined to about 400t at present. The Indian monopoly in the lemon grass trade in the world market has been broken due to the entry of Guatemala and a few other Latin American states including Brazil and Mexico, Puerto Rico, Dominica, and China.

Description, types and varieties of the plant

Lemon grass grows to a height of about 3m. The leaves of the plant are linear, lanceolate, 125cm long and 1.7 cm broad. The plant is spreading, 100 -135 cm tall, slightly hairy.

There are two main types of lemon grass namely,

- 1. The East Indian or true lemon grass (C. flexuosus) and
- 2. The West Indian lemon grass (C. citratus)

The oil obtained by the distillation of the grass of *C. flexuosus* called the East Indian oil, is the genuine oil of commercial importance. It is produced in Kerala and is popularly called the Cochin oil, since it is shipped mainly from the port of Cochin. A small quantity of oil is also obtained from *C. pendulus*, popularly known as North Indian lemon grass or Jammu lemon grass, since it is grown mainly in Jammu and other North Indian States. The West Indian (South American) oil of *C. citratus* is extracted in Indo- China, Madagascar, Guatemala, Brazil, Congo and West Indies. It is found that the East Indian oil produced in South India is readily soluble in alcohol. Both the type have practically the same citral content (75-86%), but the West Indian oil along with citral contains other aldehydes which lower the quantity of the oil. In *C. flexuosus* the red stemmed plant with chocolate to purple coloured stems, yields the genuine oil, while the white stemmed grass does not. Recently a new species *C. khasianus* has been discovered which is important for its geraniol content.

Some lemon grass varieties released for cultivation are given below. Sugandhi (OD-19): It was released from the Aromatic and Medicinal Plant Research Station (AMPRS) Odakkali, Kerala. This variety is red in colour and is adapted to a wide range of soil and climatic conditions. The plant grows from 1- 1.75 m height and with profuse tillering yields 80-199 kg/ha of oil with 80-88% citral under rain-fed conditions. Pragathi: It is a clonal selection from OD-19, evolved at CIMAP, Lucknow. The variety is tall with a dark purple leaf-sheath and is adapted to the North Indian plains and Terai belts of subtropical and tropical climates. The average oil content is 0.63% with 86% being the citral content. Praman: Evolved through clonal selection from *C.pendulus* at the CIMAP, Lucknow, it is a tetraploid plant with a profuse tillering habit. The leaves are erect and medium in size. The variety is reported to yield 227kg/ha/annum of oil with

82% citral content. RRL- 16: It is evolved from *C. pendulus* and released for cultivation from the RRL, Jammu as Jammu lemon grass. The average yield of the herb is 15-20t/ha/annum, giving 100-110 kg of oil. The oil content varies from 0.6 -0.8% with 80% citral content. CKP- 25: It is interspecific hybrid between *C. khasianus* and *C. pendulus*, developed by the RRL, Jammu. The strain gives herb yield of 80-85 t and 350-400 kg/ha/annum of oil. The citral content in the oil ranges from 80-85% In addition to the above, OD-408 from the AMPRS, Odakkali, RRL-39 from RRL, Jammu and Kaveri and Krishna from the CIMAP, Regional Station, Bangalore, have been recently released as high yielding varieties for cultivation. The other varieties under cultivation are SD-68 and GRL

Cultivation

Soil - It flourishes on a wide variety of soils ranging from rich loam to poor laterite. In sandy loam and red soils, it requires good manuring. Calcareous and water logged soils should be avoided as they are unsuitable for its cultivation.

Climate - It requires a warm, humid climate with plenty of sunshine and a rainfall ranging from about 200- 250cm, well distributed over the year. In areas where the rainfall is poor, it can be grown with supplemental irrigations. It grows well at altitudes between 1000 -1200 m.

Propagation - Lemon grass is generally propagated through seeds, vegetative propagation and rooted slips. It is reported that both the seedlings and rooted slips performed equally well, with respect to growth and yield. But due to high cost of transplanting, direct seeding is widely practiced, especially over the plains and the terraced lands in Kerala. For raising the crop by direct seeding a seed rate of 20 to 25 kg/ha is recommended. While sowing, the seeds must be thoroughly mixed with dry river sand in a ratio of 1:3, to ensure the uniform distribution of seeds during storage.

Nursery raising - For raising the seedlings required for planting 1ha of land, a 1000m area is required. The area is well prepared and raised beds of 1 to 1.5m width and convenient length are made. The recommended seed rate is 3 to 4 kg/ha. The seeds are uniformly broadcasted on the beds and are covered with a thin layer of soil, followed by watering at regular intervals. The seeds collected during the month of January – February are usually sown in the nursery during April – May.

Transplanting - The land is prepared by repeated ploughing and harrowing, and beds of 1 to 1.5 m width and convenient length are made with a spacing of 30 to 50 cm between beds. The beds are made along the contour of the land slopes. Three to four leaved, 50 to 70 days old seedlings are planted during the monsoon season (May- June) in Kerala. A spacing of 30cm x 30cm with a plant density of 1,11,000/ha is recommended. A wider spacing of 60cm x 45cm for seedlings and 90 cm x 60 cm for slips has been recommended for fertile, irrigated land under North Indian conditions.

Manures and fertilizers - Lemon grass is an exhaustive crop and it requires 275 kg N, 25 kg P2O5 and 175 kg K2O/ha/annum. In order to promote growth and to obtain a higher oil yield the crop is applied with 2t/ha of compost made from spent grass and 2t/ha of wood ash at the time

of bed formation. In addition, it has to be supplied with chemical fertilizers. Under Odakkali conditions, it was found that an application of 100kg N in 3 to 4 split doses was found to be optimum, though a response up to 200kg was recorded. The response to P and K was found to be erratic. The application of 50kg ha each P2O5 and K2O as a basal dose gave encouraging results in West Bengal. It is recommended to apply 60:45:35 kg/ha N, P2O5 and K2O as a basal dose and 60kg N in 3 to 4 splits/annum as top dressing during the growing season as an optimum dose. Lemon grass is also reported to respond well to the application of copper, iron, calcium and sulphur. It is reported from the CIMAP, Lucknow, that a lower dose of boron (2.5ppm) in combination with chloride salts can be beneficial for the crop.

Interculture - The earthing up of the plant after about 4 months of planting and again after every harvest is beneficial, as the root region of lemon grass has a tendency to grow above the soil. The field is kept stubble free. Generally 2-3 weedings are necessary during the year. Among the herbicides Diuran @ 1.5 kg a.i./ha and Oxyfluorfen @ 1.5 kg a.i./ha are effective for weed control. Intercultivation can be done by a tractor drawn cultivator or a handheld hoe in row planted crops. Under rainfed conditions, burning the dry grass and stubble of the standing crop prior to the onset of monsoon is practiced in Kerala to prevent white ant attack and also to rejuvenate the old clump. Irrigation After planting if there are no rains, the crop should be irrigated every alternate day for about a month. It is recommended that 4 to 6 irrigations are given during the period February to June under North Indian conditions for an optimum yield.

Pests and diseases - Pest infestation is very low for this crop. Several diseases are reported on lemon grass, but none are serious enough to cause major reduction in oil yield. The leaf diseases can be controlled by prophylactic sprays of Dithane M-45 and Dithane Z-78 @ 3 g/l thrice at intervals of 15 days.

Harvesting and yield - The crop is perennial in nature and gives good yields for 5 years. Harvesting is done by cutting the grass 10cm above the ground level. During the first year of planting 3 cuttings are obtained and subsequently, 5-6 cuttings per year are taken subject to weather conditions. The harvesting season begins in May and continues till the end of January. The first harvest is done about 90 days after planting. The interval from sowing to harvest exerts a considerable influence on the yield and the quality of oil. Both immature and over mature grass gives a lower quantity of oil. For the local type of lemon grass, the optimum interval is 40-50 days. The optimum period of harvesting, when grown on hill tops and low lying areas are 60 and 55 days, respectively. Herbage yield 15t/harvest and oil recovery about 0.3 – 0.5% from fresh grass can be expected. The oil is obtained by steam distillation. Oil yield of about 350-400 kg/ha from the second year onwards is considered satisfactory.

Factors influencing the oil -yield: The factors influencing the oil production during distillation are: i) Storage of the plant material ii) Treatment of the material iii) The method of distillation. The cut grass is kept in a dry atmosphere with limited air circulation. The grass when stored in the shade can increase the oil recovery up to 96 hours and storage for a further period will only decrease the oil yields. The essential oils are enclosed in the oil glands, oil sacks and glandular hairs of the plant. Therefore before distillation, the plant material must be cut into small pieces to enable them to directly expose as many oil glands as is practically possible. Once the plant material has been reduced in size it must be distilled immediately. Otherwise, the essential oil being volatile will be lost by evaporation. Dipping the chopped lemon grass in sodium chloride

solution for 24 hr at 1-2 % concentration before distillation has been found to increase the citral content.

Lec. 31. Palmrosa and Vetiver - varieties - soil and climate propagation - planting - nutrient, water and weed management - harvest- distillation of essential oil.

Ornamental palms

Palms are a special group of plants used extensively in landscape gardening, due to their beautiful trunk, leaf colour, shapes, plant structure and growth habits. Palms include about 200 genera and three thousand species. Their roots, trunks (stems), fronds (leaves), flowers and fruits are different and distinct in appearance and structure from others of the plant kingdom. Based on the trunk and its different manifestation, palms can be divided in to four groups viz.,

- 1. Solitary palms- single erect trunk (eg. Cocos, Phoenix, Elaseis)
- 2. Clumping plams- multiple trunks arising from at or just below the ground level (eg. *Areca lustescens*, Raphis)
- 3. Branching plams- branching can occur above ground (eg. *Hyphaene indica*) or below ground (eg. *Nipa fruticans*)
- 4. Trunkless palm- have very much reduced trunk called acaulescent (eg. Phoenix acaulis)

The leaves of the palms called 'fronds' vary in form. They may be grouped into 'fan leaved type' and 'pinnate leaved type' palms.

Use of palms in landscape garden

- 1. Palms are well suited as single specimens in lawn (eg. *Areca triandra*)
- 2. Palms are excellent specimens for avenue planting in the gardens (eg. Roystonea regia)
- 3. They are also suitable for decoration of conservatories, verandahs, stair-cases, for indoor decorations as potted plants.

Hints to grow palms

- 1. Palms can be propagated from seeds or division of clumps (eg. Raphis)
- 2. Palm seeds are to be harvested at fully ripe stage and are to be immediately sown in raised beds having more proportion of sand.
- 3. Depending upon the species, the seeds start geminating from 3 months even continue upto 2 years in certain cases.
- 4. The seedlings may be lifted at first pair of leaf stage and potted off simply in small pots.
- 5. Palms generally refer pot bound condition and thrive even in undersized pots.
- 6. Repotting to the next large sized pots may be done at the stage when the roots increase and fill the pots fully, almost forcing the pots to open or crack.
- 7. Liquid manuring with oil cakes and Ammonium sulphate may be given to the palms once in fifteen days.
- 8. Regular watering especially on alternate days is essential for the palms grown in the pots.
- 9. Potted palms intended for keeping indoors should be acclimatized sufficiently before keeping them indoors, so that they retain their fresh appearance and lusture.

Some attractive palms for the garden

1. Areca triandra: an elegant single trunked palm

- 2. Caryota urens: Toddy palm, produces a long drooping flower spike
- 3. Hyphaene indica: Indian doum palm unique- branching habit.
- 4. Livistona decipiens: Solitary, fan shaped leaves with stout thorns on their leaves.
- 5. Pritchardia pacifica: It has ornamental large broad flabellate plaited leaves, often 10m, broad
- 6. Raphis excelsa: Dwarf-rattan like palms, slender stem and fan shaped leaves, produce large number of suckers.

Lec. 32. Geranium and Rosemary - varieties – soil and climate propagation - planting - nutrient, water and weed management – harvest- distillation of essential oil.





INTRODUCTION

- □ Geranium : Pelargonium graveolens
- □ Common name : Rose scented pelargonium/rose geranium
- □ Family : Geraniaceae
- □ Native : south Africa
- □ Chief constituents of oil are (18%) geraniol & citronellol (25%).
- □ Plant type: Erect, branched shrub, ht up to 1.3m

- Varieties
- □ Clone PG-7 recorded 0.3% essential oil & 2.32 ml oil/plant and has been released under the name KKL-1
- □ IIHR variety sel-8 gives high yield
- □ CIMAP released Hemanti, Bipuli, Kunti
- Soil and climate
- well drained soil rich in organic matter
- pH 5.5 to 8.0 is suitable.
- □ Grows well in 10-33 degrees and opt tem is 20-30 degres c.
- □ An elevation ranging from 1000 2400 m
- □ Annual rainfall of 100 to 150 cm evenly distributed throughout the year is ideal.

- TYPES
- □ 1.algerian/Tunisian
- □ Slender with dark pink flowers
- ☐ Grown in Nilgiris & unsuitable for wet conditions
- □ Yields 50-60% more oil than reunion type
- □ 2.Reunion/bourbon
- ☐ Grown in Nilgiris & Anamalais
- □ Light pink flowers, more suitable for wet conditions
- □ Terminal portion with 6-12 leaves contains more oil than the middle and basal portions

Harvest and distillation

In the year of planting only one harvest can be done at 7 - 8 months and thereafter 3 or 4 harvests can be done in a year.

- □ The tender tip portion with 6 12 nodes constitutes the materials for harvest.
- ☐ The harvested material is withered in shade for two to three hours and distilled.
- □ The essential oil is distributed over the green parts of the plant particularly leaves.

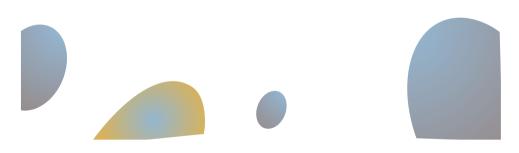
Yield

Herbage : 20 - 25 t/ha Oil yield : 15 - 20 kg/ha

- Drying method
- □ Harvested material are shade dried
- □ Moisture content of herbage must be between 8-10%
- □ Drying requires 3-6 days
- □ Geranium oil extracted by steam distillation
- □ Uses
- □ Geranium oil used in treatment of dysentery, inflammation, cancer & haemorrhoids.
- □ Perfumary, cosmetics and food industry
- □ Leaves are also used in herbal teas



Uses , Propagation ,Planting and Processing of Rose Mary



This is used for,

Perfumery culinary purposes

Climatic and soil requirements

- 1. The climatic conditions prevailing in Nilgiris and the sandy loam soils of Bangalore are found to be suitable.
- 2. It grows well in areas where the rainfall is higher than 500 mm per annum.
- 3. The crop comes well in a pH range of 6.5 to 7.0. Season

Rosemary of rooted seedlings - September - for irritated condition and the month of October, suitable for rainfed crop planting.

Age

Perennial crop. Can be grown commercially until twelve years

Propagation

- Rosemary is propagated by means of seeds, cuttings, layers and division of roots.
- Commercial propagation is through 10-15 cm tender cuttings which are planted in the nursery beds and after about 6-8 weeks they can be transplanted in the main field.

Planting

The rooted cuttings or seedlings are planted in the field at 45X45 cm spacing.

Manures

Application of FYM at 20 t/ha and 20:40:40 kg NPK per ha has to be given prior to application. Then after each harvest, 80 kg n/ha has to be given in 4

Irrigation

When establishing rosemary, it has to be irrigated twice a week. After establishment, it can be irrigated once in a week.

Weed control

The crop requires 5-6 earthing up and weeding during the crop growth. When the crop attains 2-3 years, the bushes are pruned to accelerate the formation of more vegetative shoots to increase the oil yield.

Pest and disease control

Rosemary is vulnerable to spider mites, mealy bugs, Whiteflies and thrips.

Late blight disease has been reported which can be controlled by drenching the plant with Maneb (1%) at 8-10 days interval

Harvest

- 1. The first harvest of leaves begins from 8 months after planting, and subsequent harvests can be done at an interval of 3 to 4 months.
- 2. Annually three to four harvests can be done, and this a perennial crop can be retained for upto twelve years, based on the vigour of the crops.
- 3. Harvest will commence at the time of 50% blooming and continues till 75-90 % inflorescence emergence and must end when the flowers have finished blooming.

Yield

On an average, about 12-15t/ha/annum of herbage oil yield of about 85 to 100 kg/ha/annum can be

Processing

- The leaves are harvested in the soil in order to remove the dust washed fot three times.
- Then dried in the shade. Nilgiris dried up in the 10 to 15 days. The leaves were taken in concrete floor, ventilation caused by the electric fan to dry the leaves.
- In three days, with 10 percent moisture can get good quality leaves.
- For consumption as food to be stored in a Polyethylene bags

Rosemary oil filtration

- After harvesting the stem and leaves of rosemary oil obtained by steam distillation.
- Subjecting to 120 minutes of continuous steam distillation and the number of doses can be more.



Shade drying



Steam distillation



Rose mary oil



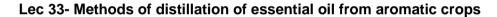
Rosemary herb's medicinal benefits:

- 1. Helps to prevent cancer disease
- 2 Aromatic oil extracted from the highprofile, perfumes

Used in the soap and the perfumery industry.

- 3. For various health problems, including indigestion, the leaf medicine and aromatic herb used.
- 4. Rosemary oil used to calm the mind, used to reduce blood pressure.
- 5. Rosemary Tea made with the leaves of rosemary improves resistance to infection following ingestion.

headache, common cold is making the best remedy.



<u>DISTILLATION OF ESSENTIAL OIL FROM AROMATIC CROPS USING CLEVENGER APPARATUS</u>

Written records of herbal distillation are found as early as the first century A.D., and around 1000 A.D., the noted Arab physician and naturalist Ibn Sina also known as Avicenna described the distillation of rose oil from rose petals The ancient Arabian people began to study the chemical properties of essential oils and developed and refined the distillation process Europeans began producing essential oils in the 12th century.

A process in which a liquid or vapour mixture of two or more substances is separated into its component fractions of desired purity, by the application and removal of heat. In simple terms distillation of aromatic herbs implies vaporizing or liberating the oils from the trichomes / plant cell membranes of the herb in presence of high temperature and moisture and then cooling the vapour mixture to separate out the oil from water. It is the most popular widely used and cost effective method in use today for producing majority of the essential oils throughout the world. Distillation is an art and not just a —Chemical" process that is reliant upon many factors for successful quality oil production.

Extraction of essential oils by distillation is governed by

Sensitivity of the essential oil to the action of heat and water.

Essential oils with high solubility in water and which are susceptible to damage by action of heat cannot be steam distilled.

Volatility of the essential oil

The oil must be steam volatile for steam distillation to be feasible.

Water solubility of the essential oil extraction of essential oils

Most of the essential oils of commerce are steam volatile, reasonably stable to action of heat and practically insoluble in water and hence suitable for processing by steam distillation.

Essential Oil Estimation: The Clevenger Apparatus

Used for estimation of essential oil content in aromatic plants on bench scale and also useful for preliminary quality evaluation of oil quality.

Hydro Diffusion

Unlike traditional steam distillation, hydro diffusion works off the diffusion principle of allowing steam to enter the top of the plant charge and diffuse its through the charge by gravity. The process uses principle of osmotic pressure to diffuse oil from the oil glands. The system is connected and low pressure steam is passed into the plant material from a boiler from the top. The condenser, generally of tubular construction which is directly under the basket within the still, is used for cooling. The oil and water are collected below the condenser in a typical oil separator. It would appear that hydro diffusion is an efficient process to use as it gives good yield of the oil. But due to coextraction of other non volatiles and polar components with the essential oils complicated the process.

Water / Hydro Distillation

Hydro / water distillation is one of the simplest, oldest and primitive process known to man for obtaining essential oils from plants. Mostly used by small scale producers of essential oils. In water / hydro distillation the plant material is almost entirely covered with water as suspension in the still which is placed on a furnace. Water is made to boil and essential oil is carried over to the condenser along with the steam. Useful for distillation of powders of spices and comminute herbs Etc. The Deg Bhabka method of India using copper stills is an example of this technique.

Steam and Water Distillation

To overcome the drawbacks of the water distillation, modifications in techniques was developed. Also sometimes referred as wet steam distillation. The plant material is supported on a cage / perforated grid below which water is boiled. Direct contact of plant material with hot furnace bottom is thus avoided. The water below the grid is heated by open fire which produces saturated and wet steam which rises through the plant material vaporizing the essential oil with it.

Direct Steam Distillation

Also referred sometimes as dry steam distillation Plant material is supported on the grid and saturated steam from outside source ie. Boiler in injected through steam coil. Steam in a field distillation unit is at atmospheric pressure and hence its temperature can be maximum 100oC. But steam in a modern pressure boiler operating at say 40 pounds per square inch pressure will have a temperature correspondingly higher. The use of high pressure steam in modern steam distillation units permits much more rapid and complete distillation of essential oils. Fuel costs

are generally lower in modern steam distillation units due to higher thermal efficiency at which most of the boilers operate.

Parameters effecting yield & quality of essential oil

- **1. Mode of Distillation –** Technique for the distillation should be chosen on basis of oil boiling point and nature of herb as the heat content and temperature of steam can alter the distillation characteristics.
- 2. Proper design of equipment's Improper designing of tank, condenser or separators can lead to loss of oils and high capital investments.
- 3. Material of Construction of equipment's Essential oils which are corrosive in nature should be preferably distilled in stills made of resistant materials like aluminium, copper or stainless steel.
- 4. Condition of Raw material Condition of raw material is important because some materials like roots and seeds will not yield essential oil easily if distilled in their natural state. These materials have to be crushed, powdered or soaked in water to expose their oil.
- 5. Filling of raw material / steam distribution Improper loading of the herb may result in steam channelling causing incomplete distillation
- 6. Operating parameters like steam injection rate inlet pressure/ condensate temperature Proper control of injection rates and pressure in boiler operated units is necessary to optimize the temperature of extraction for maximal yield.