



**B.Sc. Ag  
IV Sem**

**Production Technology for  
Ornamental Crops, MAP and  
Landscaping**

**Credit - 2(1+1)**

**As per ICAR  
5<sup>TH</sup> Dean Syllabus**

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## **Production technology for ornamental crops, MAPs and landscaping**

### **Theory**

- Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping.
- Principles of Landscaping.
- Landscape Uses of Trees, Shrubs and Climbers
- Production Technology of Important Flower Crops major -rose, gladiolus, tuberose, chrysanthemum under Open Conditions.
- Package of practices for loose flowers major marigold, jasmine, gaillardia and spider lilly under open conditions.
- Production Technology of
  - Major Medicinal plants - Aswagandha, isabgol, guggle, and senna
  - Minor Medicinal plants - Asparagus, aloe, periwinkle
  - Major Aromatic plants – Rose
  - Minor Aromatic plants- Mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver.
- Processing and value addition in ornamental crops and MAPs produce.

### **Practical**

- Identification of ornamental plants, seasonal annuals.
- Identification of Medicinal and Aromatic plants.
- Garden adornment and features. Training and pruning of ornamental plants.
- Planning and layout of garden. Special practices of ornamental plants, intercultural operations in flowers and MAPs , harvesting and post harvesting handling of cut and loose flowers.
- Processing of MAPs.
- Visit to commercial flower/MAP unit.

### **Reference Book:**

- Floriculture in India by G. S. Randhawa and Mukhopadyay.
- Introduction to Spices, Plantation crops, Medicinal and Aromatic plants- N. Kumar, Abdul Khader, P. Rangaswami, I. Irulappan.
- Textbook of Floriculture and Landscaping by Anil K. Singh and Anjana Sisodia.
- Handbook of Horticulture by K. L. Chaddha.

# Importance and Scope of Ornamental Crops, Medicinal and Aromatic Plants and Landscaping

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## **Important Definitions:**

**Ornament:** A thing that add to grace or beauty.

**Ornamental:** A plant grown for ornament or beauty.

**Floriculture:** It is an art and science of growing flowers to perfection. It 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.

## **Ornamental Horticulture:**

It is a branch of horticulture that deals not only with the cultivation of flowers but also the decorative foliage plants, trees, shrubs, climbers, creepers, lawn, cacti, succulents, palms, ferns, bonsai and also with their marketing and production of value-added products from them.

## **Commercial Floriculture:**

The floriculture which is based on flower production, which is high value added flowers. When export is done, it is known as commercial floriculture.

## **Cut Flower:**

The flower along with stalk is called as cut flowers. eg. Rose, gerbera, chrysanthemum, gladiolus, tuberose, carnation, anthurium, heliconia, bird of paradise, etc. They generally fetch high market price and are exported in other countries. They are used for flower arrangements, preparation of bouquets, bookies, baskets, on table for show purpose, etc.

## **Loose Flower:**

The flower without stalk is called as loose flowers. eg. Marigold, jasmine, gallardia, spider lily, China aster, etc. They generally fetch less market price and are sold in local market. They are used for preparation of floral gardens, gajaras, venis, floral ornaments & worshipping god.

## **Foliage plants/trees:**

These are those plants/trees whose foliage particularly leaves or branches are so attractive and can also be used as a house plant for indoor decoration as well as for outdoor gardening. Eg. Shrubs: Asparagus, arelea, croton, difenbekia, eranthemum, pothos/money plant, ferns, etc. Trees: Christmas tree, ashopalav, ashoka, casurina, peltophorum, etc.

## **Garden:**

A garden is an area adjunct to the house or any building especially made for the purpose of refreshment and recreation.

## **Landscape:**

A landscape may be defined as any area, either big or small, on which it is possible to mould a view or design with the help of plant material, changing landform, water, stones, etc.

### **Landscape Gardening:**

The application of garden forms, different styles, methods & materials with a view to improving the landscape.

### **Medicinal plants:**

Medicinal plants are those plants rich in secondary metabolites and are potential sources of drugs. These secondary metabolites include alkaloids, glycosides, coumarins, flavanoids, steroids etc. eg. Ashwagandha, guggal, senna, safed musli, etc.

### **Aromatic Plants:**

These plants possess essential oil in them. These essential oils are the odoriferous steam volatile constituents of the aromatic plants. eg. Rose, jasmine, lemongrass, citronella, palmarosa, mint, etc.

### **Importance of Ornamental Crops:**

Besides food and nutritional security, the aesthetic value is also equally important for our daily lively hood as well as for environmental purity. Floriculture is important from the following point of view;

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

#### **1. Economic point of view:**

- Floriculture is a fast emerging major venture in the world, especially as a potential money-spinner for many countries in world.
- Many flowers and ornamental plants are being grown for domestic as well as for export market will provide more return/unit area
- Gestation period of flower crop is very less compared to other crops.
- Now days, flower arrangements/decorations for bouquets preparation and for floral baskets, have increased substantially and its share of the total trade has also improved.
- The present trend in floriculture is for making dry flowers, extraction of natural colours and essential oils.
- There is lot of demand for good quality flower seeds and ornamental planting materials.
- Floriculture generates self employment opportunities round the year. The employment opportunities in the field are varied such as
  - i. One can join the floriculture field as farm/estate managers, plantation experts, supervisors and project coordinators and so on.
  - ii. Teaching, Research and Extension scientists/ teachers are some other avenues of employment in all SAUs.
  - iii. Marketing of Floriculture products for different ventures is emerging as a potential segment of this field.
  - iv. Besides, one can also work as consultant, landscape architect etc with proper training.
  - v. One can also work as entrepreneur and offer employment to others.
  - vi. In addition to these careers which involve research and actual growing of crops.
  - vii. Floriculture also provides service career opportunities which include such jobs like floral designers, grounds keepers, landscape designers, architects and horticultural therapists.

## 2. Aesthetic point of view:

- The wealth of any nation is linked with the health of its people. Unless we can ensure the healthy development of our citizens, especially for the younger generation, by providing them for open breathing places through bio-aesthetic planning like in Chandigarh city and landscape gardening, we cannot expect to build up a healthy society and prosperous nation.
- Horticultural therapy is the new dimension of horticultural sciences to heal the psychic debility and the science is to use garden, landscape plants, as a new occupational therapeutic tool to restore the lost rhythm and harmony back to human
- It is being utilized in psychiatric hospitals, general hospitals and physical rehabilitation centres, 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 where our words fail to express.
- In our society no social function is complete without the use of flowers, floral ornaments, bouquets or flower arrangements they are invariably used in all social functions.
- Used in social gatherings, birthday parties, welcoming friends or relatives and honoring dignitaries. The concept of Valentinesday is fast catching up in India also.
- The arrival of new born is rejoiced with flowers.
- To an Indian, especially for Hindus, flowers have a much greater significance in religions offerings.
- Floral garlands, gajras and venis are required in marriage ceremonies for adornment of hairs by women of all ages, especially in the south India.
- In the present modern era sick are wished for speedy recovery by offering beautiful cut flowers, while the dead are bidden farewell with flowers along with tear of sorrow.
- Flowers are very closely associated with mankind from the dawn of human civilization. There is increasing habit of saying with flowers.
- **“ Any Indians born with flowers live with flowers and finally dies with flowers”.**

## Bio-aesthetic Planning

The term bio-aesthetic planning, a concept of Prof. Lancelot Hogben, means the proper utilization of the available flora and fauna in the beautification of the surroundings.

## Air Pollution

Air pollution, one of the most-talked-about 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 India.

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 a city. The barrier of trees checks noise pollution, dust pollution, and air pollution.

## Human Welfare

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.

### **Scope of Ornamental Crops 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.
- For 100 % EOUs 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 cut flowers.
- The Government of India has identified product specific zones for selective research and development 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.

### **Importance & Scope of Medicinal Plants in India:**

- 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 from the country and abroad opium poppy, sapogenin bearing yams, senna, psyllium husk and seeds, cinchona are in great demand.
- The ancient Indian system of medicine (ISM) is predominantly a plant based material medica making use of most of our native plants. It caters to almost the entire rural population of our country mainly because of the scarcity of modern allopathic health care in our villages.
- 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 no cure. It is well known that most allopathic medicines produce many morbid side effects. For this reason more and more people in the western societies are showing increasing interest and preference for organic drugs and their preparations.
- India has about 2000 species of medicinal plants and a vast geographical area with high production potential and varied agro-climatic conditions. Most of these plants can subsist under stress conditions and are thus suited even for rain fed agriculture. Cultivation of medicinal plants offers considerable scope for rural employment and export for foreign exchange earnings.
- India is already a major exporter of medicinal plants. It is estimated that Rs. 1060 crore worth of raw materials and drugs from medicinal plants are exported from India. It holds monopoly in the production and export of psyllium and senna and is second largest exporter of opium latex.
- Many 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. Rauwolfia, 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.

### **Importance & Scope of Aromatic Plants in India:**

1. Aromatic plants are from a numerically large group of economically important plants. These are in increasing demand for essential oils, aroma chemicals drugs and pharmaceuticals in the world market since two decades. Aromatic compounds are present in plants i.e. in root, wood, bark, foliage, flower, fruit, seed etc.
2. Aromatic plants produce essential oils, perfumes and flavours are in use with our civilization since several thousand years.
3. Due to vast area and varied agro-climatic condition, they can be commercial cultivated in different part of India successfully.
4. Essential oils and aroma chemicals are indispensable in various human activities.
5. They are adjuncts of cosmetics, soaps, pharmaceutical preparation, perfumer confectionery, ice-cream, aerated waters, disinfectants, agarbatti etc.
6. Some of the important aromatic plants like Lemon grass, Citronella, Palmarose, Vetiver, Geranium, Lavender, Dawana etc. have great demand in our country.
7. Historically, India has enjoyed a pre dominant position as the supplier of natural perfumes in the world. This is true in case of sandalwood oil, lemon grass oil, palmarosa oil, vetiver oil and cedar oil.



### **Importance & Scope of Landscaping:**

1. The prime importance of landscape gardening lies in aesthetic developments and modernization of cities, town, countryside, roadways, airports, railway stations, railway lines, bus terminus, city parks, and educational institutions against industrial fast growing pollution. In recent years, bio-aesthetic planning has wider scope in landscape and gardening.
2. Landscape gardening increases the awareness towards nature developed eco-friendly concept and provide feeling of responsibility towards plants, birds and animals.
3. It also serves as a source of live medicines and herbal taste in prepared food and tea.
4. It also helps in soil-moisture retention; prevent erosion, modifying air temperature, creating microclimate and removal of noise and dust pollution.
5. It also provide habitat for birds and animals.
6. One fully developed large tree in a landscape can change the microclimate and brings down the temperature by 2 to 5°C.
7. The average temperature of concrete urban area devoid of vegetation/green belt is higher compare to a thickly vegetated area.
8. Well planned landscape around building or residence adjoins aesthetic value to it as well as affix real estate value of about 30%.
9. The landscaping profession conveys and directs to make human life more elegant, more satisfying, more eco-friendly and more productive.
10. There is unbound scope in the field of landscape gardening with the increase in demand for attractive parks, landscaped ground of schools and institution, pleasant residential backyards, eco-friendly housing society and towns.
11. Landscape flora industry employs thousands of people through various activities like nursery and rental plant services, besides landscape designing.
12. Landscape gardening also plays a vital role in giving emphasis to the tourist business by improving aesthetic and functional uses of historical places, sea beaches, rivers and dams, hill stations and other tourist places.

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## **Principles of Landscaping, Landscape Uses of Trees, Shrubs and Climbers**

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### **Principles of Landscape Gardening:**

There are some principles keep in mind when landscaping the garden. They are mentioned here.

1) **Axis:** - This is an imaginary line in any garden round which the garden created striking balance.

2) **Unity:-** Unity in a garden is very important and will improve the artistic look of the garden. Unity has to be achieved from various angles

It can be achieved by using mass planting and repetition.

3) **Mass effect:-**The use of single plant species in large numbers in one place is done to have mass effect. One should see that such mass arrangements do not become monotonous; the sizes of masses should be varied

4) **Repetition:-** It refers to repeated use of features like plants with identical shape, in form, texture and colour. Eg Hedge, Avenue planting

5) **Focal point:-**A focal point in every garden is a centre of attraction which is generally an architectural feature focused as a point of interest such as statue, fountain, rockery etc. It involves the leading visual observation towards a feature by placement of the feature e.g. center of the garden, corner of the garden.

6) **Space:-**The aim of garden design should be such that the garden should appear larger than its actual size. The aim of every garden design should be such that the garden should appear larger than its actual size. One way of achieving this is to keep vast open spaces, preferably under lawn and restrict the plantings in the periphery, normally avoiding any planting in the centre

7) **Balance:-** It refers to equilibrium or quality of usual attraction,

- Correct positioning of plants and features create well balanced design
- It is used to maintain optimum symmetry in garden.

8) **Rhythm:-** Repetition of the same object at equal distance is called rhythm.

9) **Divisional Lines:-** a landscape design there should not be such hard and fast divisional lines, the necessity of dividing or rather screening a compost pit or mail's quarter or a vegetable garden from the rest of the garden

### **10) Proportion and Scale:-**

- Proportion refers to the size of parts of the design in relation to each other and the design as a whole. Scale refers to the size of an object or objects in relation to the surroundings.

11) **Texture:-** Texture describes the surface quality of an object than can be seen or felt, surface in the landscape includes buildings, walks, ground covers and plants

12) **Time and Light:-** A good planner must roughly take in to account the seasonal movement of the sun shade and light area likely to fall during different parts of the season

### **13) Colour:-**

Colour can be used to direct attraction in the landscape. Three basic colour schemes are

i) Monochromatic ii) Analogous iii) Complementary

### **14) Mobility:-**

- Mobility means gradual changes or sudden change. Garden should be mobile.
- It can be obtained by the arrangement of objects with varying texture, forms or sizes in logical order.

### **15) Garden style:-**

- Garden styles have been changed from time to time with the new ideas and necessities. Styles of garden are Formal, Informal, and Free style or Wild style.

Selection and finalizing the style of the garden is the first step after seeing site, for planning design on paper. Style should be selected on the basis of purpose, types, landform, interest of owner, maintenance capacity, region (urban or rural area), building structure, etc. One has to be creative to evolve one's own style of gardening according to his budget, taste and the nature of the site. There are three basic garden styles given as under:

**Difference between formal and informal garden:**

<b>Formal garden</b>		<b>Informal garden</b>	
1.	More stress on geometrical balance, each thing use very proportionate.	1.	Stress on natural balance by other principle rather than geometrically.
2.	The figure is more important than idea.	2.	The idea is more important than figure.
3.	Even /leveled land.	3.	Un leveled land is preferred.
4.	More importance on straightness.	4.	More importance on curved and round mass.
5.	Balance is symmetrical.	5.	Balance is asymmetrical.
6.	Annual and perennials both have equal importance.	6.	Perennials have more importance.
7.	Design is prepared according to the plan to be used.	7.	Plan is made fit to the landscape.
8.	Highly dominated by rules.	8.	Less dominated by rules.
9.	It is creation of artificial scenery.	9.	Creation of natural scenery.
10.	Small area is required.	10.	Large area is required.
11.	Types: Mughal, Persian, Italian & French garden.	11.	Types: Japanese & English garden.

**General Principles of Garden Design:**

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

## Use of Trees, Shrubs and Climber in the landscape/Garden:

### 1. Trees:

Trees are big, tall perennial plants having very thick and hard distinct stems called as trunk and crown at the top. This single main stem i.e, trunk give rises to many branches bearing leaves and fruits.

- Trees are essential feature of a landscape garden, roadside planting, public parks, along railway line, in school and colleges and in private garden also.
- It provides shade, shelter and makes summer pleasant.
- Bears beautiful flowers and foliage.
- Some trees provide fruits.
- Trees plays important role in controlling pollution in cities and town.
- Some species of trees are used for beautification.
- Delight and refresh the eye with their green foliage.
- Trees are used as avenue e.g .Amaltas, Cassia, Gulmohar, Ashok, Rain tree etc

**e.g. flowering trees:** Gulmohar (*Delonix regia*), Bottle brush (*Callistemon lanceolatus*) Ashoka (*Saraca india*), Pride of India (*Lagerstroemia*), *Spathodea campanulata*, Bahunia, Begonia, Palash (*Butea monosperma*.) *Casia fistula (garmalo)*, etc.

**e.g. foliage trees:** Ashopalav (*Polyalthia longifolia*), Silver oak, *Peltophorum inerme*, Sharu (*Casuriana equisetifolia*), Siris (*Albezia lebbek*), Rain tree (*Samane saman*), Eucalyptus, Vad (*Ficus bengalensis*), Pipal (*Ficus relegiosa*), Rubber tree (*Ficus elastic*), etc.

### 2. Shrubs:

➤ Shrubs are plants with many woody branches arising from the base of the plant and are smaller (1 to 4 m in height) than trees but bigger than herbaceous plants.

- Shrubs are the chief attraction of ornamental garden with their handsome foliage, colorful flowers and attractive berries.
- They are perennial habit and need little care.
- Shrubs are ideally suited for topiary work, formal garden, landscape designing.
- It can be planted as single specimen in lawns or as tub plants.
- Shrubs can also be planted to secure privacy in the garden.
- Shrubs are use as Shrubbery border which is a source of perennial pleaser.
- Some shrubs can be grown along the paths.
- Shrubs can effectively break the monotony of a large open space in the garden

**e.g. flowering shrubs:** Rose, jasmine, hibiscus, ixora, hemelia, lantana, narium, *Tecoma stens*, etc.

**e.g. foliage shrubs:** Croton, duranta, acalypha, aralia, eranthemum, thuja, etc.

### Climbers and Creepers:

➤ Climbers: Climbers are defined as a plant which possesses special structures to climb over a support. These special structures may be hook-hike thorns.

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

#### **Uses of climbers in garden:**

1. Certain climbers are grown in gardens for their attractive foliage. e. g. *Asparagus spregeri*, *Ficus repens*, *Hedera helix*, *Scindapsus aureus*.

2. Some light climbers can be trained as ‘screens’ in gardens. e. g. *Bignonia venusta*, *Jacquemontia violaceae*, *Passiflora edulis*.
  3. Climbers like *Allamanda*, *Antigonon*, *Aristolochia elegans*, *Solanum seafortianum* can be used on arches, bowers and pergolas.
  4. Heavy climbers like *Bougainvillea*, *Quisqualis indica*, *Petrea volubilis*, *Adenocalymma allicea*, *Allamanda cathartica*, *Scindapsus*, *Petrea volubilis* can be trained over strong pergolas or on trees which look very attractive.
- The bare wall of building or boundary wall can be covered beautifully by a colorful climbers or a foliage type of climbers.
  - Climbers can be used for the purpose of screening to maintain privacy from the adjacent houses.
  - The climbers are also grown to be trained on trellis, pergolas, arches, arbours and against pillars or similar structures.
  - Use for climb over net house or conservatories.
  - Climbers are also suitable for roof gardens, where vertical growth is preferred because of lack of space.
  - All over climber if properly used, they serve to brighten and cheer up a place.
- Climbers are very important ornamental plants and are commonly used on walls, arches and pergolas but in cities their utility is increased for the purpose of screening the premises from adjacent houses and maintaining privacy. Bare walls can be most effectively decorated by growing colorful climbers.
- Climbers and Creepers are important group of plants which add beauty, color in striking way of fragrance in gardens and artificial structures like wall, arches, pergola, pillars; topiary, etc. are well decorated with the help of climbers.

SN	Climbers Vs	Creepers
1	They tend to grow vertically.	They tends to spread horizontally along the soil and.
2	They climb on their own .	They required support for climbing.
3	They possess special structures to climb over a support like hook-hike, thorns, tendrils, etc.	Do not posses special structures.
4	Main stem is weak.	Main stem is soft & very weak.
5	eg. Bignonia, Ficus repens, Bougainvillea, etc.	eg. Morning glory, Railway creeper etc.

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# Production Technology of Important Flower Crops under Open Conditions

## ROSE

**B. N.:** *Rosa spp.*

**Family:** Rosaceae

**Origin:** Himalaya region, West Asia, China, Europe and North America.

Rose, the king of flowers, is the most popular flower. With exquisite shape, gorgeous colours, pleasant fragrance and countless varieties, it has gained eminence in the flower trade all over the globe.

No other flower is a better symbol of love, adoration, innocence and other virtues than the rose and not in our time only, but so it has been for thousands of years. It is certainly the best known and most popular of all garden flowers throughout the world and has been growing on this earth for many million years before man himself appeared. Some countries have adopted rose as their national flower. e.g. England. Roses grouped as Hybrid Tea, Floribunda, Polyantha, Climber/Ramblers and Miniature. The HT and Floribunda roses are commercially important as cut flowers.

Dr. B.P. Pal played a significant role in the rose breeding in India, he is known as "Father of Indian Roses".

In Gujarat, Rose is cultivated on 4106 ha. area and having production of 32135 metric tons. The major rose producing districts of Gujarat are Ahmedabad, Vadodara, Bharuch, Kheda, Anand, Surat Navsari and Valsad..

### **Importance and uses:**

1	Shrub or bush	7	Hangers
2	Standard rose	8	Cut flowers
3	Climbers	9	Perfume and allied products
4	Hedges & Edges	10	Rose water
5	Rockery	11	Source of vitamins
6	Pot plant	12	Other value added products

#### **1. Shrub or bush :**

- Shrubs or bush roses, prepared by budding the desired cultivars on a rootstock at a height of 5 – 10 cm from the ground level, are planted in small groups to create excellent mass effect (rosary) in the garden.

#### **2. Standard Rose :**

- Standard roses or tree roses as it is popularly known, is a very important feature in the rose garden.
- According to their height of budding they may be full standards, half standards or weeping standards.

#### **3. Climbers:**

- The climbing & rambling roses can be used to cover the walls of houses or fencing or pergolas, arbours & arches.
- The beautiful climbers & ramblers are American pillar, blaze, Delhi pink pearl, golden showers, royal gold etc.

### Rambler Roses

1. They produce flowers once in a year
2. Produce in clusters
3. Flowers lasting for several weeks
4. Very vigorous
5. Produces heavy crops of small flowers in clusters for several weeks.

### Climber roses

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

#### 4. Hedges & Edges :

- Vigorous floribundas are suitable for hedge.
- Some suitable cultivars are Border Corel, Circus, Frensham & Ramba.
- Climbing or rambling roses may also be used for making tall hedges.
- Rose cultivars like Carolin, Lady reading, Magic, White button, etc. may be used for making edges.

#### 5. Rockery :

- For this purpose hardy miniature & Pompon cultivars such as Fairy Queen & Magic may be selected.

#### 6. Pot plants :

- Rose cultivars like Baby Darling, Cinderella, Starina etc. are quite suitable for this purpose.
- Bush roses may also be grown in pot for beautifying the compounds around the building & for display in rose shows.

#### 7. Hangers :

Miniature roses are grown in hanging baskets, some climbing miniatures like Red Cascade & Yellow Doll are also suitable.

#### 8. Cut flowers:

In the European markets, rose cut flowers are regularly imported to supplement the internal production. Germany is the biggest consumer & importer of cut flowers.

In general, cultivars having long stem with more petals & opening slowly with long lasting quality are chosen as cut flowers.

Christian Dior, Happiness, Gladiator, Queen Elizabeth, Super Star, Illona, Sonia, Red success, Belinda etc.

Indian cultivars are Arjun & Raktagandha.

#### 9. Perfume & Allied products :

Rose oil (Rose perfume) is an important commercial product obtained from rose petals.

Bulgarian rose otto is largely used in perfuming soaps & cosmetics.

The commonly grown rose species for rose oil are *Rosa damascena*, *R. barboniana*, *R. centifolia*, *R. alba* & *R. gallica*.

In India, *R. damascena* & *R. barboniana* are cultivated for rose oil.

Generally, 1 kg oil is obtained from 3000 – 4000 Kg petals.

Among the different sp. of rose *R. damascena* gives max. oil yield.

*R. damascena* → 0.057 – 0.058%

*R. barboniana* → 0.040 – 0.042%

#### 10. Rose water :

It is obtained from petals and used as perfume and in medicines and confectionary.

### 11. Source of vitamins:

Rose hips (fruit of rose) are a very good source of ascorbic acid (Vitamin C). Every 100 g of rose hip syrup contain 150 mg of ascorbic acid.

### 12. Other value added products:

#### Gulkand:

*Rosa damascena*, *R.chinensis*, *R.gallica*, *R.pomifera* & some other scented roses like Edouard rose are used for gulkand.

#### Pankhuri:

Dried rose petals are known as pankhuri, which is occasionally used for preparing sweetened cold drinks

#### Gul-Roghan:

It is rose hair oil prepared from rose petals by effleurage with wet sesamum seeds.

#### Rose petal syrup:

It is prepared with fresh or dried petals by adding sugar to it.

In Europe, roses are also used for making pot-pourri, conserve (gulkand), rose vinegar & rose petal wine.

Jams, jellies & syrup have been made for centuries in Bulgaria & exported.

### Classes of roses:

Hybrid teas	Polyanthas	Cabbage roses	Musk roses
Floribundas	China roses	Moss roses	Noisette roses
Hybrid perpetual	Miniatures	Fresh roses	Rugosus
Teas	Damask roses	Albas	Austrian briars
Grandifloras	Bourbon roses	Ramblers	Local/ <i>Desi</i>

### Important Classes of Rose and their Varieties:

#### 1) Hybrid Tea:

- Originally developed from crossing between Hybrid Perpetuals x Tea roses.
- Most popular rose.
- Bearing large highly centered single flowers.
- 'La France' (1867) – First cultivar of hybrid tea group developed by Guillot.
- Eg. Dr. B.P. Pal, Sungandha, Arjun, Dr. Homi Bhabha, Ganga, Ajanta, Blue moon, Super star, Paradise, Mr. Lincoln, Confidence, John of Kennedy, Golden Giant, First Prize, Happiness, Gladiator, Kiss of Fire, Careless Love, etc.

#### 2) Floribunda:

- Developed in 1924 from the cross between a Hybrid Tea x Polyantha.
- They combined the beautiful forms of the Hybrid Teas with the perpetual flowering habit of the Polyanthas.
- Flowering in clusters with small size and open centre.
- Good for garden display.
- Eg: Wekplapep (2000), Jumpin Jack (1998).
- Eg. Delhi Princes, Rupali, Prema, Banjaran, Mohini, Chandrika, Iceberg, Summersnow, Hemngini, Queen Elizabeth, Golden Raise, Susama, etc.

#### 3) Polyanthas:

- Dwarf with small flowered.
- Polyanthas are the forerunner of Floribundas.
- Blooms for several months.



- Their Ancestry includes crosses of *R. multiflora* and *R. wichuraiana* (Climber) and the Bengal hybrid *R. indica major* (*R. chinensis*).
- Eg: La Paquette (1875), Baby Faurax (1924), Echo (1914).

### Important Varieties:

1	Red colour	:	Passion Red, Lovely red, Gladiator, Grand Gala
2	White colour	:	Prety Girl
3	Yellow colour	:	Gold strick
4	Orange colour	:	Naranga Orange
5	Pink colour	:	Sarika, Nobbles
6	Developed IARI, New Dehli	:	Pusa Mohit, Pusa Abhishek, Pusa Manhar, Pusa Muskan, Pusa Urmil, Pusa Rajana, Pusa Arjun, Pusa Komal. Arjun and Rakhatagandha.

### Climate:

Roses can be grown successfully in different climatic zones. Rose requires cool and dry weather. It can be also grown in hot and humid weather but the incidence of pest and disease more than cool and dry weather. However, temperature, bright sunshine and high light intensity are good for flower production. In the northern plains, roses flower best during winter and spring whereas in temperate hilly regions of the Himalayas, best roses flowers are in summer. In cooler climate, maximum number of flowers is produced in summer months when light intensity is highest. Places like Pune, Nasik, and Sangli in western part of India and Bangalore in Southern India have excellent agro climatic conditions for rose growing.

### Soil:

Although any soil is good for rose cultivation with proper drainage, the ideal soil should be medium loam having sufficient organic matter with pH of 6.0 to 7.5. Heavy clay and saline soil is not suitable for roses.

### Propagation:

- Hybrid Teas and Floribunda : 'T' Budding.
- Polyantha, Miniatures, Climbers : Stem cuttings
- *Desi* Roses : Air Layering or Cuttings.

### Common rootstocks used for budding:

1. *Rosa bourboniana* (Edourad/ Bourbon rose)
2. *R. indica* var. *Odorata*
3. *R multiflora* var. *inermis*

### Methods of planting:

The pit should be dug 60 x 60 x 60 cm deep during summer and expose to sun. Fill the pit with 4-5 kg organic manures. At the time of planting, soil should be neither be too wet nor too dry. While planting, the position of the bud union should be 5.0 to 7.5 cm above the soil level. Immediately after planting, plants are to be watered copiously.

### Planting Distance:

Hybrid Tea Roses	150 x 90, 120 x 120 cm
Floribunda	90 x 60 cm , 90 x 90 cm
Polyantha	90 x 60 cm
Miniatures	60 x 60 cm

### **Manures and Fertilizers:**

- Organic fertilizers are applied two times in a year. 4-5 kg FYM per plant at beginning of Monsoon and another 4-5 kg per plant after completion of monsoon (October).
- Along with manure 250 g/plant castor cake is added around the plant.
- N:P:K @ 200:200:200 Kg/ha.

**Irrigation:** Watering should be done at weekly in normal condition. In winter season 8 to 10 day's interval, while in summer 4 to 5 days interval should be kept.

### **Special practices for rose:**

1. **Hoeing:** Light hoeing is a very effective way to keep the soil porous so that light, air and water may reach the roots better to improve moisture retention capacity and to keep weeds free.
2. **Mulching:** It is another important cultural operation to maintain optimum soil temperature, conserve soil moisture, suppress weed growth and produce more flowers of better quality. Rose beds may be mulched with straw, black polythene.
3. **Pruning:** The rose's bushes are pruned once a year during second or third weeks of October in northern plains. **In Gujarat second week of October is more beneficial.** Pruning is done to facilitate agriculture operation and to get quality of yield.
4. **Disbudding:** Removal of undesired buds is known as disbudding. Keeping only the central bud and removal of others bud increases the flower size.
5. **Pinching:** Removal of part of terminal growing portion of stem is called pinching. This operation was found to reduce the plant height but promote axillary branching, it increases number of flowers.
6. **Bending:** Bending is a major operation necessary to get good quality cut flowers under protected cultivation. It also helps in build-up of strong framework along with good quality flower stem development.

### **Harvesting:**

The rose flowers are cut while still in the bud stage. In foreign market, the size of stem varies from 60-90 cm for large size flowered roses and 40-50 cm for small size flowered roses.

**Yield:** 8 to 10 ton/ha. In hybrid tea rose's 6 to 7 lakh cut flowers/ha.

### **Post-harvest handling of rose:**

Cut flowers are to be graded according to cultivars, stem length, size and form, stage of maturity, condition of flowers and foliage. The flowers with different stem length should not be mixed together and uniform stem length is to be maintained.

**Storage of cut flowers:** Rose cut flowers can be stored dry at 0-1<sup>o</sup> C for 15 days.

**Pulsing:** Pulsing with 2 % sucrose for 3 hrs at 20<sup>o</sup> C and Silver Nitrate solution 10-20 min increase shelf life and quality of cut flowers.

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## GLADIOLUS

**B.N.:** *Gladiolus grandiflorus*

**Family:** Iridaceae

**Origin:** South Africa

### **Introduction:**

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

### **Importance and Uses:**

- Gladiolus is an important florist crop, most popular as cut flower in the domestic and International market.
- In Netherlands, it ranks next only to tulip in commercial importance
- It is relatively easy to grow and also suitable for bedding and exhibition.
- The fascinating spikes bear a large number of florets which exhibit varying sizes and forms; with smooth, ruffled, deeply crinkled or lacinated tepals.
- The flower spikes are used in flower arrangements, in bouquets and for indoor decoration.

### **Floral Biology:**

- Inflorescence is simple spike consisting of 10-25 florets all facing one side arranged in rows.
- Gladiolus is cross pollinated crop.

### **Varieties**

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

### **Important Varieties:**

1. Developed at IARI, New Delhi: Agni Rekha, Mayur, Suchitra, Pusa Suhagin, Sanjeevani, Dhanwantari, Noopur, Neelkanth, Pusa Hybrid 1, Pusa Hybrid 2, HD87-77-07, Sagar, Shakti, Shweta, Sarong, Bindiya.
2. Developed at IHR, Bangalore: Mera, Nazrana, Poonam, Sapna, Aarti, Apsara, Amar, Arka Naveen, Arka Kesar, Shobha.

### **Climatic requirement:**

- Gladioli require full exposure to sunlight for better crop, otherwise blasting may occur or plants may remain blind.
- The long day conditions of 12 to 14 h photoperiod increase number of florets, spike length and percentage of flowering.
- Low light intensity causes failure in flowering.

- High light intensity without proper temperature also affects growth adversely.
- Corm storage at 3 to 7°C is good for better growth and flower production.

**Soil requirement:**

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

**Propagation:**

**(i) Through Corms**

- Propagation of gladiolus through corms is a commercially used method.
- A single corm produces on an average of 1 to 3 flowers along with daughter corms in a season depending upon its size and the variety.
- 10-50 cormels can be obtained from a single corm.

**(ii) Through Cormels**

- Cormels from corms are used as planting material.
- The multiplication of gladiolus through cormels is an inexpensive and rapid method which enables build up of large stocks with minimum cost.
- The cormels also tend to escape diseases of viruses even if the parent corm is infected.

**Planting of corms:**

- Gladiolus corms which are healthy, disease free with diameter of 4 to 5 cm are selected and planted at the spacing of 30 x 20 cm or 40 x 20 cm on ridges and furrows during September.
- Shallow planting of corms i.e. at the depth of 5 to 10 cm is essential. Deep planting will result into poor production of cormels and also cause decaying of corms.
- The depth of planting depends more on the size of the planting materials. The medium and smaller sized corms are generally planted up to 7 cm deep while large or jumbo corms to a depth up to 15 cm.
- Only the non-dormant corms should be planted.
- The emergence of root buds at the base of the corms shows that the corms are ready for planting.
- The corms should be suitably treated with fungicides before planting.
- When planting, the lower portion of the corm should be placed on the soil such that the bud at the top lies straight above.
- It is done to make sure that the stem grows erect and does not show crooked growth.
- At planting time, the soil should contain sufficient moisture to facilitate uniform sprouting of corms.
- Planting is carried out during Sept.-October in plains and March-April in hills.
- The row to row distance is normally 30 to 40 cm while plant-to-plant is 20 cm.
- A corm with 4.5 cm diameter and weighing 20-30 gm is usually preferred for plantation thus 1 kg = 50 corms - 1,60,000 corms per ha or 3200 kg per ha.

**Nutrition:**

- FYM is mixed thoroughly in the soil while preparing in the field for planting corms @ 20 tones.
- 200 kg N + 200 kg P<sub>2</sub>O<sub>5</sub> + 200 kg K<sub>2</sub>O is applied for one ha.

- FYM -  $P_2O_5 + K_2O$  is added at the time of preparation of field while nitrogen is given in 2 splits doses i.e. first dose at 4-6 leaf stage and second at earthing up stage i.e. 6-8 weeks after planting.
- Gladiolus can be damaged by fluorine and phosphatic fertilizers containing fluorine & should not be used.

#### **Irrigation:**

- Gladiolus requires water in plenty but does not grow well under water-logged conditions.
- Frequency of irrigation depends upon the soil type, weather conditions and rainfall.
- Normally in sandy soils, the crop should be irrigated at 7-10 day intervals, whereas in heavy soils, at less frequent intervals.
- Irrigation should be withheld at least 4-6 weeks before lifting of corms.

#### **Harvesting of Spikes:**

- Gladiolus takes 60-120 days to produce spikes.
- Spikes of gladiolus are harvested when the first 5-6 flower buds show the colour and the first flower bud is ready to open the next day.
- Spike should be harvested by giving slant cut to the stalk.
- While harvesting, at least four basal leaves should be retained on the plant to ensure proper development of corms and cormels.
- The spikes should be harvested in the morning or evening hours when temperatures are mild.
- Spikes should preferably be cut with sharp knives or secateurs.
- The stage at which the spike is to be cut should depend upon the transportation distance.
- The spikes of gladiolus generally exhibit vase life of about 7-15 days.
- The spike should be placed in vertical direction only and not be placed horizontally during storage or transportation due to **negative geo-tropism** i.e tip portion of spike have the tendency to curve or bend down against the gravity (will move in upward direction) which will fetch fewer prices in market. It happens due to lateral downward movement of auxin (IAA) and its accumulation on the lower portion of the spike.

#### **Harvesting and Storage of Corms:**

- After harvesting of flowers or spike the plants with leaves are allowed to remain in the soil and irrigation is withheld (stopped). After drying of leaves (i.e. 3-4 weeks) the corms and comlets are-takenout. The corms are allowed to dry in a open and airy situation for a week. Then after cutting its leaves they are treated with 0.2 % Bavistin for 30 minutes and stored in cold storage or Airy room.
- It generally takes 6-8 weeks after harvesting of spikes for the corms to become mature and ready for lifting.
- Plant growth stops at this stage.
- Irrigations should normally be withheld at least 2-3 weeks before harvesting of corms.
- In India, lifting of corms is carried out manually with small garden forks or 'khourpas'.
- After lifting the corms from the soil, the upper leafy portions should be removed by twisting and breaking the stalk.
- The old withering mother corms attached to the bottom of the newly-formed corms should also be removed similarly with the thumb.
- The cormels should also be separated simultaneously and handled separately.

- The corms usually get damaged or bruised during harvesting and cleaning operations.
- Corms are then packed in crates or in net bags and cold-stored at 3-7°C.
- From cold storage, these corms should be taken out one month prior to planting and kept at ambient conditions at an aerated place.
- The corms or cormels of different cultivars must be handled separately and labeling properly so that they do not get mixed up.
- Before planting, these are once again dipped for one hour in 0.3% Captan solution.

**Yield of Spike & Corms:**2.0 - 3.0 lakh spikes/ha and 20,000 kg corms/ha.

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## TUBEROSE

(*Gulchhadi, Rajnigandha, Nishigandha*)

**B.N.:** *Polianthes tuberosa* L.

**Family:** Amaryllidaceae

**Origin:** Mexico

### **Introduction:**

- Tuberose (*Polianthes tuberosa* L.), belonging to the family *Amaryllidaceae*
- It is essentially a florist's flower and one of the leading commercial crops because of its multifarious uses.
- The predominant characteristics of this crop are its lingering, delightful fragrance and excellent keeping quality.
- It has a great economic potential for cut flowers trade and essential oil industry.
- Due to great demand it is being cultivated in most part of the tropical and subtropical countries.

### **Important and Uses:**

- The flowers remain fresh for pretty long time and stands long distance transport.
- They are used for making artistic garlands, floral ornaments, bouquets and buttonholes.
- The long flower spikes are excellent cut flowers for table decoration.
- The variegated ones with beautiful golden stripes on foliage margins are very attractive and suitable for garden display.
- The fleshy, white, tubular flowers emit a strong odour and hence are cultivated on a large scale in some parts of the world for the extraction of highly valued natural flower oil, the tuberose oil.
- The tuberose oil contains methyl benzoate, methyl anthranilate, benzyl alcohol, benzyl benzoate, butyric acid, phenyl acetic acid, methyl salicylate, eugenol, geraniol, nerol both free and as acetates, farnesol, methyl vanillin and piperomel.
- The leaves, flowers, bulbs and roots are reported to contain sterols, triterpenes, carbohydrates, saponins and traces of alkaloids.
- The tuberose flower oil of commerce is one of the most sought after and expensive raw materials in perfumery.
- The fresh flowers give a concrete yield of 0.08 to 0.11 %, of which nearly 18 to 23% constitutes the alcohol-soluble 'absolute'.
- The essential oil is used in only the highest grade perfumes. Sometimes, the oil is used in flavouring candy, beverages and baked food.

### **Description of Commercial Cultivars:**

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

#### **(i) Single flowered tuberose:**

- Ex., Rajat Rekha, Calcutta Single, Shringar, Single Mexican, Prajwal etc.,
- Cultivars having flowers with one row of corolla segments.
- Flowers are extensively used for essential oil extraction and also for loose flowers.
- Single types are more fragrant than double.
- Its floral buds are greenish white and flowers are pure white with only one row of corolla segment.
- Concrete content has been observed to be 0.08 to 0.11 per cent.
- Loose flowers are used for making floral ornaments.



**(ii) Semi double flowered tuberose:**

- Variety: Vaibhav
- Flowers with 2-3 rows of corolla segments on straight spikes used for cut flowers also

**(iii) Double flowered tuberose:**

- Varieties: Swarna Rekha, Suvasini
- Flowers with more than three rows of corolla segments on long and sturdy spikes used as cut flower as well as loose flower and for extraction of essential oil.
- Concrete recovery has been found to be 0.06%.
- Flower colour white and also tinged with pinkish red.
- The double type of tuberose is previously known as pearl.
- It does not open well and is not commercially viable as the single cultivar.

**Soil:**

- Tuberose can be grown on wide variety of soils from light, sandy loam to a clay loam.
- The soil should be at least 45 cm deep, well drained, friable, rich in organic matter and nutrients with plenty of moisture in it.
- The soil should have a pH range from 6.5 to 7.5 with good aeration.
- The crop can be grown even in high saline-alkaline soils with better agronomical practices.
- It is observed that the vegetative growth and flowering are affected by increasing the levels of NaCl and very a low concentration of CaCl<sub>2</sub>.

**Climate:**

- The crop is best suited for cultivation in tropical to subtropical and temperate climates.
- The crop is reported to flower profusely throughout the year, if the climate is mild and free from extremes of high and low temperature.
- A temperature range from 20-30°C is considered ideal for this crop.
- If the temperature is above 40°C, the spike length and quality of the flowers are affected.
- Very low temperature and frost will damage the plants and flowers.
- Tuberoses grow well in a sunny situation.
- Although the plant is photosensitive, exposure to a day-length of about 16 hours appreciably promotes vegetative growth and enhances the emergence of the first flower-spike by 10 days.
- The length of the flower-spike also increases under long days.

**Season of Planting:**

- Tuberoses are generally planted in Feb-March in the plains and April-May in the hills.
- The bulbs can also be planted during July-August.
- Tuberoses can be planted all year round in Bangalore, but a higher flower-yield is obtained from the April-May planting.
- To obtain flowers almost throughout the year, sequential planting can be practiced.

**Land Preparation:**

- The land is ploughed deep, twice, to a depth of 45 cm.
- The first ploughing is done in January and the second about a month before planting.
- At 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.

**Propagation:**

- Tuberoses are propagated by bulbs, bulblets and seeds.
- Multiplication by bulb-segments and *in vitro* micro propagation from scale stem-sections is also possible.
- Propagation by bulbs is the most common method practiced for the commercial multiplication of tuberoses.
- The bulbs remain dormant during the winter 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.
- Ethylene chlorohydrins can also be used for breaking the dormancy.
- The bulbs are separated from the clumps by rubbing off the loose scales and the long roots should also be removed.
- Spindle-shaped bulbs with a diameter of 2.6 to 3 cm size are used for planting.
- However, if the bulbs are very large they may be cut into 2-3 vertical sections, each containing a bud and part of the basal plate.
- Each of these sections is treated with copper fungicide and planted vertically with their tips just showing above the surface.
- About 8 to 9 tons of bulbs are required to plant an area of one hectare.

**Planting:**

- The density of planting markedly influences the yield and quality of the flowers.
- The planting distance varies with the soil and climatic conditions.
- About 1, 00,000 to 2, 00,000 bulbs are required for planting one hectare of land.
- A spacing of 15 x 20 cm (MH), 25 x 25 cm (WB), 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.
- The plots are irrigated immediately after planting.

**Fertilizer Application:**

- 100 kg N, 60 kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O /ha is recommended for tuberose production.
- 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.

**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.
- 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 2.5 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 or single flowers are harvested as they open by day; the picking of individual flowers should be completed by 8.00 a.m.
- The flowers have a shelf-life of 3 days.
- Flowers yield up to 17-18 t/ha can be expected from a well-maintained crop.

### **Handling and Packing of Flowers**

- Loose flowers are transported in poly bags to the nearby whole sale market.
- The flower spikes are graded according to spike length, length of the flowering zone and quality of individual flowers
- Bunched in round bundles each having about 50-100 spikes
- To avoid damage of the flowers and buds, the whole bundle may be wrapped with soft, white tissue paper or polythene.
- Bundles have to be packed in card- board boxes for long distance transportation.

### **Storage of Flowers**

- The fresh flowers can be stored at 10°C.

### **Lifting, Curing and Storage of Bulbs:**

- Bulbs reach maturity at the cessation of flowering when the leaves become yellow and dry during winter (February-March) in North India.
- At this stage, irrigation is withheld and the soil is allowed to dry.
- The leaves are cut off at the ground level and the bulbs are dug out.
- After digging, the bulbs are lifted out and the adhering earth shaken off neatly and thoroughly.
- The offsets are then separated out by hand, which are used as seed-stock for the next season.
- The bulbs are the graded based on the size into mature (> 1.5 cm diameter) and immature (< 1.5 cm diameter).
- Cleaned and graded bulbs are placed on sheaves to dry or cure.
- To hasten curing, artificial heat of 27o to 35o C may be applied.
- The bulbs must be stirred or have their position changed every few days to prevent fungal attack and rotting.

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## CHRYSANTHEMUM

(*Guldaudi, Sevanti, Bijlee*)

**B.N.:** Annual: *Chrysanthemum morifolium*, **Perennial:** *Dendranthema grandiflora*.

**Family:** Asteraceae

**Origin:** Europe & Asia

### **Introduction:**

- Chrysanthemum is a popular commercial flower crop of the many countries.
- It is next only to rose in value of flower trade in the world market.
- The word *Chryso* means 'golden' and *anthos* means 'flower'.
- It is commonly known as 'Queen of East/ autumn queen/ guldaudi'.
- National Flower of Japan.
- Chrysanthemum has earned tremendous popularity as an ornamental flower. Economically it is on second position after rose.

### **Importance and uses:**

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

### **Classification:**

- The species of the genus *Chrysanthemum* are annual, perennial herbs, sometimes partly woody.
  - Based on the size, shape of flower, arrangements of florets and purpose used, the chrysanthemums are classified into several groups.
    - i) Small flowered types.
    - ii) Large flowered types
    - iii) Classification based on plant growth
    - iv) Based on usage.
- i) Small flowered:** 1. Singles, 2. Anemones, 3. Korean single, 4. Korean double, 5. Spoon, 6. Decorative, 7. Quilled, 8. Button and 9. Pompon.

**ii) Large flowered types:** 1. Incurved regular, 2. Incurve irregular, 3. Refluxed, 4. Intermediate, 5. Spider, 6. Quill, 7. Exhibition and 8. Ball type.

**iii) Classification based on plant growth:**

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

**iv) Based on usage.**

1. Cut flowers :
2. Loose flowers
3. Potted/bed plants

**Varieties:** Two categories depending upon the purpose for which they are used.

1. Garland purpose: Baggi, Basanti, Shanti, Indira, Rakhi, Red Gold, Birbal Sahani, Sharad Mala, Meera, Jaya, etc.
2. Cut flower (standard/spray): Apsara, Birbal Sahani, Jayanti, Jubilee, Kundan, Purnima, Nanako, Roti etc.

**Climate:**

Sufficient light and moderate temperature is required. Long day and short night condition for vegetative growth. Short day and long night for reproductive growth.

**Soil:**

A well drained, sandy loam soil of good texture and aeration, with a neutral or slightly acidic pH (6.5- 7.0) and a high organic content is ideal. Very light soil is not recommended owing to their poor moisture holding properties.

**Propagation:**

Chrysanthemum is propagated by seed, cuttings and suckers. To get true to type it is mostly propagated by cuttings and suckers. Commercial method is terminal cuttings.

**Planting:**

Seedlings are ready to transplant within 21 to 30 days. According to spreading habit 30 x 30 cm, 45 x 45 cm, 60 x 45 cm distance is desirable. October- November is ideal time for planting.

**Manures and Fertilizers:**

SN	Time of application	FYM (t/ha)	N (kg/ha)	P (kg/ha)	K (kg/ha)
1	Basal dose	20-25	37.5	100	100
2	30 DAP	--	18.75	--	--
3	60 DAP	--	18.75		
	<b>Total</b>		<b>75.00</b>	<b>100</b>	<b>100</b>

**Irrigation:** Water logging condition should be avoided during rainy season. In winter season 7 to 10 day's interval, while in summer 3 to 5 days interval irrigation should be supplied.

**Aftercare:**

**(1) Staking:** Staking is necessary to keep plants erect and maintain proper shape of plants and bloom. Seasonal type cultivar does not require staking. Number of stakes to be used for a plant depends upon the grower. It will increase the quality of flowers.

**(2) Pinching:** If chrysanthemums are left on their own for growth after planting, the growth is mostly upward with very little branching. Plants are become erect with few flowers. Pinching is done with thumb and forefinger, knives and scissor can also be used. 3 to 5 cm top portion is pinched at 45 days after planting.

**(3) Disbudding and dis-shooting:** These operations are mostly performed for large flowered and decorative chrysanthemums. For taking 3 blooms/plant, first pinching is done. Three lateral strong shoots are allowed to grow and others are removed. For taking one bloom/plant no pinching is done. Only main stem is allowed to grow. Disbudding and dis-shooting of undesirable lateral buds and shoots are done as in the above mentioned case of 3 bloom types.

**Harvesting:** Sold as potted plants, cut flowers, and loose flowers. There is no specific period of harvesting. Fully opened flowers are harvested early in the morning or at evening. For cut flowers it should be harvested before opening of bud and packed in packing material like, newspaper, craft paper, tissue paper etc.

**Yield:** Seasonal type -- 22 to 25 t/ha.

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# Package of practices for loose flowers under open conditions

## MARIGOLD

(Galgota, Hazarigal)

**B. N.:** *Tagetes spp.*

**Family:** Asteraceae

**Origin:** It is native of central and Southern America, especially Mexico.

### **Introduction:**

Because of their ease in cultivation, wide adaptability to varying soil and climatic condition, longer duration of flowering and attractive colour of flowers with good keeping quality, the marigolds have become one of the most popular flowers in our country. African marigold represents vulgar mind and French marigold is a symbol of jealousy. Marigold is known as friendship flower in USA. Xanthophylls are the major carotenoid fraction responsible for yellow colour in the flower petals.

### **Uses:**

- Loose flower for garland and worship
- Garden display
- As a cut flowers
- Pot plant
- Mixed border and beds
- Leaf extract is good remedy of ear ache.
- Flower extract- as blood purifier, cure for piles, eye disease and ulcers.
- The essential oil from flower is used in perfumery industry.

**Types and varieties:** There are two common types of marigold.

- (1) The African marigold – *Tagetes erecta* – Tall type.
- (2) The French marigold -- *Tagetes patula*—Dwarf type.

SN	African marigold	French marigold
1	B. N. <i>Tagetes erecta</i>	B.N. <i>Tagetes patula</i>
2	Tall marigold type.	Dwarf marigold type.
3	60 to 90 cm plant height.	25 to 30 cm plant height
4	Large double globular flowers of lemon yellow, orange, primrose or bright yellow colours.	Single or double flowers with colour of yellow, orange, Golden yellow, primrose.
5.	Big size flowers.	Small size flowers.
6.	Plant spacing: 45 x 45 to 60 cm.	Plant spacing: 30 x 30 cm.
7.	Varieties: Pusa Basanti Gaiinda, Pusa Narangi Gaiinda, Giant Double African Orange & Yellow, Golden Jubilee, Golden Age, Golden Climax, etc.	Varieties: Rusty red, Red brocade, Butter Scotch, Nugget, Cupid Yellow, Orange flame, Petite, Fiesta, Goldie, Harmony, etc.
8.	High yield: Produces either 50 flowers or 800g of flowers by weight/plant.	Low yield: Produces either 100 flowers or 200g flowers per plant.

### **Inter-specific hybrids:**

- The inter-specific hybrids between African marigold and French marigold have been produced in the USA which is intermediate in characters.
- These hybrids are early flowering, medium in height, grow about 60 cm tall.



- Plants are bushy and produce double flowers with delightful colour combination of red and gold and hence they are called ‘Red and Gold Hybrids’.

**Soil:** French type marigold requires light soil, while African type marigold requires heavy black.

**Climate:** Almost all season except heavy cold, susceptible to frost. October month is best for planting. Marigold requires mild climate of luxuriant growth and profuse flowering.

**Panting:** 1.0 to 1.5 kg/ha seeds needed.

- Seeds are sown in raised bed, at the time of transplanting: they should be stocky and bear 3-4 true leaves.
- Thin and long seedlings do not make good plant.
- Very old seedlings are also not desirable.
- Transplanted in well prepared land and soil is pressed around root zone to avoid air pockets.
- Light irrigation is given after transplanting.

Time of seed sowing	Time of transplanting	Flowering time
Sept- Oct.	October- November	Winter
Jan- Feb	February – March	Summer
June – July	July - August	Rainy

**Fertilizer:**

- 20 t/ha FYM, 200- 100- 100 kg NPK/ha.
- Full dose of P and K and Half dose of N are applied at the time of transplanting.
- Remaining 100 kg/ha N is applied one month after transplanting.

**Irrigation:**

- Marigold takes 55-60 days to complete vegetative growth.
- At all stages of vegetative growth and during flower production, sufficient moisture in the soil essential
- Lighter soil required more frequent irrigation than heavy soil
- Summer- irrigation is given at 4-5 days interval.

**Pinching:**

- To make the plant bushy and compact and quality and high flower yield.
- In tall cultivars of *Tagets erecta*, development of axillary branches and flower production are influence by the presence of apical dominance and grow upward to their final height and produce terminal flower bud and after that the axillary branches develop which also bear flower.
- 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 whereas, late pinching at 50-60 days proved to be less effective.

**Harvesting:**

- Fully opened flowers are harvested early in the morning.
- Field should be irrigated before plucking so that flowers can be kept well for longer time.
- Regular plucking is important for increasing productivity.
- Flowers are collected in polythene bags or bamboo basket for carrying to the market.

**Yield:** 11 to 18 t/ha in African and 8 to 12 t/ha in French marigold, respectively.

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## JASMINE

**Botanical Name:** *Jasminum spp.*: Three important species are as below.

**Family:** Oleaceae.

**Origin:** Tropical Asia.

### **Introduction, Importance & Uses:**

- About 200 species of jasmine are found in temperate, tropical, and sub tropical region of the world.
- The jasmine is highly prized for their fragrant flowers which are used for the preparation of perfumes.
- They are commercially grown in our country for the extraction of the essential oil for perfumes, loose flowers which are used for making garland and veni.
- Tamil Nadu is the leading producer of our country.
- Jasmine is one of the oldest fragrant flowers cultivated by man.
- The world famous Jasmine oil is extracted from the flowers of Spanish jasmine (*Jasminum grandiflorum*).
- The Grass region of France supplies the best quality jasmine perfume in the world.
- The flower of Arabian Jasmine- *Jasminum sambac* (Mogra) are reported to be used in China for flavouring tea.

### **Varieties:**

- 1) *Jasminum sambac* (Mogra): Arka Aradhana, Single Mogra, Double Mogra, Gundumalli, Soojimalli, Kasthurimalli, Madanban, Ramabanam, Khoya and Ramanathapuram.
- 2) *Jasminum grandiflorum* (Chameli): Arka Surabhi, CO-1 Pitchi, CO-2 Pitchi, Pin type, Thrum type, J.G.1 (Bangalore), J.G.2 (Coimbatore), J.G.3 (Lucknow), J.G.4 (Tenkasi white), J.G.5 (Thimmapuram), J.G.6 (Triploid), Surabhi.
- 3) *Jasminum auriculatum* (Jojee): CO-1 Mullai, CO-2 Mullai, Parimullai, Long point, Long round.

**Climate:** Mild tropical climate for proper growth and flowering. Mild winter, warm summer, moderate rainfall and sunny days are ideal.

**Soil:** Medium to sandy soil with sufficient amount of organic matter and assured supply of water for high yield. In clayey soil yield is reduced.

### **Propagation:**

- The jasmines are commonly propagated through hardwood & semi-hardwood cuttings. The best time of propagation is rainy season.
- The highest rooting of 90% was recorded in soft wood cutting treated with IAA 1000 ppm and hard wood cutting treated with NAA 500 ppm.
- Best rooting and survival were obtained with IBA at 4000 ppm.

### **Spacing:**

- The dwarf shrub like *J. sambac* is planted at 1.0 x 1.0 m or 1.5 x 1.5 m. distance.
- Whereas creeper may be grown about 3.5 m apart trained on arbours, arches, pergolas.
- *J. sambac* can be grown in large pots.

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

### Planting:

- Land with proper drainage, irrigation facilities and sunny location are essential.
- Pits of 45 cm<sup>3</sup> 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.

### Manures and Fertilizers:

Well rotten organic manure/ mixture @ 10 kg/plant are applied per year.

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

### Irrigation:

Moderate watering is good for jasmine. It is more essential in flowering season. During blossoming, the water should be applied twice in a week and once in week during rest of months. Soon after the cessation of flowering, watering is to be completely stopped until pruning and fertilizer application.

### Pruning:

Pruning encourages growth of new healthy shoots and influences flower yield. The shoot are pruned half of their length in January. Cow dung or farmyard manure @ 10 kg /plant/shrub is applied after exposing the roots for few days. Watering is stopped in the end of November. The watering of plants started slowly and later increased after the appearance of flower buds. Watering is withheld after each flush or flowering until fresh buds appear again. The flowering in *J. sambac* is best during summer, particularly in June-July.

### Weeding:

- Commonly done manually but is expensive.
- Chemical weed control is effective and economical.
- 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& are harvested between 6 to 8amin the morning.



- Picking of flowers after 11 am 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.

**Yield:**

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

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

**Extraction of Jasmine oil:**

- 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 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.

**Essential oil:** An essential oil is the volatile material(s) derived from odorous plant material of a single botanical species. Chemically these are organic compounds made up of hydrocarbon molecules and can further be classified as terpenes, alcohols, esters, aldehydes, ketones and phenols etc.

**Concrete/Oleoresin/Resinoid:** It is the mixture of volatile oils with some odorless compounds or wax or other organic compounds which is produced during extraction of essential oil. The names are different according to plant material.

**Absolute:** Absolutes are highly concentrated product generated after alcoholic extraction of concrete/oleoresin/resinoid. Alcoholic extraction helps in eliminating waxes, terpenes, sesquiterpenes and other odorless matters from the concretes/oleoresin/resinoid. Commonly used solvents are alcohol and hexane.

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## GAILLARDIA

**B.N.:** *Gaillardia pulchella* (Annual) and *Gaillardia aristeta* (Perennial)

**Family:** Asteraceae

**Origin:** America

### **Introduction:**

- Gaillardia is popularly known as Blanket Flower.
- These are grown in herbaceous borders & beds and are also suitable for loose flowers.
- Flowers are very useful for making garlands and as loose flower to offer in worship.
- Besides, their utility in landscape G. pulchella is useful in reducing erosion in coastal dune areas.
- Gaillardia requires low maintenance for growing.
- There are 12 sp. of gaillardia present. Plants are bushy with spreading branches. The leaves are alternate, more or less toothed & rough. Flowers are born solitary, usually showy heads. The ray florets yellow & red, 3 – 5 toothed.

**Soil & Climate:** Gaillardia is grown in summer & rainy season on any type of soils however it prefers well drained sandy loam soil & sunny location. Medium fertility status of soil is ideal.

### **Species:**

1. *Gaillardia pulchella* – Annual season: It has single & double flowers in different colours viz. red, yellow – tipped red. Height is 35 – 75 cm.
2. *Gaillardia aristeta* – Perennial: has number of strains & cultivars than in *G. pulchella*.

**Varieties:** Indian Chief, Lollypop Yellow, Lollypop Orange, Sunshine Strain, Gaity Double, Double Tetra Fiesta, Bremen, Burgundy, Dazzler, Goblin, Regalis, Monarch Strain and Sanguinea.

### **Propagation:**

The annual gaillardia is propagated through seeds with a seed rate of 300 to 500 g/ha. The perennial forms can be propagated by division, cutting or seed. The seed may be sown either in pot or nursery & then transplanted in field. The sowing is done in both seasons (Kharif: May-June and Rabi: Nov.-Dec.).

**Spacing:** 40 cm x 40 cm or 45 cm x 45 cm.

**Fertilizer:** FYM @ 50 tones/ha and 50:00:00 kg NPK/ha.

**Irrigation:** At 8-10 days interval.

### **Harvesting:**

Flowering in gaillardia commences after 3 – 4 months of sowing. Fully opened flowers are harvested for loose flowers which remain fresh for 5 – 6 days. The seeds are collected from the plant when they are fully ripe.

**Yield:** 20,000 to 25,000 kg/ha.

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## SPIDER LILY

**B.N.:** *Hymenocallis littoralis* L.      **Family :** *Amaryllidaceae*      **Origin:** South Africa

**Uses:** Widely used as a loose flower for preparing garlands, veni, gajra& for stage decoration.

### **Soil:**

1. The plants thrive best in well-drained sandy loam fertile soil.
2. The field should be dug 45-60 cm deep.
3. The pH of soil should be around 6-7.
4. Acidic soil can be neutralized by addition of lime and it should be done before planting.
5. The moist environment is required for growing of this plant.

### **Climate:**

1. Spider lily favours hot & humid climatic conditions and also thrives well in sub-tropical conditions & even in high rainfall zones. Very severe winter affects the flower production while high temperatures favours flowering.

**Varieties:** Generally two types of local varieties are seen

1. Thin & dark green coloured leaves variety & which produced flowers mostly in rainy season.
2. Thick & light green coloured leaves variety which produced flowers year round.

### **Propagation:**

1. It is propagated through bulbs; the small bulbs that develop at the base of large bulbs in group of 5-7.
2. These are separated for planting
3. Spider lily bulbs should be fresh and planted 7-7.5 cm deep in well prepared soil beds of the field.
4. The location should be sunny or have very light shade.

### **Planting:**

1. Planting is generally done in May-June with the onset of monsoon.
2. The fresh bulbs are used otherwise they should be stored in well ventilated storage in plastic crates.
3. Before planting the bulbs should be treated with fungicides.
4. The planting distance should be 30×30 cm, or 45×30 cm. or 45x45cm.
5. The location should be sunny or have very light shade.

### **Manures & Fertilizers:**

Well decomposed FYM @ 30 t/ha at the time of planting i.e. in May-June and NPK @ 300:225:200 kg/ha should be applied. Whole P & K should be applied as basal whereas, N should be given in 4 equal split in June, September, December & March.

### **Irrigation:**

Light irrigation should be given after planting and continue till the sprouting of bulbs. After that apply irrigation at 5 to 7 days as per seasons and can be rested in winter season as the production is down.



**Harvesting and post harvest handling:**

1. Spider lily flowers should be harvested at tight bud stage in the early morning or evening.
2. Harvesting of individual buds is done manually.
3. 50 or 100 buds are tied in a bunch.
4. These bunches are packed in bamboo basket or gunny bag and transported for market.
5. During transporting the packing is kept moist.
6. Use of plastic crates or corrugated cardboard boxes to pack the buds bundles is advisable.
7. These buds are used to prepare veni, mala, wreath, mandap decoration, etc.

**Yield:**

1. Higher yield is obtained during summer followed by rainy & lower in winter season.
2. 5 to 6 lakhs bundles/year/ha depending upon soil & climate conditions & management practices.
3. About 1 lakh/ha income can be generated from spider lily cultivation.

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# Production Technology of Medicinal crops

## ASHWAGANDHA OR ASGANDH

**Scientific name :** *Withania somnifera* (L.) Dunal

**Family:** Solanaceae

**Origin :** Africa

**Distribution:** Asgandh is an important medicinal plant cultivated only in north western regions of Madhya Pradesh and Rajasthan on about 5000 ha.

**Botany:** It is an erect evergreen under shrub 60-120 cm in height, branched greish, tomentose with long tuberous root growing up to 0.75 m -1.5 m in height. Stem and branches are hairy. Leaves are simple, ternate, petiolate, and elliptic-ovate, inflorescence is an axillary, umbellate cyme of 5-25. Fruits are green when unripe, turning orange-red when mature. Seeds are numerous, small and yellow.

### Uses:

Asgandha roots and occasionally its leaf and seeds are used in ayurvedic and unani medicines.

1. Several alkaloids and withaniol are present in roots. The total alkaloid content of the Indian roots is reported to vary between 0.13 to 0.68 per cent. The roots of cultivated crop contain up to 50% of these alkaloids.
2. Used in several female disorders, bronchitis, rheumatism, dropsy, stomach and lung inflammation, skin diseases and general weakness.
3. It is also aphrodisiac, tonic, diuretic and abortifacient. Used in the preparation of vital tonics
4. Withaniol group of alkaloids are therapeutically important.
5. The alkaloids are also found in the bark, seeds and leaves.
6. Warm leaves are used for providing comfort during eye diseases.

**Chemical:** Withanine and somniferine

### Variety :

Jawahar Asgandh -20 and Jawahar Asgandh-134 is a high yielding variety other varieties i.e. WS-10, WS-12, WS-14, WS-16, WS-19, and WS-22 were developed by AICRP (M and AP) at JNKVV, Regional Agril. Research Station, Mandsaur.

### Soil & Climate:

It can grow well in well drained light sandy loam soil having pH of 6 to 8. Asgandh is late kharif crop. It grows well under dry climate. A late winter shower favors its good root development. On an average 600 to 700 mm rainfall is best for rain fed crop.

### Preparation of land

Soil is well pulverized by poughing and harrowing. Subsequently the field is leveled thoroughly.

**Propagation :** Ashwagandha is propagated through seed.

**Seed rate:** 7 to10 kg ha<sup>-1</sup> for broad casting. Line sown crop needs half of the given seed rate.

**Seed treatments:** Seeds are treated with Thiram or Dithane M- 45 @ 3 g/ kg.

**Sowing method:** Broad casting or line sowing. Generally, seeds are broadcasted, but line sown crop facilitate better cultural practices and yield. Germination takes place within 6-7 days of sowing. The crop can also be raised by transplanting.

**Spacing:** Line sowing of plants by keeping distance 30 cm x 5 to 7 cm is most convenient for this crop. The crop can also be raised by transplanting.

**Time of Sowing:** After second fortnight of September.

**Thinning :** 30 days after sowing

**Manures and Fertilizers:**

Ashwagandha is very low input crop.

FYM @ 5 to 10 t/ ha. Should be applied at the time of soil preparation.

NPK kg ha<sup>-1</sup> 15 + 15 + 0 as a basal dose.

**After care :**

1. Seed broadcast or sown in line should be thinned out within one month after sowing to maintain a plant population of 30-60 plants per square meter.
2. Apply 3 to 4 irrigation according to soil and climatic condition.
3. One hand weeding and inter culturing 30 days after sowing is sufficient to smother the weeds.

**Pest and Diseases:** Diseases Seedling Mortality Seedling blight and leaf blight

**Harvesting and yield:**

1. Crop is ready for harvest in 135 to 150 days after sowing.
2. Harvesting starts from January and continues up to March.
3. The entire plant is uprooted for roots, which are separated from the aerial parts by cutting the stem 1-2 cm, above the ground.

**Yield:** Seed: 50-75 kg/ha and 600 to 700 kg dry roots/ha.

**Processing**

1. Roots are transversely cut into smaller pieces (7 to 10 cm) for drying.
2. The dried roots undergo cleaning, trimming and grading before packing for the market.
3. The entire produce carefully sorted into following 4 grades for marketing purpose.

**Root grades**

1. Grade A : Root piece 7 to 10 cm. Long, diameter 1 to 1.5 cm.  
Root should be brittle & Solid and pure white from inside.
2. Grade B : 5 cm long, diameter 1 cm, brittle, solid and white.
3. Grade C : 3 to 4 cm. long, diameter less than 1 cm.
4. Lower grade: Small pieces of root, hollow, yellowish from inside.

## PSYLLIUM OR ISABGOL or *Plantago*.

**B.N.:** *Plantago ovata Forsk*

**Family:** Plantaginaceae

**Origin:** West India

*Plantago ovata F* is known as Psyllium, Isabgol or spogel seeds. The dried matured seeds are used in medicine. India is the sole exporter of isabgol to the world market and about 80 to 90 per cent is exported. In the whole world isabgol is traditionally cultivated in North Gujarat & south-western Rajasthan only.

India – 50,000 ha. area under cultivation.

Gujarat – 25,000 ha. (Banashkantha, Kutch, Mehsana, Jamnagar, Surendranagar).

- Plant part used: Husk and seed
- Chemical content: Mucilage

### Uses:

1. The husk from the seed has the property of absorbing and retaining water and therefore, it works as an anti-diarrheas drug.
2. It is beneficial in chronic dysenteries of amoebic and bacillary origin.
3. It is also used for treating constipation and intestinal disorders because it works as a calorie free food, promoting regular bowel movement (No any adverse side –effects).
4. The seeds are used in Ayurveda, unani and allopathic medicines.
5. The seed and husk are used to cure inflammation of the mucous membrane of gastro – intestinal and genital – urinary tracts, duodenal ulcer, gonorrhoea and piles.
6. It is also used as cervical dilator for termination of pregnancy.
7. In addition to these medicinal uses, it has a place in dyeing, calico printing, in ice-cream industry as stabilizer. It is also used in confectionery and in cosmetics industries.

**Plant:** It is a small, annual herb, 30 to 40 cm tall. Tillers (usually 3-4) arise from the base of the plant.

### Known varieties:

- Gujarat Isabgol –1
- Gujarat Isabgol -2
- TS-1-10
- EC-124345
- Niharika,
- Haryana Isabgol –5
- Jawahar Isabgol-4

### Soil

Psyllium is a cool and dry weather crop and grows well in light sandy soils. Heavy soil and soils with poor drainage are not conducive to good growth.

### Climate

It requires cool and dry sunny weather. Early sowing with higher seed rate makes the crop vulnerable to downy mildew disease, whereas late sowing provides lesser period of growth in winter and there is also possibility of shedding of seeds due to summer rains in April.

### Preparation of land

Field must be free from weeds, clods and should have fine tilt for good germination.

**Bed size:** 8 x 3 m. suitable for irrigation and cultural practices.

**Seed rate:** 4 kg / ha.

## Time of Sowing

This plant is photosensitive. The sowing is done between 20<sup>th</sup> November and 20<sup>th</sup> December. However, sowing in the first week of Dec. is considered ideal. Early sowing with higher seed rate makes the crop vulnerable to downy mildew disease, whereas late sowing provides lesser period of growth in winter and there is also possibility of shedding of seeds due to summer rains in April. The seeds are small and light. Hence, before sowing the seed is mixed with sufficient quantity of fine sand or sieved FYM.

**Method of Sowing:** Broadcast or Line sowing.

**Manures and Fertilizers:** 5 to 10 t FYM / ha

N	P	K	kg/ ha
15	+ 15	+ 0	Basal dose
15	+ 0	+ 0	30 days after sowing
-----			
30	+ 15	+ 0	

## Irrigation and inter culture:

Immediately after sowing, light irrigation is given. First irrigation is given with controlled slow rate of flow of water. The seeds germinate in 6-7 days. If the germination is found to be poor, second irrigation is given. The crop requires 3 irrigations the first at the time of sowing and subsequent irrigations after 30 and 70 days. After 20-25 days of sowing, first weeding is done. 2 to 3 weeding are required within 2 months of sowing.

## Harvesting and yield:

The crop matures during March – April i.e. 110-130 days after sowing. **Maturity indices :** The crop turns yellowish and the spikes turn brownish.

**Yield** Gujarat Isabgul - 1 800 to 900 kg/ ha.

Gujarat Isabgul - 2 1000 kg/ ha.

**Note:** At the time of harvest, the atmosphere must be dry and sunny there should be no moisture on the plant at harvesting.

**Diseases:** Downy Mildew Control: To spray Metalyxil 0.2 %, Mencozeb – 0.3 % at 40, 55 and 70 days (Three sprays). Damping off , Wilt , Powder mildew , Leaf Blight .

## Processing

**Raw seed are cleaned by mechanical processes through various steps**

1. After cleaning seeds from the cleaning and pre cleaning chambers, de-husking processes begin. The process consists of crushing the seed with emery mills and separation of husk in a closed circuit of an automatic pneumatic aspiration system.
2. The psyllium seed husk is then separated from the remainder of the seed by using slight mechanic pressure. The seeds are crashed between rotating rollers and plates.
3. Psyllium husk is then purified by sieving the mixture to separate the husk from the remainder of the seed part.
4. To obtain high yield of pure quality psyllium seed husk, there is intact milling of psyllium seed in a mill which causes the husk to be fragmented by collision under certain conditions. The husk is fractured separating non-husk portion of the isabgol seed.
5. Psyllium powder is obtained through crashing the pure husk psyllium.
6. The products are then packaged under total hygienic control. Packaging includes uncoated and coated Uv stabilized PP woven fabric without liner, HDPE laminated paper bags with inner poly-liner, laminated PP woven bags with inner poly, fiber paper drum and silver plated ring with inner poly-liner.

## GUGGAL

**B. N. :** *Commiphora wightii* (Arnott)

**Family :** *Burseraceae*

**Origin :** Africa and Asia

Guggal or Indian bdellium (*Commiphora wightii*) is a large spine scent shrub to a small tree inhabiting drier parts of western India, mainly Rajasthan and Gujarat. Its gum-resin is used in Ayurveda medicines as a remedy to reduce cholesterol content in blood. The active principle of gum-resin is Z and E gugglusterones which has anti-inflammatory and hypoglycemic properties. It has also utility in treatment of arthritis and obesity. The entire demand of gum-resin in pharmaceutical industry is being met from tapping of wild growing plants for centuries but the number of trees have dwindled in nature considerably now and a part of the demand is met by regular import from neighbouring Pakistan. Its small-scale cultivation has been established in Kutch (Gujarat) and western districts of Rajasthan. A large plantation exist (30ha) in Ajmer district of Rajasthan.

It is a very slow-growing plant, taking 7–8 years to reach maturity for tapping. It is a shrub reaching height up to 3-4 m. Its branches are crooked, knotty and aromatic and end in sharp spines. It is considered to be a threatened plant and is included in the Red Data Book (IUCN), the world conservation union (International Union for Conservation of Nature) and over exploited species in the country.

### **Description of the Plant**

Guggal is a woody, perennial shrub to small tree, 3–5m tall with spirally ascending spinescent branching. The leaves are 1–3 foliate, thick, rhomboid to ovate in shape with irregular margins. The tree defoliates in rainy season. Stem is pale-green, covered with papery exfoliating. The flowers are small, borne 2–3 in a fascicle, brown to pink in colour. Most flowers are bisexual but male and female plants are also reported to occur in nature. Fruit is a drupe, 6–8mm across, ovate in shape, green, changing to red on ripening. It has 2 stony seeds.

### **Distribution of species**

The distribution of the species in Rajasthan, Gujarat, Maharashtra and Karnataka State. Of these Rajasthan and Gujarat is the main Indian commercial source of gum guggal. Survey of Gujarat State indicated that natural stand of guggal is available from northern most part of the State (low rainfall, relatively smaller plants) to the ravines of river Mahi (higher rainfall, taller plants) in middle Gujarat.

Plant part used: Oleo gum resin.

Chemical content: Guggal lipids.

### **Uses**

The gum resin of guggal is an indigenous drug plant known to be highly effective in the treatment of obesity, arthritis and several other diseases in Indian System of Medicine.

Variety :

Marusudha is the variety in guggal. Total 33 germplasm are collected at AAU, Anand.

### **Soil**

Guggal is grown in well-drained calcareous, sandy to silt loam soils, poor in organic matter but rich in several other minerals in arid tracts of western India. It is noted that growth is faster over soils which have moisture retaining capacity.

### **Climate**

It grows luxuriously under extreme temperature (summer 40°C and winter touching zero) in areas receiving low (10–40cm) rainfall, but abundant sunshine.

## **Land Preparation**

The land for field planting is well prepared, giving deep ploughing. The soil is exposed to hot sun for weathering to desiccate all perennial weeds. It is given 20kg of Aldrin (10%) at land preparation to protect the plants from termite attack. The pits of 50cm × 50cm × 50cm size are dug out at 2m × 2m spacing, accommodating 2,500 plants/ha. The pits are filled with well-rotten farmyard manure mixed with a table spoon full of Aldrin or Gamaxine. The pits are given soaking irrigation before planting, followed by one irrigation/month till next rainy season.

## **Propagation**

**Seeds:** Seed germination is very poor (5%) but seedling produce healthier plants which withstand high velocity winds, which is a usual phenomenon in desert region. The seeds are sown in July.

## **Vegetative method**

1. **Cutting:** Plants are best raised from stem cutting from semi-woody (old) branch. For this purpose, 45 to 50 cm long woody stem of 10 mm thickness is selected and the cut end is treated with IBA or NAA and planted 15 cm deep in a well manure nursery bed during June-July months. The cuttings initiate sprouting in 10-15 days and grow into good green sprouts in next 10 to 12 months. These rooted plants are suitable for planting in the field during next rainy season (84 to 90 %). These are ready for field planting in the next rainy season.
2. **Air layering**  
It can be done in June–August; after 2 months, these rooted plants could be separated and planted directly in field.

## **Planting**

**Pit Size:** 50 x 50 x 50 cm.

**Spacing:** 3 x 3 m. or 2 x 2 m

**Time of planting:** Rainy season

## **After care:**

1. No response of fertilizers however, 25 g urea/ plant give better growth of plants.
2. Removal of side – branches and low level of irrigation supports a good growth of these plants.
3. The plantation does not require much expenditure on weeding and hoeing operations. But soil around the bushes is pulverized twice in a year to increase their growth.

## **Manures and Fertilizers**

Use of N and P does not give any positive response either on growth or gum yield.

## **Irrigation**

But low level of irrigation gives positive response in registering high rate of growth in Rajasthan and Gujarat.

## **Intercultural & Weeding**

The plantations are given 1–2 weeding-cum-hoeings in a year.

## **Pruning**

Wherever, annual pruning of lateral branches is carried (leaving only 2–4 branches), the bushes attain better height and larger girth of main trunk and lateral branches in a shorter duration.

## **Tapping**

1. The plants attain 3–5m height in 7–8 years and 3–4cm thick main trunk and some lateral branches.
2. The trunk is ready for tapping during autumn season (December–February).
3. The tapping is done by giving 9–11cm long triangular or circular cut, 40cm above the ground.
4. The depth of the cut should never exceed the thickness of the bark, as resin ducts inhabit this part and may injure phloem and cambium part, causing damage to trees besides obstructing outflow of gum-resin.
5. A paste of gum-resin in water is applied at the incised spot and bandaged to potentiate flow of gum-resin (guggal).
6. The flow of gum starts 3–7 days after tapping and is exhausted in next 15–20 days. Since gum-resin gets hardened on exposure to air, it is collected in earthen cups fixed below the cut part.
7. Two to three collections of gum are possible in a season. Use of 40mg of ethephon (2-chloroethyl phosphoric acid) fed to the roots through injection can increase the flow of gum and maximize yield significantly.

The gum is pale-yellow aromatic sap, which gradually hardens on exposure to form golden-brown to reddish-brown mass. It is a complex mixture of diterpenes, aliphatic esters, steroids, carbohydrates, inorganic ions and essential oil. The growing demand of guggal gum and rise in price has brought adulteration of several gums (like Katira, Damar and Senegal) in the market. Samples can be easily distinguished on chemical testing.

## **Yield**

The yield of a tree may vary from 200–500g/ season. However, tapped branches or the entire tree die 8–10 months after yielding the gum. The cause (either physiological or pathological) is not yet known. Price Rs. 150/ kg.



## SENNA

B. N.	:	<i>Cassia angustifolia</i> Vahl.
Family	:	Leguminaceae
English Name	:	Senna
Indian Name	:	Svarnapatri (Sanskrit) Savvy Sana ka Patt (Hindi)
Origin & Distribution	:	India
Spp. & varieties	:	<i>Cassia angustifolia</i> Vahl. <i>C. acustifolia</i> Del, <i>C. obovata</i> <i>C. italica</i> , <i>C. abovata</i>
Plant parts and Uses	:	Leaves and Drugs

Senna (*Cassia angustifolia*) is a small, perennial, branched under shrub. It is cultivated traditionally over 10,000 ha in semi-arid lands in coastal districts of Tirunelveli, Ramnathapuram and Madurai in Tamil Nadu. Its commercial cultivation has recently come up in Kutch (Gujarat) and Jodhpur division of Rajasthan. It can grow over sand dunes after rainy season and can be maintained as a perennial crop for 2–3 years. A major part of the produce is exported in the form of leaves, pods and sennosides concentrates. The export of leaves and pods from India is of the value of Rs. 20 million annually.

The plant bears compound leaves, made up of 5–8 pairs of shortly stalked oval-lanceolate leaflets (2.5cm × 1.5cm) and produce successive flush of flowering shoots both in axillary and sub-terminal position 60–70 days after sowing. The flowers are large and brilliant yellow in colour, producing medium-sized pods (3.5cm–6.5cm × 1.5cm) after 90 days. They contain 5–8 yellowish, flat seeds. It is predominantly self-pollinated crop but outcrossing could be high (20%) through beetles.

### Use

- Senna is used in medicine as a cathartic.
- It is especially useful in habitual constipation.
- It increases the peristaltic movement of the colon.
- The pods have the tendency to gripe caused by senna may be obtained by combining it with an aromatic or a saline laxative.
- The laxative principles of senna, are two glycosides, viz., sennoside A and sennoside B.
- The plant also contains sennosides C & D.
- The leaves and pods as such or in powder form do not lose potency easily.

### Varieties

The Gujarat Agril. University under the AICRP on Medicinal and Aromatic crops at Anand developed late flowering type as 'ALFT-2' through selection. The CIMAP, Locknow, has released a high yielding variety named Sona.

### Soil

The crop thrives over well-drained, sandy loam lateritic soils of 7–8.5 pH, though fertile fields and irrigated crop support better growth and produce higher yields. Senna is legume but produces no nodules for fixing atmospheric nitrogen. It is sensitive to waterlogged conditions.

## Climate

Senn is a sun-loving crop and requires bright sunshine for its successful growth. The trials at Bangalore have shown that it can be grown as an early summer (Feb-March) or a winter (Oct-Nov) crop. However, sowing in the rainy season is not good, as the crop on harvest cannot be dried easily. Whereas, under North Indian conditions like Delhi and Gujarat, where, the rainy season is short, it is reported to be the ideal. Heavy rains and cloudy weather during growth are harmful to the crop. An average rainfall of 25-40 cm distributed from June to October is sufficient to yield good harvests.

## Land Preparation

The land is prepared deep and exposed to the sun for 110-115 days to dry out the roots of perennial weeds, followed by two cross-ploughings, harrowing and leveling. FYM is incorporated into the soil at the time of the final cross ploughing. Then the land is laid out into plots of convenient sizes with irrigation channels.

## Cultivation

### Propagation

The crop is raised from seeds. Since the seeds have a hard and tough seed coat, a certain amount of abrading of its surface is necessary, to induce quick germination. This is achieved by pounding the seeds lightly with coarse sand in a mortar. Soaking the seeds for 10-12 hours before sowing is reported not only to give 100% germination, but also the stand of the plants grown is even. About 20 kg of seeds are required to cover a hectare of land

### Sowing

**Seed rate:** 5.0 kg/ha.

### Seed treatment

It is found that treating the seeds with Thiram, Captain or Agrosan G.N. at 25g/kg protects the seedlings from damping-off and seedling blight diseases which are common occurrences.

### Sowing method and spacing

Broad casting or line sowing at 30 x 30 cm at with 1.5-2.5 cm depth. The seeds can also be dibbled on the inner sides of the ridges opened at 45 cm distance, maintaining a plant-to-plant spacing of 30 cm. Only about 5 kg of seeds are required for this method of sowing.

### Germination

The germination commences on the third day and is completed within a fortnight. Before sowing, the field should be perfectly levelled, lest it hamper uniform seed germination.

**Thinning:** 30 DAS to maintain plant to plant distance of 30 cm in the rows.

### Manures and Fertilizers

**Manures and Fertilizers:** 8 to 10 tones FYM.

N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O (kg/ha)	
40	40	20	Basal
20	00	00	35-40 DAS
20	00	00	80-85 DAS
80	40	20	Total

The entire dose of P and K and 50% of N should be applied at the time of sowing, and the remaining 50% of N is to be applied 90 days after sowing.

### Crop Rotation and Intercropping

In Tamil Nadu, it is grown after the paddy and intercrop cultivation in between rows of cotton, sesamum, chillies, brinjal, okra and tomatoes are popular.

**Irrigation:** Grown in rain fed conditions. Irrigation given at 40, 75, and 100 DAS.

### **Weeding and Inter culturing**

When the plants begin to grow, once or twice inter culturing is given after which the rows close up. The first hand weeding-cum-hoeing is done at 25-30 days, a second at 75-80 days and a third at 110 days, to keep the soil free from weeds. The use of Teeflan herbicide as a pre-emergent spray at the rate of 4 kg/ha has been reported not only to increase the yield, but also the anthraquinonoid content.

### **Pest and disease**

The larvae of several leaf-eating caterpillars feed on the green senna leaves. Another pest, a pod borer is also reported to attack the pods and can be controlled by spraying Endosulphan (0.05%) or Carbaryl (0.25%) at an interval of 10-15 days.

### **Diseases**

The leaf-spot disease is the most serious disease and causes severe damage to the crop. Damping-off of seedlings is the most devastating disease.

### **Maturity indices, harvesting and yield**

1. Foliage containing higher sennosides between 50-90 days of sowing.
2. The first picking of the foliage crop should be done at 50-70 day's age, depending upon the total plant growth.
3. The picking of leaves is done by hand so that most of the growing tops are removed at harvest, this also induces more branching which, otherwise, reduces the foliage growth considerably. A second picking is taken at 90-100 days and the third picking between 130-150 days, when the entire plants are removed, so that the harvested material includes both leaves and pods together.

**Yield:** Dried leaves: 1500 kg/ha

Dried pods : 700 kg/ha.

### **Processing and Storage**

The harvested crop should be spread in a thin layer in an open field to reduce its moisture. Further drying of the produce is done in well-ventilated drying sheds. The dry leaves and pods should have a light-green to greenish-yellow colour. Improper and delayed drying changes the colour to black or brown which lowers the sennoside content

Yield : 15 q/ha of dry leaves and 7 q/ha of pods.

### Minor Medicinal Crop:

Details/Crops	Asparagus	Aloe	Periwinkle
<b>B.N</b>	<i>Asparagus racemosus</i>	<i>Aloe barbadensis</i> Mill	<i>Catharanthus roseus</i> G. Don
<b>Family</b>	Liliaceae	Liliaceae	Apocynaceae
<b>Origin</b>	Eastern Mediterranean countries Distributed to Tropical and subtropical India	African continent & Mediterranean Distribution India, West Indies, South Africa	West Indies
<b>Indina name</b>	Shatmuli(Sanskrit) Satawar(Hindi) Saatawari, Ekalakanto (Gujarathi)	Indian Aloe, Jaffarabad Aloe,Kumari (Sanskrit), Gheekanvar (Hindi)	Vinca, barmasi, Madanah (Sanskrit), Mainphal. Madan Sadabahar (Hindi)
<b>Important and use</b>	<ul style="list-style-type: none"> <li>• Roots- galactagogue</li> <li>• Lost body weight also known as an aphrodisiac.</li> <li>• Ailments like dysentery, tuberculosis and diabetes.</li> <li>• Immunity to diseases.</li> <li>• Energy provider to the weak body system.</li> </ul>	Uses Drugs (therapeutic, purgative, vermifuge), Cosmetics	It is a unique medicinal plant used in curing blood cancer, used in controlling high blood pressure.
<b>Part used</b>	Tubers and leaves	Leaves	Leaves and Roots
<b>Chemical constituents</b>	Steroidal saponins	Barbaloin	Ajmacline, Vineristine, Vinablastine
<b>Varieties</b>	Two groups- purple spears and free from purple colour. There is no named variety developed so far in this crop.Perfection (IARI)	Chinensis Baker, littoralis Koenig ex Baker, A. abyssinica Jafrabad aloe and A. variegata Linn.NBPGR, New Delhi : Accessions IC series	Nirmal and Dhaval (a) alba- white flowers (b) Roseus- pink flowers (c) ocillata- rose - purple spot in centre.
<b>Climate</b>	Temperature to tropical hill regions. Rainfall of 600–1000 mm or less. It tolerates drought as well as low temperature.	Humid or dry climate with even 35-40 cm of yearly rain-fall during the growing period.	Tropical and sub-tropical with high rainfall for commercial cultivation
<b>Soil</b>	A well-drained fertile sandy-loam to clay-loam soil, with a pH of 6–8	Sandy coastal to loamy soils of the plains with a pH of up to 8.5	Coastal soils, light sandy rich in humus for large scale cultivation.
<b>Propagation</b>	Root suckers or seeds	Root-suckers or rhizome-cuttings.	By seed
<b>Sowing/planting</b>	<ul style="list-style-type: none"> <li>• The field is divided into convenient sized plots and laid out into ridges at 60 cm apart.</li> <li>• Well developed root suckers are planted on the ridges.</li> </ul>	June-July	Seed rate : 2 to 3 kg/ha.(Direct sowing) For seedling : 500 g/ha

<b>Spacing</b>	60 x 60 cm	60 x 30 cm or 60 x 45 cm	45 cm x 30 cm or 45 cm x 45 cm.
<b>Manuring</b>	FYM 20 t/ha. NPK 60-40-40 g/pl.	150 kg/ha of NPK	15 t FYM and 80-40-40 NPK kg/ha.
<b>Interculture</b>	6-8 weeding and IC	2 weeding & IC	3 weeding & IC
<b>Irrigation</b>	Immediately after planting. weekly interval.	If there is no rain one irrigation should be applied after planting.	4-5 irrigation for good yield Two weeding should be done.
<b>Harvesting</b>	Crop matures: 12 MAP Seed harvesting: after 20 months. Time: Above-ground parts start turning pale yellow.	After eight months, uprooted with help of a tractor-drawn disc harrow or cultivator.	Ready for harvest of roots at 7.5 cm above the ground after one year.
<b>Yield</b>	Yield : 4–5 t/ha for one year crop, while 20 months old, 6 t/ha of tubers along with 35 kg/hectare of seeds.	10 to 12 t/ ha	Irrigated Leaves : 4 t/ha, Stem : 1.5 t/ha, Roots 1.5 t/ha Rain fed Leaves : 2 t/ha, Stem & roots: 0.75 t/ha
<b>Processing</b>	Drying of leaves and tubers	Gel and powder	The roots are washed well and dried in shade and later made into bundles for marketing.
<b>Value addition</b>	-	Many cosmetic & pharmaceutical products	-

# Production technology of aromatic plants

## ROSE

B.N.	:	<i>Rosa damascene</i> Mill. (Damask Rose)		
Other Species	:	<i>R. barboniana</i> , <i>R. centifoliana</i> , <i>R. alba</i> , <i>R. gallica</i> , <i>R. teptie</i> , etc.		
Family	:	Rosaceae		
Origin	:	Europe		
Part Used	:	Petals		
Composition	:	Rose oil - 0.057 to 0.058 % (Which contains citronellol-0.4 %, nonadecane-12.3%, geraniol-14.49 %, Henicosane-6.69%, etc).		
		1	<i>R. damascena</i>	0.057 to 0.058 %
		2	<i>R. barboniana</i>	0.040 to 0.042 %
		3	<i>R. teptie</i>	0.030 to 0.035 %
Uses	:	<ul style="list-style-type: none"> <li>➤ Used as source of rose oil, rose water, rose absolute, rose attar, gulkand, gulroghan, pankhuri, otto of rose, etc.</li> <li>➤ Used in cosmetics, beverages, cold drinks, foodstuffs, tobacco flavoring like snuff and chewing tobacco, fruit flavours, soft drinks, alcoholic liquors and medicines.</li> </ul>		
Varieties	:	Noorjahan, Jwala, Himroz, etc.		
Soil	:	Preferred natural, well-drained, sandy loam soil. pH- 5.6 to 7.0.		
Climate	:	<ul style="list-style-type: none"> <li>➤ At the time of flowering: Humidity &gt; 60%, Temperature (15-20° C)</li> <li>➤ Low humidity reduces the essential oil content in the flowers and high temperature leads to abscission of the flower-buds before blooming.</li> <li>➤ Temp. ranging from 0-5° C for a period of about 15 days prior to the start of blooming enhances the quantity as well as the quality of the flowers.</li> </ul>		
Preparation of land	:	The land is ploughed deep (30 cm) in order to minimize the weeds and finally level by planking. Pits of 0.45 cm in good soils and 60 cm in poor soils are dug at a spacing of 1.0 to 1.5 m x 1.0 to 1.5 m and filled with 3 to 4 kg FYM.		
Propagation Method, Time and Planting	:	Semi hardwood or Hardwood Cuttings in June-July. The cuttings begin to sprout after a month's time (30 to 35 days) and when the cuttings have attained a height of 10 to 15 cm, rooted cuttings are transplanted into the field after six months.		
Spacing	:	1.0 m x 1.0 m or 1.5 m x 1.5 m.		
Manures & Fertilizers	:	FYM @ 18-20 t/ha and 160:80:80 kg NPK/ha per year		
Irrigation	:	About 10 to 12 irrigations. Irrigation after pruning is necessary		
Pruning	:	The first pruning is done after the plant attains two years of age. Heavy pruning at 30-45 cm is done during December-January and the soil around the base of the rose plants is dug up to bare the primary roots which facilitates the chilling of roots and in February, the soil is again heaped at the base of the plant. The plants take about 70 to 90 days to flower after pruning.		
Harvesting	:	Harvested in the early mornings when they start opening. The collected flowers should be distilled immediately as they lose their whole aroma within 25 hours of their opening.		
Yield	:	<ul style="list-style-type: none"> <li>➤ Fresh flowers yield: 3.5 - 5.0 t/ha.</li> <li>➤ Oil recovery: 0.025-0.030 %.</li> <li>➤ Generally, one kg oil is obtained from 3000 to 4000 kg petals.</li> <li>➤ Oil yield: 0.75 – 1.5 kg/ha.</li> <li>➤ Rose concrete: 0.35-0.45 % and Rose absolute: 0.15-0.20 %.</li> <li>➤ Economic life of crop: 15-20 years.</li> </ul>		

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**MINT (MENTHA)**

B.N.	:	<i>Mentha arvensis</i> L.		
Family	:	Lamiaceae		
Origin	:	Mediterranean Region		
Part Used	:	Leaves		
Composition	:	Menthol		
Types/Species	:	As below		
<b>Name / Types</b>		<b>B.N</b>	<b>Chemical Components</b>	<b>Oil %</b>
Japanese mint or Corn or Field mint		<i>Mentha arvensis</i> L.	<u>Menthol (65-75%)</u> , Menthyl acetate (12-15 %) & Terpenes	Leaves: 0.4-0.6
Peppermint		<i>M. piperita</i> L	<u>Menthol (35-50%)</u> , Menthyl acetate (14-15 %) & Menthone (9-25%) Menthofuran and Terpenes	Herb: 0.4-0.6
Spearmint or Lamb mint		<i>M. spicata</i> L	<u>Carvone (57.71%)</u> , Phellandrene, Limonene, L-pinene and Cineole.	--
Bergamot mint or Orange mint		<i>M. citrata</i> Ehrh	Linalool and Linalyl Acetate	--
Uses	:	<ul style="list-style-type: none"> <li>➤ Flavouring of pharmaceutical and oral preparations like toothpastes, dental creams, confectionery, beverages and other items like tobacco, cigarettes and paan masala.</li> <li>➤ Medicinally, it is an excellent carminative and gastric stimulant.</li> <li>➤ The oil is used directly in perfumes. Cosmetic preparations like scents, soaps, after-shave lotions and colognes also contain this oil.</li> </ul>		
Varieties	:	Japanese: Himalaya (MAS-I), Kalka (Hyb-77), Shivalik, EC-41911, Kosi, Peppermint: Kukrail, Bergamot Mint: Kiran, Spearmint: MSS-1, MSS-5, Punjab Spearmint-1, etc.		
Soil	:	Medium to deep, loam to sandy loam well drained, well aerated and loose textured soil with good water-holding capacity and pH of 6-7.5 is best.		
Climate	:	For Japanese mint, tropical and subtropical areas. A temperature of 20-25°C for vegetative growth and 30°C for the essential oil and menthol. For Peppermint and spearmint, humid and temperate conditions. Bergamot mint : Both in temperate and subtropical areas.		
Preparation of land	:	A flat bed of convenient sizes or ridges are prepared as per spacing and FYM @ 25 to 30 t/ha is mixed with soil.		
Propagation Method, Time, Planting and Spacing	:	<ul style="list-style-type: none"> <li>➤ Through the creeping stolons or suckers or runners. 400 kg stolons/ha</li> <li>➤ Best time for obtaining stolons is: Dec.-Jan.</li> <li>➤ The stolons pieces 7-10 cm planted in shallow furrows about 7-10 cm deep with a row-to-row distance of 45-60 cm. While planting on ridges, the stolons are planted half-way down on the inner sides of the ridges.</li> </ul>		
Manures & Fertilizers	:	NPK 50 : 75 : 37 kg/ha as basal dose and 75 kg of N/ha as top dressing in three equal doses should be applied.		
Irrigation	:	As roots do not penetrate deep in the soil, light and frequent irrigations are recommended. During summer irrigate the crop weekly.		
Inter-culture	:	<i>Mentha</i> needs frequent inter culturing weeding and hoeing.		
Harvesting	:	Normally 2-3 times in a year (120 days) 1. First crop should be harvested before the onset of monsoon. 2. Second harvesting after monsoon is over (September - October). 3. Third harvesting (November - December).		
Yield	:	150 kg of Oil/ha during the first year and subsequently 200 - 250 kg per hectare can be obtained under good management.		

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## LEMON GRASS

B.N.	:	<i>Cymbopogon flexuosus</i>				
Family	:	Poaceae/ Graminae				
Origin	:	India / South Asia				
Part Used	:	Leaf				
Species & Composition	:	Citral				
		<b>SN</b>	<b>Common Name</b>	<b>B.N.</b>	<b>Oil %</b>	<b>Major constituent in oil</b>
		1	East Indian Lemongrass	<i>C. flexuosus</i>	1.0 to 1.2	Citral- 80 %
		2	West Indian Lemon grass	<i>C. citratus</i>	1.0	Citral-Major
		3	Jammu & North India Lemongrass	<i>C. pendulus</i>	0.75	Citral- 75 to 80 %
Uses	:	Chief constituent of the oil is <i>citral</i> , which is used in the manufacture of vitamin- A tablets. Oil has bactericidal, insect repellent, mosquito repellent and medicinal uses. Used in soap and detergent making.				
Varieties	:	OD-19, SD-68, CKP-25, RRL-16, etc.				
Soil	:	Hardy and drought resistant crop can be grown on loamy to poor lateritic soils. Optimum range of pH is 4.5 to 7.5.				
Climate	:	The most ideal condition is warm and humid climate with plenty of sun shine. Uniformly distributed 250-280 cm rainfall is beneficial.				
Preparation of land, Propagation Method, Time, Sowing/Planting and Spacing	:	<p>Seeds and through slips. Slips are better.</p> <p><b>Nursery:</b></p> <ul style="list-style-type: none"> <li>The soil should be well pulverized for forming raised bed.</li> <li>FYM is also added to bed.</li> <li>15-20 kg of seeds/ha are required for raising seedlings.</li> <li>Seeds are sown in lines at 10 cm interval on beds and -covered with cut grass materials.</li> <li>When the seedlings are about 2 months old or about 12 to 15 cm high, they are ready for transplanting.</li> </ul> <p><b>Through Slips:</b></p> <p>The land is cleared of the underground vegetations and pits of 5 cm cube are made at a spacing of 15 x 19 cm. Slips from old clumps can also be used for propagations. Planting can also be done by preparing the ridges and furrows at 60 x 45 cm spacing on which 2-3 seedlings or slips are planted per hill.</p> <p><b>Plantingtime:</b> - May - June</p>				
Manures & Fertilizers	:	<p>100: 50: 50 kg NPK per ha per year.</p> <p>Entire P and K are applied as basal.</p> <p>Nitrogen is applied as 2 – 3 splits first at 30 days after sowing and remaining after each harvest.</p>				
Irrigation	:	Crop responds to irrigation during hot months.				
Harvesting	:	<p>Lemon grass comes to harvest at 90 days after planting and subsequently it is harvested at 50-55 days interval. The grass is cut 10 to 15 cm above the ground level and 5-6 cuttings can be taken in a year subject to the climatic conditions. Depending upon the soil and climatic conditions, the crop can be retained in field for 5 to 6 years. Delayed or early harvest reduces <i>Citral</i> and oil content. Discard flower stalks from time to time.</p>				
Yield	:		<b>Condition</b>	<b>Herbage (t/h.)</b>	<b>Oil (kg/ha.)</b>	
			Rainfed	18-20	80-100	
			Irrigated (Well managed field)	25-30	150-180	

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### CITRONELLA GRASS

B.N.	:	<i>Cymbopogon winterianus</i>			
Family	:	Poaceae/ Graminae			
Origin	:	SE Asia / Ceylon			
Part Used	:	Leaves			
Species & Composition	:	Citronellal			
<b>SN</b>		<b>Common Name</b>	<b>B.N.</b>	<b>Oil %</b>	<b>Major constituent in oil</b>
1		Java citronella	<i>C. winterianus</i>	1.2 to 1.5 %	Citronellal: 30 to 80 %
2		Ceylon citronella	<i>C. nardus</i>	0.70 %	Citronellal: 20 to 25 %
Uses	:	<ol style="list-style-type: none"> <li>1. Citronella oil is a raw material for production of geranial, citronellal, hydroxyl citronellal, etc.</li> <li>2. These are used in perfumery, soaps, and cosmetics.</li> <li>3. Used in pharmaceuticals.</li> <li>4. Used in flavouring industries.</li> <li>5. Used as an ingredient in mosquito repellent creams.</li> </ol>			
Varieties	:	Jor-3, IW 31243, IW-31245, KS-CW-SI, Bio-13, Manjusha, Mandakini, etc.			
Soil	:	It is a moisture loving plant sandy loam soil is most suitable, but water stagnation condition is undesirable. This grass can be grown in neutral soil in Gujarat. Soils rich in humus having good water holding capacity and good drainage should be preferred. Alkaline water logged soils are detrimental for crop growth.			
Climate	:	The plants are hardy and grow under a variety of conditions. The most ideal condition is a warm and humid climate with plenty of sun shine. Uniformly distributed 200-250 cm rainfall and 75 to 90 % humidity favours the crop growth.			
Preparation of land, Propagation Method, Time, Sowing/Planting and Spacing	:	<p>Due to irregularities in <i>Meiosis</i>, viable seeds are not formed. Therefore citronella is propagated through slips, obtained by dividing healthy mature clumps. Each slip should have 2-3 tillers. At the time of planting trim fibrous roots and leaves. One ha of citronella produce is enough as planting material i.e. slips for planting in 20 ha of main field.</p> <p><b>Planting time:</b> April – May – June (with onset of monsoon).</p> <p><b>Planting distance:</b> - The seedlings or saplings or slips can be transplanted on ridges and furrows at 90 x 60 cm or 45 x 40 cm spacing and two slips are planted per hill.</p>			
Fertilizers	:	Apply 8 to 10 t FYM and 200 : 80 : 50 kg NPK/ha.			
Irrigation	:	For healthy crop growth it should be irrigated frequently. This crop uses large amount of water. Irrigation interval of 15 days in winter and 10 days in summer is required for good yield.			
Weeding	:	Weeding is necessary for the first 2-3 months till the planting material get established			
Harvesting	:	The first crop is ready for harvesting within 8 to 9 months after planting and then subsequent cuttings can be taken at an interval of 60 to 65 days. Leaves are cut 10-15 cm above ground in morning. Only leaf blade should be cut leaving leaf sheath as it contains more oil than sheath. Crop is economical for 4 to 5 years. Optimum oil yield is obtained when the sixth leaf is well developed. After 1 year the harvesting is needed at 2.5 months interval.			
Yield	:	Herbage (t/ha)	Oil (kg/ha)		
		20 - 25	150 - 200		

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**PALMAROSA**

B.N.	:	<i>Cymbopogon martini</i> var. Motia					
Family	:	Poaceae/ Graminae					
Origin	:	India / Indo China					
Part Used	:	Tender stems, leaves and flower stalks					
Species & Composition	:	Geraniol					
		<b>SN</b>	<b>Name</b>	<b>B.N.</b>	<b>Oil %</b>	<b>Oil Constituent</b>	<b>Characters</b>
		1	Palmarosa	<i>C. martini</i> var. <i>motia</i> .	0.45 to 0.52 %	Geraniol: 95 %	Fine yellow stem with dark green leaves, height-1.8 to 2.4 m.
		2	Ginger grass	<i>C. martini</i> var. <i>sofia</i>	0.75 %	Geraniol: 35 to 50 %	Purple stem, small stem, height-0.9 to 1.2 m.
Uses	:	Geranoil has rose like aroma, hence useful for fine perfumery, soap and tobacco industries.					
Varieties	:	IW- 31244, RRL (B) – 77, RRL (B) 71, Jam Rosa, Trishna, etc.					
Soil & Climate	:	As like lemongrass & citronella grass.					
Preparation of land, Propagation Method, Time, Sowing/Planting and Spacing	:	By transplanting of seedlings and rooted slips, seed rate @ 2.5 kg/ha are sown during April to Sept. and after attaining 15 cm height they are transplanted. Generally ridges and furrows method is used. The distance 90 cm (furrow) x 60 cm (ridges) are kept. In Kerala: 45 x 45 cm and in Delhi: 30 x 30 cm closer spacing is kept.					
Manures & Fertilizers	:		Time	N	P	K	ZnSO <sub>4</sub>
			Basal dose (kg/ha)	60	40	40	25 kg/ha in north India
			Top dressing (kg/ha)	25	50	25	
			Total	85	90	65	
Harvesting	:	First harvest or cutting is taken after 5-6 months of planting <i>i.e</i> in December, if transplanting is done in May-June. The upper 1/3 <sup>rd</sup> portion is cut with leaves. Harvest 15-20 cm above the ground at the time of flowering to early seed formation stage as the oil content is higher when the plant starts blooming. Subsequently the crop is harvested at 2 ½ to 3 months interval for 3-4 years.					
Yield	:	Yield increases up to 4 <sup>th</sup> year. First year: 20 kg oil per ha; Second year: 60 kg oil per ha; Third year: 70 kg oil per ha; Fourth year: 70 kg oil per ha.					

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### OCIMUM (INDIAN BASIL, TULSI)

B.N.	:	<i>Ocimum sp.</i>
Species		<i>Ocimum americana</i> , <i>O. basilicum</i> , <i>O. gratissimum</i> and <i>O. sanctum</i> , are distributed in India.
Family	:	Lamiaceae
Origin	:	South Asia
Part Used	:	Leaves and Inflorescence
Oil Composition	:	Linalool, geraniol, eugenol, citral, camphor, methyl chavicol, saffron, thymol, methyl cinnamate, etc.
Uses	:	Essential oil is used in perfumery and cosmetic industries. It is also used as herbs and in the indigenous systems of medicine. The oil of certain spp. has the antifungal, bactericidal and insecticidal properties too. It is also useful in fever, cough, cold, bronchitis, indigestion, vomiting, migraine, headache, throat problem, mouth odour, cholera, toothache, tetanus, intestinal worms, chest pain, liver pain, allergy, etc.
Soil	:	Sandy loam soil with good organic matter is considered ideal.
Climate	:	Can be grown successfully in tropical and sub-tropical climates.
Varieties	:	Ram or Green Tulsi, Shyam or Black Tulsi, RRL-01 ( <i>O. canum</i> ), RRL-02 ( <i>O.americana</i> ), RRL-08 ( <i>O.viride</i> ), RRL-08 ( <i>O.gratissimum</i> ), RRL-07 & RRL-011 ( <i>O.basilicum</i> ), Closimum (hybrid) etc. released by RRL, Jammu.
Preparation of land, Propagation Method, Time, Sowing/Planting and Spacing	:	It is propagated by direct seeds sowing or transplanting the seedlings. Seed rate: 200 to 250 g seed/ha. <b>Nursery:</b> Seeds are sown in nursery during March-April. Mostly raised beds are preferred to sown. Line sowing should be done at a distance of 60 cm between two rows. The seeds are very small and so should be mixed with sand for uniform placement. <b>Transplanting:</b> Within 6-7 weeks in nursery, when they attain 15 cm height with 6-7 leaves, they are transplanted into field. TP is done at distance of 60 x 45 cm in June-July.
Manures & Fertilizers	:	FYM @ 25 t/ha and 15:40:40 kg NPK/ha as a basal dose with 25 kg N/ha as a top dressing after each cutting.
Harvesting	:	Cutting is done when flowering starts and cut is made at 15-20 cm above the ground level. Generally three cuttings are done, each at interval of two months. Fresh herbage of tulsi is used for oil extraction.
Yield	:	20,000 to 30,000 kg fresh herbage which gives 60 to 70 kg oil.

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## GERANIUM

B.N.	:	<i>Pelargonium graveolens</i>
Species/Types	:	1. Rose geranium: <i>Pelargonium graveolens</i> 2. Ornamental geranium: Differ from rose geranium which does not possess essential oil.
Family	:	Geraniaceae
Origin	:	South Africa
Part Used	:	Leaves and Flowers
Composition	:	Chief constituent are Geraniol- 68 to 75% and Citronellol-23 – 40%.
Uses	:	Geranium oil is widely used in expensive soaps, perfumes.
Varieties	:	Kodaikanal-1, Hemanti and Kunti.
Soil	:	A deep porous well drained soil rich in organic matter and acidic in nature (pH 5.5 - 6.0) is suitable for the crop.
Climate	:	Sub tropical climate with humid atmosphere and evenly distributed 1000 -1500 mm rainfall is essential.
Preparation of land, Propagation Method, Time, Sowing/Planting and Spacing	:	Land should have a gentle slope and be sheltered from heavy winds. Geranium stands for some years, it is desirable to clean the land and bring it to fine tilth. Methods of propagation: Terminal stems cuttings. Pit Size: 30 x 30 x 30 cm. Spacing: 110 cm x 60 cm (1600 pl/ha). Planting: Planting is done after first monsoon showers.
Manures & Fertilizers	:	In the first year 85 kg urea and 15 kg MoP is applied during Sept. Oct. in subsequent years N: P : K @ 50:30:70 is applied. P is applied by placement and N and K are applied by broadcasting.
Irrigation	:	Geranium is rainfed crop. Irrigation during summer increases the yield.
Pruning	:	Pruning of bushes is necessary when they show signs of decline (weak and stubby laterals) the branches are cut back to 7-15 cm during 4 <sup>th</sup> year at the beginning of the monsoons.
Harvesting	:	In the 1 <sup>st</sup> year only one harvest can be taken. From the 2 <sup>nd</sup> year onwards leafy shoots are harvested 3-4 times a year. The tender tips with terminal leaves are harvested which constitute the oil material for extraction. The harvesting is done at the beginning of flowering season when the lemon like odour of the leaves has changed to a pronounced rosy note. After every harvest; adequate foliage should be left on the plant. The harvesting should be carried out possibly in full bloom which takes 120 days after planting. The harvested crop should be dried in open air 1-2 days and send it for distillation. After each harvest spray 0.1% Bavistin or Benomyl, give fertilizers and irrigation immediately.
Yield	:	➤ Herbage yield is 30-40 t/ha/year and Oil yield is 30-40 kg/ha/yr and up to 100 kg/ha in well managed plot. ➤ Oil content ranges from 0.1 to 0.15 % on fresh weight basis. ➤ Terminal portion with 6-12 leaves contain more oil than the middle or basal portions.

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## VETIVER (KHAS)

B.N.	:	<i>Vetiveria zizanioides</i> L.
Family	:	Graminae
Origin	:	India and Srilanka
Part Used	:	Roots
Composition	:	Veteverol
Uses	:	The vetiver oil is extracted from the roots of grass. Oil from roots is used for soap making, perfumes and attars. Roots are used to make mats, brooms, screens, mattresses along with bamboo. Roots are used in pharmaceuticals. Leaves are used as roofing material and for mulching. The roots are also used in pharmaceutical preparation both in allopathic & Ayurvedic system of medicine.
Varieties	:	Akhila, Bharatpur, Musanagar, ODVI, Nilambur, Hybrid 7 &8, etc.
Climate & Soil	:	It prefers a mild climate but can be grown under both wet and dry or arid and tropical conditions. Under temperate or warm winter hill areas, the growth of vetiver remains stunted. The most suitable soil consists of loose sandy soils, preferably on the sloppy hills. In such soils only, the roots can be easily pulled out without much loss of thin roots. Compact and heavy soils may be avoided.
Preparation of land	:	The land is laid out in to beds of 30 cm high, 68 cm wide and 45 cm apart edge to edge and the slips are planted on these in two rows 22.5 cm apart, leaving 22.5 cm on either sides.
Propagation Method, Time, Sowing/Planting and Spacing	:	<ul style="list-style-type: none"> <li>➤ Through slips or tillers. Tillers take long time for growing &amp; therefore, slips are the better for propagations.</li> <li>➤ The top of the slips are cut down before planting to reduce transpiration loss, thus giving a better chance for survival.</li> <li>➤ The slips are planted in pits, 5 to 8 cm deep made with a pointed stick. Two or three slips are planted in each hold.</li> <li>➤ After planting, the soil around the slips is pressed firmly and leveled.</li> <li>➤ For One ha. 150000 to 225000 slips with 2 - 3 slips/pit are required.</li> <li>➤ The best planting time to get higher oil yield under South Indian condition is June-July.</li> <li>➤ Spacing: 22.5 cm x 22.5 cm.</li> </ul>
Manures & Fertilizers	:	Generally, application of groundnut cake or cattle manure has a beneficial effect on the yield of roots. Dose; 20 : 22.5 : 22.5 kg NPK/ha.
Harvesting	:	Roots for distillation will be ready for harvesting at 18 months after planting. Young tender thin roots give poor quality oil. Oil from the old thicker well developed roots is of better quality and darker colour. <u>Harvesting time</u> : Oil content and yield are less during rainy season as the oil is diffused into soil. Harvesting roots during dry periods is more preferable. <u>Harvesting method</u> : Portions are cut to 15 to 20 cm above the ground. Clumps are uprooted by digging forks. Soil is dug up to 30 to 40 cm to get 50 % roots. Clumps are beaten to remove adhering soil and roots are separated from the stem portion with sharp knife. Clean the roots thoroughly in running water and send for distillation.
Yield	:	On an average one hectare of vetiver plantation yields 5 to 7 tones of roots which on distillation yield 15 to 16 kg of oil. Roots yield 1.00 to 1.50 per cent of oil on dry weight basis: The colour of the oil is light yellow and the oil contains 65 to 75 per cent veteverol.

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# PROCESSING AND VALUE ADDITION IN AROMATIC PLANTS

## A. Processing / Extraction of Essential oil from Aromatic Plant Extract:

### **Important features of Essential Oil:**

- These essential oils are the odoriferous steam volatile constituents of the aromatic plants.
- These essential oils are used in perfumery, cosmetic and pharmaceutical industries.
- They are usually present in the aerial parts of plants such as flowers, fruits and leaves.
- Most of the commercial essential oil bearing plants belongs to the families Labitae, Myrtaceae, Rutaceae, Compositae, Rosaceae, Graminae and Pinaceae.
- The essential oil accumulation in a plant depends upon the developmental stage of the concerned organ/plant part.
- The composition of the essential oil also varies greatly with the developmental stage of the plants.

### **Methods of Essential Oil Extraction:**

<b>I. Distillation</b>	<b>II. Expression</b>	<b>III. Solvent extraction</b>
1. Water distillation	1. Sponge expression	1. Maceration
2. Water-Steam distillation	2. Sfumatrice Process	2. Enfleurage
3. Direct steam distillation	3. Pelatrice Process	3. Solvent extraction
• Other specialized distillation		4. Super critical carbon dioxide CO <sub>2</sub>
1. Cohobation		
2. Fractional distillation		

### **I. Distillation:**

It is often termed as hydro distillation. Because of water is used in this method. There are mainly three different types of methods of distillation as below:

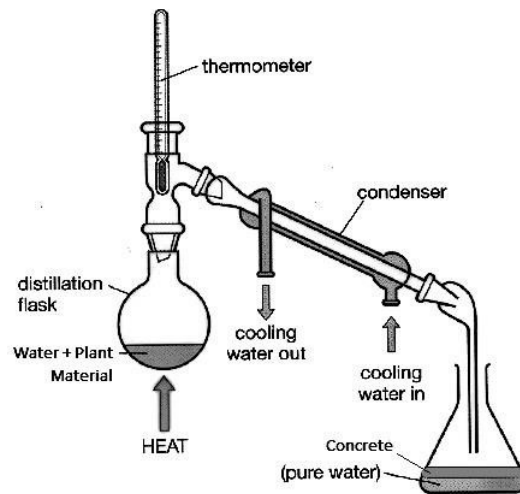
**1. Water Distillation:**In this method, the material is completely immersed in water, which is boiled by applying heat by direct fire, steam jacket, closed steam jacket, closed steam coil or open steam coil. The main characteristic of this process is that there is direct contact between boiling water and plant material. When the condensed material cools down, the water and essential oil is separated and the oil decanted to be used as essential oil. The water that is so separated in this process is also used and is marketed as "floral waters" (also called hydrosol or sweet water) - such as rosewater, lavender water and orange water.

#### **Advantage:**

1. Permits extraction of essential oil from finely powdered plant materials.
2. Inexpensive, easy to construct and suitable for field operation.
3. Oils from powdered material can be extracted.

#### **Disadvantage:**

1. Complete extraction is not possible.
2. Certain esters are partly hydrolyzed and aldehydes tend to polymerize.
3. Water distillation requires a greater number of stills, more space and more fuel.
4. Plant material sometimes burns.



**Fig. 1:Water distillation unit**

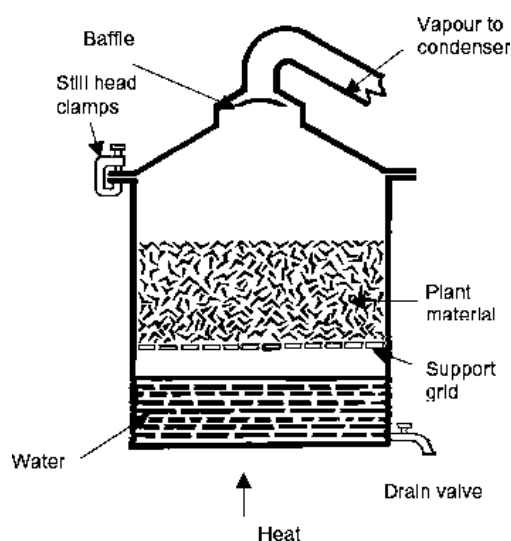
**2. Water- Steam Distillation:**In water and steam distillation, the steam can be generated either in a satellite boiler or within the still, although separated from the plant material. plant material cannot be in direct contact with the fire source beneath the still; however, the walls of the still are good conductors of heat so that still notes can also be obtained from the thermal degradation reactions of plant material that is touching the sides of the still. A Like water distillation, water and steam distillation is widely used in rural areas. Moreover, it does not require a great deal more capital expenditure than water distillation. Also, the equipment used is generally similar to that used in water distillation, but the plant material is supported above the boiling water on a perforated grid. In fact, it is common that persons performing water distillation eventually progress to water and steam distillation.

**Advantages:**

1. Higher oil yield.
2. More energy efficient.
3. High oil quality.
4. Volatile oil is less susceptible to hydrolysis and polymerization.

**Disadvantage:**

1. Requires longer hours of distillation.
2. Plant material of lower portion resting on the grid becomes waterlogged.



**Fig. 2:Water-steam distillation unit**

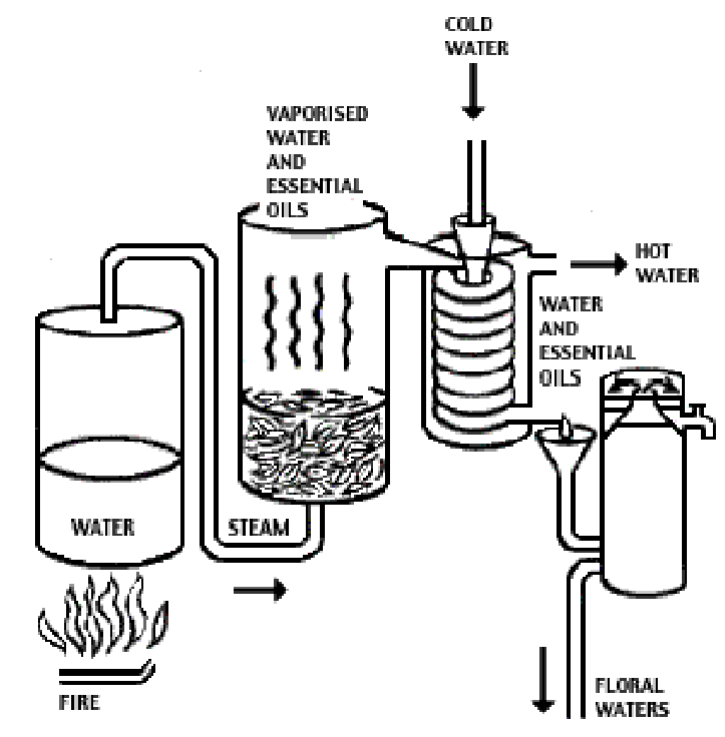
**3. Direct Steam Distillation:** Direct steam distillation is the process of distilling plant material with steam generated outside the still in a satellite steam generator generally referred to as a boiler. As in water and steam distillation, the plant material is supported on a perforated grid above the steam inlet. A real advantage of satellite steam generation is that the amount of steam can be readily controlled. Because steam is generated in a satellite boiler, the plant material is heated no higher than 100° C and, consequently, it should not undergo thermal degradation. Steam distillation is the most widely accepted process for the production of essential oils on large scale. Throughout the flavor and fragrance supply business, it is a standard practice.

**Advantages:**

1. Amount of steam can be readily controlled
2. No thermal decomposition of oil constituents
3. Most widely accepted process for large-scale oil production

**Disadvantage**

1. Much higher capital expenditure needed to establish



**Fig. 3:Direct steam distillation unit**

**4. Cohobation:** This technique can be used for water distillation or for water and steam distillation. It uses the process of returning the distillate water to the still after the oil has been separated from it so that it can be re-boiled. This is basically an improvised methodology of the directly fired type steam and water distillation units for oils which have partial solubility in water.

**Advantage**

1. The oils which have comparatively higher solubility in water are extracted through cohobation. eg: Rose, Lavender and Geranium oil.



## **II. Expression**

Manufacturing of essential oil by means of mechanical pressure to the plant material is basically referred as expression method. No heating of plant material is done during pressing. It is often termed as "cold pressed" method. This method was applied earlier exclusively for citrus oil extraction in Sicily.

### **Characteristics of this method:**

1. No heat is required in this method
2. Mostly nuts and oil seeds are extracted using "cold pressed" method
3. Oil is forced from the material under high mechanical pressure
4. Generally produces a good quality oil
5. Citrus oil, orange oil, bergamot oils are also extracted following this method

Three different expression methods are sponge expression, pelatrice process (machine abrasion) and sfumatrice process. These methods are not generally useful for aromatic and medicinal herbage.

## **III. Solvent Extraction**

1. **Maceration:** In this process, crushed plant materials are placed in a closed vessel filled with solvent called menstruum. The system is allowed to stand for seven days, with occasional shaking. Seven days after the liquid is pulled off through a cloth from the solid plant materials (marc). The marc is also pressed to recover as much occluded solution as possible. The strained and expressed liquid thus obtained is mixed (*miscell*) and clarified by filtration.

### **Principles behind maceration**

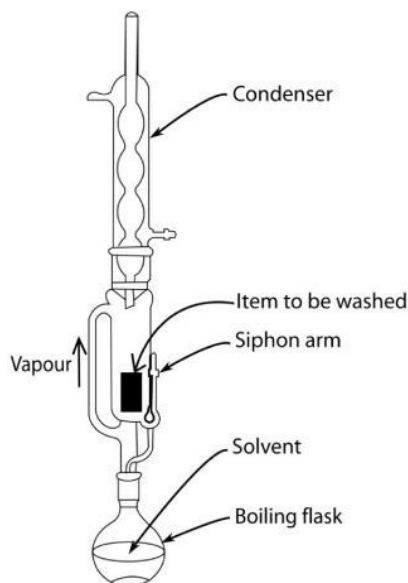
1. The process of extraction works by molecular diffusion which requires more time.
  2. Occasional shaking
    - Assists diffusion
    - Ensures dispersal of solution adhering around the surface of the particles
    - Bringing fresh menstruum to the particle surface for further extraction
  3. A closed vessel is used to prevent evaporation of the menstruum during the extraction period
2. **Enfleurage (Cold fat extraction):** In this process flower petals are placed on the fat for a few hours; then repeatedly, the oil petals are removed, and a new layer of petals is introduced. After the fat has absorbed as much fragrance as possible, the oil may be removed by extraction with alcohol. This method was formerly used extensively in the production of perfumes and pomades.
  3. **Solvent Extraction:** In this method Soxhlet apparatus is used. Plant material is placed in a thimble-holder, which is filled with condensed fresh solvent. When the liquid reaches the overflow level, a siphon is attached with thimble-holder which helps to unload the solvent it back into the distillation flask, carrying extracted solutes into the bulk liquid. Solute is left in the flask and fresh solvent passes back into the plant solid bed. The operation is repeated until complete extraction is achieved.

### **Advantages:**

1. The displacement of transfer equilibrium by repeatedly bringing fresh solvent into contact with the solid matrix
2. Maintaining a relatively high extraction temperature with heat from the distillation flask
3. No filtration of the extract is required

**Disadvantages:**

1. Agitation is not possible in the Soxhlet device
2. The possibility of thermal decomposition
3. Time consuming method

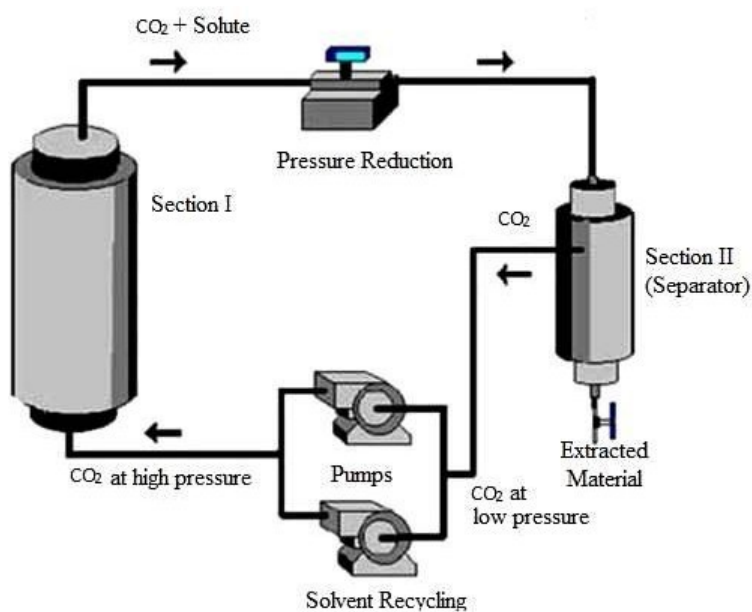


**Fig. 4: Soxhlet apparatus**

**4. Super Critical Fluid Extraction CO<sub>2</sub>:** The process is basically composed of two main sections:

**Section I:** In this part plant materials come in contact with CO<sub>2</sub>. Usually, CO<sub>2</sub> forced towards plant materials at high pressure ( $P_c=73.81$  bar) and high temperature ( $T_c=31.06$  °C). At this condition (super critical) CO<sub>2</sub> turns into fluid form and able the extract essential oil from plant material. A solvent is also used to increase the solubility of essential oil in supercritical CO<sub>2</sub>.

**Section II:** It is known as separator. Separation of essential oil from supercritical CO<sub>2</sub> usually carried out by adjusting the temperature and pressure. Due to the low solubility in supercritical CO<sub>2</sub>, after recovery of the essential oil the solvent must be recycled and pumped back to the extractor, in order to minimize operating costs.



**Fig. 5: Super critical fluid extraction CO<sub>2</sub>**

## II. Value Added Products from Aromatic Plants

Technologies are available for isolation of aroma principles from aromatic plants through distillation, fractional distillation, solvent extraction, expression, super critical fluid extraction etc. The products can be obtained from aromatic plants and enterprises can be established based on these products.

1. Essential/ aromatic oils
2. Aroma chemicals
3. Concretes & Absolutes: obtained from flowers.
4. Oleoresins: obtained from spices.
5. Resins, resinoids obtained from wood or dry plant parts.
6. Gums
7. Perfumed water / Hydrosol

These products are widely used in fragrance industry, flavour industry, aromatherapy and pharmaceutical industry. A number of single consumer product or multiple products enterprises can be started at rural and urban centres. Examples of small and medium enterprises in existence include companies manufacturing soaps, agarbatties, rose water, attars, perfumes, hair oils etc.; aromatherapy/ naturopathy centres, beauty clinics, etc.

### Processed products:

1. Essential Oils: It is extracted from flowers like rose, jasmine, tuberose, marigold, calendula, etc through steam distillation. It is the volatile material(s) derived from odorous plant material of a single botanical species. Chemically these are organic compounds made up of hydrocarbon molecules and can further be classified as terpenes, alcohols, esters, aldehydes, ketones and phenols, etc.
2. Concrete: It is a wax like substance containing the natural flower perfume together with some plant waxes, albumin and colouring matter which is generally absorbed by the solvent in form of volatile material.
3. Absolute: It is highly concentrated, entirely alcohol soluble and usually liquid perfume material obtained by alcohol extraction of concrete or from fat extracts of plant materials.
4. Rose water: It is obtained from petals & used as perfume & in medicines & confectionary.
5. Gulroban/ Gulroghan: It is rose hair oil prepared from rose petals by effleurage with wet sesame seeds. It is used as a hair oil, aromatherapy and body massage.
6. Gulkhand (Jam): It is most delicious and is prepared from rose petals and is rich in calcium and has antioxidant activity.
7. Pankhuri: Dried rose petals are known as pankhuri which is occasionally used for preparing sweetened cold drinks.
8. Floral Products: edible products like squash, sharbat, syrup, gulkhand, pankhuri, water, tea, jam, etc can be prepared from rose.
9. Bathing and Body Care Products: The best herbal baths includes dried flowers and also used in lotions, toners, facial steams, masks, hair rinses and sprays.
10. Pharmaceutical Compounds: Like vincristine, catharanthine, etc are used in cancer treatment. Rose fruits contain vitamin-C which is used for cure of scurvy.

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