TRAINING MANUAL

On

ADVANCE FLOWER NURSERY AND VALUE ADDITION

Supporting Institution :

Ministry of Rural Rehabilitation and Development, MRRD

Afghanistan Rural Enterprise Development Programme, AREDP, Afghanistan

Organizer and Consultancy :

Center for Environment and Economic Development, CEED

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List of acronyms

ACKNOWLEDGEMENT

Centre for Environment and Economic Development (CEED), India would like to acknowledge the contributions to a successful training workshop made by the CSK Agriculture University, IHBT, Palampur and UHF, Solan Himachal Pradesh and supported by the Ministry of Rural Rehabilitation and Development, MRRD, Afghanistan Rural Enterprise Development Programme, AREDP, Afghanistan.

Centre for Environment and Economic Development (CEED) also acknowledge this Manual which will be milestone for the Flower Cultivation and floriculture Nursery Business in Afghanistan and in future it will be useful for improve technical skills among the SEMs of Parwan provinces of Afghanistan. Further, it also improve to increase the flower production and nursery Management as well which will directly and indirectly boosts the Rural economy in Afghanistan. CEED also assured that it will continue its training support MRRD/AREDP and look forward for future collaboration and cooperation for development rural economy of Afghanistan and its people. Furthermore, CEED is always committed for sustainable development in Asian countries.

BRIEFING ABOUT THE AFGHANISTAN RURAL ENTERPRISE DEVELOPMENT PROGRAM (AREDP):

The Ministry of Rural Rehabilitation and Development (MRRD)|Afghanistan Rural Enterprise Development Program (AREDP), is planning to arrange a technical know-how (Commercial Floriculture Nursery Preparation ,Development and Marketing) training & exposure visit for its SMEs.

Introduction of AREDP :

Afghanistan Rural Enterprise Development Program (AREDP) is a national government-led program to jump-start private sector growth in rural Afghanistan. The Program seeks to facilitate the rural private sector development through; (i) integrated, value chain, knowledge-based interventions from top to bottom; (ii) community enterprise development; and (iii) from bottom to top by addressing credit and capital needs for rural and small and medium enterprises. Some of the sectors of focus are: large farms, agro processing, food processing, handicrafts, manufacturing, construction materials, and marble/tile. The Program components are:

- Community-based Enterprise Development: to supply business knowledge and build financial capacity in the rural enterprise sector; and
- Small and Medium Enterprise (SME) Development: to support small and medium enterprises with business advisory services and to connect rural enterprises to available credit and other financial services.

The components aim to increase income generation and employment through support to producers in key value chains. These chains will vary according to the geography, infrastructure and trading profile of each provin

1. Background

Nurseries can grow plants in open fields, on container fields and in tunnels or greenhouses. In open fields, nurseries grow ornamental trees, shrubs and herbaceous perennials, especially the plants meant for the wholesale trade or for amenity plantings. On a container field nurseries grow, small trees, shrubs and

herbaceous plants, usually destined for sales in garden centers. Nurseries also grow plants in greenhouses, a building of glass or in plastic tunnels, designed to protect young plants from harsh weather (especially frost), while allowing access to light and ventilation. Modern greenhouses allow automated control of temperature, ventilation and light and semi-automated watering and feeding. Some also have fold-back roofs to allow "hardening-off" of plants without the need for manual transfer to outdoor beds. Most nurseries remain highly labor-intensive. Although some processes have been mechanized and automated, others have not. It remains highly unlikely that all plants treated in the same way at the same time will arrive at the same condition together, so plant care requires observation, judgment and manual dexterity; selection for sale requires comparison and judgment. Business is highly seasonal, concentrated in spring and autumn. For enhancing the technical skills of the SMEs from the Parwan Province and promotion of Floriculture Nursery and develop economies of Rural Afghanistan this training was proposed and organized. . The rebuilding of the country's horticulture can provide abundant employment opportunities and significant income at the farm level, and foreign exchange at the national level. Horticulture provides a critical source of nutrients and production diversity and represents the most attractive alternative to current poppy cultivation in rural areas. The reestablishment of horticulture must focus upon quality produce, with increased production emphasizing sustainable practices with effective linkages to markets, both local and international. This training will generate job opportunities for both men and women, especially in the rural areas of Afghanistan, which leads to local economic growth. It will further upgrade skills of SME members in scientifically managing the nuresy; increase their knowledge on the value chain; link them with markets; provide guidance on how develop hi-tech horticulture can work in groups; and develop rural folk into effective business managers and organizational leaders. Hence increased production of quality nursery will help meet domestic and export demand of food security which is expected to increase as a result of the completion of the road rehabilitated of the North-South Corridor.

2. Objectives

The main objectives of this training are to:

i) *Training on value addition and quality control for better economic gain from the products by the nursery activities.*

ii) *Hands-on training on Flower cultivation, breeding, irrigation, diseases, cutting, green houses,*
iii) *Training on Grafting, fertilizing and seed processing*
iv) *Train the participants on modern nursery practices and problems*
v) *To train the members of the SME for establishment of better management system.*
vi) *To enhance skills of the SME members.*
vii) *To improve quality of products in order to compete with similar imported products in local market.*

3. Target Participants

- This training programme is targeted for 7 SMEs from Parwan province of Afghanistan. This training was scheduled and organized for 8 days in Himachal Pradesh, India.

4. Expected outcomes:

The participants will acquire knowledge and skills on advanced floriculture and nursery practices related to processing/ preservation, packaging and marketing of flower bearing plants. The participants will also be exposed to latest developments in technology and hands-on training at different nurseries/processing plants.

5. Venue:

The training was hosted by CSK Agriculture University, IHBT, Palampur and UHF, Solan Himachal Pradesh India.

6. Training Schedule:

July 3rd -10th July 2013

WELCOME ADDRESS

Welcoming Address by Dr. Surinder Bhan, PhD, Head of Department, Department of Vegetable Science and Floriculture. He well come all the SMEs from the Afghanistan and given a bunch of flower as symbol of friendship and given assurance for best possible cooperation and support from the University Side.

After the welcome session, Dr. Ashutosh Mohanty has explained about the programme and objective of the session. He elaborated how this programme could be milestone for knowledge exchange and sharing information and experience from the both the countries. He also appreciates the University support for making this event possible in CSK University.

Honorable Dean Dr. Paul has given vote of thanks and given Flore to start the training programme. He has given some examples from the Afghanistan Floriculture and need of cooperation and exchange of knowledge between the two countries for better cooperation in the arena of Commercial floriculture and land management's.

Mr.Andalib Mushtari Business Development Service Officer of AREDP Parwan Province and Team leader of this training given special thanks to CSK Agriculture University and CEED Authorities on behalf of AREDP and introduced Participants of the Training, moreover he explained goals and objectives of the training and expectation of participants.

Status, scope and importance of Commercial Floriculture

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Floriculture is fast emerging venture on the world scenario growing at a modest annual rate of about 8-10 percent. This has become a potential money-spinner activity for the third world countries. Total value of flowers and floricultural products at wholesale level has been recorded over 50 billion US$ from about 2 million hectare area. Total value of all floricultural products from 191 countries has crossed over 20.8 billion US$ in 2011 (www.uncomtrade.com).

Top Ten Cut Flowers in 2012	
Name	Value (m euros)
Rose	768
Chrysanthemum spray	294
Tulip	227
Lilium	137
Gerbera	134
Chrysanthemum disbud	74
Cymbidium	60
Freesia	50
Eustoma	47
Hydrangea	35

In India, floriculture is also being viewed as high growth activity in agriculture sector. The area under flower crops has increased from thirty thousand hectares in 1993 to 2.53 lakh hectares in 2012 (www.nhb.gov.in). Indian floriculture industry is fast becoming more aware of the importance of offering products according to the wishes of consumers. With the changing trends and a constant urge for new innovative products in domestic and foreign flower markets, therefore, the flower growers have to respond immediately. The export of total floricultural products has increased from Rs. 14.5 crores in 1991-92 to over 423.4 crores in 2013 (www.apeda.com).

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

Country	2009-10	2010-11	2011-12	2012-13
USA	53.06 (I)	56.87 (I)	71.29 (I)	83.81 (I)
the Netherlands	42.18 (II)	41.62 (III)	54.13 (III)	59.70 (II)
UK	37.88 (IV)	37.62 (IV)	38.56 (IV)	45.68 (IV)
Germany	40.65 (III)	42.81 (II)	57.53 (II)	56.75 (III)
Japan	15.59 (V)	11.52 (V)	14.72 (V)	15.67 (VI)
Others	105.10	96.01	129.09	161.79
Total	294.46	296.0	365.32	423.4

The nature has endowed Himachal Pradesh with a variety of agro-climatic conditions due to which large number of flower crops with excellent quality can be produced throughout the year in one or the other part of the state. The climate in the state ranges from sub-tropical to wet and dry temperate. Flower cultivation has eminent role in amelioration of the hill environment and to boost the rural economy of the state, which owes because of the following points viz., generating various sources of cash income to the hill and mountain people, generating employment opportunities in pre and post harvest activities in this sector, satisfying aesthetic needs of the people and developing sustainable agriculture system in hill and mountain areas.

Major flowers grown in India

The farmers are in general reluctant to take up floricultural activities on commercial scale, as flowers are highly perishable commodities. But, higher returns per unit area and time have attracted the selected farmers to take up the flower cultivation on commercial scale, as Floriculture industry in our country is growing at a modest rate, which has been because the ncrease in per capita income especially disposable income, increase in individual purchasing power, change in social values of peoples, increase in population specially in cities, increase in number of hotels & tourists and increasing awareness among peoples for air pollution and to improve deteriorating environment.

Favorable conditions for flower cultivation in hill and mountain areas :

The congenial environmental conditions particularly in hill and mountain areas are ideally suited for commercial flower growing. High temperature coupled with hot winds during June to September makes it difficult to grow quality flowers in north-western plains, therefore, causes shortage of flowers in the major cities like Delhi,

Chandigarh, Panchkula, Amritsar, Ludhiana and Pathankot, where flower prices shot up sharply during this period. As per one estimate alone in Delhi market total sale turn over of various flowers and floricultural products is over rupees one thousand crores per annum. The farmers from mid and high hills can take this advantage of congenial mild climate during May to November and can earn higher profit per unit area. It is evident from the progress made in flower cultivation in the state that the area under flowers has gone up from 30 ha in 1993-94 to around 860 ha in 2011-12 and more than 3000 farmers have taken up commercial flower cultivation. During 2011-12 floricultural products of worth over Rupees Ninety seven crores were sold (Source: Directorate of Horticulture, Shimla, Himachal Pradesh).

Major flower production areas in Himachal Pradesh:

Leading flower producing districts are Sirmaur (559 ha) followed by Kangra (91), Solan (66), Chamba (50), Bilaspur (47), Shimla (38) and Kullu (26 ha) during 2012-13.

Major flowers being grown in Himachal Pradesh:

The major flowers (acreage-wise) in Himachal Pradesh are chrysanthemum (315) followed by marigold (314 ha), gladiolus (101), carnation (65), rose (35), Lilium (13) and Gerbera (6 ha), Daffodils (1.7) and Alstroemeria (0.9 ha) during 2012-13.

Agencies and organizations providing incentives for promoting Floriculture in Himachal Pradesh:

The main agencies promoting Floriculture in Himachal Pradesh are through Horticulture Technology Mission of Government of India, National Horticulture Board, NABARD, APEDA, Desert Development Board, Nationalized and State Co-operative/ Rural/Gramin Banks and Ministries of Rural Development/ Commerce/ Environment, Government of India.

A. Directly Associated Components of Floriculture in Himachal Pradesh:

1. Production of off-season flowers:

Nature has blessed Himachal Pradesh with a varied agro-climatic conditions congenial for growing a variety of flower crops at a time when these can not grown in the adjoining North Indian plains, thus resulting in the scarcity of quality flowers especially in the major cities like Delhi, Chandigarh, Amritsar, Ludhiana, etc. The

important potential cut flowers are Gladiolus, Carnation, Chrysanthemum, Lilium, Gerbera, Daffodils and Alstroemeria in addition to some specialty cut flowers like Bird of Paradise, Calla lily, Liatris and Licianthus (Eustoma). Among the loose flowers the marigold is most important in addition to further scope to cultivate chrysanthemum, tuberose, gaillardia, gomphrena and jasmine to fulfill the increasing demand for loose flowers in the cities for religious and social functions. Horticulture Technology Mission and Pandit Deen Dayal Bagvan Yojna have further boosted the commercial flower cultivation.

2. Production of cut foliage:

Himalayan region is very rich with plant wealth containing a number of plants suitable for cut greens or cut foliage. The cut foliage is used in various floral arrangements including bouquets. At present the trade over Rupees 1140 million is being done globally. The important exporting countries for cut greens are the Netherlands, Denmark, USA, Italy and Belgium, whereas the leading importing countries are the Netherlands, Germany, USA, Belgium and France. The important cut greens in world floriculture trade are *Asparagus,* Ferns, *Banksias, Eucalyptus, Podocarpous, Cypress* and *Thuja.* The other plants in Himachal Pradesh, which can be used for cut foliage are *Cocculus*, local Ferns, *Myrsine, Myrtus, Ophiopogon*, Privet, Conifers (*Abies, Cryptomeria, Cupressus, Picea, Taxus, Thuja*), etc. These cut greens are used in softening lines of floral arrangements, provide contrast in

floral arrangements, complement the beauty of flowers and fills voids or gaps in floral designs. The cut foliage must be looking fresh with no wilt, rolling, discolouring or leaf dropping for a reasonable length of time (Desh Raj, 2011)

3. Production of planting material:

The main growing/production season of most of bulbous plants in hills is summer and rainy season, when there are long days, ideal temperature for growth, development and enlargement of bulbs in comparison to the plain areas. The bulbs produced in the hills are of good quality, healthy and of bigger size than produced in the plain areas. The important bulbous plants suitable for planting material production are Gladiolus, Lilium, Tulip, Calla lily, Alstroemeria, Daffodil, Iris, Hyacinth, Ornithogallum, Kniphofia, etc.

4. Production of live/pot/ house plants:

The important house/ pot plants which can be commercially grown in hills are Araucaria, Begonia (Rex and Tuberous), Belloperone, Calceolaria, Chrysanthemum, Cyclamen, Fuchsia, Ferns, Geranium, Juniper, Saintpaulia, Streptocarpus, etc. There are over forty commercial nurseries in the state and out of which about fifty percent are in district Kangra, which are selling 300-400 different types of live/pot plants for interior and exterior landscaping.

5. Production of bonsai:

Bonsai is an art, which expresses in miniature the beauty of natural tree forms. The word 'Bonsai' is comprised of two words '*Bon*' means a tray or shallow container and '*sai*' means to grow; thus bonsai means something growing in a shallow container or tree in a pot. Bonsai culture requires painter's eye, poet's imagination and sculpture's hand. Bonsai is essentially the art of choosing a plant which has the potential of becoming a good bonsai. Growing it under complete, constant and affectionate care so that it blends with the container in which it is planted to express its natural beauty. Thus, every bonsai has its own personality and individuality like human beings. The important factors affecting the success of a good bonsai are selection of right plant species, constant, complete and affectionate care, suitable growing media, adequate sunshine, water, ventilation and fertilizers, careful

trimming, training, pruning, wiring and repotting and balance among the roots, trunk, branches and foliage should always be maintained.

The plants suitable for making bonsai are Abies, Amaltas, Araucaria, Babul, Bamboo, Banyan, Ber, Bottle brush, Bougainvillea, Casuarina, Cherry, Chinese orange, Coranda, Cryptomeria, Deodar, Duranta, Excoecaria, Gulmohar, Hibiscus, Ixora, Jacaranda, Java fig tree, Murraya, Malpighia, Oleander, Peach, Pines, Pilkhan, Pipal, Plum, Podocarpus, Silver oak, Spruce, etc.

6. Production of flower seed:

The agro-climatic conditions prevailing in different parts of the state are congenial for quality seed production of ornamental annuals, biennials and perennials. The seed production of the ornamentals which produce quality in seed only hills is of greater importance to the farming community of the state as their seed can not be produced in the plains. The important flowers for seed production are China aster, lupine, pansy, viola, Rudbeckia, oxalis and geranium, etc.

7. Production of dried ornamental plant parts and floral craft items:

The rich biodiversity of the ornamental plants growing wild or naturalized in the state offers enormous opportunity for sale of naturally dried ornamental plant parts and their value added products in the domestic and foreign markets. On an average for the last almost two decades the contribution of dried ornamentals export is about 60-70% of the total export of floricultural products, thus highlighting the importance of this component in national economy and state in particular.

8. Flower perfumery:

During the last two decades several flower crops viz., roses, geranium, lavender, jasmine, etc are being grown for extraction of perfume or essential oils. The main advantage of expansion of flower perfumery industry in the state is that the essential oil percentage is more with better quality in comparison to plain areas.

9. Consultancy services:

Educated youth in Agriculture/ Horticulture with specialization in Floriculture and specialized flower growers can offer expertise to other new and upcoming flower

growers within the state and other hilly states for further boosting floriculture activities for better livelihood of the mountain society.

10. Plant rental services:

Keeping in view the increased demand of ornamental plants in various hotels, banks and other offices, some persons can be engaged in supplying live/pot plants for interior decoration on rental basis. Further, there is also scope for starting contract landscape maintenance services.

B. Indirectly Associated Components of Floriculture in Himachal Pradesh:

1. Manufacturing pots and containers:

Various types of pots i.e. earthen, plastic, brass, glass or concrete are required to grow various types of ornamental plants. Thus, some person can be involved in producing these pots for earning their livelihood.

2. Greenhouse material and its construction:

For quality flower production green houses have become an indispensable aspect of the floriculture industry. In the recent years the greenhouses have shown greater practical utility with higher returns per unit area to the growers and their demand is regularly increasing. Thus, some persons can earn their livelihood by involving in the business, construction and maintenance of greenhouses and related material.

3. Material for flowers packaging:

For marketing of the various floricultural products their good packaging is essential as ill-packed material become inferior and fetches little or no price. Thus, for packaging good material be used and number of persons can be involved in preparing the packaging material like cartons of corrugated cardboard, wooden or plastic, bamboo baskets, etc.

4. Transporting floricultural products:

For transporting the flower products from their place of production to the actual marketing place, some persons can earn their livelihood and for avoiding the cruelty of middlemen, the growers should make their own co-operatives, self help

groups and their representatives can be involved in the marketing channels for ensuring higher profit to the growers.

5. Cold storage:

As flowers are most perishable commodity therefore, these should be stored at the recommended temperature and humidity in the cold storage. The cold storage built at the production centres and whole sale markets will be of greater utility. The persons can keep the flowers in cold storage on rent basis for earning their livelihood and higher returns to the growers.

6. Floral preservatives:

Treatment of cut flowers, loose flowers and cut foliage before marketing and after taking them to homes by the consumer, different types of flower preservatives can enhance the longevity of flowers and foliage. Thus, some companies and persons can be involved in this trade also.

7. Horticultural inputs:

For growing quality flowers, foliage and pot plants different types of inputs like fertilizers, fungicides, insecticides, implements, etc. are required by the growers. Thus, some persons can earn their livelihood by selling such types of horticultural inputs.

Bottlenecks of developing Floriculture in Himachal Pradesh:

The major bottlenecks of developing Floriculture in Himachal Pradesh are non-availability of quality seed and planting material, poor availability of scientific/ technical know-how, less awareness among farmers regarding flower cultivation, poor quality flowers as per International standards, poor/ inadequate transport facilities, meager facilities for cold storage, pre-cooling of cut flowers & cool chain, lack of organized cooperative societies and self help groups, high freight rates and higher profits earned by middle-men.

Suggestions for boosting Floriculture in Himachal Pradesh:

For boosting Floriculture in Himachal Pradesh it is proposed to consider various measures viz., production of only those cut flowers and other floricultural products, which are in demand especially in off season (May to November) or in a

lean flower producing period in plains, more emphasis is to be given for cultivation of those flower crops which can only be grown in hill and mountain areas, development of viable Floriculture cooperatives of the flower growers for smooth procurement of quality planting material and sale of the flower produce, adequate incentives and support for promoting Floriculture from the government agencies, proper use of the new post harvest management practices, environment friendly with use of organic farming and low pesticide application technology should be promoted, promoting the custom seed production and buy-back arrangements for the floricultural produce, proper use of the advanced information technology system in the country for better marketing of the produce so that flower grower's share in profit is increased and introduction of crop insurance scheme in flower crops, as flowers are more perishable than other agricultural crops, thus making the cultivation more risky.

Summary:

The future prospects of Floriculture industry in the state seems to be bright keeping in view the congenial agro-climatic conditions for production of quality flowers all through the year in one or other part of the state, which has been witnessed through the recognition of a natural greenhouse of the country. Further, with the increasing population especially in the nearby metropolitan cities, the demand for various floricultural products is increasing. Thus, high profit per unit area in the cultivation of flower crops in comparison to other agricultural crops, the farmers will be more benefited and the flower cultivation in the state will get the boost on one hand while, the aesthetic desire of million of people residing in the plain areas will be fulfilled by relishing, enjoying and complimenting the beauty of flowers produced from the hill and mountain areas.

Commercial Production Technology of Lilium

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Today floriculture has been identified as the most rapidly expanding enterprises with annual growth rate of 12-15 percent. Lilies are among the top 10 cut flower of the world and belong to family Liliaceae. Several cultivars of lily are grown for cut flower purpose. It has beautiful, attractive and bright flowers with long life. It fetches a very good price in the market. They grow well in 50 % shade net. Among the different types of lilies, the Asiatic and Oriental hybrid lilies are very popular. Asiatic hybrid lily are relatively easier to grow and can be grown apart from alleviated locations, even in the plains during the cooler months. Oriental hybrid lily can be successfully grown in cool hilly regions. In Asiatic group, few important cultivars are Pollyanna, London, Grand Paradiso, Prato, Novecento, Navona, Brunello, Elite etc.

The commercially cultivated Oriental lilies are Star Gazer Pink, Star Gazer White, Casa Blanca, and Siberia etc. They are commercially propagated through bulbs, bulbs scale and tissue culture. Sandy loam soil with pH range of 5.5 to 7.0 found suitable for cultivation of lilies. To obtain the best quality lily, the day temperature range should be 20 to 25^{o}C and 10 to 15^{o}C during night. At the time of bud initiation, growers are advised to use shading net to cut off 50% light. The size of bulb is very important factor to produce the quality flower. 14-16 cm and 18-20 cm circumference of bulb are standard size for Asiatic and Oriental lily respectively for 'A' grade flower production. It is advisable that lily should be planted on raised bed 20 cm above the ground with 1.0-1.2 m width and maximum depth for commercial size bulb 10-12 cm. The bulb to bulb and row to row distance for commercial size bulb kept 15 cm for Asiatic and 20 cm in case of Oriental lily. Excessive watering is harmful to the crop. So, irrigate the crop as and when required. The flowers are generally harvested from 20 cm in case of Asiatic and 30 cm in Oriental lily above the soil surface of bed, so that development of the bulb may continue in the soil. Among the different fungal diseases, the Bulb and Scale Rot caused by *Fusarium*, Foot Rot by *Phytophthora*, Root Rot by *Pythium* and Leaf Spot by *Botrytis* are major

diseases. The bulbs should be dipped for 1 hr in 0.2% Bavistin+0.2% Captan solution before planting and after harvest the bulbs and bulblets. Aphids and thrips cause damage to the lily plants. Endosulfan or Malathian spray @ 2 ml/ l of water will protect the plants. The flower stems are harvested for packing and transportation of cut flowers at primary bud colour showing stage. Bulbs are lifted after showing yellow colour of aerial parts. After lifting the bulbs are washed, treated with fungicide and stored in cold room at 4^0 C for12 weeks in case of Asiatic lily and Oriental lily 14 weeks for forcing.

Commercial Production Technology of Alstroemeria

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Alstroemeria is known as the lily of Incase (Inca lily) or Peruvian lily, has been grown as a cut flower. It is an exotic perennial and rhizomatous plant. Its plants produce beautiful, large inflorescence in various colour– orange, lavender, pink, maroon, yellow, white, red, purple and bicolours. Flowering period of Alstroemeria is February to August depending upon the crop cycle, planting time and variety. The cut flowers remain fresh for 10–12 days at room temperature. Its does not prefer direct sunlight and can be grown successfully in cool place under polyhouse and shading net conditions. Alstroemeria prefers sandy loam soil with pH 5.5 to 7.0. In case of clay soil, it is advised to mix sand and well decomposed farm yard manure (FYM) to make it porous. For better plant and quality flower production, the optimum day and night temperature should be maintained between 18-22^{o}C and 12-16^{o}C respectively. High temperature may increase the production of blind shoots. It is a long day plant. Sufficient light (5000 ft candles) is important to prevent bud abortion and improve the quality of flowering shoots. Selection of Alstroemeria cultivars should be made on the basis of its colour demand in the markets, large florets, long stems, good in keeping quality, resistance to diseases and high cut flower production. Beds should be made in well pulverized soil. Soil should be dug to a depth of 30-40 cm deep to allow the roots to grow properly during 2-3 years production cycle. Before planting incorporate judicial quantity of organic and inorganic fertilizers and mix up to 30-40 cm depth of the soil. Bed should be prepared long and 1 m wide along with the 40-50 cm wide paths between the beds. Alstroemeria is propagated by division of rhizomes. From 1 year old plant, 10-15 and from 2 year old plant 20-25 rhizomes can be obtained. It can be planted throughout the year in cooler place. The best time of planting in the mid hills is July-November. It can be planted in 1 m wide beds in two rows at 50 cm spacing. The plant to plant distance within the row should be 30-50 cm. Regular fertilization with 450 mg N and 300-450 mg K per plant per week is required for good growth and development of plant. Alstroemeria requires quality water for irrigation for better growth. If sufficient water is not given to the crop, the flower production declines. Newly planted crop should not be over-irrigated. Thinning of undesirable shoots

promotes the production of new shoots and improves the quality of flowers. At one time, 30% of the shoots should be removed. Flowering shoots emerge after 5–6 months of the planting, depending upon the cultivar and it takes further 25-35 days to flower. For nearby markets, flower should be harvested when primary florets are fully developed colour and majority of them are showing colour. Harvesting should preferably be done by pulling the flowering shoots in the morning hours. Yield of flowering shoots mainly depends upon the cultivars, plant spacing, growing conditions and cultural practices. Alstroemeria plant can produce 50 to 75 flowering shoots per plant per year under polyhouse conditions. The plants are affected by a number of fungal diseases which attack the plants and flowers. The most destructive diseases are botrytis, root rot and foot rot. It can be controlled by use of fungicides and sterilization of soil before planting, better air circulation and decreasing the moisture content of growing media. Aphids and caterpillar are mainly insect damage to the crop. Regular spray of Endosu lfan or Malathian @ 1.0 – 1.5 ml/ l of water at every 15-20 days can control it.

Production Technology of Gladiolus

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Gladiolus is one of the important flowers among the bulbous crops, grown for flowers. It is very much popular among the customers and available in different shape, size and colour. It can be grown easily under different climatic conditions. The time of planting is Oct.-Nov. in the plains and March-April in the hills. It can be grown up to 2000 m height. In the areas having chances of heavy frost it can be grown in poly houses. Gladiolus should be grown in the places having full sun. Places having strong winds should be avoided for cultivation. The optimum temperature required is 10^{o} C to 25^{o}C. Gladiolus can be grown in different types of soil if there is no stagnation of water. Sandy loam soil rich in organic matter is most suitable for gladiolus cultivation. In heavy soil, mix sand to make it suitable for cultivation. Soil having pH 5.5 to 7.0 are suitable for growing gladiolus. Soil should be prepared 30-40 cm deep and mixed with well rotten FYM@10 kg/m^2 before the soil treatment. Treat the soil with 2% formaldehyde (50 ml/ liter of water) 20-30 days before the corm planting. Disease free planting material should be selected for flower and corm production. Corm having circumference 2.5 cm or above should be selected for flower production. Corm less than 2.5 cm circumference should be used for planting material production. Treat the Corm and Cormel in 0.2% solution of Captan + Benomyl for an hour to make them fungus free before planting and after harvesting. Corm and Cormel should be planted immediately after taking them out from the solution.

Gladiolus can be planted by two methods: Flat beds and ridges. In sandy soil corms can be planted in flat bed. In heavy soil and high rain fall area it can be planted in ridge or 4-6 inches raised beds. In flat beds keep row to row space 15 cm and in ridges 30 cm. Corm should be planted 15 cm apart in the row and Cormel 5 cm apart. Depending upon the size of corm they should be planted 10-15 cm deep in soil. Cormel and corms should be covered with 2-4 inches layer of soil. If sowing is done on ridges earthing should be done at 3-4 leaf stage. Gladiolus needs light moisture throughout its growing period. Water requirement is maximum after emergence of 3^{rd} leaf to 7^{th} leaf stage. Irrigate the plants in the morning hours.

Weeds adversely affect the growth of crop. Spray Glyphosate @ 5 ml/ l of water two weeks before the planting of corm and cormel in the field. Spray of Glyphosate can be done in between the row after emergence of the plants. Spray in the morning or evening hours during the clear weather. Apply 50 gm of single super phosphate and 25 gm of potash per square meter at the time of field preparation. Apply first dose of Calcium amonium nitrate (CAN) @ 40 gm/m^2 after the emergence of 1st leaf to third leaf stage. Apply second dose of CAN @ 40 gm/m^2 after 20-30 days of the first dose.

Gladiolus flowers within 60 to 120 days of planting. Crop generally mature within 6-7 months. Corms mature within 60 to 80 days of flowering. Spray the crop with insecticide and fungicides time to time. After flowering when the leaves start drying cut the plants 6" above the ground and stop irrigation. Harvest the corm and cormels after 25-30 days of cutting the plants and grade them accordingly. Corms have 3-4 month dormancy period. Harvested corm and cormels should be cleaned and treated with 0.2% Bavistin or Benomyl and dry them in shade. Store the corms in plastic crates and keep them in cool, and ventilated place. In hot places gladiolus should be stored in cold rooms at 3-7^0 C for 3 months to break the dormancy. Gladiolus flower should be picked as soon as the bottom flower bud of the spike starts colouring.

Commercial grading system:

Grade	**Spike length cm**	**minimum number of florets**
Fancy	>107	16
Special	0-107	15
Standard	>81-96	12
Utility	< 81	10

Popular varieties

American Beauty, Friendship, White Prosperity, Yellow Supreme, Video, Priscilla, Orange

Trump, Peter Pears etc.

Commercial Production Technology of Rose

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Rose is perhaps the most important ornamental bedding plant in a garden and is acclaimed universally as the “queen of flowers”. . It derives popularity because of its adaptability to various soil and climatic conditions, long blooming period and beautiful flowers with good shelf life which lend themselves to numerous uses ranging all the way from religious offerings to intricate decorative arrangements. Rose petals are used as medicament in Ayurveda and for extraction of highly prized essential oil used in the perfumery industry Rose is the number one cut flower in the international market. For cut flowers roses are extensively cultivated in Netherlands, Columbia, Japan, Italy, Germany, France, Spain, United States of America (USA) , Morocco, Korea, Israel, Kenya, Zimbabwe, India and Malaysia. In flower markets mainly Hybrid Tea (H.T), Floribunda and the Spray Types are in demand for production of cut roses.

Roses can be grown successfully under various climatic conditions. Quality flowers are obtained in areas with bright sunny days, cool nights, moderate humidity and absence of strong winds. In general, it preferres day temperature of 25 to 28^0 C and night temperature 16 to 18^0 C. Long days of 12 hours and humidity of 60 to 70% favours growth and quality flower production. During flower bud initiation, long days play an important role but later stage of bud development is influenced by light intensities.

Selection of site is very important for successful growing of roses . The selected site for rose planting should get full day sunlight. In summer season it prefers partial shade during the hot afternoons . In the garden rose plantation area should not be too close to tall trees. Rose plants can not survive in water logging conditions even for a short period. The location of rose plantation should be free from dusts. Rose plants grow well in medium loamy , rich in organic matter, well drained soil of at least 40 to 50 cm depth. s. The sub-soil must have the capacity to hold and retain adequate r moisture. Water logging adversely affects growth therefore, clayey soils which are heavy and poor in aeration are not preferred by

rose plant. In case of clay soil, it is advised to mix sand and well decomposed FYM to make it porous. The best soil pH for roses should be 6.0-6.5 with electrical conductivity less than 1.0. . Now-a-days, artificial media like cocopeat, perlite and mixture of cocopeat and perlite are preferred because they are inert, sterile and have no cation exchange capacity, so that applied nutrients are available to the rose plants directly.

Roses are perennial plants and will remain in the same bed/pit for many years . The initial preparation of the soil should preferably start during summer season. In the garden, the design of beds should be simple and informal. Rectangular beds with 30 cm wide path between two beds offer certain advantage for cultural operations. The length and width of bed may be 6.0 m x 1.2 m. In the rectangular bed, planting two or three rows will be a good practice. Dig pits 30 cm in diameter and a similar depth at least one month before planting and expose them to sunlight. Few days before planting the l pits are filled with one part of well decomposed FYM and one part each of fresh soil and coarse sand. In termite prone areas, antitermite chemicals like chlorpyriphos should be applied to the soil before planting. Pits should be irrigated to settle the mixture.

Rose is propagated by seeds, budding, grafting, layering, cuttings; and through micro-propagation for disease free plants. Asexual propagation allows plants to grow true to type. It is commercially propagated by budding. Rose plants revel in low temperature and root growth is very active in winter season. Its plants can be planted at any time of the year. However, irrespective of the locations in hills, October is the most suitable time for planting of roses. In temperate climate, it can be planted in open field from October-November and February to March. Rose plats are best planted in rows. Rose beds present a harmony of colour and height of plants. A spacing of 50-60 cm from plant to plant and row to row within beds may be required for Hybrid Teas, Polyanthas, Floribandas and Teas. In case of vigorous growing bushes of rose plants, the spacing may be 75-100 cm. To get maximum flowering shoots, roses should preferably be planted 20x30 cm apart. Roses should be planted on thoroughly prepared pits in beds. Before operation of planting, this should be ensured that the soil just moist in pits. A hole, measuring 20-30 cm in diameter and 30 cm in depth, will be sufficient in most of the cases. The depth of planting will vary

with the type of planting materials. The budded plants are planted in such a way that the budding/matrix point should remain 5-7 cm above the soil surface.

Roses are very fond of water and require one to two inches of it every week. During hot, dry season, even more may be needed depending on the size of the bushes. In spite of their need for abundance of water, roses hate standing in water and provision for proper drainage is essential. Irrigation should be done during the morning time. Avoid evening watering, which could foster powdery mildew which. is a very common disease among roses. During the rainy season, watering will be required only during the dry periods between the rain events.

Pruning is one of the most important operations in rose cultivation which influences the yield and quality of flowers. . In pruning all dry, diseased, weak and crisscross shoots are removed to open up the center of the bush. Any suckers that arise from the root-stocks are also removed. The best time of pruning is during the period when the rose plant is at dormant to near dormant stage. It will depend on the climatic conditions of the rose growing region. Usually the Hybrid Tea and Floribunda roses take 45-50 days to come to flowering after the pruning. In, plains pruning is recommended in October after rainy season. In hilly areas where the winter is very cold, the pruning operation is done in last week of February to 15 March. Like all plants, roses require air, water, nutrients and sunshine for growth and development. The yield and quality of flowers can be markedly increased through supply of proper quantity of fertilizers and manures to plants..Nitrogen, phosphorus, and potassium are required large quantities. For roses, the entire quantity of phosphorus and potash should be applied at the time of land preparation. Nitrogen is applied in split doses. Well rotten farmyard manure @ 5-6 kg/m^2 should be incorporated well in the soil at the time of soil preparation.

An investigation on the effect of nitrogen in combination with phosphorus and potassium on growth, flower yield and quality of four indigenous cut flower rose varieties (namely Pusa Gaurav, Dr. Bharat Ram, Arjun and Nehru Centenary) at Palampur (H.P.) revealed that the. maximum diameter of flowering stem & flower bud, width of flower, number of petals per flower and flowers with stem length of 60 cm and above were recorded with application of 9g N + 8g P_2O_5 + 8g K_2O per m^2 per

week . Foliar spray of micronutrients is more effective in roses. Biswas (1984) recommended that 3 g each of magnesium sulphate and potassium sulphate along with 0.75 g borax dissolved in 1 liter of water and sprayed on rose corrected the deficiency of magnesium, potassium and boron.

INSECTS

Red spider mite

Mites are very common on rose. They first appear on lower surface of leaves, and can subsequently cover the entire leaf, stem and after sometime whole plant with their web. The infected plants give dusty and webbed appearance. These can be controlled by spraying Kelthane (Dicofol) @ 0.1% or Omite 0.03%.

Caterpillar

Caterpillars are mostly a problem of rose buds and young leaves. In the initial stages, they eat away the foliage. The eggs are laid on the buds and larvae eat into the bud damaging it completely . These can be controlled by spraying Nuvan @ 0.15 to0.2%.

Aphids

Aphids occur in more than 4000 aphis species. Many are vectors for a number of viruses. Aphids areSucking insects that draw chlorophyll from leaves and buds. Spraying of Metasystox or Malathio @ 0.2 % controls aphids.

Thrips

Among insects, thrips are the most serious pests on rose. Thrips prefer dry hot conditions. Both nymphs and adult forms of this small insect suck the cell sap from the leaves, tender stem and flowers. Nair *et al.,* (1991) recommended the application of dimethoate and monocrotophos @0.05-0.1% to control thrips.

Red Scale

Red scale insects attack on the lower part of old stem of rose and cover them with reddish brown waxy incrustation. The scale insect sucks the plant sap and the infested stems gradually dries up. Rainy season is the main period for infestation of red scale insects on rose plant. These insects can be removed by rubbing the infested stems with old soft tooth brush. These can be controlled by spraying Monocrotophos @0.1%.

DISEASES

Dieback

Fungi such as *Colletotrichum* sp. have also been found associated with die back disease. The severity of this disease is noticed after the pruning operation. As sit name indicates, symptoms of this disease are blackening at the tip of stem which spreads downwards rapidly. Blackening of twigs results from browning of internal tissues. The disease can be prevented by taking precaution at the time of pruning. The pruning cut should be slanting and made with sharp secateurs. Some systemic fungicides like Bavistin 0.2% should be sprayed immediate after pruning. Removal of affected part including about 2-3 cm below in the healthy part and use of Bavistin paste afterwards controls the disease.

Powdery mildew

In powdery mildew, initialy whitish tiny spots appear on young leaves. The entire plant displys white powdery appearance in severe cases, consequently reducing the vigour of the plant. Infected buds do not open and in open flowers the infection leads to discolouration. The disease can be controlled by Karathane (0.1%) or Benlate (0.1%) sprays.

Downy mildew

Downy Mildew is a very common disease of roses and occurs under moist cloudy conditions. All species of cultivated and wild rose seem to be susceptible. Under cool and moist spring conditions, young leaves, stems and flowers may manifest purple to red or brown irregular spots. As the disease advances, lesions on leaves become angular and black with the possible appearance of white mycelium on the underside of the leaf. Advanced infections display yellowing of leaves with brown necrotic areas and noticeable leaf abscission. The disease can be controlled by spraying Ridomil or Dithane M-45 0.2%.

Black spot

This fungal disease was first reported by R.D. Ansted (Bardoli and Ganguli, 1963) and causes major problems in cold climate of temperate region. The infested leaves show black spots on upper and lower sides.. At later stages, leaves become yellow and fall off. The disease can be controlled by spraying Dithane M-45 0.15%.

Botrytis

In *Botrytis, the* disease infection appears as brown patches on the flower buds. It is more common in temperate humid climates. At later stages, buds become brownish and rot. Spraying of Bavistin 0.2 % controls botrytis. Bar *et al.* (2001) observed that susceptibility to *Botrytis* decreased with increasing concentration of calcium in the flower.

HARVESTING OF FLOWERS

The beauty of the roses is best enjoyed when they are on the plants in the garden. Sometime it may be necessary to have a few rose flowers for decorating the drawing room or the dining table. The flowers are harvested when they are at tight bud stage and when petals have just started unfolding. The flowers should be harvested either in the morning or evening by sharp secateur. After harvesting, flowers should be dipped in clean water under proper ventilation. They should remain there for about one and half hour before any further operation.

Production of Perfumery Ingredients from Aromatic Crops

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Overall is a growing demand of organically grown crops especially those are directly used for human consumption. WTO has put strong restriction on wild collection and farm produce materials out of cultivated sources are mandatory for processing industries. Cultivated crops assure traceability of the product and also address the environmental concerns. International buyers will strict on good agricultural practices (GAP) and good manufacturing practices (GMP).

Uniform quality herb raw materials of known identity and properties can be ensured through cultivation but suitable production technology, availability of characterized planting materials and information on large number of herbs are important for a new entrepreneur. Therefore, an attempt has been made here to present useful information on selected aromatic crops suitable for production in Afghanistan.

1. CULTIVATION OF GERMAN CHAMOMILE (*MATRICARIA CHAMOMILLA* LINN.)

Botanical Name: *Matricaria chamomilla* Linn. (Syn. *Camomilla recutita* L.)

Family: Asteraceae (Syn. Compositae)

Common Name: German Chamomile

Other Names: Blue chamomile, Matricaria, Hungarian Chamomile, Raushert Chamomile, Mother Herb etc. This oil is not to be confused with Roman Chamomile (*Arthemis nobilis*) or Moroccan Chamomile (*Ormims multicaulis*). These are entirely different plants. A related perennial species, Roman Chamomile (*Anthemis nobilis* L. or *Chamaemelum nobile* L.) has similar uses. Both species have white, daisy-like flowers, but the flower receptacle of German Chamomile is hollow while that of Roman chamomile is solid. All these 3 species are reported under one Unani name "Babuna" at different places in literature. The correct scientific name of Babuna is *M. chamomilla*.

Distribution: German Chamomile (*Matricaria chamomilla* L.) is an annual plant that is native to Europe. It has been cultivated in North America for many years and in Germany, still the major user, where the name originated. It is also widespread in Central Europe, particularly Hungary and Czechoslovakia. It has been successfully introduced in many other countries.

Major Producing Countries: Egypt (1 tonne), France (1 tonne), Hungary (1 tonne), Bulgaria (700 kg), Portugal (500 kg), Czechoslovakia (100 kg) and also being promoted in India, Brazil and Argentina. A total of 50 tons oil is produced by Italy, Egypt, France and Mexico. In India it is not in common production and the requirement is met only through imports. However, dried flowers are traded mostly in India.

Yield and Description: German Chamomile is grown as an annual crop having crop duration of 4-5 months. The plant is a small herb that attains 50-75 cm average height. The oil is present in the flowers. The yield and quality are dependent on correct selection of crop variety, harvest time, location, use of fertilizer and climatic conditions. The dried flowers are reported to contain between 0.3 and 0.5% oil. The

oil is dark blue in colour. This color is indicative of the freshness and age of the oil. Old oil loses the liquid sheen, turning dark grey -green. The oil on ageing and during distillation tends to form a deposit on the walls of metal containers. Yield of Chamomile flowers range from 35-50 q/ha fresh flowers.

Main Uses; The flowers of German chamomile are used in herbal teas and flower extracts are used in herbal shampoos and cosmetics. Infusions are prepared from the flowering tops that are used as mild sedatives and as digestive aids. Essential oil from flowers is used in cosmetics, perfumery, as a flavouring agent for confectionery and in beverages. This oil is called "blue Chamomile" because of the compound “chamazulene” which is formed during the distillation process. The essential oil has several names (Oil of German Chamomile, Oil of Blue Chamomile, Oil of Matricaria, Oil of Raushert Chamomile and Mother Herb Oil). Pharmaceutical use of the oil for its anti-inflammatory, anti bacterial and fungicidal properties is well known. These properties have been attributed to both the chamazulene and to bisabolol constituents. In the 16th century, Chamomile was used for the treatment inverse. Chamomile drinks are today reported to be used for cardiac ailments due to the presence of as well as for chronic gastritis, stomach spasms and diarrhea. The medicinal properties are attributed the chamazulene and (-) alpha bisabolol in the oil.

Growth Habit; The branched stem is erect and smooth and grows to a height of 15–60 cm. The long and narrow leaves are bipinnate or tripinnate. The flowers are borne in paniculate capitula. The white ray florets are furnished with a ligule, while the disc florets are yellow. The hollow receptacle is swollen and lacks scales. This property distinguishes German Chamomile from Corn Chamomile (*Anthemis arvensis*), which has a receptacle with scales. The flowers have a strong, aromatic smell, and bloom in early to mid summer.

Climate: German chamomile is relatively easy to grow and prefers cooler climate during its growth period. Chamomile is seeded in early spring. Chamomile is a very adaptable plant and responds to the local climate or altitude, growing from 300 to 2500 m *amsl*. Experiencing some freezing temperatures will not harm the plants, but reduces the 'bloom' period. Temperature and light conditions have greater effect on essential oils and chamazulene content than soil type. Greater day length is reported to increase oil content and quality as well as chamazulene content.

Soil: It can be grown on any type of soil, except on rich, heavy and damp soils. It is suitable for planting in saline soils. It has a high sodium uptake, thus regenerating the soil. At Banthra farm of the National Botanical Research Institute, Lucknow, the crop has been grown successfully on soil with pH of 9.

Cultivation

Chamomile is an annual herb propagated by seeds during October onwards, transplanted during November to March and the flowers in full bloom stage are harvested in January and continue till July, highly dependent on location of cultivation ranging from sub-tropical to temperate. In Europe and Argentina, the herb is a summer crop. In India and Egypt, it is a winter annual crop and is used as a fill-in between cereal crops. Allthough chamomile oil has good market but dried flowers fetch better price.

Chamomile may be cultivated from seed by transplants or by direct seeding. The direct seeding rate is 0.35 to 0.50 kg/ha. The seed is small and must be planted shallowly. Moisture conditions in the fields should be very good in case of direct seed sowing otherwise, adequate plant stand is not obtained due to poor seed germination.

After 5-6 weeks the seedlings can be transplanted at a spacing of 0.30 m x 0.30 m apart. Chamomile has shallow roots and so the plants have to be frequently irrigated. Irrigation is usually needed, especially during seedling establishment. The soil has to be moist, but not flooded. Constant weeding is necessary until the chamomile 'mat' takes over. Successive plantings can be made to spread out the harvest.

Insects; Aphids are a spring problem, while powdery mildew, which would damage the crop, is controlled by spraying with wettable sulphur.

Harvesting Period: This is a continuous procedure once chamomile is in bloom. In Egypt, flowers are picked by children on a 7 - 10 day rotation during January to April. Harvesting is best during temperatures from 22 - 25 ^{0}C.

Harvesting Methods: Hand harvest for the highest quality (tea grade) product involves raking the flower heads from the plants at weekly intervals. This is labour intensive and the harvesting method is adapted to suit the size of the operation. Clipping the flower heads from the plants may be an option for oil production, but a

lower quality oil results if too much foliage is included. Flower forks are used to pick up the flowers and these have been converted for mechanical operation in Hungary and South America. Hand harvesting of chamomile flowers is extremely labour intensive. In Australia, up to 1 kg dry flowers are harvested in an hour, but the average is 0.3 to 0.5 kg. The number of labourers required to harvest a field every 7 days or so must be considered when deciding whether to grow chamomile. Therefore, commercial cultivation of the crop is economically viable where cheap labour is available.

Although harvesters have been designed and built but are not commercially available. The plants grow quite uneven with repeated raking, making it more difficult to reach the flowers lower in the plant. Shearing the plants resulted in re-growth of the flowers at a uniform height at the clipped surface. A combination of clipping and raking may be most useful if a grower wishes to produce both an essential oil and a dried tea-grade flower.

Drying and Storage of Flowers: The flowers have to be dried immediately on picking. The flowers must be dried carefully to avoid discolouration or heating. This cannot be done in the Sun, but in the shade, turning to prevent browning. For large operations, they are dried in a heated tunnel. Preservation of the flowers is controlled by moisture content attained during drying. The flowers, whether for use as such, or for oil production, should be stored in dry polyethylene lined bags. The oil must be stored cool, in full containers out of contact with light. When the oil is to be decanted, the flasks or bottles should be well agitated.

Estimated productivity and production of Chamomile at farmers' fields

Particular	Detail/value
Gestation period	**4 months**
Crop life	**4 months**
Harvest frequency	**20-30 days bloom interval, harvest weekly**
Economic product	**Fresh Flower**
Economic product yield	**50 q/ha**
Economic product price	**Rs. 25/kg**
Gross return	**Rs. 1.250 lakh/ha/y**
Cost of production	**Rs. 0.745 lakh/ha/y**
Net return	**Rs. 0.505 lakh/ha/y**
Essential oil content	**0.20 %**
Essential oil yield	**10 kg/ha/year**
Essential oil price	**Rs. 25000 /kg**

2. CULTIVATION OF DAMASK ROSE (*ROSA DAMASCENA*) FOR HIGH VALUED ROSE OIL

Damask rose (*Rosa damascena* Mill.), is an important species among the scented roses and yield highly fragrant and commercially valuable essential oil known as rose oil. Its other product is rose concrete, rose absolute and rose water. Rose oil and rose water are produced by steam distillation; and rose concrete and rose absolute through solvent extraction. The products of Damask rose are used in medicine, food in perfume industry as well as in cosmetic and health products. Commercial cultivation of Damask rose in India dates back to Mughal times.

Different kinds of rose oil blends were discovered in India and *Gulab* is important rose *attar* produced with blending of sandal wood oil. The world production of rose oil is estimated to be 15-20 t with Bulgaria, Turkey, Morocco, France, and Italy being the largest producers. Turkey and Bulgaria are presently leading in the production of rose oil while Morocco produces mainly rose water. India, Egypt, China, France and Russia are among other countries which produce rose oil, rose water, concrete and absolute. Over the centuries, Damask rose oil has been used in high class perfumes and in cosmetics. Rose water finds use in skin and ophthalmic diseases. Its products have worldwide industrial acceptance. Rose oil has been the subject of a number of studies since ancient times. Anti-HIV, antibacterial and antioxidant activities of *R. damascena* essential oil have been demonstrated recently.

Distribution and Production

There are mainly four species of roses for essential oil production. These are *Rosa damascena* Mill., *Rosa gallica* L., *Rosa moschata* Herrm. and *Rosa centifolia* L. Turkey, the main rose oil producer in the world, uses *R. damascena* for rose oil production. Since the plant was originally brought to Europe from Damascus, it is called Damask rose. *R. damascena* was first found grown wild and it is still self-growing in Caucasus, Syria, Morocco and Andalusia. Iran has also been mentioned as one of its origins.In Iran, cultivation and consumption of *R. damascena* has a long history. It is believed that the crude distillation of roses for the oil was originated from Persia in late 7th century A.D., and spread to the provinces of Ottoman Empire later in 14th century. Iran was the main producer of rose oil until the 16th century exporting around the world.

In India about 2500-3000 hectares of land is under cultivation of *R. damascena* in the states of J&K, Himachal Pradesh, Uttar Pradesh, Punjab, Rajasthan and Bihar. India produces about 150 kg rose oil besides major quantity of rose water and a small quantity of blended rose *attars*. Higher acreage under Damask rose is in northern plains. Western Himalayan region is most suitable for its cultivation.

Origin, Plant Type and Varieties

Recent studies on tri-parental origin of Damask roses established three *Rosa* species viz. *R. moschata*, *R. gallica* and *R. fedschenkoana*, as parental species of the original hybridization that contributed to forming the four oldest Damask varieties. This group has two distinct sections; The Summer Damasks and the Autumn Damasks. The former flowers once only and are large, thorny quite open growing shrubs with intensely fragrant pink flowers. The latter and their allies, the Portland roses, are shorter, more compact shrubs with the ability to repeat flower in autumn.

Damask rose is a perennial bushy shrub having economic plantation life of more than 25 years. Cultivation of Damask rose and production of rose oil began in what was then the Turkish province of Eastern Roumelia (now Kazanlik) in the 15th century. It was not until 1894 that *R. damascena* was re-introduced in Turkey from Kazanlik, and large-scale production recommenced in the south-western part of Turkey including Isparta and Burdur provinces. Gestation period is three years for attaining economic production level. Plant produces flowers once in a year for 25 to 35 days during early summer period.

The Institute of Himalayan Bioresource Technology (IHBT), Palampur has developed two cultivars of Damask rose i.e. Jwala and Himroz. Jwala is suitable for cultivation in subtropical northern plains, mid-hills and mild temperate regions up to 1200 m altitude. Himroz is suitable for cultivation in mild temperate to cold temperate regions (1200 to 2500 m altitude). It tolerates cold temperature and grows in temperate areas without any winter injury to flower buds.

Soil and Climate

Damask rose requires heat, water, high fertility and under these conditions it flowers well. It needs moderate temperature and humid air during flowering to achieve maximum oil content. For producing quality grade rose oil with higher oil yields a cold dry and mild temperate climate is suitable. It performs well in foothills, Shivalik ranges and north Indian plains with adequate precipitation or irrigation. Areas, without an impact of winter having high temperature coupled with high humidity, such as coastal peninsula and other parts of south India are not suitable for cultivation of Damask rose. Rose plantation requires bright sunny conditions and performs better when sun shine is available during whole day. It can not be

cultivated under tree plantations. A temperature range of 0 to 5^0C during winter season for plant dormancy, 25 to 30^0C temp and relative humidity more than 60% during flowering season provides good harvest of flowers.

Multiplication

Damask rose is propagated through one year old stem cuttings. It can also be propagated by sub division of old plant, lateral sprouts with roots (water-shoots) and seeds. Stem cuttings are used for raising nursery at the time of pruning during November- December. The rooting establishes within a year and rooted cuttings can be transplanted into main field. Planting can be done in Monsoon (July/August) but winter season (November- January) is most ideal period for its establishment in the field.

Planting:

One to two years old nursery grown rooted stem cuttings are preferred. It can be planted in 30 cm deep furrows or pits of 45 x 45 x 45 cm^3 size. Organic manure @ 25 tones/ha and N:P:K (12:32:16) fertilizer @ 25g per plant may be applied at the time of transplanting.

Plant geometry

Plant geometry in conjugation with pruning management systems are identified as follows:

System-1:- Dense plantation (1.0-1.25 m x 0.5- 0.75 m), with deep pruning up to ground level during November- December. This is followed in traditional rose growing areas of central and north Indian plains.
System-2:-Dense plantation (1.0-1.25 m x 0.5- 0.75 m), with deep pruning up to ground level during August. This is modified from system 1 for mid hill areas.
System-3:- Row plantation (1.50 - 1.75m x 0.50-0.75m), with cyclic pruning (successive increase of 10-12 cm height every year). This is evolved for foot hills to high hills.
System-4:- Spaced plantation (1.5-2.0 x 1.5-2.0 meter), tall bush formation and maintenance pruning during Nov-Dec once in year. This is suitable for temperate hills.

Crop management

Irrigation is necessary in young plantation during dry periods and the frequency can be reduced when the plants are established. Proper drainage is essential to avoid water logging. *R. damascena* requires balance doses of nutrients which can be given through organic manures and chemical fertilizers. Application of nitrogen, phosphorus and potassium (NPK) in established plantation should be applied @ N: 120, P: 60, K: 40 kg/ha. The above doses may be applied in two equal splits in fourth week of August and in January after pruning but before hoeing.

Following nutritional schedule should be maintained in rose fields:

Recommended Soil Fertility Status		**Recommended Fertilizer Dosages**	
Organic Carbon (%) (low to medium)	0.4 - 0.6	Compost / FYM t/ha	20 (1st year than every 3rd year)
Available nitrogen (N) Kg/ha (low to medium)	250-300	Nitrogen (N) Kg/ha	120
Available phosphorus (P) Kg/ha (medium to high)	25-35	Phosphorus (P_2O_5) Kg/ha	60
Available Potassium (K) Kg/ha	150-200	Potassium (K_2O) Kg/ha	40
pH	5.5-8.5		

Pruning

In rose, pruning is necessary not only to ease the harvesting of flowers and other inter cultural practices but it is also known to influence its yield. Pruning seems to affect both morphological as well as yield parameters in roses. As holds true for ornamental rose plant, pruning has been found to be fruitful in aromatic rose as well. Pruning is carried out to maintain the plants of desired size, to remove injured and diseased parts, to remove the terminal buds to change the growth habit and for taking optimum yield of flowers. Time, height and frequency of pruning are crucial

parameters for optimum yield of rose flowers. In the above, system-1 deep pruning upto ground level during November- December, system-2: cyclic pruning (successive increase of 10-12 cm height every year) and system-3**:-**tall bush formation and maintenance pruning during Nov -Dec once in year.

Interculture: Standard practices for inter-culture operation should be adopted to keep the fields weed free and to maintain proper soil tilth.

Plant protection: Aphids, thrips, chaffers, beetles, red scale mites, termites, caterpillars, rose leaf hoofers and rose leaf rolling saw flies are common insects of *R. damascena*. High rate of infestation is noticed during the flowering period which causes significant losses to flower yields. Foliar spray of 0.1% water solution of Monocil/ Nuvacron be applied during flower bud formation at 15 days interval. Black spot disease is very common and severely attacks rose plantation. This causes circular black spots on leaves and stems. All affected tissues should be removed from the plants and soil surface. High volume fungicide sprays with 0.1% carbendazim (Bavistin-50 WP) solution, applied regularly during summer and autumn, gives an effective control.

Flowering and plucking

The plantation starts yielding economic returns during the third flowering year. *R. damascena* flowers once in a year during late spring and early summer, however, exact flowering time varies from place to place depending on prevailing temperature. Flowers are plucked daily in the early morning hours before sunrise, when they have more concentration of oil. These are transferred to well aereated bamboo baskets before processing. Flowers are processed for different products immediately after harvesting. Loss of essential oil occurs when flowers are stored for a longer period. This results in fermentation of rose petals which increases the citronellol content and decreases geraniol, nerol and farnesol.

Erratic flowering

Damask rose is known for its irregular flowering behaviour. Following factors contribute to this phenomenon :

I. Plant growth hormone status

II. Nutritional imbalances

   i) In plantation system

ii) In soil system

III. Genotypic influences

IV. Crop husbandry practices

i) Pruning (height, time, number)

ii) Fertility management

V. Environmental factors

i) High temperature, dry weather and low air humidity

Yield and recoveries

Primary produce of Damask rose plantation is fresh rose flowers which are processed for obtaining different kinds of products.

I. Flower yield (q/ha): 25-30

II. Oil recovery (%): 0.025- 0.030

III. Oil yield (kg/ha): 0.65 -0.80

Extraction of aromatics

Rose flowers are harvested for processing rose water and rose oil which are produced by hydro-distillation. Rose concrete, a waxy semi solid material, is produced by extraction of fresh rose flowers with an organic solvent, hexane. Rose absolute is prepared from rose concrete by refluxing it with 90 % alcohol followed by filtration and removal of undesired fats. Solvent traces are removed by vacuum distillation leaving behind a highly fragrant viscous liquid called rose absolute. Production technology of three grades of rose water namely “A”, “AA”, and “AAA” grades and criteria for grading rose water and its quality analysis has been established by IHBT for the first time in the country.

Scale of Production - Hydrodistillation

Damask rose is a capital intensive and highly specialized enterprise wherein a relatively high initial investment on plantation and installation of distillation plant is required. Actual benefits are derived after a gestation period of 3 years plantation and sustained production is obtained for at least 10-12 years. Three scales of production level have been designed by IHBT for different categories of entrepreneurs:

I) Mini scale: About 0.25 to 0.40 hectare of Damask rose plantation with a mini distillation unit of 10 kg per batch flowers comprises minimum viable scale of production for marginal growers. 1000 -1200 litres of rose water can be produced during one flowering season. For this scale, rose oil production is not practical.

II) Medium scale: The size of plantation of 1.2 to 2.0 ha is suggested along with a direct fired field distillation unit specially designed for rose oil distillation. A target of 1.0 to 1.5 kg rose oil can be achieved with this set up.

III) Large scale: A minimum of 3 ha area should be brought under Damask rose plantation while adopting large size steam fed rose oil distillation unit. A capacity of 400 kg/ batch flowers is designed for such large scale plantations. One such unit can support up to 6-8 ha area. However, for plantations larger than 8 ha, two distillation units are recommended.

Quality parameters of rose oil

The following constituents give different characteristics of rose oil which determine its quality.

I. Basic fresh rosaceous character	:	1- citronellol, geraniol and nerol.	
II. Floral character	:	phenyl ethyl alcohol and farnesol	
III. Strong top notes	:	trans rose oxides	
IV. Rose alcohols	:	citronellol, geraniol, nerol, phenylethyl alcohol and farnesol.	
V. Minor constituents	:	cis-rose oxide	0.1%
		trans-rose oxide	0.1%
		□-damascone	0.1 %
		□-Damacenone	0.01%
		rose furan	0.10%
		Nerol oxide	0.1 %
VI. Fixative properties	:	stereoptenes	

The role of minor constituents in rose oil is very important as they contribute tremendous towards odour value in terms of having higher odour units. These minor constituents vary between 0.5 to 1 %. Although in very low concentration, the minor constituents possess half the odour value of major constituents. The sensory properties of minor constituents are decisive for the development of rose fragrance. Key to the odour secret of rose oil lies in these minor constituents and are responsible for the authenticity control of genuine rose oil produced on commercial scale. In addition to these sulphur compounds in rose oil also play an important role in its fragrance. The sulphur compounds so far identified in Rose oil are dimethyl sulphide, dimethyl disulphide, n-butyl methyl sulphide, and dimethyl trisulphide. These compounds contribute for the quality of Rose oil.

For profitable cultivation: Following points need consideration

1. Selection of best planting material to suit the locality
2. Development of own nursery and as such nursery can also be a business
3. Long gestation period; requires intercropping of short duration crops which need to be location specific and need based
4. Analysis of prevailing weather conditions of an area for a minimum of 10 years before taking up Damask rose
5. Deciding the scale of production based on market as well as suitability for processing facility
6. Care to avoid pod borer inhabiting other food crops like chillies, peas etc before the start of flowering season
7. Labour availability or integrating Damask rose with other crops to utilize the labour force during flower plucking.
8. Proper water management during dormancy period
9. Minimum nitrogenous fertilizers at the time of sprouting
10. Proper plant architecture
11. Hail storm during budding/flowering is detrimental to the crop.

Estimated Productivity And Production Of Damask At Farmers' Fields

Particular	Detail/value
Gestation period	24-30months
Crop life	120 months
Harvest frequency	Daily for 25-30 days in a year
Economic product	Fresh Flowers
Economic product yield	25 q/ha
Economic product price	Rs. 60/kg
Gross return	Rs. 1.500 lakh/ha/y
Cost of production	Rs. 0.700 lakh/ha/y
Net return	Rs. 0.661 lakh/ha/y
Essential oil content	0.025 %
Essential oil yield	0.625 kg/ha/year
Essential oil price	Rs. 350000 /kg

MARKET REPORT OF NATURAL ESSENTIAL OILS OF INDIAN ORIGIN

As on 31st December 2012

Sl. No.	Product	Price INR/kg.
1.	Ajowan oil	1000-1200
2.	Angelica root oil	25000-28000
3.	Anise oil	2000-2500
4.	Basil oil	800-1000
5.	Betel leaf oil	25000-40000
6.	Cajuput oil	900-1000
7.	Calamous oil	4400-4600
8.	Camphor oil	150-175
9.	Caraway oil	7000-7500
10.	Cardamom oil	10000-12000
11.	Carrot seed oil	5200-5500
12.	Cassia oil	2500-3000
13.	Cederwood oil (Himalayan)	700-800
14.	Celery seed oil	4300-4500
15.	Chamomile blue oil	25000-28000
16.	Cinnamon leaf oil	1300-1450
17.	Citronella oil	1000-1100
18.	Clove bud oil	1800-2000
19.	Coriander seed oil (Indian)	14000-15000
20.	Costus root oil	60000-65000
21.	Cubeb oil	9000-9500
22.	Cumin seed oil	4000-5000
23.	Curry leaf oil	6500-6800
24.	Cypriol (Nagarmotha) oil	8500-9500
25.	Davana oil	20000-22000
26.	Dill (Anethi) seed oil	1700-1800
27.	Elemi oil	2500-3500
28.	Eucalyptus citriodora oil	1000-1100

Sl. No.	Product	Price INR/kg.
29.	Eucalyptus globules oil	900-1000
30.	Fennel seed oil	2800-3000
31.	Galangal alpine oil	21000-22000
32.	Galangal kaempferia oil	15000-17000
33.	Galangal officinarum oil	7500-8500
34.	Geranium oil (south Indian)	9000-9200
35.	Ginger oil	5000-5500
36.	Ginger Grass oil	2000-2400
37.	Hedychium (Kapoor kachari) oil	2800-3000
38.	Jamrosa oil	1200-1500
39.	Juniper Berry oil	2600-2800
40.	Lemon Grass oil	800-900
41.	Lime (distilled) oil	1900-2100
42.	Mace oil	6500-7000
43.	Mandarin oil	1500-1600
44.	Marjoram oil	7500-8000
45.	Mentha arvensis (de-Mentholised) oil	1400-1450
46.	Mentha arvensis (shivalik) oil	1400-1450
47.	Mentha citrata (bergamot mint) oil	2300-2500
48.	Mentha piperita (pepermint) oil	1600-2000
49.	Mentha spicata (spearmint) oil	2200-2500
50.	Nutmeg oil	4500-5000
51.	Olibanum (frankincence) oil	2700-3000
52.	Orange oil	900-1100
53.	Palmarosa oil	2100-2500
54.	Pepper Black Oil	11000-13000
55.	Pine oil	160-200
56.	Sandalwood oil (East Indian)	80000-85000
57.	Spikenard (Jatamanshi) oil	13000-15000
58.	Sughan kokila oil	1700-1800
59.	Sughand mantri oil	13500-14500

Sl. No.	Product	Price INR/kg.
60.	Tagetes oil (North India)	5500-6500
61.	Thuja oil	2700-3000
62.	Tomar (xanthoxylum) Seed oil	1800-2000
63.	Tulsi (Ocimum sanctum) oil	4000-4500
64.	Turmeric (Curcuma aromatica)	2000-2100
65.	Turmeric (Curcuma longa) oil	1800-2000
66.	Valerain (Sughand Bala Root) oil	22000-23000
67.	Vetiver oil (Ruh khus)	30000-32000
68.	Vetiver oil (South Indian)	15000-16000

The above quoted prices are approximate and are always subject to deviation with the market trend. However, inquiries about the price and availability can be made from "Essential Oil Association of India, C-56A/25, Sector-62, Noida, U.P.-201301, Phone: 91-120-2400200, Fax: 91-120-2400103, E-mail: eoairdcenter@gmail.com, Website: www.eoai.in

Source: Indian Perfumer, Published by Essential Oil Association of India, Dec 2012, Vol. 56 no. 4, pp.**21**

Aromatic plant products for small and medium enterprises

Aromatic plant products can be in the form of botanicals & aroma concentrates as given here under:

- Seeds and nursery plants
- Fresh and dried herbs and also frozen herbs
- Essential oils
- Perfumed water/ hydrosol
- Concretes/ absolutes/ pomades from flowers
- Oleoresins from spices
- Resins, resinoids
- Gums
- Aroma chemicals from fractionation of essential oils

Table1- Global trade in aromatic plants and their products

Particulars	Trade
Aromatic plants traded in the world	400 types of essential oils
Value of essential oils traded in the world	US$ 5 billion in 2011
Value of aroma chemicals in the world	US$ 2.8 billion in 2011
Global trade for flavours & fragrances	US$ 22 billion in 2010
Global trade in cosmetics	US$ 300 billion in 2010

Production of essential oils

- Essential oils are the product of secondary metabolites of the plants and generally are concentrated, fragrant volatile liquids consisting of complex mixtures of mono and sesquiterpene hydrocarbons an oxygenated materials biogenically derived from them.
- These are natural flavourants which are derived from plant parts such as leaves, flowers, fruits, buds, seeds, twigs and stem.
- Essential oils are commonly liquid at room temperature and evaporate completely when heated, lighter than water and possess a high refractive index. It is readily soluble in alcohol, slightly soluble in water and dilute alcohol, somewhat more soluble in sugar solution.

Concrete and Absolutes

- A concrete is the solid waxy residue derived from hexane extraction of plant material (usually the flower petals).
- Absolutes are “essences,” rather than “essential oils”. They are generally, obtained from the extraction of a concrete with alcohol.
- This method of extraction is used for botanicals where the fragrance and therapeutic parts of the plant can only be unlocked using solvents.
- These are not to be used internally, as traces of petrochemicals remain in the oil. Jasmine, rose and neroli are examples of absolutes.

Methods of Production of Essential Oils

- Distillation
- Expression
- Solvent extraction
- Supercritical carbon dioxide (C02) extraction
- Microencapsulation
- Microwave accelerated distillation
- Absolutes

- Steam distillation is the oldest and traditional method of extraction. During distillation, aromatic plant material exposed to boiling water or steam release their essential oils through evaporation. Recovery of essential oil is facilitated by distillation of two immiscible liquids, viz, water and essential oil.
- At the boiling temperature, the combined vapor pressure equals the ambient pressure. Thus, the essential oil ingredient, whose boiling points are normally in the range $7O^0$ to $3OO^0$ C, are evaporated at a temperature close to that of water. The essential oil laden steam rises and enters narrow tubing that is cooled by an outside source (condenser). As steam and essential oil vapor are condensed, both are collected and separated in a vessel called 'Florentine flask'.
- The essential oil, being lighter than water, floats at the top, while water goes to the bottom and can be easily separated. The quality and quantity of steam distilled oil depends on the nature of botanical, temperature, length of distillation time and pressure. Yields are expressed as g essential oil/ 100 g of plant material.

Expression Method

- When a "cold pressed" method is referred to in the manufacture of essential oils, it basically refers to the expression method. Various pressing mechanisms are used to extract oil from peel and seeds. The mechanical forces applied over rinds leads to the movement of oil outside the oil sacs.

This extract is in the form of emulsion which is further separated by centrifugation at cooling temperatures.

- The method is cost efficient and oil retains natural aroma, freshness and flavor of citrus fruit. Oil so obtained is bright and colored with no loss of volatile components as in distillation method.
- Although, less oil is recovered during pressing of rinds as oil is absorbed within the albedo (spongy white layer) in case of citrus peel oil.

Solvent Extraction Method

- Essential oils can be extracted using solvents such as hexane, petroleum ether, ethanol, methanol, di-methylene chloride and acetone. After the solvent percolates through the treated plant material, it produces a waxy aromatic compound referred to as 'concrete'.
- A solvent extracted essential oil is very concentrated and is very close to the natural fragrance of the material used. During this type of extraction, non-volatile components- such as waxes and pigments are also extracted and some amount of oil remains in the concrete. Alcohol is used to extract essential oil from other constituents. Since waxes and fatty acids are not soluble in alcohol, they are separated. Secondary distillation leaves absolute oil behind.
- When a plant such as tuberose and jasmine contain very little oil or when the odorous properties of flavor and plant materials would be destroyed or altered by steam or water distillation, solvent extraction is used. But there is no guarantee that the finished product will be free of solvent residues.

CO_2 and Supercritical CO_2 Extraction

- It is the most advanced method for oil extraction. It involves use of carbon dioxide as the solvent which carries the essential oil away from material. The lower pressure CO2 extraction involves chilling to carbon dioxide between 0-12° C and pumping it through the plant material at about 1000 psi.
- Supercritical CO2 extraction (SCO2) involves carbon dioxide heated to 30^0 C and pumped through the material at high pressure around 8000 psi. Under these conditions the carbon dioxide is liquefied and release of the pressure in

the process, the carbon dioxide escapes in gaseous form, leaving oil behind.

- The resultant product is quite pure. Like solvent extraction and distillation there is no heat applied to oil to alter it in any way.

Chemistry of Essential Oils

Essential oils are natural flavor and contain aroma compounds which are responsible for odour and fragrances. These aroma compounds are chemical compounds found naturally in different plant parts of aromatic plants. Oils are accumulated in specialized structures such as oil cells, glandular trichomes, and oil or resin ducts. Chemically the essential oils are composed primarily of monoterpenes and sesquiterpines and aromatic polypropanoids synthesized via the mevalonic acid pathway for terpenes and the shikimic acid pathway for aromatic polypropanoids.

Precautions for storage of essential oil for maintaining the quality

Since most of the constituents in essential oils are terpenic in nature they can get oxidized, resinefied or polymerized in the presence of air, light, moisture and elevated temperature during storage. Following steps should be ensured during storage

- The oil should be moisture free and devoid of suspended materials and dust particles This can be done by adding sufficient amount of sodium anhydrous sulphate or sodium chloride over night and filtering the oil.
- The container should be clean, dust and rust free. The rust get dissolved in the resins and darkens the colour of the oil. Galvanized drum are suitable but aluminum container are reported to be the best.
- Oil should be filled up to the top, leaving no space for air and the cork/stopper should be air tight.
- The temperature of the storage place should not be high and drums should be protected from direct sunlight.

BEST AND FASTEST WAYS TO PROCEED (Conclusion)

- Selection of best established product out of available plant resources in the region
- Introduction of suitable exotic aromatic plant species having high demand in the industry
- Supply of characterized plant materials to growers
- Determination of optimal planting and harvesting time
- Implanting appropriate production technology
- Formation of larger units of production or groups of producers like cooperatives
- Centralized production and marketing system

Planning, Design and Construction of Greenhouses

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A greenhouse is a framed or an inflated structure covered with a transparent or translucent material in which crops could be grown under the conditions of at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations.

Greenhouse Effect

In general, the percentage of carbon dioxide in the atmosphere is 0.035% (345 ppm). But, due to the emission of pollutants and exhaust gases into the atmosphere, the percentage of carbon dioxide increases which forms a blanket in the outer atmosphere. This causes the entrapping of the reflected solar radiation from the earth surface. Due to this, the atmospheric temperature increases, causing global warming, melting of ice caps and rise in the ocean levels which result in the submergence of coastal lines. This phenomenon of increase in the ambient

temperature, due to the formation of the blanket of carbon dioxide is known as greenhouse effect.

The greenhouse covering material acts in a similar way, as it is transparent to shorter wave radiation and opaque to long wave radiation.

During the daytime, the shorter wave radiation enters into the greenhouse and gets reflected from the ground surface. This reflected radiation becomes long wave radiation and is entrapped inside the greenhouse by the covering material. This causes the increase in the greenhouse temperature. It is desirable effect from point of view of crop growth in the cold regions.

Advantages of Greenhouses

The following are the different advantages of using the green house for growing crops under controlled environment:

1. Throughout the year four to five crops can be grown in a green house due to availability of required plant environmental conditions.

2. The productivity of the crop is increased considerably.

3. Superior quality produce can be obtained as they are grown under suitably controlled environment.

4. Gadgets for efficient use of various inputs like water, fertilizers, seeds and plant protection chemicals can be well maintained in a green house.

5. Effective control of pests and diseases is possible as the growing area is enclosed.

6. Percentage of germination of seeds is high in greenhouses.

7. The acclimatization of plantlets of tissue culture technique can be carried out in a green house.

8. Agricultural and horticultural crop production schedules can be planned to take advantage of the market needs.

9. Different types of growing medium like peat mass, vermiculate, rice hulls and compost that are used in intensive agriculture can be effectively utilized in the greenhouse.

10. Export quality produce of international standards can be produced in a green house.

11. When the crops are not grown, drying and related operations of the harvested produce can be taken up utilizing the entrapped heat.

12. Greenhouses are suitable for automation of irrigation, application of other inputs and environmental controls by using computers and artificial intelligence techniques.

13. Self-employment for educated youth on farm can be increased.

14. Greenhouse structures of various types are used successfully for crop production. Although there are advantages in each type for a particular application, in general there is no single type greenhouse, which can be considered as the best. Different types of greenhouses are designed to meet the specific needs.

Greenhouse type based on shape

Greenhouses can be classified based on their shape or style. For the purpose of classification, the uniqueness of the cross section of the greenhouses can be considered as a factor. As the longitudinal section tend to be approximately the same for all types, the longitudinal section of the greenhouse cannot be used for classification. The cross sections depict the width and height of the structure and the length is perpendicular to the plane of cross section. Also, the cross section provides information on the overall shape of the structural members, such as truss or hoop, which will be repeated on every day.

The commonly followed types of greenhouse based on shape are lean-to, even span, uneven span, ridge and furrow, saw tooth and quonset.

a. Lean-To Type Greenhouse

A lean-to design is used when a greenhouse is placed against the side of an existing building. It is built against a building, using the existing structure for one or more of its sides. It is usually attached to a house, but may be attached to other buildings. The roof of the building is extended with appropriate greenhouse covering material and the area is properly enclosed. It is typically facing south side. It should face the best direction for adequate sun exposure.

b. Even span type greenhouse

The even-span is the standard type and full-size structure, the two roof slopes are of equal pitch and width. This design is used for the greenhouse of small size, and it is constructed on level ground. The cost of an even-span greenhouse is more than the cost of a lean-to type, but it has greater flexibility in design and provides for more plants. Because of its size and greater amount of exposed glass area, the even-span will cost more to heat.

c. Uneven span type greenhouse

This type of greenhouse is constructed on hilly terrain. The roofs are of unequal width; make the structure adaptable to the side slopes of hill. This type of greenhouses is seldom used now a days as it is not adaptable for automation.

d. Ridge and furrow type greenhouse

Designs of this type use two or more A-frame greenhouses connected to one another along the length of the eave. The eave serves as furrow or gutter to carry rain and melted snow away. The side wall is eliminated between the greenhouses, which results in a structure with a single large interior, Consolidation of interior space reduces labour, lowers the cost of automation, improves personal management and reduces fuel consumption as there is less exposed wall area through which heat escapes.

e. Saw tooth type Greenhouse

These are also similar to ridge and furrow type greenhouses except that, there is provision for natural ventilation in this type. Specific natural ventilation flow path develops in a saw- tooth type greenhouse.

Quonset greenhouse

This is a greenhouse, where the pipe arches or trusses are supported by pipe purling running along the length of the greenhouse. In general, the covering material used for this type of greenhouses is polyethylene. Such greenhouses are typically less expensive than the gutter connected greenhouses and are useful when a small isolated cultural area is required. These houses are connected either in free, standing style or arranged in an interlocking ridge and furrow.

In the interlocking type, truss members overlap sufficiently to allow a bed of plants to grow between the overlapping portions of adjacent houses. A single large cultural space thus exists for a set of houses in this type, an arrangement that is better adapted to the automation and movement of labour.

Greenhouse type based on utility

Classification of greenhouses can be made depending on the functions or utilities. Of the different utilities, artificial cooling and heating of the greenhouse are more expensive and elaborate. Hence based on the artificial cooling and heating, greenhouses are classified as green houses for active heating and active cooling system.

a. **Greenhouses for active heating**
b. **Greenhouses for active cooling**

Greenhouse Type Based on Construction

The type of construction is predominantly influenced by the structural material, though the covering material also influences the type. Span of the house inurn dictates the selection of structural members and their construction. Higher the span, stronger should be the material and more structural members are used to make sturdy truss type frames. For smaller spans, simpler designs like hoops can be followed. Therefore based on construction, greenhouses can be broadly classified as wooden framed, pipe framed and truss framed structures.

Wooden Framed Structures

In general, for the greenhouses with span less than 6 m, only wooden framed structures are used. Side posts and columns are constructed of wood without the use of a truss. Pine wood is commonly used as it is inexpensive and possesses the

required strength. Timber locally available, with good strength, durability and machinability also can be used for the construction**.**

a. Pipe Framed Structures

Pipes are used for construction of greenhouses, when the clear span is around 12m. In general, the side posts, columns, cross ties and purlins are constructed using pipes. In this type, the trusses are not used**.**

b. Truss Framed Structures

If the greenhouse span is greater than or equal to 15m, truss frames are used. Flat steel, tubular steel or angular iron is welded together to form a truss encompassing rafters, chords and struts. Struts are support members under compression and chords are support members under tension. Angle iron purlins running throughout the length of greenhouse are bolted to each truss. Columns are used only in very wide truss frame houses of 21.3 m or more. Most of the glass houses are of truss frame type, as these frames are best suited for pre-fabrication.

Greenhouse Type Based on Covering Materials

Covering materials are the major and important component of the greenhouse structure. Covering materials have direct influence on the greenhouse effect inside the structure and they alter the air temperature inside the house. The types of frames and method of fixing also varies with the covering material. Based on the type of covering materials, the greenhouses are classified as glass, plastic film and rigid panel greenhouses.

a. Glass Greenhouses

Only glass greenhouses with glass as the covering material existed prior to 1950. Glass as covering material has the advantage of greater interior light intensity. These greenhouses have higher air infiltration rate which leads to lower interior humidity and better disease prevention. Lean-to type, even span, ridge and furrow type of designs are used for construction of glass greenhouse.

b. Plastic Film Greenhouses

Flexible plastic films including polyethylene, polyester and polyvinyl chloride are used as covering material in this type of greenhouses. Plastics as covering material for greenhouses have become popular, as they are cheap and the cost of

heating is less when compared to glass greenhouses. The main disadvantage with plastic films is its short life. For example, the best quality ultraviolet (UV) stabilized film can last for four years only. Quonset design as well as gutter-connected design is suitable for using this covering material.

c. Rigid Panel Greenhouses

Polyvinyl chloride rigid panels, fibre glass-reinforced plastic, acrylic and polycarbonate rigid panels are employed as the covering material in the quonset type frames or ridge and furrow type frame. This material is more resistant to breakage and the light intensity is uniform throughout the greenhouse when compared to glass or plastic. High grade panels have long life even up to 20 years. The main disadvantage is that these panels tend to collect dust as well as to harbor algae, which results in darkening of the panels and subsequent reduction in the light transmission. There is significant danger of fire hazard.

Natural Ventilation

In the tropics, the sides of greenhouse structures are often left open for natural ventilation. Tropical greenhouse is primarily a rain shelter, a cover of polyethylene over the crop to prevent rainfall from entering the growing area. This mitigates the problem of foliage diseases. Ventilators were located on both roof slopes adjacent to the ridge and also on both side walls of the greenhouse. The ventilators on the roof as well as those on the side wall accounts, each about 10% of the total roof area. During winter cooling phase, the south roof ventilator was opened in stages to meet cooling needs. When greater cooling was required, the north ventilator was opened in addition to the south ventilator. In summer cooling phase, the south ventilator was opened first, followed by the north ventilator. As the incoming air moved across the greenhouse, it was warmed by sunlight and by mixing with the warmer greenhouse air. With the increase in temperature, the incoming air becomes lighter and rises up and flows out through the roof ventilators. This sets up a chimney effect, which in turn draws in more air from the side ventilators creating a continuous cycle. This system did not adequately cool the greenhouse. On hot days, the interior walls and floor were frequently injected with water to help cooling.

Roll Up Side Passive Ventilation In Poly Houses

In roll up method of ventilation, allowing the air to flow across the plants. The amount of ventilation on one side, or both sides, may be easily adjusted in response to temperature, prevailing wind and rain. During the periods of excessive heat, it may be necessary to roll the sides up almost to the top. Passive ventilation can also be accomplished by manually raising or parting the polyethylene sheet. The open vent areas must be covered with screens to prevent virus diseases. Screens with small holes blocks air movement and cause a buildup of dust. Rollup side passive ventilation on plastic greenhouses is only effective on free standing greenhouses and not on gutter connected greenhouses.

Site Selection and Orientation, Structural Design and Covering Materials.

A greenhouse, is basically the purpose of providing and maintaining a growing environment that will result in optimum production at maximum yield. The agriculture in the controlled environment is possible in all the regions irrespective of climate and weather. It is an enclosing structure for growing plants, greenhouse must admit the visible light portion of solar radiation for the plant photosynthesis and, therefore, must be transparent. At the same time, to protect the plants, a greenhouse must be ventilated or cooled during the day because of the heat load from the radiation. The structure must also be heated or insulated during cold nights. A greenhouse acts as a barrier between the plant production areas and the external or the general environment.

Site Selection and Orientation

A greenhouse is designed to withstand local wind, snow and crop loads for a specific cropping activity. In this way, the structure becomes location and crop specific. The building site should be as level as possible to reduce the cost of grading, and the site should be well aerated and should receive good solar radiation. Provision of a drainage system is always possible. It is also advisable to select a site with a natural windbreak. In regions where snow is expected, trees should be 30.5 m away in order to keep drifts back from the greenhouses. To prevent shadows on the crop, trees located on the east, south, or west sides should be at a distance of 2.5 times their height.

Structural Design.

The most important function of the greenhouse structure and its covering is the protection of the crop against hostile weather conditions (low and high temperatures, snow, hail, rain and wind), diseases and pests. It is important to develop greenhouses with a maximum intensity of natural light inside. The structural parts that can cast shadows in the greenhouse should be minimized.

Loads in designing the greenhouse structures include the weight of the structure itself and, if supported by the structure, loads of the equipment for the heating and ventilation and water lines. Greenhouse structures should be designed to resist a 130 km/h wind velocity. The actual load depends on wind angle, greenhouse shape and size, and the presence or absence of openings and wind breaks.

The ultimate design of a greenhouse depends on the following aspects:

i. The overall structural design and the properties of the individual structural components.

ii. The specific mechanical and physical properties which determine the structural behaviour of the covering materials.

iii. The specific sensitivity of the crop to light and temperature to be grown in the greenhouse.

iv. The specific requirements relevant to the physical properties of the covering material.

v. The agronomic requirements of the crop.

Covering materials

The following factors are to be considered while selecting the greenhouse covering material i.e., light, transmission, weight, resistant to impact, and durability to outdoor weathering and thermal stability over wide range of temperatures. Before selecting the covering material, two important points should be taken into consideration: the purpose for which greenhouse facility is intended and service life of material. In temperate regions where high temperatures are required, the covering material with high light transmission and far IR absorption must be selected. Also the loss of heat by conduction should be minimum.

Covering material	Life span
Glass and acrylic sheet	20 years
Polycarbonate and fiberglass-reinforced polyester sheet	5-12 years
Polyethylene	2-6 months
Polyethylene stabilized for UV rays	2-3 years

The ideal greenhouse selective covering material should have the following properties:

1. It should transmit the visible light portion of the solar radiation which is utilized by plants for photosynthesis.
2. It should absorb the small amount of UV in the radiation and convert a portion of it to fluoresce into visible light, useful for plants.
3. It should reflect or absorb IR radiation which are not useful to plants and which causes greenhouse interiors to overheat.

Should be of minimum cost.

The following materials commonly used to build frames for greenhouse are (i) Wood, (ii) Bamboo, (iii) Steel, (iv) Galvanized iron pipe, (v) Aluminum and (vi) Reinforced concrete (RCC). The selection of above materials was based on their Specific physical properties, requirements of design strength, life expectancy and cost of construction materials.

Wood

Wood and bamboo are generally used for low cost polyhouses. In low cost polyhouses, the wood is used for making frames consisting of side posts and columns, over which the polythene sheet is fixed. The commonly used wood is pine, which is strong and less expensive. Wood must be painted with white colour paint to improve light conditions within the greenhouse.

Galvanised iron (GI), aluminum, steel and reinforced cement concrete

GI pipes, tubular steel and angle iron are generally used for side posts, columns and purlins in greenhouse structure, as wood is becoming scarce and more expensive. In galvanising operation, the surface of iron or steel is coated with a thin layer of zinc to protect it against corrosion. The commonly followed processes to

protect against corrosion are:

I. Hot dip galvanising (hot process) process: The cleaned member is dipped in molten zinc, which produces a skin of zinc alloy to the steel.

II. Electro-galvanising (cold process) process: The cleaned member is zinc plated similar to other forms of electro-plating

The galvanising process makes the iron rust proof, to eliminate the problem of rusting of structural members. Aluminium and hot dipped GI are comparatively maintenance free. In tropical areas, double dipping of steel is required, as single dip galvanising process does not give a complete cover of even thickness to the steel. Aluminum and steel must be protected by painting with bitumen tar, to protect these materials from corrosion, while these materials contact with the ground.

Design criteria of construction

For locating the greenhouse, a piece of land larger than the grower's immediate need should be acquired. The ultimate size of the greenhouse range should be estimated.

Construction of glass greenhouses

Glass greenhouses have an advantage of greater interior light intensity over plastic panel and film plastic covered greenhouses. Glass greenhouses tend to have a higher air infiltration rate, which leads to lower interior humidity, which is advantageous for disease prevention. On the other hand, glass greenhouses have a higher initial cost than double-layer film plastic greenhouses. While comparing the price of a glass greenhouse to a film plastic greenhouse, one needs to take into account the initial purchase price of each as well as the cost of re-covering the film plastic greenhouse every three to four years. Several types of glass greenhouses are designed to meet specific needs. A lean-to-type design is used when a greenhouse is placed against the side of an existing building. This design makes the best use of sunlight and minimizes the requirements for roof supports. It is found mostly in the retail industry. An even-span greenhouse is one in which the two roof slopes are of equal pitch and width. By comparison, a un-even-span greenhouse has roofs of unequal width, which makes the structure adaptable to the side of a hill. This style is seldom used today because such greenhouses are not adaptable to automation. Finally, a ridge-and-furrow design uses, two or more A- frame

greenhouses connected to one another along the length of the eave. The sidewall is eliminated between greenhouses, which results in a structure with a single large interior. Basically, three frame types are used in glass greenhouses, which are wood frames (6.1 m in width), pipe frames (12.2 m in width) and truss frames (15.2 m in width). Latest glass greenhouses are primarily of the truss frame type. Truss frame greenhouses are best suited for prefabrication.

All-metal greenhouses proved cheaper to maintain since they required no painting. At present, virtually all glass greenhouse construction is of the metal type. The structural members of the glass greenhouse cast shadows that reduce plant growth during the dark months of the year. Aluminum sash bars are stronger than wooden ones; hence wider panels of glass can be used with aluminum bars. The reduction in materials and the reflectance of aluminum have given these metal greenhouses a great advantage over wooden greenhouses in terms of higher interior light intensity.Glass greenhouse construction of today can be categorized as high profile or low profile. The low profile greenhouse is most popular in the Netherlands and is known as the Venlo greenhouse. The low profile greenhouses uses single panels of glass extend from eave to ridge. The low profile greenhouse slightly reduces exposed surface area, thereby reducing the heating cost, but more expensive to cool. The high profile greenhouses require more than single panel to cover the eave to ridge. A problem with this design is the unsealed junction between pieces of glass in the inner layer. Moisture and dust may enter between the layers and reduce light transmission.

Construction of Pipe Framed Greenhouses

The choice of construction of pipe framed greenhouses often favours low initial investment and relatively long life. Galvanized mild steel pipe as a structural member in association with wide width UV- stabilized low density polyethylene (LDPE) film is a common option of greenhouse designers.

Material Requirement

The structural members of greenhouse are

i. hoops
ii, foundation
iii. lateral supports

iv. polygrip assembly end frame

v. The following materials are required for a greenhouse having 4m x 20 m floor area:

vi. GI pipe class A (25 mm diameter, 85 cm long, 30 m total length)

vii. GI pipe class B (15 mm diameter, 6.0 m long, 21 No.s)

viii. GI sheet (20 gauge, size 90 x24 cm, 4 sheets)

ix. MS flat (25 x 3 mm size, 4 m length)

x. Lateral support to end frames (10 mm diameter rod, 10 m length)

xi. Cement concrete (1: 3: 6 mix, 1.0 m)

xii. UV- stabilized LDPE film (single layer 800 gauge, 5.4 m2/kg, 154 m2)

xiii. Polygrip (channel 2000x3.5x4 cm, 2 No.s; Angle 2000x2x2 cm, 2 No.s; both made from the procured 20 gauge GI sheet, key 6 mm diameter, 56 mm length)

xiv. Wooden end frames (5 x 5 cm wood, 0.15 m)

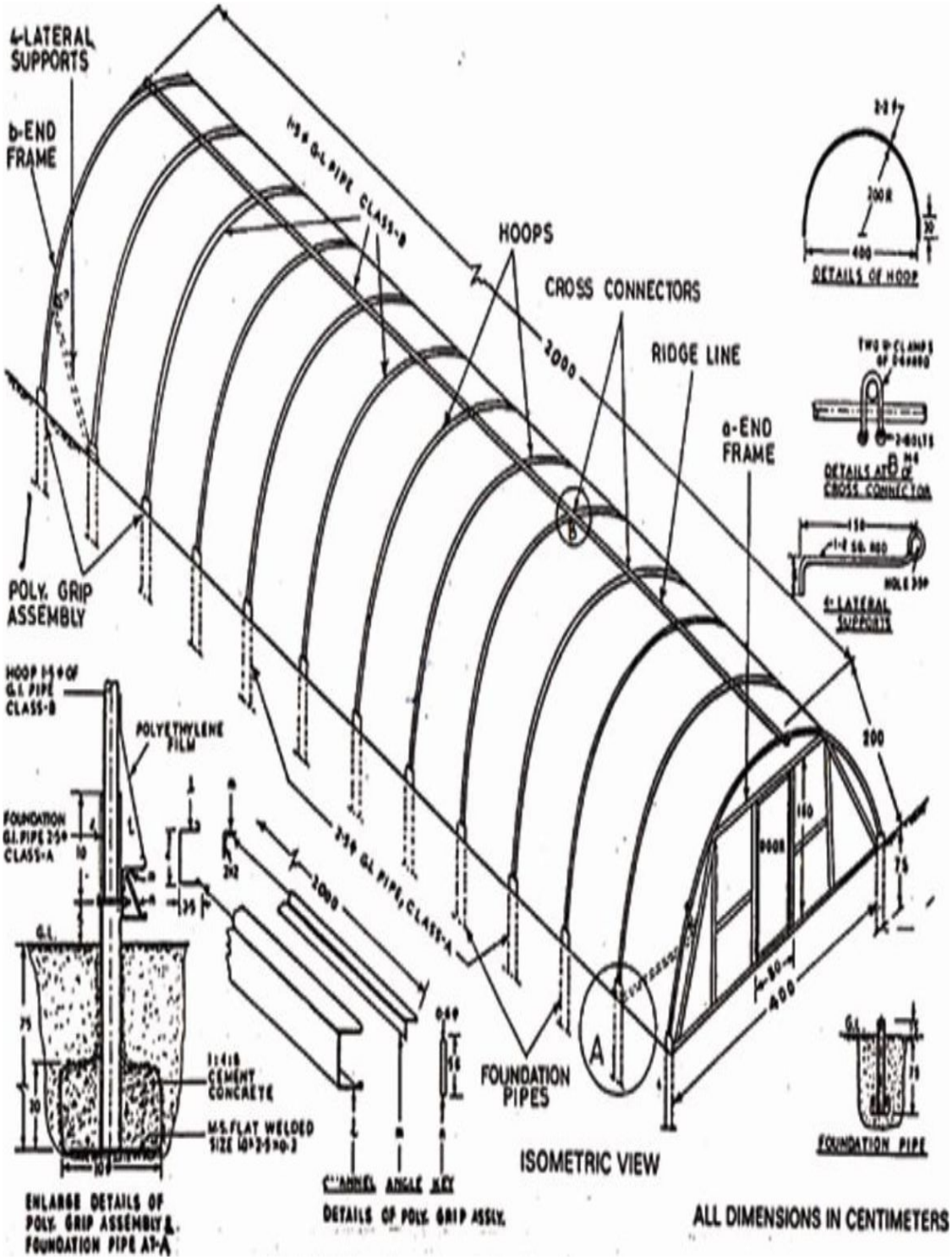
xv. Nuts and bolts 6 mm diameter, 35 mm long, 70 sets)

xvi. Miscellaneous items like nails, hinges and latches as per requirement

Procedure of Erection

1. A 4m by 20m rectangular area is marked on the site, preferably orienting the longer dimension in east-west direction. This rectangle will act as the floor plan of the greenhouse.
2. Mark four points on the four corners of the rectangle.
3. Start from one corner point and move along the length of marked rectangle, marking a point every 1.25 m distance until reaching the other corner (16 bays; 17 points). The same procedure is repeated on the other side of the rectangle.
4. Dig 10 cm diameter holes upto 70 cm depth on all marked points with the help of bucket auger (or) a crowbar. This way a total of 34 holes on both the parallel sides of the greenhouse floor is obtained.
5. Polygrip sections formed according to the drawing into two 20m length.
6. Fix the prefabricated polygrip channels to the foundation pipes on 1.25 m spacing with the help of 6 mm diameter bolts.
7. Set these assemblies on temporary supports between the holes with the foundation pipes hanging vertically in the holes.
8. Pour cement concrete mix of 1: 3 : 6 around foundation pipes in such a way that the lower 15 cm to 20 cm ends are covered in concrete. The concrete is compacted around the foundation pipes with the help of the crowbar and is allowed to cure for 2-3 days.
9. After curing, fill the soil around the foundation pipes to the ground level and compact it well.
10. Position end frames on the two ends. Mark the position of legs and dug holes for fixing of legs. Now install both the end frames.
11. Put the ringside of lateral support members on adjacent foundation pipe to the corner, and other side is hooked to the end frame.
12. Put all the hoops in the foundation pipes in such away that straight portion of hoop is inserted into the foundation and rests on the bolt used for fixing of polygrip channel .
13. Take a 20 m long ridge line by spacing 15 mm diameter pipes together. Put the 20m long pipe at the ridge line of the hoops.

14. Use cross connectors on the ridge line pipe, in such a way that one half of it remains on the one side of the hoop and the other half on the other side.
15. Put two bolts of 6 mm diameter in the holes provided in the ends of cross-connector. Tie a few of them with the help of nuts.
16. Repeat the same procedure for joining all the hoops with ridge line pipe.
17. While forming cross-connectors, the distance between the cross-connectors or hoops should be maintained 1.25 m center to center. This poly grip mechanism will provide a firm grip of the ridge line pipe and hoops at right angles without allowing for slippage.
18. Spread polyethylene film over the structure from one end to the other end without wrinkles and keeping the edges together.
19. Place polyethylene film between the polygrip channel and right angle strip and secure them under pressure with the help of iron rods. The film is stretched gently and fixed on the other parallel side by polygrip. This way the polyethylene is secured on both the longer sides.
20. On the other two remaining ends, polyethylene is nailed to the end frames using wooden battens and nails.
21. The remaining portion of the end frames is covered with polyethylene film, which is secured with wooden battens and nails.
22. Mechanical ventilation, heating and cooling equipment is installed on the frames as per the crop requirement.


4-LATERAL SUPPORTS
6-END FRAME
HOOPS
CROSS CONNECTORS
RIDGE LINE
6-END FRAME
POLY. GRIP ASSEMBLY
FOUNDATION PIPES
ISOMETRIC VIEW
ALL DIMENSIONS IN CENTIMETERS
DETAILS OF HOOP
DETAILS AT B OF CROSS CONNECTION
4-LATERAL SUPPORTS
FOUNDATION PIPE
POLYETHYLENE FILM
1:4:8 CEMENT CONCRETE
ENLARGE DETAILS OF POLY. GRIP ASSEMBLY & FOUNDATION PIPE AT A
DETAILS OF POLY. GRIP ASSLY.

Dried Flower Industry and Production of Dried Ornamentals from Biodiversity of Himalayas

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Flowers and ornamental plants have been associated with the mankind from the dawn of civilization and in the modern era these have become an integral part of human civilization, as love for flowers and ornamental plants is considered as most natural instinct in human beings. The catchy flowers growing and glowing in all their grandeurs with simplicity makes it tempting to wish the season to continue for never ending. But, it may be beyond reach of human beings. The answer for it could be, however by producing and preserving ever-lasting or long-lasting flowers and other attractive ornamental plant parts. These are now becoming a favourite especially with the adventurous flower lovers across the globe. The beauty and fresh look of cut flowers and cut foliage is generally lost due to microbial activities and biochemical changes thus these are retained only for a few days even by using the best techniques of post harvest management says Datta, 1999. The charm of dried ornamental plant parts can be maintained from few months to years with lesser cost if protected from the damage of high humidity as in dried flowers the microbial activities in the aging process come to stand still.

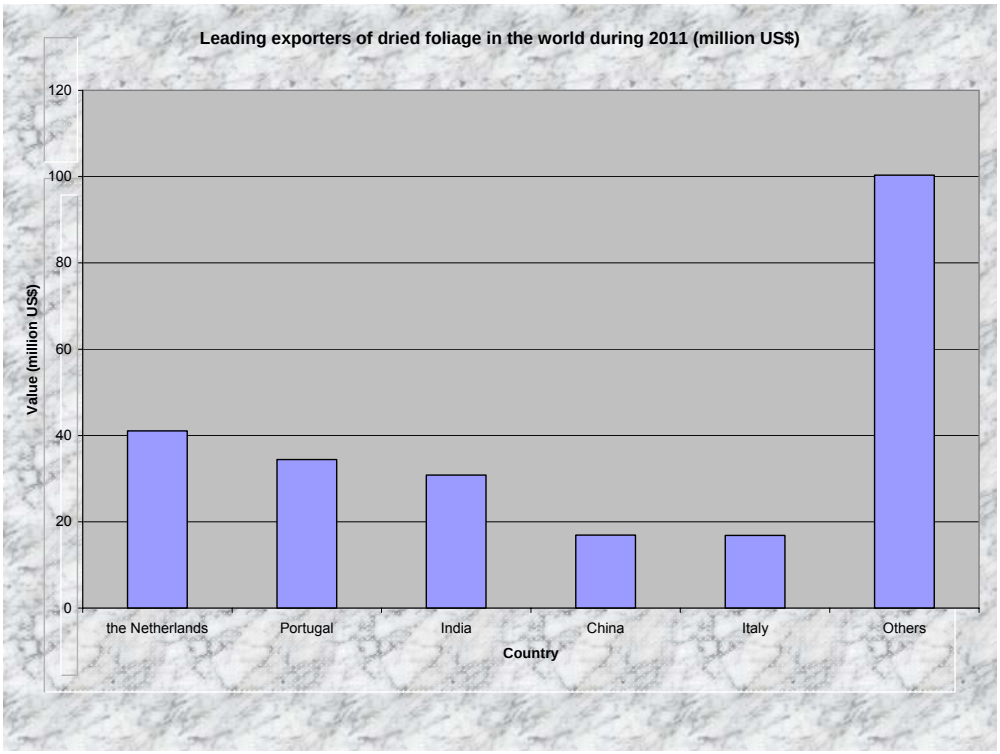
The native and naturalized Himalayan flora is comprised of a wide variety of ornamental trees, shrubs, climbers, herbaceous plants, fleshy fungi, ferns, lichens, mosses and sellaginellas, etc. Many of these ornamental plants with their magnificent array of flowers, foliage, fruits, cones, seeds, roots, stems, shoots/twigs, bark, lichens and fleshy fungi have fascinated the tourists, naturalists, environmentalists and amateur gardeners. These plants can not be retained as cut flower or cut foliage for longer duration and the masses residing in the metropolitan and other large cities who can not visit countryside or Himalayan region remain deprive of the beauty of these plants. The charm and beauty of these plants, however, can be maintained for months to years by employing various techniques of dehydration (Desh Raj, 2001).

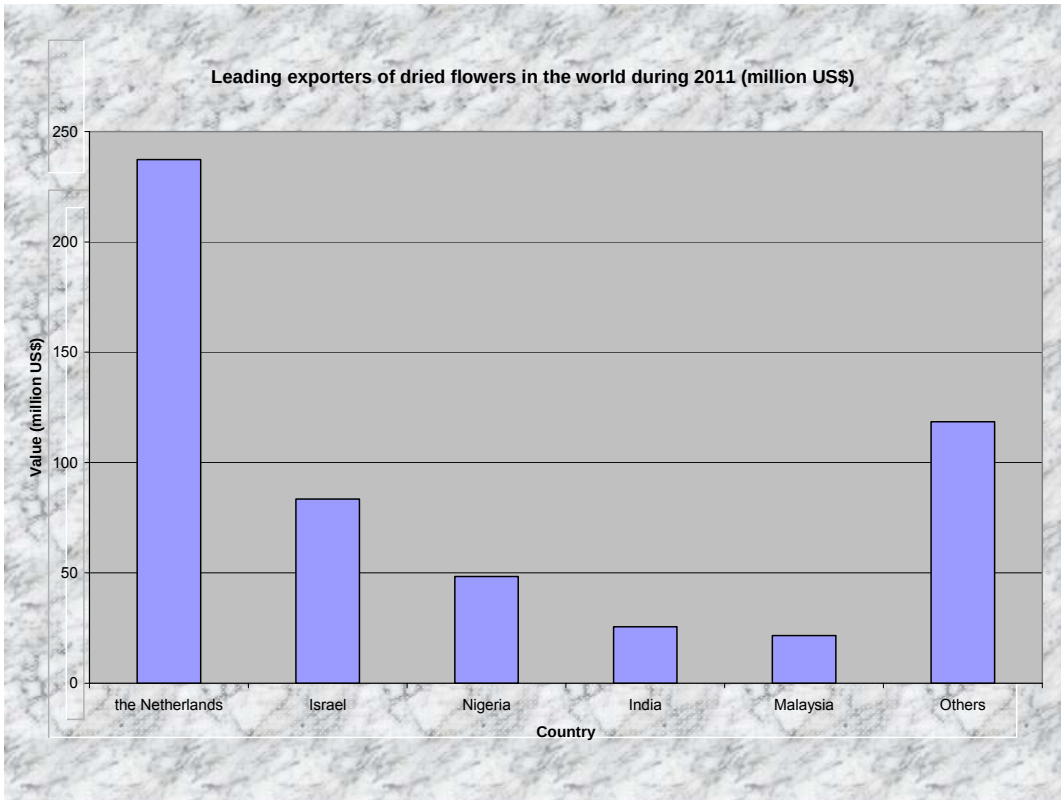
The chief characteristics of dried ornamentals are novelty, longevity, aesthetics, flexibility and year-round availability. Thus, dehydrated or dried ornamentals are generally inexpensive and are sought for their everlasting and attractive appearance globally (Smith, 2000). Being largely focused on the qualities of attractive flowers, living plants and plant parts, floriculturists generally pay little attention to dried and preserved flowers and plants. Therefore, these products remained overlooked and underrated throughout the world. These are overlooked in the sense that their considerable economic importance is generally unrecognized and these are underrated in the sense that their aesthetic contribution is largely discounted. In contrast to the other areas of floriculture including post-harvest management, relatively very little publicly research and development projects have been undertaken on the dried flower industry across the globe. This has slower the pace in optimizing the dehydration technology and quality of the produce. Privately funded research and development work has sustained, but such findings are usually kept secret and limited information is available to the common man. Thus, this component of the floriculture industry has remained ill defined with respect to the processes, products and organizations in the developed and developing countries. As we see in the major cut flower crops, there are defined standards available for judging the quality, however these are lacking in dried ornamentals. Thus, there is an urgent need to start war- footing efforts and mass awareness for the dried ornamentals with a view to attract greater public support to conduct concentrated research and development with more professionalism in the trade of these products.

Status of dried ornamentals in the world:

The demand for dried ornamentals, dried floral arrangements & floral craft items has increased manifolds during the last two decades. The world import of dried flowers and plants has increased from 14.88 million US$ in 1996 to 230.73 million US$ in 2008 and decreased to 167.34 million US$ in 2009 (Source: UNCOMTRADE). The United Kingdom is the biggest market for dried flowers. The leading dried ornamentals products exporting countries during 2009 in the world were India (18%) followed by the Netherlands (17%), USA (14%), Italy (10%) and Germany (6%). The leading dried ornamentals products importing countries during

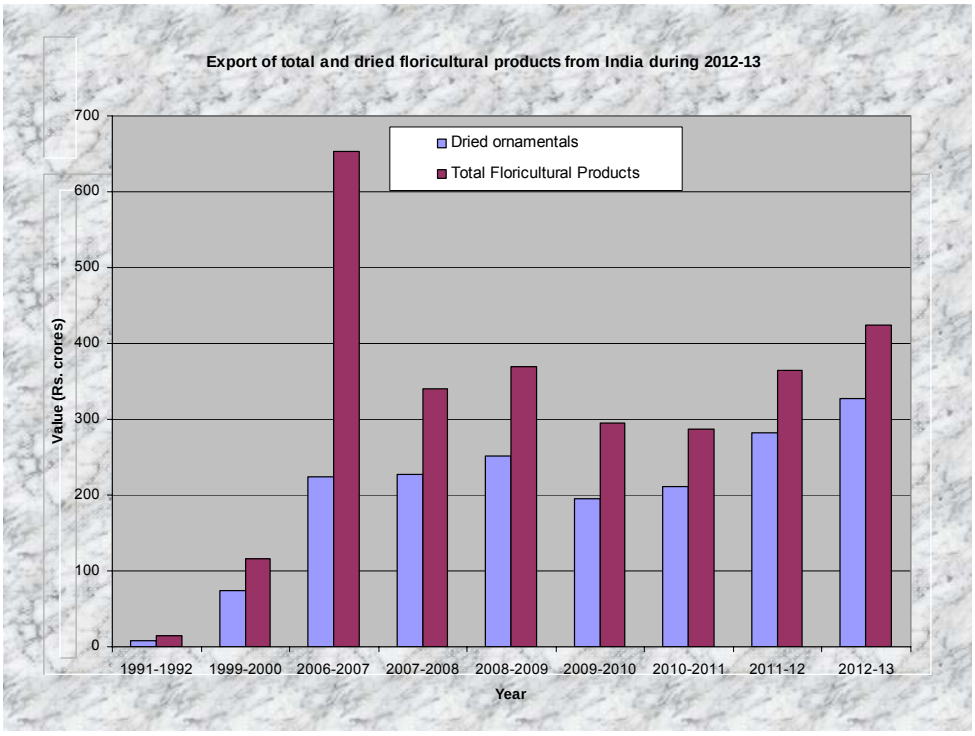
2009 in the world were USA (18%) followed by Germany (17%), the Netherlands (11%), Belgium (11%) and France (7%).





The dried ornamentals market is most profitable in terms of total sales and unit value among all the floricultural products. The top ten dried flower genera as ever-lasting cultivated are *Helichrysum, Helipterum, Limonium, Nigella, Gypsophila, Delphinium, Amaranthus, Papaver, Carthamus* and *Rosa* (Anonymous, 1989).

In India flower export has sharply increased after liberalized EXIM policy from Rs. 14.5 crores in 1991-92 to 652.7 crores in 2006-07. However, total export of floricultural products has now decreased to 423.4 crores during 2012-13. The contribution in total export of dried flowers and plants is over 60 per cent and at present the export from India is over 20 thousand tonnes of dried ornamentals to USA, UK, the Netherlands, Germany, Japan, Singapore and other European countries. The main exporting items are lotus pods in addition to dried flowers of camellia, dahlia, bell cups, marigold, jute flowers, wood rose, wild lilies, paper flower and naturally dried plant parts from Himalayan region. The dried flower business is confined to about sixty private companies operating from Kolkata, Tuticorin (Tamil Nadu) and Mumbai close to sea ports, as the material being bulky is usually shipped through the sea routes. Ramesh Flower Limited at Tuticorin has about 50 per cent share of the total dried flower export from India.



Ornamental plant parts for dehydration:

The range of dried flowers and other attractive plant parts is extensive viz., stems, roots, shoots, buds, flowers, inflorescence, fruits, fruiting shoots, cones, seeds, foliage, bracts, thorns, bark, lichens, fleshy fungi, mosses, sellaginellas, etc. (Desh Raj, 2001).

Essential precautions during dehydration:

For insuring better results and quality products the following points should be considered:

i. Collect material after the dew and surface moisture has evaporated.

ii. Collection should be made in dry season and on a sunny day.

iii. Material should be collected after irrigating fields a day or two.

iv. Fresh material should be collected.

v. All stages of flower development in an inflorescences should be collected, which have sufficiently harden as immature shrivel very fast.

vi. Material should be embedded immediately after plucking.

vii. One type of flowers and foliage should be embedded at one time.

viii. Undesirable plant portions should be cut before embedding.

ix. Spread uniformly all plant parts/ petals in herbarium press.

x. The plant parts should be harvested when highest possible quality product can be harnessed.

Uses of dried ornamental plant parts:

These dried items may be used with fresh flowers or alone as floral arrangements, bouquets, gift boxes/packs, festive decorations, collages, flower pitchers, floral balls, pomanders, wall sceneries, sweet smelling pot-porris have become very popular among the flower lovers especially in European countries.

Pot-porris:

Pot-porris a special dried floral arrangement is the mixture of sweet smelling leaves, spices, seeds, roots and distilled essential oil which is filled in pillows or

sachets. The important dried ornamental plants used for making pot-porris are roses, lilacs, lavender, pinks, hyacinths, lilies, violets, wall flowers, marigold and many others which are associated with perfume viz., geranium, daisy bush, bergamot, sage, savory, thyme, angelica and sweet cicely. In addition, foliage of ferns, pine- cones, lily pods and driftwood and other items from nature's treasure of exotic bloom are collected from forests and gardens. The material used should be resistant to mould, non-toxic, free from noxious odours and sufficiently robust to withstand mechanical bending. Pot-porris is normally designed in a transparent glass bowl or a ceramic jar or stored in a colourful salin or muslin sachet, while other arrangements are designed in a beautifully culoured or specially shaped pots (Anonymous, 1999 and Datta, 1999).

Technology for dehydration:

Dehydration technology means to dry something under artificially produced heat through controlled temperature, humidity and air- flow. In dehydration- process moisture is removed from flowers and foliage. In nature the plant material tend to discolour during drying largely due to oxidative reactions associated with loss of compartmentation within the plant cells during desiccation of the plant tissues. Such plant- material turns brown and is particularly used as filler in various floral arrangements. Artificially there are many varied approaches/ methods to dehydrate or dry flowers and ornamental plant parts which have been described by numerous workers (Dubois and Joyce, 1989 and Westland, 1993). However, the principle involved is common to all processes, as per which the plant material is exposed to a vapour pressure deficit (v.p.d. = $v.p._{source} - v.p._{sink}$), which induces water vapour to move by transpiration/ evaporation from the plant material (source) into the surrounding environment (sink). The flux of water vapour (J) is proportional to the vapour pressure deficit: viz., J = k x (v.p.d.); where k is a constant dependent upon the water vapour transfer properties of the particular product (Joyce, 1998).

Techniques for dehydration:

1. Natural Drying

In this method ornamental plant parts are allowed to dry naturally on the plant itself. These are collected as and when completely dried during excursion trips to forests, countryside, gardens or cultivated fields. The important naturally dried

plants were identified by Desh Raj and Gupta, (2002) in the outer Himalayan region as follows:

The plants viz., *Aegle marmelos, Bambusa* spp., *Bauhinia retusa, Cassia fistula, Caesalpinia sepiaria, Clematis grata, Dioscorea deltoides, Mallotus philippensis, Rosa moschata, Oroxylum indicum, Pinus roxburghii, Picea smithiana, Sapindus mukorossii*, etc. have beautiful fruiting shoots, whereas plants like *Abrus precatorius, Aesculus indica* and *Sapium sebiferum* have beautiful seeds.

2. Vertical hanging drying in air

This is the most common process for drying ornamentals. In this process only rope/ wire and newspaper/ blotting sheets are required. Plant material is simply kept hanging down under cover on racks or from rafters in dark or kept on newspaper/ blotting sheets. Drying in the sun result in discolouration and browning due to oxidation. Improved control over the rate of drying can be achieved by ensuring air movement around each and every stem and by lowering the relative humidity of the air. Good air circulation assists in sweeping away moisture vapours, thereby decreasing the thickness of the unstirred boundary layer of the water vapour with fresh plant material in surrounding. Relative humidity is lowered by adequate ventilation, heating, dehumidifying and pressure reduction. Ventilation with outside air will flush away the moisture vapours released during the process of drying the plant material. Heating will lower the relative humidity because warm air can hold more water vapours per unit volume than can cool air. Kiln drying is the common method of flower drying used in India by most of the export oriented units in South India. Another energy intensive system is air tunnel, which operates on a convection air system at a minimum 50^{o}C temperature. Dehumidification can be achieved with moisture scrubbers (e.g. silica gel- based or by frosting water vapour out into cold coils. Pressure reduction may be achieved by large exhaust fans fitted to rooms with a restriction imposed on the supply of the air flow or with vacuum pumps. Thus, the entire process of air-drying depends upon the relative humidity, air velocity, pressure, moisture in plant material and type and shape of flowers. This is the most simple and cheep process of dehydration/drying. The main drawback is its weather dependence and petals/foliage shrinkage, thus lowering the aesthetic value of plant material. Hanging drying of small quantity of plant material with reasonable more success can be achieved by drying in microwave oven, hot air

oven or solar dryer within short span in comparison to air-drying. Flowers with crisp texture viz., *Acroclinum, Anaphalis, Helichrysum, Delphinium*, Lemon mint, *Oregano, Limonium, Rumex, Holmskioldia*, etc. are more suitable for vertical hanging drying in microwave/ hot air oven/ solar dryer.

3. Embedded Drying

It is rather difficult to avoid shrinkage and changes in morphology of dehydrated ornamental plant material during vertical hanging drying in air/ microwave/hot air oven/ solar dryer, due to the loss of moisture/ water vapours from the cells. The petals/foliage generally droop- down and as a result aesthetic value of that material reduces. In embedding the drying medium/desiccant supports the flower/ foliage from all around and maintains perfectly the original shape.

Characteristics of desiccants:

The material which removes the moisture quickly from the ornamental plant parts embedded without reacting with the water vapours released during drying or bleaching of petals and foliage, etc. The drying material/ desiccant should normally have the ideal size of 0.02-0.2mm or 20-200 mesh. It should be heavy so as to keep the plant parts perfectly in its original shape. It should not stick to the plant parts during drying. It should also not be very costly as the market value of most of the dried ornamental floral arrangements and craft is low.

Different types of desiccants:

Silica gel (white and self indicating blue), borax, boric acid, river sand, alum powder, aluminium sulfate, saw dust, corn granules are commonly used desiccants in purely single form or in combinations of two or more desiccants so as to be more effective and economical in drying ornamental plant parts.

Process of embedding:

Various types of containers are used for embedding different ornamental plant parts which suits to the plant material and the process of drying in room, sun, solar dryer, hot air oven or microwave oven. The containers should uniformly get heated so that the material evenly dry out from all sides. Aluminium or tin containers are normally used which maybe cylinder or tray type. In microwave nonmetallic containers like glass, china clay, heat tolerant plastics are used. Spread

the layer of the desiccant on the bottom of the container. Arrange the plant parts according to type, well spaced and with no two items touching each other or the sides of the containers. Pour the desiccant gently, gradually and completely from all the sides until it forms a top layer for about 1.5 cm above the plant parts. In flowers where pedicels/ inflorescence are very delicate or hollow, insert a thin wire before embedding so as to maintain the original shape. After embedding the containers are left in the room for drying. But it takes longer time to dry. The containers for quick drying are kept in sun, solar dryer, hot air oven or microwave oven, in which drying is faster with superior quality of the dried plant parts. These are described as follows:

i. Drying in Sun

After embedding the plant material the containers are daily exposed to Sun, resulting in rapid dehydration. Containers are shifted under a room in the evening and again on the next morning these are kept in the Sun light. The efficiency of drying depends upon the prevailing weather in the region.

ii. Drying in Solar dryer

The containers are kept in solar dryer in which movable tray at the bottom is fitted to regulate the temperature. This is quicker method of drying and drying is done without use of energy. The results are at par with hot air oven or microwave-oven thus is more economical method.

iii. Drying in Hot air oven

The containers are kept in the hot air oven at 45 to 60^{o}C for few hours to three days depending upon the moisture content in the plant material to be dried. Drying technology for number of cultivated ornamental plants has also been standardized at NBRI Lucknow.

iv. Drying in Microwave oven

The plant material in microwave oven is dried with the help of electronically produced microwaves. Non-metallic containers in which various plant parts are embedded in desiccants are kept in microwave oven for 2-5 minutes. Then, these are kept in the room for 2-5 hours known as setting time before taking out from the desiccant. In microwave oven the mostly plant material is dried at a range of 300-

700 Hz., which may be given once or in splits. The results in split drying are comparatively better.

v. Vacuum drying

The embedded plant material may be dried/ dehydrated under vacuum. The vacuum is created under thick-walled chamber fitted with a heating device, a vacuum pump and condenser. Low temperature is very effective and the quality of the product is excellent.

Taking out embedded plant material:

The embedded plant material after drying/dehydration is taken out by gently tilting the container in order to remove the desiccant over and around the plant material. The dried material is either picked up with the help of fingers or tweezers. It is cleaned by inverting and tapping with fingers slowly and gently. Any remaining desiccant is finely removed with the help of a fine camel hair painting brush.

4. Freeze drying

Freeze-drying is now becoming a very popular although more expensive method of producing dried flowers and plant parts throughout the world. The worldwide market of freeze-dried products during 1997 was about $18-20 million. The necessary equipment for freeze-drying is more expensive than vacuum drying, but the quality of the finished floral product is almost double and this process is relatively simple. The flowers are arranged in the specimen chamber. Then, these are frozen unto -35^{o} C. Any frozen ice crystals on the flowers are sublimed or vaporized with the application of heat. After transforming into condensation, the vapour is captured into a separate chamber as ice. By eliminating the water, the flowers dry up with the life of freshness and retain better integrity and more durability. Thus, rapid dehydration particularly at low or ambient temperature tends to result in better-coloured products (Chen *et al.*, 2000).

5. Drying in water

The flowers and foliage are kept in water and allowed to dry. Water drying, which usually seems to like a contradiction, but gives fairly good results with flowers like Hydrangea, Corn flower, baby's breath and fever few. In water drying first the lower leaves and flowers from the stem are stripped and are kept in standing cold

water with about 5cm depth. The material is kept undisturbed in a dry, well-aerated room until both the holder and flowers are dried. This takes 6-7 days depending upon the water content in plant material and water taken in container/holder.

6. Press drying

The flowers and foliage are placed between the pages of a book or magazine or between the folds of newspapers or blotting sheets by giving some space between the flowers/foliage. These sheets are kept one above another and corrugated cardboard sheets of same size are placed between the folded sheets so as to allow the water vapours to escape. The whole bundle is then kept in the room. For quicker drying herbarium press is kept in hot air oven at 45^{o} C for 12 to 24 hours depending upon the moisture in the flowers or foliage. Too much material should not be pressed simultaneously. Material of varied thickness should also be avoided in the same folders. When press drying is practiced in room, one must over-turn the flowers/foliage daily which will help in maintaining the original colour and prevent the plant material from discolouration. This method is laborious and time taken for drying is more than drying in solar dryer/ hot air oven. The press-dried material is stored in cardboard boxes. These boxes are lined with blotting sheet, which keep flowers/foliage dry. These boxes are stored in herbarium vasculums fitted with cork sheet. The press-dried material is used for preparation of greeting cards, wedding cards, wall plates, sceneries, table- tops, interiorscaping designs and other festive decorations.

7. Polyset

Polyset is a polymer preservation method, which is applied to the flowers/foliage about 45 minutes before drying. It is a chemical pre-treatment application, which is used before air drying to improve the quality of the dried flowers. This method lessens the drying time and improves the intensity of flower colour. It also minimizes shattering and wrinkling of the petals, which may occur during drying. Polyset treatment may be applied to the freeze-dried flowers to hold them together or to help the flowers in retaining their colour for longer duration.

8. Preserving

Ornamental plant material is commonly preserved (plasticized) by treatment with a humectant. Humectants are hygroscopic chemicals, which help to maintain

the suppleness of dried plant material by attracting water vapour from the surrounding atmosphere. Therefore, the preserved plant material is less brittle than dried material, making it less prone to shattering and mechanical damage. This material is more life like in appearance and to touch. Humectants used for preserving plant tissues are drawn from four general groups of chemicals viz., sugar and sugar alcohols (e.g. glycerol), polyols (e.g. polyethylene glycol), salts (e.g. KCl) and quaternary ammonium compounds (e.g. Comfort). These humectants have different moisture sorption isotherm characteristics. These can be applied by uptake or immersion, where the former method is not used commercially. Relationships between specific plant characteristics and humectants uptake are poorly defined, despite the common perception that some species preserve easier and better than others. Although relatively more volume of solution is required for immersion method of preservation but this offers some unique advantages as dried and/ or bleached plant parts can be treated. There is more uniform penetration and distribution of the humectants. Waxy plant cuticles are removed by Na OH or organic dip treatment prior to preservation in order to facilitate penetration of aqueous humectants solution. The risk of sweating can be reduced by using humectants with a relatively low moisture attracting capacity and/ or by reducing the amount of humectants taken up i.e. shorter treatment time at low concentration of humectants.

9. Bleaching and Sulfuring

Otherwise aesthetically attractive plant material, which is inherently coloured by unwanted pigments or brown or dicoloured due to oxidative browning can be bleached or sulfured for their use in various floral arrangements. In bleaching both the oxidative or reductive bleaches can be used on the plant material, where former tends to break down coloured compounds and the latter tends to modify into colourless compounds (Dubois and Joyce, 1988). Multiple bleaching (e.g. hypochlorite- chlorite peroxide) is used for lilen offers advantages in terms of reduced brittleness, cost and yellowing.

In sulfuring, sulfur dioxide acts to bleach coloured (e.g. green) plant material and below certain concentration, to fix red colours in some flowers. Colour fixation is associated with acidification of the tissues. Sulfuring of fresh material is achieved by burning sublimed sulfur powder (e.g. 10g/m^3) or by injection of sulfur dioxide gas

(1-3%) into a sealed chamber. The plant material is usually treated over night prior to ventilation of the chamber and subsequent completion of the drying process. Both bleaching and sulfuring are dangerous processes by virtue of the use of chemicals, thus should be taken up by trained persons with all safety equipment.

10. Colouring

Dyes can be applied to fresh, dried or bleached ornamental plant parts in order to increase their aesthetic value as per the changing seasons and fashions. Dyes are usually applied by immersion to dried and bleached plant material. In Australian plants viz., *Banksia hookeriana* and *B. prionotes,* inflorescence is commonly marketed after colouring. Dyeing of ornamental plant material is considered much as an art. Accordingly for determining the optimum treatment protocol for a particular product is often a matter of systemic trial and error. Immersion dyeing is improved by removing the waxy cuticle with Na OH from dried plant material and by adding surfactants to improve the contact between the dye bath solution and the plant material. In addition to dyeing, which is properly called staining the plant material can also be coloured by painting and commonly silver or gold paints are used.

Packaging, Handling and Storage of dried ornamentals:

One of the clear benefits associated with dehydrated/dried plant material is its relatively non-perishable nature as compared to fresh parent plant material. As a result packaging and handling should theoretically offer no real problem, but due to less moisture dried plant material is very brittle. Thus, packaging for delicate dried plant material should serve to both contain and protect the product. Therefore, it is advisable to purchase superior grade or standard cartons/ boxes for packing dried plant material. Dried plant material should not be roughly handled during transportation and distribution and it can be done through education by creating awareness of the product characteristics. Dried plant material should be protected from moisture through out the marketing channel. Dried plant materials absorb atmospheric moisture and loose their shape, therefore, should be stored immediately in moisture proof containers. Different containers like glass desiccators, tin boxes, cartons, wrapped with plastic sheets or wax paper and herbarium vasculums fitted with cork sheet are used for storage of dried ornamental

plant material. Small quantity of silica gel may be placed at the bottom to absorb moisture. Protect the material from direct sunlight or more light intensity especially from incandescent lamps. The storage should be dust free and keep the cartons/ boxes clean from time to time. Store separately different dried ornamental plant material and fix proper label outside with complete description of the product kept inside, which will be very helpful during handling, transportation and marketing.

Insect-pests and diseases:

Insect-pests can afflict all types of dehydrated plant material. These can be controlled by insecticides applied in solid pest strips (dichlorvos), liquid (synthetic pyrethroids, ethyl parathion- 0.01%) or gas (methyl bromide, phenyl tablets). Book lice, silver fish, mice are the common pests infesting dried plant material. Microbes notably fungi can be controlled by regulating relative humidity to keep the water activity of the dried plant material below that which does not allow spore germination, mycelial growth and sporulation. As a general principle the development of fungi is negligible below 65% relative humidity (Wilson and Abramson, 1992). The dried plant material to be packed at low relative humidity and the containers should be properly sealed which preclude fungal growth and prevent suppleness during handling. The common genera of fungi viz., *Aspergillus, Penicillium* and *Rhyzopus* infest dried plant material. The plant material before collection should be treated with Dithane-M. 45 (0.2%). Sulfur burning or sulfur dioxide fumigation also reduces these fungi during storage.

Marketing of dried ornamentals:

In comparison to fresh ornamentals the profitable marketing of dried ornamental plant material requires the understanding of various markets viz., economics, psychologically attraction for such products and physical consideration like ware- housing, distribution and sale facilities. Being delicate material losses are more and little attention is given to maintain the quality. This sector could get least attention; therefore, both consumer and producer are at loss, whereas middleman is earning the huge profit. Bhutani (1993) carried out the feasibility study for export, inland marketing and commercial exploitation of dried ornamental plant material and floral crafts. It is possible to start a home scale establishment with a meager amount of rupees fifteen thousand and one may supplement his/her income by

employing other members of the family. If properly explored, it can develop into a successful cottage industry in our country.

This industry is poorly defined in terms of producers, products, handling systems, marketing and consumers/ customers. This industry can earn huge financial gains if professional profile is enhanced as a discrete entity. Further quality assurance has to be given and followed w.r.t. processing conditions, defined temperature and relative humidity limits, proper description of the product, performance characteristics, longevity, uniformity in grading, packing and overall quality of the product. This warranted more scientific investigation on dehydrated/dried ornamental plants so as to develop it into a full-grown separate industry.

Irrigation and Fertigation in flower crops

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Micro irrigation is the system for precise application of water to synchronize with the plant needs. It maintains a favourable soil water regime and restricts the fluctuation of soil water potential within narrow range. This system recharges the root –zone and maintains the uniformity of seed–zone moisture throughout the planting area for a longer period as compared to conventional methods of irrigation. Irrigation scheduling based on micro irrigation system takes into account moisture depletion pattern, infiltration, retention, transmission and redistribution pattern of soil and atmospheric demand. It is eco-friendly irrigation system saving > 60 percent water and increase in the yield to the extent of 30-40 percent over conventional methods.

The regulated supply of water through drippers not only affects the plant root and shoots growth parameters but also the fertilizer use efficiency and nutrient uptake. Drip irrigation added with fertilizer through fertigation reduces the wastage of water and chemical fertilizers, subsequently optimizes the nutrient use by applying them at critical stages and proper place and time, which finally increase water and nutrient use efficiency.

Fertigation which combines irrigation water with fertilizer is well recognized as the most effective and convenient means of maintaining optimal nutrient levels and water supply according to specific needs of each crop and type of soil. The technique applies both water and fertilizer at a low rate to the vicinity of plant root zone as per crop needs and according to crop developmental phase, resulting in higher yields and better quality of produce. Fertigation technology reduces the requirement of fertilizer by 40-60 per cent and enhances the yield. The right combination of water and nutrients is the key for increasing the yield and quality of produce. The availability of N, P and K nutrient was found to be higher in root zone area of drip fertigated plot .

What is fertigation?

1. Application of fertilizers with irrigation water

2. Fertigation is used to spoon feed additional nutrients or correct nutrient deficiencies detected in plant tissue analysis
3. Injection during middle one-third or the middle one-half of the irrigation recommended for fertigation using micro propagation
4. Most plant nutrients can be applied through irrigation systems
5. Nitrogen is most commonly used nutrient
6. Other nutrients include nitrate, ammonium, urea, phosphate and potassium
7. Fertigation allows the landscape to absorb UP TO 90% OF THE APPLIED NUTRIENTS, while granular or dry fertilizer applications typically result in absorption rates of 10% to 40%.

Features of fertigation

1. The localized wetting patterns produced by drip systems can induce limit to a nutrient uptake, making necessary to apply the fertilizers through the drip system, operation known as fertigation, injecting them
2. Drip irrigation introduces possibilities for precise application of fertilizer and other chemicals. The restricted root growth necessitates that type of fertilizer application, "fertigation", to prevent nutrient deficiencies
3. The high efficiency of water application reached in drip irrigation systems is ideal for the high efficiency of applied nutrients in fertigation.
4. This improved use efficiency of fertilizers, reducing nutrient losses due to leaching, thereby limiting groundwater pollution, better control of the soil solution nutrient contents, reducing soil solution salinity due to fertilizers and the ease of application, reducing labour and saving energy, are the prevailing potential advantages of fertigation
5. But, some of these potential benefits can reverse into disadvantages when the irrigation system design or management is not correct (non uniform nutrient distribution, overfertigation, excessive leaching, clogging).

Advantages

1. Increased nutrient absorption by plants

2. Reduction in fertilizer and chemicals needed
3. Reduced leaching to the water table and,
4. Reduction in water usage due to the plant's resulting increased root mass being able to trap and hold water
5. Application of nutrients at the precise time they are needed and at the rate they are utilized

Disadvantages

1. Concentration of solution decreases as fertilizer dissolves, leading to poor nutrient placement
2. Results in pressure loss in main irrigation line
3. Limited capacity
4. Use of chemical fertilizers of low-sustainability, instead of organic fertilizers.
5. Dependent on water supply not being restricted by drought rationing.

Fertigation techniques

The total fertilizer quantity of water soluble fertilizers calculated is divided into 10 equal parts and each part is applied at 8-10 days intervals. In venture system, 1/10 part of total water soluble fertilizer quantity is generally dissolved in 4 litre of water and is applied in 6-8 minutes. In fertilizer tank system, 1/10 part of total water soluble fertilizer quantity is dissolved in 20 litre water and is applied in 4-5 minutes.

Prominent Diseases and Integrated Diseases Management in Flower Crops

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Introduction

Integrated disease management (IDM) is a disease control approach that uses all available management strategies to maintain disease pressures below an economic injury threshold. It does not advocate a routine chemical application program to prevent disease, but promotes the integration of cultural, physical, biological and chemical control strategies. The routine application of fungicides for insurance purposes is not appropriate, as it does not focus the proper attention on the real problem and can lead to resistance and potential environmental issues.

The basic objectives of any IDM program should be to achieve at least the following:

- reduce the possibility of introducing diseases into the crop
- avoid creating conditions suitable for disease establishment and spread

A sound disease management program integrates a few universal principles and concepts into the overall production system for that particular crop. It is important to understand the concepts of disease control and the strategies developed from them and to make modifications appropriate for a particular greenhouse or crop situation. A disease control program involves more than a fungicide application, which too often addresses the symptoms but not the problem.

The Disease-Triangle Concept:

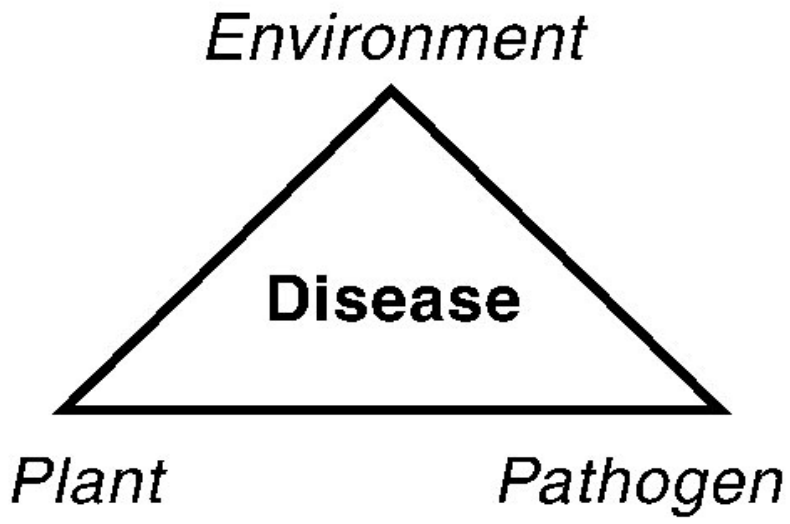

Figure 1-1. The Disease Triangle

The Disease Triangle shows the importance of the three factors necessary for disease development:

- a pathogen or disease-causing organism (e.g., a fungus, virus or a bacterium)
- a susceptible plant for the pathogen to infect
- a suitable environment in which the first two will interact

For example, *Thielaviopsis basicola* will attack the bedding plant Vinca when air and media temperatures are cool (15-17°C), but rarely at temperatures above 21-22°C. However, this pathogen will attack pansy when the temperature is above 25-26°C, the media pH is high (above 6.5) and the sanitation is generally poor.

The plant environment includes the soil or growing media in which the roots grow and the above-ground environment or air where the shoots, leaves and flowers are produced and developed.

Soil or media environment characteristics that must be considered include:

- **pH of the growing media** - pH strongly influences the availability of micronutrients such as iron and manganese and can influence the development of the root system in the growing media.
- **Nutrient levels and their balance** - These affect the plant tissue content and can trigger toxicity or deficiency symptoms. This tissue is typically more susceptible to attack by pathogens.
- **EC (electrical conductivity created by soluble salts)** - High EC can damage root hairs creating a wound site for attack by root disease pathogens.
- **Moisture-holding capacity** - Media must hold sufficient available water to prevent desiccation of the roots once the root system becomes pot-bound.
- **Media texture to allow good drainage** - Adequate coarse-fibred peat is required to ensure sufficient aeration when the growing media is at full water holding capacity to prevent water logging and oxygen deprivation of the roots.
- **Oxygen content** - Adequate media aeration is critical to healthy root growth and nutrient uptake and preventing temporary exposure of roots to anaerobic conditions.
- **Media temperature** - Roots develop best at temperatures somewhat lower than those required for shoot growth. High media temperature causes significant root death in most crops when media temperatures are above 26-28°C. This is of significant concern when plants are grown on metal trough or concrete floor sub-irrigation systems during the heat of the summer.

Aerial environment characteristics that must be considered include:

- **Light levels** - Exposure of high light requiring plants to low light levels or heavy shading often triggers soft, weak growth that is more susceptible to leaf rot pathogens.
- **Temperature** - Growing crops at air temperatures above or below the optimal temperature for the specific crop often results in higher incidence of root and foliar disease problems. For example, crops typically considered cool crops when grown during high temperature periods of the year are usually more susceptible to crown and root rot pathogens.
- **Air movement** - Air flow patterns within the greenhouse influence the severity of powdery mildew and botrytis. Open doors causing drafts and fluctuating

leaf and air temperature or horizontal air fans (HAF) that are improperly positioned that cause air turbulence or down drafts in front of the fan unit will increase the severity of foliar diseases. Insufficient air movement can also increase the incidence of foliar diseases because of the high relative humidity levels developing within the plant canopy.

- **Relative humidity (RH)** - Fluctuating RH with high RH at night (above 90%) increases the incidence of foliar diseases.
- **Air quality** - Chronic low level air pollution often associated with ethylene-like hydrocarbons can trigger premature senescence of older leaves whose tissue is more prone to opportunistic fungi like Botryis.

Six General Principles of Plant Disease Control

Exclusion

Preventing pathogens from becoming established in the greenhouse is a primary aspect of disease control. For example, geranium propagators use this principle each year when they purchase new virus-indexed/pathogen-free cuttings for stock plant production. This minimizes the potential for fungal and bacterial infections such as geranium rust or bacterial wilt.

Growers who use soil or compost in their media pasteurize the material to eliminate soil-borne pathogens. The use of new, clean pots, plug trays, cell packs and flats prevents any potential carryover disease inoculum from infecting newly planted crops the following growing season.

Avoidance

This involves using common sense practices to avoid situations that promote disease development. For example, do not use overhead watering late in the day in crops with a dense canopy because this creates conditions favourable for the development of *Botrytis*.

Resistance

This involves the inherent ability of a host plant to remain healthy or resist attack, even though a pathogen is present and/or the environment is conducive to pathogen development. For example, many Rieger begonia cultivars are being bred with resistance or tolerance to powdery mildew.

Protection/prevention

Fungicides can be applied before any disease is observed as a preventive measure to protect crops during periods when conditions are conducive to disease development. However, this proactive approach should be taken judiciously and only under specific crop conditions or crop staging. For example, application of a fungicide such as fenhexamid at the end of the poinsettia crop can protect the bracts from Botrytis infections without leaving significant residue. This is often appropriate when outdoor conditions are cool and wet and the temperatures within the greenhouse have been lowered to tone the crop prior to shipping.

Another good example is applying a fungicide to Easter lilies just after visible bud for Pythium root rot. It is well documented that during the phase of rapid bud expansion, root rot typically sets in resulting in lower leaf yellowing because most of the energy produced by the plant is directed to the expanding flower buds.

Eradication

Plant pathogens can be eliminated via several means, such as steam pasteurization of ground beds or rock-wool slabs, to eliminate root-borne diseases and nematodes. Sanitizing products containing hydrogen peroxide, chlorine bleach (sodium hypochlorite) or quaternary ammonium chloride compounds can effectively control bacteria or fungal mycelium and spores in dust or on surfaces of benches, in or on irrigation lines and emitters, and on tools used for propagation or production.

Plant breeders and primary propagators routinely index and use tissue culture techniques to maintain vegetatively-propagated plants free of plant-infecting bacteria and viruses.

Therapy

Treat infected plants to prevent further sporulation and spread of the disease. For example, myclobutanil when sprayed on rose foliage can kill the mycelium of the powdery mildew fungus.

Basic Integrated Disease Control Strategies

Symptom recognition

Successful disease management begins prior to the start of each crop. Knowing the diseases most likely to infect the crop is helpful in anticipating the potential problems that may arise. However, with so many new plant introductions each year, the susceptibility to disease is not always known. Experience has shown that most new plant material is susceptible to many of the same diseases that have frustrated growers for decades.

Becoming familiar with the typical symptoms of the most common economically important diseases is important in quickly recognizing and identifying a disease in its early stages.

Sanitation and Roguing

Sanitation is the first step in any disease management program. If a source of infection or infestation is constantly present due to poor hygiene, disease management programs will be expensive and frustrating. Proper sanitation practices are the first line of defence in the greenhouse, outdoors in the immediate vicinity of the greenhouse and during every stage of crop production.

Proper greenhouse sanitation is a continual, year-round process. Cleanliness on its own may not totally control pest problems, but it is a basic component of any control program. It is important to:

- Use footbaths between greenhouse compartments, particularly between propagation and stock plant areas. Proper maintenance of these footbaths is

essential. Follow the label of the product being used. Household bleach is not recommended for this purpose.

- Remove dead and dying plants, leaves and flowers as detected. In geraniums, removing and disposing of all flowers away from the greenhouse plays a significant role in reducing the incidence of *Botrytis*. Do not leave diseased plants under benches.
- Place rogued plants with difficult to control diseases in commercial garbage containers and dispose of them in a landfill to reduce potential sources of inoculums.
- Dedicate wheelbarrows or soil carts used to discard diseased material strictly for disposal purposes. If this is not possible, disinfect after every use.
- Have employees wear disposable gloves when handling diseased plant material. Otherwise, employees should wash their hands thoroughly with soap or bactericidal hand lotion before performing another function. They should also wash their hands or change disposable gloves between cultivars when taking cuttings.
- Store normal crop residues well away and downwind from the greenhouse to prevent particles of media or plant tissue being blown or sucked into the greenhouse. It is preferable to cover plant residues; alternatively, move residues off-site on a routine basis.
- Keep walks and the surfaces of benches clean. Sanitize between crops.
- Carefully check both the foliage and roots for disease when bringing new vegetative cuttings into the greenhouse. It is advisable to initially isolate new plant material, particularly material destined for stock plant production.
- Avoid over-wintering garden or houseplants in the greenhouse, as they may act as a source of disease.
- Maintain proper drainage to eliminate puddles and wet surfaces, as these provide ideal breeding sites for fungus gnats and shoreflies. These insect pests are a common vector of infection for root diseases such as Pythium and Fusarium.
- Keep the greenhouse free of weeds that may harbour diseases like impatiens necrotic spot virus/tomato spotted wilt virus (INSV/TSWV) and other common viruses or insects that can be vectors of virus diseases.

- For soil-grown crops, steam soil before planting winter crops to minimize the carryover of root and crown rot pathogens.
- Steam traditional propagating benches regularly.
- Disinfect propagating benches and trays before use and between each round of rooting to eliminate bacteria and fungi.
- Use expanded metal benches rather than wooden benches for easy cleaning and to minimize the spread and survival of pathogens during propagation.
- Sweep or vacuum bench surfaces before sanitizing to ensure the best possible effectiveness of sanitizer. Peat and other organic matter left on the bench prior to sanitizing reduce the effectiveness of most sanitizing agents. If necessary, wash down benches and walls with horticultural detergents to remove algae and other organic material before sanitizing.
- Empty and sanitize tanks used to hold re-circulated nutrient solution at the same time as concrete floors or troughs are being sanitised to prevent recontamination of the production areas.
- Dip cutting knives in 70% alcohol between cultivars to prevent the spread of disease.
- Between crops, perform a general disinfection of the greenhouse structure (walls), heating pipes, walks, benches or equipment if possible.

Environmental Control and Manipulation

Environmental factors such as light, air temperature, plant temperature, RH, air circulation, media composition, pH and EC, as well as the nutritional status of the crop, impact both the health of the plant and the diseases that attack them. The use of environmental controls to manage diseases is complex because of the simultaneous effect on crop production.

Know and understand the conditions required for both the optimal growth of the crop and the common diseases of that crop:

- Avoid extremes or, more importantly, rapid changes in RH. This minimizes the time period and conditions suitable for Botrytis or powdery/downy mildew to develop.

- Be aware that temperatures of leaf surfaces are lower in plastic houses than in glass houses particularly at night, because of greater heat loss due to far-red radiation.
- Avoid poor air circulation (too little/too much) within individual greenhouse zones. This can cause uneven temperatures throughout the crop. It can also lead to free moisture forming on the plants, particularly at night, which creates ideal conditions for mildew and *Botrytis* infections.
- Avoid extremes, as much as possible, for the crops. For example, the combination of high temperature and over-fertilization promotes *Fusarium* crown and root rot in cyclamen, while the combination of high temperature and high RH is favourable to *Rhizoctonia* attacking cuttings during or just after propagation. Also avoid low temperatures to prevent outbreaks of *Pythium* in warm-temperature crops.

Modification of Cultural Practices

Chronically stressing plants, for example, by growing them too dry or too wet can make them more susceptible to attack by disease pathogens. Plants become stressed when unsuitable root and/or shoot environments for a specific crop are provided by the grower.

Understand the growing requirements of the crops being produced. Not all crops will tolerate the same conditions. For example, Easter lily and Primula require very different root management; lily roots cannot tolerate being overly wet and starved for oxygen while Primula cannot tolerate having the media drying out.

Monitor the media or substrate pH and EC weekly if necessary to ensure that they are not quickly changing over time. Reduce rate of fertilization when soluble salts (EC) are high. The definition of high salts varies with the crop and its stage of development (see Chapter 3, Water, Growing Media and Crop Nutrition). High salts damage root hairs and young roots by desiccation. These wound sites become entry points for disease pathogens like *Pythium* and *Fusarium*.Use clean containers and porous, well-draining media to minimize the potential for pathogens such as *Pythium* and *Phytophthora*.

If foliar diseases are an ongoing problem, review temperature, RH, air circulation patterns and watering practices. Often, by maintaining higher night temperatures, higher minimum overhead pipe temperatures, lowering under bench heating pipe temperatures or ensuring that air exchange occurs regularly throughout the night through gapping of blackout or energy curtains, the incidence of foliar diseases can be lessened.

Monitoring

Regular crop monitoring and record keeping provides reliable information to guide an IDM program if the crop inspection is routine and structured. It is essential to monitor for the presence of plant diseases, just as it is in reviewing crops for plant growth regulator (PGR) application or for irrigation. It must be considered part of the production process. Concentrating on known susceptible crops or areas within the greenhouse that are typical locations for certain problems (e.g., powdery mildew near door entrances) can save time when growing a range of crops.

To monitor effectively for disease incidence and development, it is important to inspect foliage and flowers (if present) weekly. Roots should also be checked at least bi-weekly, which is practical for potted crops although not for soil-grown cut flowers. Check EC and pH at least biweekly for each crop grown as these two factors often predispose plant roots to attack by various root rot pathogens. Monitoring greenhouse RH and temperature for dramatic fluctuations by reviewing graphs produced by environmental computers provides early warning of the potential for foliar disease problems. Detecting diseases early makes control easier and may mean containing a problem with only a spot spray or other localized action.

Monitoring can only be successful when pertinent information is recorded. This is beneficial when attempting to identify a crop problem or when completing a post-crop production review. The following information should be recorded when monitoring or applying a fungicide:

- date
- compartment or section in the greenhouse
- crop species and cultivar

- stage of plant development
- diseases present or suspected
- control action (pesticide used, rate, area treated, time taken, etc.)
- greenhouse environmental conditions (temperature, RH, light levels, shading used).

Biosecurity

Biosecurity is a process to protect a geographic area or individual facility from pests and diseases. It includes reducing the risk of the introduction of new pests and diseases and eradicating or effectively managing the spread of those that have already arrived. Taking common sense precautions to prevent pests and diseases from entering the farm is a worthwhile investment. In the context of greenhouse floriculture, this should entail proper sanitation, thorough inspection of incoming cuttings and the other integrated disease strategies described in this chapter and in Integrated Insect and Mite Management. The implementation of a biosecurity protocol for visitors entering the facility also plays an important role in reducing the potential for the introduction and establishment of new pests and diseases.

Disinfectants

These products play an important role in the prevention and control of fungal and viral pathogens within the greenhouse. There are a number of products available including the following:

- **Agribrom** - used to control microbial slimes in greenhouse evaporative cooling systems and to control algae and microbial slimes in irrigation systems. Maintenance of desired levels in automatic irrigation systems has proven difficult for most growers even when using a brominator.
- **A 0.5-1% final solution of sodium hypochlorite bleach** - mix 1 part common household bleach with 10 parts water to obtain a final solution of 0.5%. For a 1% solution, mix 1 part bleach to 5 parts water. Use a higher strength solution (up to 10%) in cases of serious disease outbreaks or when disinfecting wooden benches or surfaces with considerable organic matter remaining on surfaces. Chlorine is very effective but rapidly volatilizes when

mixed in water, with the strength reduced by 50% in two hours. Chlorine fumes can be harmful to plants, so if plants are present in adjacent areas, ensure adequate ventilation. Organic matter very quickly inactivates the chlorine. Be aware that residual chlorine can be released from surfaces when rewetted if rapid drying has occurred.

- **Horti-Klor** - a chlorinated cleaner or detergent that can be used initially to remove algae and plant residue from packing equipment, planting lines, plug trays and coolers. Follow manufacturer's directions.
- **Hydrogen Peroxide** - 35% regular hydrogen peroxide is an effective disinfectant through the process of oxidation for cleaning and sanitising greenhouse surfaces and irrigation systems.
- **Strip-It** - an acid-based formulation for end of crop cleaning of greenhouse structures and irrigation systems that removes algae, biofilm and fertilizer build-up.
- **KleenGrow** - a quaternary ammonium chloride compound with broad fungicidal and bactericidal activity, recommended for general hard surface disinfection of packing lines, plug trays and foot baths.
- **Floralife D.C.D**. - a quaternary ammonium chloride compound with fungicidal and bactericidal activity. Surfaces should be pre-cleaned prior to disinfection and should remain wet for 10 minutes.
- **Virkon** - potassium monopersulphate, a non?corrosive disinfectant with broad fungicidal, bactericidal and virucidal activity for greenhouses and other agricultural buildings.
- **ZeroTol** - 27% acidified hydrogen peroxide is an effective disinfectant through the process of oxidation for cleaning and sanitising greenhouse hard surfaces and irrigation systems including flood floors and benches.
- Quaternary ammonium chloride compounds are quite stable because the chlorine is not volatile, but they disinfect in a way similar to chlorine bleach. As with bleach, contact with any type of organic matter will inactivate the disinfectant. Therefore, it is very important to remove as much organic matter as possible prior to application.

Soil pasteurization

Greenhouse media containing field soil and cut flower soil-based ground beds typically contain weed seeds, insects, bacteria and fungi that may be harmful to the plants being grown. This includes potting mixes and their components, unless guaranteed sterile or pasteurized by the manufacturer. Pasteurization of media containing soil is important to eliminate these harmful organisms. Ideally, this is accomplished without injuring beneficial soil organisms. For information on soil pasteurisation methods.

Pathogen-Free Plant Material

Purchase cuttings from specialized propagators or from plant breeders to minimize the chance of introducing diseases into a greenhouse operation. If possible, isolate new plant material to reduce the potential for contamination.

Change stock plants regularly. This may mean quarterly or every six months, depending on the crop. Do not carry stock of any bedding plants from one season to the next.

Do not bring young clean stock into the same production zone until the old has been moved out and the area is thoroughly sanitized.

Vector Control

Insects spread many viruses and viroids. For example, aphids spread Aster yellows in chrysanthemum, while INSV/TSWV is transmitted by western flower thrips. Consider using screening on open cooling vents to block many insect pests from the greenhouse. This makes control of the insect population easier.

Fungus gnats can spread the spores of *Pythium*. The larvae damage young roots through feeding activity. Research has shown that *Pythium* oospores (thick-walled sexual spores) are routinely transmitted through the gut of fungus gnat larvae. In addition, the adult can transfer the pathogen with its legs and mouthparts. Controlling algae growth through judicious watering practices and providing

adequate drainage under benches helps control fungus gnat and shorefly populations and minimizes the spread of disease pathogens.

Host Plant Resistance

Many plant species display varietal differences in their susceptibility to disease attack. Breeding of crops can provide growers with cultivars resistant to one or more insects or diseases. For more information

Chemical Control

Fungicides have been the conventional approach to disease control. The role of fungicides can vary from protecting healthy plants to treating infected plants and eradicating diseases. It is necessary to rotate fungicides with different modes of action to reduce the likelihood of resistance development. Rotation of fungicides has become increasingly important as most newer fungicides have a single-site mode of action and are more prone to resistance development. Never use fungicides with the same grouping number back-to-back. The grouping/class number is printed on the front of the label. Reducing the use of and reliance on fungicides is also critical in resistance management. An important aspect of reducing fungicide use is developing a better understanding and appreciation of the role of cultural practices in disease management.

Biological Control of Diseases

Biological disease control involves the use of naturally occurring fungi and bacteria that strongly suppress disease-causing organisms without harming the crop. Mechanisms of action include competition, antibiosis, parasitism or induced resistance. Most biocontrol products should be considered preventative or suppressive and their use should start with the planting of a crop. Note that labels indicate suppression of disease, not control of disease.

Microbial fungicides having received Canadian registrations for use on greenhouse grown ornamental crops are listed below. For root diseases:

- Mycostop is registered as a bio-fungicide for the suppression of damping-off caused by *Pythium*, root and crown rot caused by *Phytophthora*, and wilt caused by *Fusarium* on greenhouse ornamentals. The soil bacterium *Streptomyces griseoviridis* K61 is the active ingredient. Its mode of action includes hyperparasitism (microbe deprives pathogen fungi of nourishment by colonizing plant roots in advance of the fungi) and antibiotic production, which inhibits pathogen growth. Because the effect is preventative, drench Mycostop immediately after potting and repeat the treatment every 3-6 weeks, depending on disease pressure.
- Rootshield is registered as a bio-fungicide for suppression of *Fusarium*, *Pythium* and *Rhizoctonia* on all ornamental crops. The naturally occurring fungus *Trichoderma harzianum* KRL-AG2 strain provides protection by colonizing the surface of the roots and root rhizosphere through the utilization of waste products produced during normal root growth. It also parasitizes disease-causing fungi through the release of enzymes that cause breakdown of their cell walls. This bio-fungicide should be applied soon after germination, rooting or sticking of vegetative cuttings. Two formulations are available: a granular formulation that can be incorporated into the growing media, or a drench to be applied to newly transplanted seedlings or cuttings and to apply at regular intervals.
- PreStop WP is registered as a contact bio-fungicide for the suppression of *Pythium, Rhizoctonia* and *Phytophthora* on a variety of ornamental and bedding plants. It is also registered for use against *Botrytis* on various ornamentals. The active ingredient is the fungus *Gliocladium catenulatum* strain J1446, which works by competing with plant pathogens for colonization of plant root surfaces, depriving the pathogen of nutrients. Additionally, it produces enzymes that break down the cell walls of pathogens, an action known as hyperparasitism. It can be applied as a growing medium treatment or soil drench for root diseases, or as a foliar spray for *Botrytis*.
- *Bacillus subtilis* MBI 600 is a naturally occurring bacterium that has been shown to rapidly colonise the roots of growing plants and produces an antibiotic protein that suppresses the ability of *Pythium* spp, *Fusarium* spp and *Rhizoctonia solani* to grow and become pathogenic. The bio-fungicide Subtilex Biological Fungicide was first registered for commercial incorporation

into Promix soilless media manufactured by Premier Peatmoss. BioTak is another end use product registered for incorporation by commercial growers into their peat-based growing media prior to planting.

- Contans is a biological fungicide registered for the control of sclerotia activity of Sclerotinia in soil grown greenhouse cut flowers and for suppression in outdoor grown cut flowers. The active ingredient, fungal strain *Coniothyrium minitans* Strain Con/m/91-08 should be applied to the soil three months prior to anticipated Sclerotinia outbreak in a susceptible flower crop.

For foliar diseases:

- Actinovate SP is registered as a contact biological fungicide for suppression of powdery mildew on greenhouse and field-grown gerbera daisy and peppers and for suppression of Botrytis and powdery mildew on greenhouse and field-grown strawberries. The active ingredient, *Streptomyces lydicus* strain WYEC 108, is a bacterium that colonizes the leaf surface and competes against foliar pathogens. It has been shown to produce antibiotics that act against plant pathogens. For powdery mildew in gerbera, it should be applied as a foliar spray at transplant with 2 subsequent sprays at 7-day intervals.
- PreStop WP is registered as a contact biofungicide applied as a foliar spray for *Botrytis*. For mode of action, see description on PreStop under Biological Control of Diseases.
- Rhapsody ASO and Cease biofungicides contain the bacterium *Bacillus subtilis* strain QST 713 and is registered for suppression of powdery mildew, *Botrytis* and leaf spots on a number of greenhouse and outdoor ornamental crops. *Bacillus subtilis* produces chemicals that break down the cell membrane of disease organisms. The bacterium must contact the disease pathogen. It also inhibits pathogens from colonizing the plant. There is a range of rates depending on the disease pressure and it should be applied at 7-day intervals.
- Regalia Maxx contains an extract from *Reynoutria sachalinensis* that, when applied to plants, improves their natural defense mechanisms against certain fungal diseases and is registered for the suppression of *Oidium* spp of powdery mildew on greenhouse and outdoor-grown ornamental crops.

- Cyclone, containing fermentation products of *Lactobacillus caseii* strain LPT-111 is registered for the suppression of powdery mildew and blackspot on greenhouse roses when applied as a foliar spray.

As with pesticides, biocontrols are not a panacea for disease control. Biocontrol agents will not replace proper crop management strategies.

Achieving Successful Disease Management

Successful disease management can be achieved if these measures are followed:

- Emphasize prevention rather than cure. This is critical in any production system, but is especially true when crops are being grown in closed sub-irrigation systems.
- Monitor crops daily (or at least two times per week) by walking the crop(s) to achieve early detection. This involves checking the crop foliage and root systems and equally importantly, manual and automated computer-controlled environment settings.
- The employee responsible for monitoring must work closely with the person responsible for overall crop scheduling and growing. Ideally, the individual in charge of growing should be the one who monitors for disease and environmental control. In many operations, this should be done by an employee dedicated to the task because the owner/grower often has other issues on which he/she is focused.
- Correct diagnosis is crucial. Without correctly identifying the pathogen, control using cultural or chemical strategies is impossible. Soil-borne fungi are the most difficult pathogens for growers to identify. Send samples to the Pest Diagnostic Clinic, University of Guelph, for a more accurate diagnosis. See Appendix E. Diagnostic Service, for further details. For some diseases, ELISA disease diagnostic kits for grower use are available from Agdia Inc.
- Develop a thorough understanding of the diseases that affect the crops being grown. Correct use and timing of management strategies then becomes part of an ongoing process.
- Because disease pathogens are microscopic, learn to anticipate when possible pathogen infection periods are likely to occur. By the time the

problem is visible, the pathogen has usually been present for some time and is more difficult to control.

- As a grower/manager, keep detailed records that enable merging of cultural, environmental, and insect and disease data for review when a production problem arises or for doing post season crop summary reviews.
- Monitor the weather to help anticipate potential disease problems. For example, a cool, cloudy and wet summer with the central heating system off creates ideal conditions for downy mildew development. Poinsettia propagators can anticipate slow, uneven rooting and increased *Botrytis* rot without supplementary heating.

Nursery Management in Horticulture

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Nursery development has great scope for enhancing the production and profitability of fruit crops because of poor yields and overall low productivity, year to year fluctuations in production, poor quality of produce and non-availability of quality planting material. The modern era of horticultural development is known for effective utilization of hi-tech interventions for different aspects. Hi-tech interventions in nursery establishment are technological advancements, which are capital intensive, minimally environment dependent and useful in rapid multiplication of planting material of fruit plants.

Nursery management is a technical and skill oriented job, which require proper attention at different stages of production of quality planting material. Setting up of a fruit nursery is a long term and capital intensive venture. It needs lot of planning, expertise and efficient management for the production of quality planting material. Mistakes committed initially in the establishment of a nursery can not be rectified easily at later stages; moreover it reduces the returns greatly as well as results in wastage of time and energy. Therefore, careful planning is needed before establishment of a nursery. The nurseryman should prepare a layout of the proposed

nursery, which should include allocation of plots/area to different components of the nursery such as mother orchards of different fruits/cultivars, rootstock banks, nursery beds, roads/paths, water channels, drainage system, buildings/other structures, etc. Provision of certain basic pre-requisites must be made for the establishment of a fruit nursery on modern lines.

Selection of location and site:

Selection of an ideal location and site is of utmost importance in order to achieve the level of sufficient growth to raise good quality plants in the nursery. Keeping in view the variation in the requirement of nursery production as well as to maintain quality, an isolated area is more desirable for nursery raising. The nursery site should be well connected with modern transport and communication facilities and should be located near a city or town, so that it is easily accessible and the customers can visit it conveniently. The area should be receiving adequate sunshine and should preferably be on "north-western" aspect. It should have access to good water source, electricity, skilled and unskilled labour availability throughout the season as well as professionally qualified and competent manpower. Places with a mild climate, long growing season and even distribution of rainfall are most suitable for planting material production while areas with extremes of temperature or commonly subjected to dry winds, frequent flooding, hail, storms or known to be frost pockets should be avoided as they adversely affect the quality of planting material. Soil should preferably be light to medium in texture with good fertility, water holding capacity and drainage, ideally with a pH range of 6.0 to 7.0. Topography should preferably be plain with gentle slope (1 to 2 %); and in very sloppy areas terracing need to be done.

Components of Model nursery:

A genuine prospective nurseryman can earn reputation for production of quality planting material by considering following points before establishing a model nursery.

1. Technical Knowledge:

The knowledge on nursery management before establishing a nursery is pre-requisite for its success. Nursery management is highly skilled and technical job,

which requires proper attention and expertise. Therefore, a person who wishes to establish a fruit plant nursery must have technical knowledge on every aspect of the nursery production.

2. Nursery Registration:

In order to regulate the quality of nursery plants, the fixing of nursery standards and to bring the fruit nurseries under the ambient of nursery certification is very important. Fixing of nursery standard and certification of nursery stock are the twin services which are highly valuable from customer's point of view. While nursery standards ensure the supply of healthy disease free and commercial grade plants to the customers, setting of certified nursery stock protect the customers against planting poor quality and undesirable varieties.

Certification of nursery means that the nursery plants have been checked and identified as true to type by the competent authority. For the purpose of certification the plants shall have to be propagated by using the scion wood and rootstocks material only from the registered trees maintained in the nurseries for the purpose. For producing certified nursery stock, the fruit nursery shall maintain a scion block and stool bed and shall have to use the propagation material only from these sources. For the production of certified nursery plants, certain minimum standards have been fixed for different fruits and the nurserymen are required to adhere to these standards. The general standards for different fruit plants are as under

1. Nursery plants should be true to type and raised from healthy, disease free, high yielding progeny trees of good quality.
2. Nursery plants should be raised on recommended rootstocks and should not be raised on old stock.
3. The bud/graft union should be smooth and strong enough.
4. The bud/graft union should be 15-25 cm from the ground level.
5. Nursery plants should be of standard height 60-120 cm depending upon the kind of fruit crops.
6. Root system should be well developed and there should be no damage while uprooting the plants from nursery.
7. Nursery plants should be healthy and free from diseases and insect-pests.

3. Layout of model Nursery

Layout is the arrangement of different essential features of a nursery including the roads, paths, buildings, beds, irrigation channels, etc. It is prepared for effective utilization of inputs and to do things in proper manner. A location specific model should be designed for nursery establishment as per requirements. Certain important components should be taken into consideration and provision should be made for these during planning and layout of nurseries, which are as follows:

(i) Fencing

Prior to the establishment of a nursery, a good fence with barbed wire must be erected all around the nursery to prevent tress pass of animals and theft. The fence could be further strengthened by planting a live hedge with thorny fruit plants.

(ii) Roads and paths

A proper planning for roads and paths inside the nursery will not only add beauty, but also make the nursery operations easy and economical. This could be achieved by dividing the nursery into different blocks and various sections. But at the same time, there should not be wastage of land by unnecessarily laying out of paths and roads. Each road/ path should lead the customer to a point of interest in the nursery area.

(iii) Progeny block/Mother plant block

The nursery should have a well-maintained progeny orchards or mother plant block/scion bank of commercial and recommended varieties. The mother plants for establishing progeny orchards should be obtained preferably from the original research institute from where these are released or from a reputed nursery. It is well realized that the success of any nursery largely depends upon the initial selection of progeny plants or mother plants for further multiplication. Any mistake made in this aspect will result in loss of the reputation of the nursery. A well managed progeny block or mother plants block will not only create confidence among the customers but also reduces the cost of production and increases the success rate of grafting/ budding/layering because of availability of fresh scion material throughout the season within the nursery itself and there will not be any lag period between separations of scion and grafting/budding.

(iv) Irrigation system

Nursery plants require abundant supply of water for irrigation. Hence provision for assured irrigation facilities must be made well in advance to obtain better growth and success in the production of planting material. In areas with low water table and frequent power failures, water storage tanks/ rain water harvesting tanks should be constructed to provide life saving irrigation to the nursery plants. Since water scarcity is a limiting factor in most of the areas in the state, a well laid out PVC pipeline system will solve the problem to a greater extent. An experienced agricultural engineer may be consulted in this regard for layout of pipeline. This facilitates efficient and economic distribution of irrigation water to different blocks in the nursery and also reduces the seepage losses.

(v) Office cum stores

An office-cum-stores is needed for effective management of the nursery. The office building may be constructed in a place which offers better supervision and also to receive customers. The office building may be decorated with attractive photographs with important characters of fruit varieties propagated in the nursery. A store room of suitable size is needed for storing polybags, tools and implements, packaging material, labels, pesticides, fertilizers etc. There should also be provision for separate sale counter.

(vi) Seed beds

In a nursery, this component is essential to raise the seedlings and rootstocks. These are to be laid out near the water source, since they require frequent irrigation. The beds should be raised 15 cm from the ground level to ensure good drainage. These should be located in an open place which receives sufficient sunlight. Beds of 1-meter width of any convenient length are to be made. A working space of 60cm between the beds is necessary. This facilitates ease in sowing of seeds, weeding, watering, spraying and lifting of seedlings. Irrigation channels are to be laid out conveniently. Alternatively, sprinkler irrigation system may be provided for irrigating the beds, which offers uniform germination and better seedling growth.

(vii) Nursery beds

Seedlings are taken out from the seed beds and transplanted in the nursery beds. Nursery beds are required for establishing rootstock seedlings for grafting/

budding as well as for planting of cuttings and layered plants. Such beds can be irrigated through sprinkler system.

(viii) Propagation structures

There should be adequate provision for modern propagation structures like mist chamber, poly houses, net houses etc. These structures provide optimum conditions required for seed germination, rooting of cuttings and hardening of plants before transplanting them in the field.

(ix) Potting mixture and potting yard

For better success of nursery plants, a good potting mixture is necessary. The potting mixtures for different purposes can be prepared by mixing fertile soil, well rotten farm yard manure, leaf mold, etc. in different proportions. The potting mixture may be prepared well in advance by adding sufficient quantity of super phosphate for better decomposition and solubilization. The potting mixture may be kept near the potting yard, where potting is done. Construction of a potting yard of suitable size facilitates potting of seedlings or grafting/budding operations even on a rainy day.

(x) Packing yard

A packing yard is used for packing the plant material before sale/dispatch to outstations. The yard can be combined with the working shed. There should be plenty of space to enable a number of workers to sort out and pack the plants with care. On the packed bundles description of the plant variety, name and address of customer should be properly indicated. Packing yard should be located near the sale counter.

(xi) Compost unit

It is an important component of the nursery. A huge quantity of organic manure is required in the nursery for the production of healthy planting material. Therefore, it is advisable to construct vermi-compost pits, where the weeds and waste material can be utilized for the production of organic manure at the nursery site itself and will reduce the expenditure to be incurred on the purchase of manures. It should be constructed near the potting shed.

4. Maintenance of nursery records

Nursery records must be maintained properly by incorporating all the information about the production of planting material and the observations recorded at each stage of production. The nursery records include store/stock of inputs used, nursery raising of seedlings/rootstocks, grafting/budding/layering/cutting, stock and disposal of propagated material. These may be maintained either in the registers and / or in the computer using suitable software such as Excel or MS Access, for monitoring the quality control mechanism. This will prove useful to identify the probable flaws in the production of planting material retrospectively as well as to rectify them subsequently. It would be useful to establish continuous and effective linkage with research organizations for the latest technological development regarding the nursery management aspects to upgrade and perfect the quality control measures.

5. Labeling of planting material

Planting material produced should be labeled properly as per the records, with necessary information such as crop, variety, rootstock used, date of production, name of the nursery etc and the planting material may be got certified from the competent authority by constituting committee comprising of horticulturist, pathologist and entomologist as a part of the quality control mechanism.

6. Linkage

Nursery production is a programme which requires proper planning and monitoring for obtaining quality planting material and better returns. This can be performed by better coordination and linkages with the experts in Universities, State Department of Horticulture, reputed nurserymen as well as concerned stakeholders.

7. Finance

Nursery production for horticultural crops is capital intensive intervention. Therefore, nursery growers should be provided with financial assistance for efficient and smooth working of various units of the nursery. It can be provided through Government sponsored schemes like National Horticultural Board, APEDA, National Horticulture Technology Mission or institutions like Nationalized Banks or Cooperatives.

8. Hi-tech interventions

Hi-tech interventions like protected cultivation, micro-propagation, micro-irrigation, fertigation, use of growth regulators, canopy management, organic farming, and automatic climatic controls measures etc. are used for efficient utilization of inputs and increasing production efficiency. Mechanization for enhanced efficiency is essential. There is need to adopt media siever, media mixer, poly bags filler, automatic grafting machines and electrically/pneumatically/hydraulically operated secateurs etc. for enhancing the efficiency in the large scale production of quality planting material.

9. Marketing management

The commercialization of nursery production is possible with efficient and organized marketing. This can be promoted by encouraging participation in Agri-fest, seminars and other market linkage activities.

Nursery Management Practices

Nursery management is one of the important aspects of production of quality planting material. Various nursery management practices have been standardized and sufficient technical know how has been generated on the various nursery management practices such as plant nutrition, irrigation and moisture conservation, weed control, plant protection and other cultural practices. Since the nursery management practices play a significant role in the production of healthy and good quality planting material, the available technology should be followed for improving the quality of nursery plants. Young nursery plants require intensive care to make them grow well. There are various practices which should be paid special attention.

Mulching

Mulching is an essential practice particularly in the areas of water scarcity in order to promote germination of seed as well as for better establishment of nursery plants. Immediately after sowing of seeds, seed beds should be mulched with 10-15 cm thick dry grass mulch, straw, pine needles, dried leaves and black polythene sheet can also be used as mulching material. As the germination starts, the mulch from the seed bed should be removed to avoid damage to newly emerged shoots. Similarly, immediately after grafting, nursery plants should be mulched. This practice helps to conserve soil moisture and control weed growth in the nursery.

Manuring

The commercial manuring and fertilization programme depends largely on the type and fertility of soil. Farm yard manure (60-80 tones/ha) should be mixed in the nursery beds before sowing of seeds or transplanting of plants into nursery beds. Nitrogen @ 60-120kg/ha, phosphorus @ 30 kg/ha and potassium @ 60-90 kg/ha should be added to the soil to get better growth of nursery plants. Half the dose of nitrogen and full dose of phosphorus and potassium should be applied at the time of nursery bed preparation whereas half dose of nitrogen should be applied at the time of onset of monsoon during the month of July.

Irrigation

Nursery stock and young plants require frequent irrigation to make them grow well. Therefore, provision of assured irrigation is essential for the success of a fruit nursery. In those areas where there is scarcity of irrigation water, it is essential to construct a water storage tank near the nursery area to ensure proper irrigation of plants. Plants should be watered at frequent intervals preferably in the evening, to avoid evaporation of water from the nursery beds. Irrigation may be given by constructing irrigation channel and sub channel, plastic pipes, water cans and sprinkler irrigation system. However, sprinkler irrigation system has been observed to be the best for nursery plants.

Hoeing and weeding

Nursery area should be kept free of weeds. For this, nursery beds should be dug 5-10 cm deep at least 3-4 times with the help of hand forks for loosening the soil, removing the weeds and satisfactory growth of plants. If manual labour is not available, the pre emergence weedicide (Simazine or Atrazine @ 6 kg/ha) is effective in controlling weeds in seedling stocks and grafted plants. Grammaxone @ 2 L/ha as post emergence application along with pre emergence weedicide reduces the cost by about 60% as compared to hand weeding.

Removal of polythene :

It is very important that the tying material does not girdle the rootstock, as this will delay growth and lower the quality, therefore, the tying material should be removed timely. This is an important operation of budded/grafted nursery plants, which must be done timely. After about one month of sprouting when the grafted

plants attain 30-45 cm height and the graft union start swelling, polythene strips should be loosened by giving sharp cut on the back side of the graft.

Deshooting:

After grafting and budding, the shoots generally arise from the rootstock below the graft union. It is necessary to remove the shoots from the rootstock at a regular interval as and when appear; otherwise it results in the failure of grafting/budding.

Staking

After removal of polythene, staking is must since the unions are tender in summer and the plants are blown off with slightly higher wind velocity in windy situations. Attachment to the stock remains weak and they get easily broken. To protect the plant from breaking and to ensure a single trunk, the plants should be staked with wooden stakes and tied at least at 2-3 places to ensure safety against heavy wind. Problem of breakage is less in much populated nursery beds. In unstaked nurseries, the losses may be as high as 20-30 per cent. Simple wooden stakes can be used for this purpose.

Single stemming:

It is necessary to regularly pinch the side shoots coming from the growing scions. Single stemming to a height of at least 45 cm should be done by allowing one sprout to grow properly and rapidly.

Uprooting and packing of plants

The evergreen fruit plants such as mango, litchi, citrus, guava, papaya and aonla are uprooted from the nursery during rainy season (July) whereas, peach, pear and pomegranate during winter (December) when they have entered into dormancy, after all shoot growth has stopped and most leaves have abscised. While uprooting, the nursery plants, care should be taken not to cause damage to the root system. Plants should be uprooted only after rains or after giving irrigation to the nursery beds. Before uprooting the plants, deep furrows should be made on both sides of plant rows. Plants should be uprooted manually without damaging the bud union and root system. After uprooting, the root system should be dipped in a solution of metasystox (1 ml/l water) for 30 seconds before packing. Plants should be properly labelled and packed cultivar wise in bundles of desirable and convenient size. The roots should be covered with moss grass and wrapped securely in gunny bags.

Prominent Insect Past and Integrated Insect Pest Control in Flower Crops

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Commercial cut-flower crops are grown in the open as well as under protected environment. They are prone to attack of insect-pests which need to be managed regularly to avoid any loss of aesthetic value of flowers. Different types of insect-pests are recorded to inflict losses to flower crops world-wide. A wide array of insect-pests has been reported to inflict direct or indirect damage but only a few occur in numbers enough to warrant control measures. The important insect-pests associated with flower crops are being grouped in four categories namely, sap sucking insects, flower feeders, foliage feeders and root feeders.

1. **Sap-Suckers:**

   A variety of sap-sucking insects like aphids, whiteflies, mealy bugs, mites etc. comprise this group. Amongst these the important one are rose aphid, *Macrosiphum rosae,* chrysanthemum aphid, *Macrosiphoniella sanborni,* green peach aphid, *Myzus persicae,* greenhouse whitefly, *Trialeurodes vaporariorum,* red spider-mite, *Tetranychus* spp., mealy bug, *Phenococcus* spp., are of immense importance and inflict lot of damage to a wide array of flower crops. Majority of these insects are minute in size and their presence is detected only when they have inflicted lot of damage to crop plants.

2. **Flower feeders:**

   Flower feeder insect-pests fall into two categories:

   a) Flower/ bud borers, and b) Flower scrappers

   Bud and flower borer, *Helicoverpa armigera,* tobacco caterpillar, *Spodoptera* sp., flower feeding beetle, *Mylabris* sp. are much problematic and difficult to control. Flower-thrips, yellow-mite that infest blossom as well as flower petals are minor pests.

3. **Foliage feeders:** Insects feeding on leaves of flower crops comprise this group. A variety of insects like tobacco caterpillar, *Spodoptera* sp., semi-looper, *Trichoplusia* sp., leaf feeding beetle complex, leaf miner, *Liriomyza trifoli* etc. inflict damage by biting-holes, mining leaves thereby reducing the plant vigour adversely.

4. **Root feeders:**

   In this group the white-grubs are of immense importance. They inflict considerable damage to the roots of plants especially in light sandy soils.

IPM of spider mites in roses

Spider mite populations in roses and dianthus can reach epidemic proportions in flower crops grown on the equator. The same power which fuels the production of flowers-year-round sunshine-also fuels the growth of spider mites. Over 50% of the annual costs of a crop protection program can be attributed to the control or suppression of spider mites.

While bending roses increases productivity, it also provides a safe haven for spider mites as chemical sprays cannot reach the underside of the leaf. As a consequence, in spite of effective spraying in the upper canopy, spider mites continue to migrate upwards from the base of the plant and the existence of this "mites reservoir" is why growers have to spray for spider mites routinely, to prevent damage to the crop year in and year out.

The predatory mite *Phytoseiulus persimilis* is well-known to growers and has been sold in most parts of the world as a biological control for spider mites. Phytoseiulus has the advantage over sprays in that it has legs and actively walks to the underside of leaves, in search of spider mites.

Success is assured as long as enough *Phytoseiulus* are applied to the crop in relation to the number of spider mites present. Also, be sure care is taken to integrate the predator introduction with compatible insecticides and fungicides. To determine how many *Phytoseiulus* to apply to a crop, the grower needs to assess the number of spider mites present in a crop. This is achieved by sampling leaves from the base, middle and top of plants and determining the average number of spider mites per leaf. From there it is a matter of a few calculations to determine how many leaves per plant and how many plants per house to estimate the total population of spider mites in the crop.

The speed at which the spider mites are controlled depends on the introduction ratio of *Phytoseiulus* to spider mites. Best control is achieved if this ratio is at least one *Phytoseiulus* for every five spider mites.

Growers are often not aware of how many spider mites are actually present in their crop, as this information is not usually used when acaricide programs are employed. However, many growers are now finding IPM scouting methods very useful even in their conventional crops, which use agrochemicals to control mites. The data will also objectively indicate the effectiveness of a particular acaricide in controlling mite numbers.

It takes about 1.5 man hours to scout a 0.25-ha mature rose crop with a moderate population of spider mites, using IPM scouting techniques. With the gradual eradication of spider mites, this process gets quicker. Crops should be scouted a minimum of once per week.

Measuring the progress of biological control

Upon introducing the predatory mite *Phytoseiulus persimilis* as a biological control for spider mites, the best control is achieved if this ratio is at least one *Phytoseiulus* for every five spider mites. But how to tell if your efforts are working?

Simply put: data collection. Progress is measured by following the progress of the ratio of *Phytoseiulus* to spider mites. If the introduction ratio was 1:150 in week one of the program, the ratio should progress to 1:110, then 1:75, then 1:23, then 1:5 and so on. Eventually there will be one *Phytoseiulus* to every spider mite and at this point the spider mite population will crash to virtually nothing.

Until this time, the spider mites numbers per leaf may have continued to rise, but an experienced practitioner of integrated pest management (IPM) will be confident enough not to spray acaricides in the knowledge that the ratio is coming down and the mites will soon be overcome. There may be some damage during the weaning program, but the advantage of this is that for the first time it will be possible to have virtually no spider mites in the crop.

Growers who lack confidence may choose to intervene and "help" protect the crop through chemical means. Keep in mind, however, even a "safe" pesticide could kill up to 25% of the beneficial *Phytoseiulus*. Continuous "help" of this kind will prolong the time it takes to achieve control and may cost more in terms of the *Phytoseiulus* themselves, as it may be necessary to replace the ones killed by sprays.

When the spider mites are decimated, the *Phytoseiulus* will then attack each other, leaving leaves completely clean. Maintain this spider mite-free zone by enforcing sanitation procedures between clean and unclean zones (reorganizing work plans for harvesting teams, etc).

Successful suppression of insect-pests on ornamentals depends on several factors and integrated pest management (IPM) is a systematic approach to manage pests that combines a variety of techniques and strategies to either reduce pest populations or lessen their economic impact. It is a site-specific strategy for managing pests that relies on correct pest identification. Therefore, efforts are made to identify the pest and detect the infestation at an early stage for deciding about the tools to be used for the management of pest problems. The monitoring tools (pheromone traps, light traps, yellow/ blue sticky traps) as well as the characteristic symptoms produced on the plants can effectively be used for early detection of pest problems. With a long-term perspective it is easier to see that an investment in IPM can pay for itself in a higher-quality crop produce and a cleaner environment.

Breading Strategies in Flower Crops

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Introduction

The shapes, forms and colours of present day ornamentals differ from those of their ancestors on account of man's intervention. Within the past 80 years, progress in producing ornamentals of new types and forms has accelerated largely due to need for higher yields, novelty and disease resistance. Every year about 10,000 new varieties of ornamental crops are being released. Novelty and the quest for new varieties has remained the aim of flower breeding since years. All the present day cultivars and the novelties are the result of extensive hybridization, spontaneous and induced mutation, selection and molecular breeding. Since in flowers a specimen cannot maintain interest for a long time, people have desire to develop new forms through various methods of breeding. Presently, many peculiar shades and forms like dwarf hollyhocks, dwarf delphiniums; red and white marigolds, etc. are available in seasonal flowers. The possibilities for creating different forms and improving ornamentals are infinite.

Propagation methods

Propagation of ornamentals involves control of different types of developmental life cycles, viz. sexual and asexual. It is well known that preservation of unique characters of plant or a group of plants depend upon transmission of a particular combination of genes from one generation to the next. Based on the mode of reproduction, the ornamentals are broadly divided into two groups, viz. sexually propagated and asexually propagated. Sexual cycle utilizes seed propagation as a means of producing offspring plants whose characters reflect the genetic contributions of the two parents. Reproduction by seeds results in certain amount of variation among the progeny. Improvement of sexual forms takes a number of generations. During this period, the best types are selected from segregating

material. Among ornamentals, seasonal flowers are propagated by seeds whenever genetic improvement of a particular plant is done through hybridization.

Breeding System

In seasonal flowers, breeding system fall into two groups, viz. self-pollinated (inbreeding types) and cross-pollinated (outbreeding types). Many species have an intermediate type of breeding system with varying proportions of crossing and selfing. They are grouped in the following breeding systems.

Inbreeders

Obligate inbreeders are rarely cross-pollinated. Highly self-pollinated seed propagated herbaceous annual flowers include China aster, balsam, sweet pea, lupin, clianthus, gypsophilla, bells of Ireland, salvia, saponaria, sweet William and dianthus. In these flowers, there is negligible cross-pollination in nature. In flowers like statice, linaria, lobelia and nemasia cross pollination is also quite extent.

Outbreeders

Obligate outbreeders are cross-pollinated because of the presence of a built in system preventing self-pollination. The group of outbreeding seed propagated herbaceous annuals and biennial flowers include ageratum, hollyhock, arctotis, cornflower, antirrhinum, delphinium, verbena, calendula, cosmos, gazania, poppy, marigold, zinnia, primula, pansy and viola. Self incompatibility occurs in ageratum, gerbera, daisy, petunia and antirrhinum. In primula, self sterility is due to heterostyly. Cytoplasmic male sterility has been reported in petunia, ageratum and sunflower. Monogenic recessive factor for male-sterilty exists in marigold, zinnia, calceolaria and salvia.

Breeding Objectives

In ornamentals, floral quality is the major consideration for evaluation of a particular genotype. In commercial seasonal flowers like china aster, marigold and antirrhinum, besides quality, total flower yield is also an important criterion for genetic improvement. Since ornamentals are affected by a number of diseases and pests, breeders should consider this aspect also while breeding for different parameters. Varieties resistant to abiotic stresses need to bred in commercially viable crops. Breeding suitable varieties for various climatic zones is necessity. In

India, F_1 hybrid varieties in view of their superiority over open pollinated varieties have a great potential. Transgenics can be utilized for production of transgenics in flowering plants, viz. for blue colour in rose, yellow colour in sweet peas, disease resistance in various flower crops, etc.

Genetic improvement in ornamentals has been done through introduction of important germplasm from other countries. The germplasm is evaluated and some introductions are directly recommended for cultivation, which are called primary introductions, whereas others, utilized in breeding programmes, are called secondary introductions. Besides introduction, other methods of improvement are hybridization, mutation breeding, polyploidy breeding, heterosis breeding and biotechnology.

The management of genetic resources of ornamental plants with an emphasis on their genetic improvement was started at Indian Agriculture Institute (IARI), New Delhi, during 1950s under the leadership of Late Dr. B. P. Pal. Other institutes like National Botanical Research Institute (NBRI), Lucknow; Indian Institute of Horticultural Research (IIHR), Bangalore and Bhabha Atomic Research Centre (BARC), Mumbai also contributed significantly in the genetic improvement of seasonal flowers. The work was greatly strengthened and streamlined with the establishment of All India Co-ordinated Floriculture Improvement Project in 1972.

Hybrids in Annual crops

The main advantage of F_1 hybrids is the unique combination of appreciable vigour and uniformity. Apart from this, F_1 are dwarf, compact with basal branching, free- flowering with larger flowers, prolonged duration of flowering and may have insect- pest and disease resistance.

Marigold

Marigold is a member of Asteraceae family. It is native to Central and South America, especially Mexico. Pusa Basanti Gainda (yellow coloured flowers) and Pusa Narangi Gainda (orange coloured flowers) have been developed in India through pedigree method of breeding.

F_1 Hybrid seeds in marigold were produced by using apetalous male sterile lines. Tester parents were maintained as inbred lines. Male sterile lines and tester parents were grown in separate polyhouses. Apetalous male sterile lines were

maintained. These were exploited by making crosses with the respective tester parents from 9 a.m. to 2 p.m. by taking pollens from desirable male parents in a petri dish and dusting it on male sterile flowers with the help of a soft brush. The flowers were bagged with perforated butter paper bags. In French marigold and African marigold, Line x Tester was carried out by using tester parents. F_1 hybrid seeds were collected and sown for evaluation in the subsequent seasons.

Antirrhinum

Antirrhinum belongs to family Scrophulariaceae and is a native of Southern Europe. Flower form is controlled by a single dominant gene. F_1 hybrid seeds in antirrhinum were produced by using hand emasculation technique. The female parent was emasculated by removing anthers from the florets when the lowermost floret is fully opened. Emasculation was done on lower one third length of the spikes and rest of the spike was chopped off. With the help of a pair of forceps, the petals were peeled and anthers were removed and bagged with muslin cloth bag. Fresh flowers should be plucked from intended male parent which have been previously bagged and pollen dusted on the stigmas of emasculated flowers. Crossing was done during 10 am to 12 noon. The pollinated spike was then bagged with perforated butter paper bag to prevent cross pollination. The hybrids seeds of all the crosses were collected when spikes are matured. F_1 hybrid seeds were collected and sown for evaluation in the subsequent seasons. Tetra Giant variety developed by polyploidy has higher number of flowering stems with large, deeper coloured flowers which are longer lasting than diploid counterpart.

Pansy

In Pansy, selections were put to evaluation and maintained as pure lines. F_1 hybrid seed in pansy was produced by using hand emasculation technique and making crosses among the selected tester parents. The female parent was emasculated by removing anthers from the flowers when the flower starts showing colour. The emasculated flower is then bagged with perforated butter paper bag to prevent cross pollination. Crossing was done during 10 am to 12 pm, by taking pollens from desirable male parents in a petri dish and dusting it on male sterile flowers with the help of soft caramel brush. The flowers were bagged with perforated butter paper bags. The pollinated flowers were tagged showing male, female parents

and date of crossing. Same procedure of crossing with the same male parent was repeated the next day to ensure proper pollination and seed set.

China aster

China Aster belongs to family Asteraceae, is native to China. Four varieties, namely, Kamini, Poornima, Shashank and Violet Cushion have been developed by pedigree method. Appreciable heterosis was observed for all the characters. Based on the economic characters like flower size, flower per plant and stalk length, three crosses Shell Pink Azure Blue, AST-20 Azure Blue and AST-20 AST-16 were recommended for exploitation of heterosis on commercial scale.

Petunia

Petunia, a member of Solanaceae family, is native of South America. A large number of F_1 hybrid varieties have been developed in Single and double petunias of multiflora and gradiflora types in the U.S.A., U.K. and Japan.

Balsam

*Impatiens balsamina,*is native of India, China and Malaysia. It belongs to Balsaminae. One pink coloured, double flowered seedling selection has been maintained and the seed is being produced every year in Nauni.

Gloxinia

Sinningia speciosa which normally does not produce seeds under Nauni-Solan conditions, seed was produced through artificial pollination and from the first progeny one variant which produced large red flowers with white frilled margins was obtained.

In *Gomphrena globosa* two selections were made in 1996 and evaluated in Nauni. Similarly, in **Salvia** *(Salvia splendens)* two selections red and purple have been maintained. Many seedling selections in **Phlox**(*Phlox* x *drummondii)* have been maintained and are being evaluated.

Year Round Flowers Production with Special Reference to Chrysanthemum and Carnation

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Floriculture is a lucrative and income generating sector of the country's economy. With the increase in per capita income, demand for flowers and floral products has also increased. Flowers find place in all occasions, may it be a festival, a celebration or a ritual function. Most of the growers produce a particular flower in the normal season following the traditional production technology. As a result, larger quantities of flowers are being produced during the normal blooming period, creating glut in the market which lowers the price of the produce. On the other hand, during special occasions or off-season the prices are much higher.

Flower regulation means to produce flowers at desired periods/date(s) for sale at higher prices than during the normal blooming season. Generally, it is done with the following objectives:

1. Reducing glut in the market during peak flowering times
2. To obtain higher price of the produce
3. To avoid spoilage due to excessive production at a particular time
4. Making the produce available at desired time
5. To provide employment throughout the year
6. To reduce imports and balance the trade

To regulate flowering of any ornamental crop, one should have the sound knowledge of factors which affect flowering. Flowering in most of the crops is mainly controlled by photoperiod and temperature. However, plants give flowers only when they attain a particular stage which is referred to as 'ripeness to respond' stage.

TECHNIQUES OF FLOWER REGULATION:

1. Temperature manipulation

Both, air temperature as well as temperature of the growing medium are equally important in flowering control. Greenhouse heating can be provided either by steam or hot water. Fuel is burned in a boiler and the hot water or steam is piped to

the heating lines to distribute heat evenly throughout the entire area. Temperature control is attained by regulating the temperature of water. On the other hand, moist pad, mist, or combination of two can be used for cooling greenhouses. Unit heaters can be installed overhead and the heat can be circulated by using a fan. *Lilium longiflorum* is scheduled to flower by controlling greenhouse temperatures and by monitoring the rate of leaf unfolding during the period between flower bud initiation and visible bud formation stage, 5-6 weeks before flowering. When flower initiation occurs, leaf formation ceases. This 'Leaf Counting' concept was introduced by Blaney and Roberts in 1967. By dissecting several representative plants at flower bud initiation stage, number of leaves to be unfolded by the desired visible bud formation date is determined. Semi-weekly counts of leaf unfolding are made on index plants to monitor the actual leaf unfolding rates. Average daily greenhouse temperatures are adjusted upward or downward to control the development rate. By rising the temperature leaf unfolding rate will increase and early flowering will take place. However, if the leaf unfolding rate is ahead of the schedule decrease the temperature to delay flowering.

Freesias have a basic annual thermoperiodic cycle of warm (30^{o}C), cool (10^{o}C) and warm (30^{o}C) sequence. Flower production is year-round when night temperature is 15^{o}C or lower. Flowering is induced after 7 or more leaves are formed by lowering the temperature below 15^{o}C. In case of Alstroemeria, flowering is controlled by temperature manipulation of the growing medium. Regardless of the air temperature, plants flower for an extended period if the medium temperature is held at 16^{o}C. Reproductive shoots are produced from 9-13^{o}C upto a continuous 17^{o}C. At 21^{o}C rhizomes get devernalized, and only vegetative shoots are produced. Stored bulbs of tulips and irises can be accelerated to flower by exposing to low temperatures (9-13^{o}C), but a high temperature (20-30^{o}C) pretreatment is necessary if flower formation is to occur at all.

Cold temperature treatment given to a plant to induce flowering is termed as vernalization. To cite an example, programming of lilium is done by giving the bulbs a cold temperature treatment prior to planting. Six weeks of vernalization at a temperature of 4.5-7.5^{o}C results in rapid and uniform flowering. Vernalized bulbs can be devernalized by increasing the temperature above 21^{o}C which will result in delayed flowering.

Easter lily requires a cool moist period for rapid flowering. Flower buds are not present in bulbs during or immediately after storage. It has been found that compared to non-cooled bulbs, storage at 2.2-10^{o}C accelerated flowering. Further, bulbs vernalized for 4 weeks in dry peat require 143 days to flower, whereas, bulbs vernalised under moist conditions required only 109 days to flower. More vernalization causes more rapid flowering. Bulbs stored at temperature below the optimum temperature for vernalization will accumulate the stimulus more slowly and thus can be held longer before planting. This will delay the date of anthesis. Warm storage above 10^{o}C before normal vernalization increases leaf number and therefore days to flower (Miller and Kiplinger, 1966).

In gladiolus, a low temperature <10^{o}C treatment is used to break dormancy after drying and curing of corms. The length of this treatment which varies with the cultivar, lifting date and growth conditions of the mother plants is 4-8 weeks in general. A high temperature treatment of 23-30^{o}C is then used to promote shoot and root development during storage and subsequent rapid growth of the daughter plants. The length of this treatment varies from 4-6 weeks. Tulip production is divided into two groups based on forcing programmes. One group is called rooting room A which involved production of early flowering and the other group is called rooting room B, which involves production for later flowering. For rooting room A planting should be done in mid September and for rooting room B during early October. Most tulip varieties require 15 to 16 weeks of cold temperature followed by 3 to 4 weeks in the green house to force them. In the rooting room bulbs are given 48ºF temperature for 4 to 6 weeks until the roots begin to grow. The temperature is lowered to 41ºF and maintained until the roots are about one inch long. At this stage, temperatures are dropped again to 31 to 35º F for the duration of cold week requirement. Each cultivar has an optimum number of cold weeks for a specific flowering date.

2. Photoperiodic manipulation

Plant response to seasonal variations in the length of day is known as photoperiodism. This phenomenon served the basis for regulation of flowering in many florists crops. Plants can be divided into 3 groups according to the critical day length requirement for flowering: **(1) short day plants**, those that flowers in relatively short photoperiods, **(2) long day plants**, those that flowers in relatively long photoperiods, and **(3) day neutral plants**, one in which flowering is not

affected by photoperiod. Duration of dark period is more important than the duration of light. It is found that if a short day plant is grown under short day, it will flower; but if the long night is interrupted with light and length of the day is not changed, the plant will not flower.

Certain plants can be made to flower at any time of the year by manipulation of photoperiod either by providing supplementary light from artificial sources, such as incandescent bulbs or fluorescent lamps to achieve artificial long day or by keeping the plants in dark to give artificial short days. By providing supplementary light to a long day plant during the non inductive cycle can induce flowering. However, by providing artificial light to a short day plant, it will remain in the vegetative phase. Modern carnation cultivars are quantitatively long day plants, i.e. flowering is not inhibited by short day but it is hastened by long days. Long days from night interruption lighting are more effective than day extention. Cyclic lighting is as effective as continuous night break lighting (Dole and Wilkins, 1988). Shoots become receptive to photoperiod induction when 6-8 leaf pairs are formed. Extended lighting durations produce significant differences for number of days taken for flowering. In general, extended lighting which was provided at night resulted in earlier flowering. Six hours extended lighting resulted in 26 days earlier flowering in comparison to without artificial lighting (Mahant, 2003).

Chrysanthemum is a short day plant, and cannot form flower buds when the daylength exceeds 14.4 hours or develop them when it exceeds 13.5 hours. Short days are to be provided during natural long days for obtaining flowers. Artificial short days can be provided by covering the plants with some material impervious to light such as black sateen cloth from 5 p.m to 9 a.m. Similarly, artificial lighting in the midnight for 4 hours helps in keeping the plants growing vegetatively.

3. Use of plant growth regulators:

Gibberellins can substitute for long day requirement of some plants and hence induce flowering. They also overcome the need for vernalization in some species. Growth retardants such as; Phosphon D, CCC, Amo-1618, Ancimydol etc. promote initiation of floral primordium by antagonizing the inhibitory effect of endogeneous abssisic acid level on floral initiation. In warm climate, GA_3 can be applied as corm dip treatment before planting to break corm dormancy of gladiolus and to hasten the formation of flower bud primordium. Foliar spray of naphthalene acetic acid (NAA)

@ 100 ppm helps in delaying flowering in rose (Bhattacharjee and Rajan, 1995) while spraying GA_3 500 ppm resulted in early flower bud appearance.

4. Physical methods:

Pruning:

Pruning is an important practice for manipulation of growth and flowering as it influences growth, flower bud initiation, differentiation and ultimately flower production. It helps to broaden the C:N ratio, thus stimulating flowering. This can be seen in case of bougainvilleas in which flowering occurs soon after pruning. Roses are another example which require pruning for flower induction. In case of *Jasminum auriculatum* it has been reported that flowering pattern can be shifted by pruning on different dates from early November to late March at 10 days interval. By pruning different plants at 6 months interval, staggered flower production could be achieved.

Pinching:

Pinching of the apical portion helps in delaying flowering. This is commonly practiced in case of carnation, marigold and chrysanthemum. In carnation, three type of pinchings are prominent for flower regulation, **a) single pinch**: only the terminal stem is pinched above 5-6 nodes. The resulting 4 to 5 vegetative shoots will elongate and flower about the same time in the shortest possible time from planting, **b) pinch and a half**: first single pinching of the main stem is done and later when the resulting shoots are long enough, about half of the shoots are pinched above 4-5 nodes again. This reduces the amount of first crop and provides a steady production of flower later in the season, **c) double pinching**: a single pinch of the main stem and later pincing of all the resulting shoots. This provide delayed flowering with too high density of flowering stems at one time. Laurie *et al.* (1987) also suggested multiple pinching (pinch and a half and double pinching) for regulation in carnation. For Solan conditions of Himachal Pradesh, single pinch for early crop, pinch and a half for spreading the harvest and double pinch for late crop have been suggested (Anonymous, 1992). Pathania and Sehgal (1993) also obtained staggered flowering in carnation over six months by multiple pinching.

Thinning:

Thinning is practiced in case of alstroemeria to remove weak vegetative shoots for stimulating rhizome branching and staggered flowering. It is performed at

different times of the year in different manners. Orchid types usually finish flowering by the end of summer. In those conditions, where the orchid types are to flower in the following spring, growers cut back all stems during July to September. Then, in winter months, they continue to thin about 15-25% of the vegetative shoots until flowering begins. During winter months, butterfly types are thinned about 15-25% each month until flower initiation has occurred. Thinning is usually accomplished by pulling out stems rather than cutting them off.

5. Cultural operations

Time of planting:

Staggered planting is practiced to obtain flowers for longer duration of time. In gladiolus successive planting at an interval of 7-10 days give continued flowering over a long period. Marigold can be raised three times a year i.e. rainy, winter, and summer seasons. For flowering during late rainy season, sowing is done in mid June and transplanting in mid July, and for winter season flowering, sowing in mid September followed by transplanting in mid October. For summer flowering crop, sowing is done in January-February and transplanting in February-March.

Marigold is a day neutral plant and flowers are available almost throughout the year. It takes around 2 to 3 months time from seed sowing to flower harvesting. Flower regulation in marigold can be done by manipulating the date of planting.

In gladiolus, for delayed flowering, planting of corms is delayed. Corms used for delayed flowering must be kept in cold storage after cleaning and grading. They can be transferred to a mean temperature15-20^{o}C one or two weeks before planting.

In chrysanthemum also, flowering can also be regulated by staggered planting from April to August. By doing so, flowering can be regulated from September to November.

Depth of planting:

In certain bulbous crop, the depth of planting governs the sprouting time which in turn will decide the flowering time. Deep planting results in delayed sprouting and flowering while shallow planting results in early sprouting and hence flowering.

Size of the propagule:

In lilium since larger bulbs have more leaves, more vigour, they have higher daily rates of leaf unfolding and flower earlier (Lange and Heins, 1990). In case of

gladiolus, larger corm have more food reserves and grow vigorously thereby resulting in earlier flowering.

Selection of cultivar:

Different cultivars within a same species may vary in their flowering time. In many ornamentals, early, mid and late season flowering cultivars are available. So, by careful selection of cultivars, flowering can be regulated to some extent.In chrysanthemum, cultivar ‘White Wonder’ required 6 weeks of short days to come into flowering and can be grouped under early flowering cultivar. Cultivars ‘Encore’ and ‘Fortune’ require 10 and 12 weeks of short days, respectively and are grouped under mid season flowering cultivars. Similarly, cultivar ‘Snow’ require 15 weeks of short days to come into flowering which is a late flowering cultivar.

Micro-irrigation and Fertigation

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Department of Soil Science, CSKHPKV Palampur

Micro irrigation is the system for precise application of water to synchronize with the plant needs. It maintains a favorable soil water regime and restricts the fluctuation of soil water potential within narrow range. This system recharges the root –zone and maintains the uniformity of seed–zone moisture throughout the planting area for a longer period as compared to conventional methods of irrigation. Irrigation scheduling based on micro irrigation system takes into account moisture depletion pattern, infiltration, retention, transmission and redistribution pattern of soil and atmospheric demand. It is eco-friendly irrigation system saving > 60 percent water and increase in the yield to the extent of 30-40 percent over conventional methods.

The regulated supply of water through drippers not only affects the plant root and shoots growth parameters but also the fertilizer use efficiency and nutrient uptake. Drip irrigation added with fertilizer through fertigation reduces the wastage of water and chemical fertilizers, subsequently optimizes the nutrient use by applying them at critical stages and proper place and time, which finally increase water and nutrient use efficiency.

Fertigation which combines irrigation water with fertilizer is well recognized as the most effective and convenient means of maintaining optimal nutrient levels and water supply according to specific needs of each crop and type of soil. The technique applies both water and fertilizer at a low rate to the vicinity of plant root zone as per crop needs and according to crop developmental phase, resulting in higher yields and better quality of produce. Fertigation technology reduces the requirement of fertilizer by 40-60 per cent and enhances the yield. The right combination of water and nutrients is the key for increasing the yield and quality of produce. The availability of N, P and K nutrient was found to be higher in root zone area of drip fertigated plot .

What is fertigation ?

8. Application of fertilizers with irrigation water

9. Fertigation is used to spoon feed additional nutrients or correct nutrient deficiencies detected in plant tissue analysis
10. Injection during middle one-third or the middle one-half of the irrigation recommended for fertigation using micro propagation
11. Most plant nutrients can be applied through irrigation systems
12. Nitrogen is most commonly used nutrient
13. Other nutrients include nitrate, ammonium, urea, phosphate and potassium
14. Fertigation allows the landscape to absorb UP TO 90% OF THE APPLIED NUTRIENTS, while granular or dry fertilizer applications typically result in absorption rates of 10% to 40%.

Features of fertigation

6. The localized wetting patterns produced by drip systems can induce limit to a nutrient uptake, making necessary to apply the fertilizers through the drip system, operation known as fertigation, injecting them
7. Drip irrigation introduces possibilities for precise application of fertilizer and other chemicals. The restricted root growth necessitates that type of fertilizer application, "fertigation", to prevent nutrient deficiencies
8. The high efficiency of water application reached in drip irrigation systems is ideal for the high efficiency of applied nutrients in fertigation.
9. This improved use efficiency of fertilizers, reducing nutrient losses due to leaching, thereby limiting groundwater pollution, better control of the soil solution nutrient contents, reducing soil solution salinity due to fertilizers and the ease of application, reducing labour and saving energy, are the prevailing potential advantages of fertigation
10. But, some of these potential benefits can reverse into disadvantages when the irrigation system design or management is not correct (non uniform nutrient distribution, overfertigation, excessive leaching, clogging).

Advantages

6. Increased nutrient absorption by plants

7. Reduction in fertilizer and chemicals needed
8. Reduced leaching to the water table and,
9. Reduction in water usage due to the plant's resulting increased root mass being able to trap and hold water
10. Application of nutrients at the precise time they are needed and at the rate they are utilized

Disadvantages

6. Concentration of solution decreases as fertilizer dissolves, leading to poor nutrient placement
7. Results in pressure loss in main irrigation line
8. Limited capacity
9. Use of chemical fertilizers of low-sustainability, instead of organic fertilizers.
10. Dependent on water supply not being restricted by drought rationing.

Fertigation techniques

The total fertilizer quantity of water soluble fertilizers calculated is divided into 10 equal parts and each part is applied at 8-10 days intervals. In venture system, 1/10 part of total water soluble fertilizer quantity is generally dissolved in 4 litre of water and is applied in 6-8 minutes. In fertilizer tank system, 1/10 part of total water soluble fertilizer quantity is dissolved in 20 litre water and is applied in 4-5 minutes.

ANNEXURE

International Collaborative Training Schedule on
Advance Flower Nursery and Value Addition *for Afghan Small and Medium Enterprises (SME's)*

Venue: CSK HPKV, Palampur; IHBT, Palampur and UHF, Solan
3rd – 10th July 2013

Day 1 :- 3.7.2013

Time	Topic	Speaker
9.30-10.0am	Registration	Dr. S Bhan/ Dr. Desh Raj
10 -11.30am	Inaugural session	
11.45am -1.0pm	Status, scope and importance of Commercial Floriculture and cut flowers production.	Dr. Desh Raj
	Lunch	
2.30-4.30 pm	Acquaintance with flower crops and infrastructures available for commercial flower production and visit to the University floriculture unit.	Dr. Desh Raj
	Day 2:- 4.7.2013	
9.30-11.00 am	Commercial production technology of Lilium and Alstroemeria	Dr. Markandey Singh
11.0 am– 1.0 pm	Production technology for virus free planting material of ornamental crops and visit to national facility lab on plant viruses Lab demonstration and Practical	Dr. Vipin Hallan and Dr. Raja Ram
	Lunch	
2.0-3.0 pm	Production technology of Gladiolus	Dr. Devendra Dhyani
3.00-4.30 pm	Visit to Floriculture farm of CSIR-IHBT	Dr. Markandey Singh

Day 3:- 5.7.2013

9.30-11.0 am	Commercial production technology of Rose and visit to Rose field	Dr. Markandey Singh
11.15 am–1.0 pm	Production of perfume from flower crops and visit to commercial unit of CSIR-IHBT Palampur	Dr. Virendra Singh
	Lunch	
2.00 – 4.30 pm	Designing, construction and installation of polyhouses and greenhouses for flower crops	Dr. R.K. Gupta

Day 4:- 6.7.2013

9.30-10.30 am	Dried flower industry and production of dried ornamentals from biodiversity of Himalayas	Dr. Desh Raj
11.00-12.00 noon	Irrigation and fertigation in flower crops	Dr. Sanjeev Sandal
12.0-1.0 pm	Prominent diseases and Integrated disease management in flower crops	Dr. Amar Singh
	Lunch	
2.0-3.0	Visit to lab and field for hands on training on disease management	Dr. Amar Singh
3.15 -5.0 pm	An overview of the Pomology nursery and visit to the department of Horticulture	Dr. Suresh Upadhyay

Day 5:- 7.7.2013

9.30-10.45 am	Prominent insect-pests and Integrated insect-pests control in flower crops	Dr. Ajay Sood
11.00 am-1.0pm	Visit to lab and field for hands on training on insect-pests management	Dr. Ajay Sood
	Lunch	
2.00 – 3.00 pm	Hands on training on cut flower	Dr. Desh Raj

	production and pot plants practical Demonstration in Field	
3.00-400 pm	Feedback and any other topic of interest of the participants	Dr Desh Raj
4.00-5.00	Valedictory function	
	Day 6:- 8.7.2013	
9.30 am -5.00 pm	Field visit to commercial flower nurseries/ polyhouse flower growers and onwards journey towards UHF, Solan	Dr. S Bhan/ Dr. Desh Raj
	Day 7:- 9.7.2013	
9.30-10.45am	Breeding strategies in flower crops	Dr YC Gupta
11.0am-1.0pm	Year round flower production with special reference to chrysanthemum and carnation	Dr Sita Ram Dhiman
	Lunch	
2.0-5.0pm	Visit to Dr YS Parmar UHF, Nauni, Solan and its Floriculture farm	Dr YC Gupta/ concerned scientist
	Day 8:- 10.7.2013	
	Spot Lectures in Floriculture in field	To be nominated by HOD

Lists of Participants

No	Name	Father Name	Passport No
1	NAJIBULLAH	MOHAMMAD YONUS	OA 1767144
2	HAMIDULLAH	HABIBULLAH	OA 1767196
3	ABDULMALEK HABIBI	ABDUL JALIL	OA 1767149
4	TOORYALAI	BAHADUR KHAN	OA 1305640
5	SAYED ABDUL WAHID	ABDUL SAYED	OA 1767154
6	ABDULRAHIM BAGRAMWAL	ABDUL KABIR	OA 1018578
7	ABDULRAWOF	ABDUL HAMID	OA 1767177
8	ANDALIB	ASADULLAH	OA 1554993

References

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Commercial Production Technology of Lilium , Dr. Markandey Singh,PhD., Institute of Himalayan Bio-resource Technology,Palampure-176061 (H.P.),India

Commercial Production technology of Alstroemeria, Dr. Markandey Singh, PhD., Institute of Himalayan Bio-resource Technology,Palampure-176061 (H.P.),India

Production Technology of Gladiolus , Dr.Markandey Singh,PhD., Institute of Himalayan Bio-resource Technology,Palampure-176061 (H.P.),India

Commercial Production Technology of Rose , Dr.Markandey Singh,PhD.,Institute of Himalayan Bio-resource Technology,Palampure-176061 (H.P.),India

Production of Perfumery Ingredients from Aromatic Crops , Virendra Singh, Chief Scientist, Extension & Advisory Service Unit CSIR-Institute of Himalayan Bioresource Technology, Palampur (H.P.)

Planning , Designing, Construction and Installation of Polyhouses and Greenhouses for flower crops, RK Gupta ,Associate Professor Department of Agriculture Engineering, CSK Himachal Pradesh, Agricultural University, Palampur-176 062, (HP),India

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