

PACKAGE OF PRACTICES

**CULTIVATION OF FLOWERS
&
LANDSCAPE GARDENING**

2020



Directorate of Extension

**Sher-E-Kashmir
University of Agricultural Sciences and Technology, Chatha,
Jammu-180 009**

LIST OF CONTRIBUTORS

Division of Vegetable Science and Floriculture

1. Dr. R.K. Gupta (Professor & Head)
2. Dr. R.K. Pandey (Professor)
3. Dr. Sheetal Dogra (Asstt. Prof.)
4. Dr. Arvinder Singh (Asstt. Prof.)
5. Dr. Nomita Laishram (Asstt. Prof.)

Division of Plant Pathology

1. Dr. S.K. Singh (Assoc. Prof)
2. Dr. R.S. Sodhi (Assoc. Prof.)

Division of Entomology

1. Dr. Hafeez Ahamad (Prof. & Head)
2. Dr. Uma Shankar (Assoc. Prof)

Complied by:

1. Dr. A.K. Sharma Assoc. Director Extension
2. Dr. Rakesh Sharma Senior Scientist
3. Dr. Pawan Sharma Scientist

FOREWORD

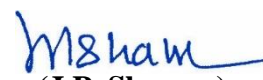
Flowers have been associated with mankind since time immemorial for religious offerings and other social ceremonies from birth to death. In recent past, floriculture has emerged as an important component of diversification in agriculture. India has tremendous potential for flower cultivation for domestic and export needs in view of opening up of world market under WTO regime. Enormous indigenous diversity, varied agro-climatic conditions and cheap labour offer great opportunities for establishing credibility of floriculture as an important sector for diversification in agriculture.

Jammu region of Jammu and Kashmir Union Territory is endowed with varying range of agro-climatic conditions and holds tremendous potential for raising flower crops throughout the year. In the recent past, growing of trees, shrubs, herbs, climbers and flowers has assumed great significance in view of environment consciousness and profitability. There has also been a quantum jump in production and trade of flowers in past few years in this region due to combined efforts of scientists, officers of line departments and flower growers.

I congratulate Prof. R. K. Gupta, scientists associated and officers of line departments for their joint efforts in preparing **Package of Practices on Flower Cultivation and Landscaping-2020** exclusively for Jammu region. It contains wealth of information contributed by various scientists of the University, shared experience of the officers of the line departments and relevant inputs taken from published papers and popular articles in the subject relevant to this region.

I hope that the package of practice will be a useful reference material for all those interested in floriculture.

Date
Place: Jammu


(J.P. Sharma)
Vice Chancellor

PREFACE

Floriculture has emerged as a fast growing enterprise and an important component of diversified agriculture in the region. There has been significant utilization of flowers by people of the region from all walks of life for various occasions. Jammu region has tremendous potential for cultivation of flowers in various agro climates. At the same time, farmers of the region are finding it difficult to compete with those from valley and other neighbouring states. It is also common to see terrace gardens, kitchen gardens and balcony gardens in Jammu region.

The Package of Practice for Flower Cultivation and Landscaping-2020 includes the agronomic and management practices of various crops like marigold, gladiolus, chrysanthemum, gerbera, liliun, rose, tuberose, jasmine, seasonal flowers and carnation have been dealt within a very simple and easy to understand language. The list of trees, shrubs, climbers and foliage plants for landscaping in various agro-climates and a chapter on lawn have also been included to make it meaningful for the Jammu region.

I congratulate Prof. R. K. Gupta and team of scientists of the university for their joint efforts in bringing out this publication for the benefit of everyone interested in floriculture. The present compilation has been written in simple and understandable language for the benefit of amateur gardeners, flower growers, field functionaries, young agri-entrepreneurs, students and researchers interested in adopting and promoting floriculture.

(S.K. Gupta)
Director Extension

PREFACE

Throughout the human history, flowers have been used on all social occasions, in places of worships; offerings in religious and social ceremonies; home decoration; enhancing beauty of parks, gardens and landscape. India has long tradition of floriculture documented in ancient Sanskrit classics including *Rigveda* and *Ramayana*. Tremendous progress has been made in floriculture in past few years in Jammu region through technical guidance of scientists, officers of the line departments and farmer friendly policies of government. Floriculture has now become important component of profitable farming and emerging as a potential agribusiness option.

Floriculture comprises traditional flower cultivation, cut flower production, florist trade, nursery, potted plants, seed and bulb production, micro propagation and extraction of pigments and essential oils from flowers. It has assumed great significance as a fast emerging field for providing ample opportunities of employment.

The scientists of the Division of Vegetable Science and Floriculture have made an endeavor to compile information that includes work carried out by the scientists, relevant technical inputs from sister institutions, validated technologies for the region and shared experience of the officers of line departments.

I am thankful to the scientists namely Dr. R. K. Pandey, Dr. Sheetal Dogra, Dr. Arvinder Singh, Dr. Nomita Laishram and scientists from Division of Entomology and Plant Pathology at various stages through technical inputs. I would also like to thank Director Extension, Director Research and Dean, Faculty of Agriculture for their interest and motivation to team in bringing out this updated publication.

I would like to place on record my sincere thanks to Prof. J.P. Sharma, Hon'ble Vice Chancellor, SKUAST of Jammu for giving the scientists of the Division an opportunity to complete tough task of compiling and updating the information in the form of Package of Practices for Cultivation of Flowers and Landscaping.

(R.K. Gupta)
Professor & Head

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INTRODUCTION

Floriculture comprises of traditional flower cultivation, cut flower production, florist trade, nursery, potted plants, seed and bulb production, micro-propagation and extraction of essential oil from flowers. It has recently assumed great dimension and is a fast emerging field for providing ample opportunities of employment in the region. The area and production under floriculture has shown increasing trends in very short span of last 5 years. Jammu province of Union Territory of Jammu and Kashmir (J&K) is endowed with diverse agro-climatic situations ranging from subtropical plains to intermediate and temperate zones with altitude ranging between less than 300 m amsl to above 2300 m amsl.

The plains and intermediate regions of entire Jammu and Samba districts, lower parts of Kathua, Reasi, Udhampur and Rajouri districts (altitude less than 300 m to about 800 m amsl) has tremendous potential for the production of loose flowers and cut flowers (marigold, gladiolus, rose, tuberose, jasmine under open and liliun and gerbera under protection).

Intermediate zone having (altitude more than 800m to about 1500m amsl) that includes parts of Kathua, Udhampur, Reasi and Rajouri districts can be utilized for off season production of flowers for higher returns.

High hills and temperate regions (altitude above 1500 m, extending to 2150 m in mid belts and 2400 m amsl or more in upper reaches that covers parts of Kishtwar, Poonch, Doda, Ramban and Kathua districts) can be utilized for off-season production of flowers like marigold, bulbous plants (gladiolus, liliun, carnation, tulip, gerbera) and seed production of temperate varieties of annuals.

For further boosting production and productivity, synergy between scientists, officers and flower growers is required for paying special attention in following areas:

Nursery: Both public and private ornamental nurseries assume great significance in all the microclimatic regions to meet demand of quality planting material of various kinds including production of seedlings, budded plants, rooted cuttings, bulbs, tubers, corms and seeds of annuals.

Seed production: It can be taken up in open pollinated varieties and that of hybrids in annuals flower crops. The seed production looks lucrative business. It is highly scientific job and requires technical guidance.

Protected cultivation: It is another advantageous area, especially for production of cut flowers for domestic needs and export. The potential crops that can be grown profitably in naturally ventilated low cost green houses include roses, gerbera and liliun.

Industrial products: Essential oils, dry flowers, natural colours, and other products have got tremendous potential for export. Dry flower industry is not well organized and depends on plant material available from forests.

All the stakeholders involved in flower production, promotion, value addition, marketing and export must consider following facts:

1. Practical training of the personnel interested or involved in floriculture at various stages.
2. Linking flower production with market demand period for various functions, ceremonies, marriages and festivals.
3. Promoting concept of cluster of farmers or self help groups who can make this venture more sustainable than individual farmer jumping into the venture.
4. Planned marketing strategy to eliminate middlemen in chain.
5. Planned production for year round supply of flowers for domestic and export needs in varied agro-climatic conditions.
6. Growing of already identified /adapted flower varieties and hybrids for various agro-climates for different needs while using matching production technologies.
7. Making use of quality seed/planting material from authentic sources.
8. Promoting cold storages, cold chains, market intelligence and buy back arrangement

MARIGOLD

Scientific name: *Tagetes spp.*

Family: Asteraceae

Marigold is a very important loose flower crop as well as bedding plant. It is in great demand during daily worships, rituals, festivals, decoration for wedding and other events. It produces flowers with wide range of attractive colours, shape, size and quality. Due to easy cultivation, many farmers are undertaking cultivation of African marigold (*T. erecta*) and French marigold (*T. patula*) at commercial level. The cultivation of marigold



deters some insects and reduces population of parasitic nematodes in soil. The flowers of African marigold are used as food colour as well as colourants in poultry feeds.

Climate and soil

It can be grown in wide range of climate and also performs well under dry hot conditions but is very sensitive to frost. For loose flower production, it can be grown round the year in Jammu region. The common practice is to grow marigold during winter and spring in plains and summer in mid hills. It is important to match varieties with season/climate for optimum yields since marigold is a short day plant.

Deep, well drained and fertile soils having good water holding capacity with neutral pH of 7-7.5 are considered ideal. Land can be prepared with 2-3 ploughings. Well rotten farm yard manure (FYM) should be mixed during last ploughing.

Varieties

African marigold:

Pusa Narangi Gaiinda: The average plant height ranges between 60 and 70cm. Flowers are double type, orange coloured with 6-7 cm diameter. It takes 125-135 days to flower in plains. The potential yield of fresh flowers is 250-300 q/ha.

Pusa Basanti Gaiinda: The average plant height ranges between 60 to 70cm. Flowers are double type, sulphur yellow in colour with 6-7 cm diameter. It takes 135-145 days to flower in plains. The potential yield of fresh flowers is 200-250 q/ha.

French marigold:

Pusa Arpita: Deep orange colour variety suitable for planting during rainy season in plains/low hills. The variety flowers during December to January.

Desi gutta: Plant height varies with season (40-50 cm in winter and 50-80 cm in rainy season). It is a prolific bearer. Flower is dark red with velvety shining petals having 3-4 cm diameter. It takes 115-125 days to flower in plains. The potential yield of fresh flower varies from 150-200 q/ha.

Tagetes minuta:

It is a wild species of marigold which is commercially utilized for oil extraction. All the parts of the plant yield essential oil.

Propagation

It is mainly propagated through seeds. However, vegetative propagation through cuttings is also possible.

Nursery raising and transplanting

In plains and low hill regions, rainy season crop are sown in June and transplanted in July; winter season crop is sown in September-October and transplanted in October-November and summer season crop is sown in January under protection and transplanted in February. In intermediate low regions, nursery sowing is done in the month of March-April and transplanting is done after 4-6 weeks.

Well rotten FYM @ 10 kg/sqm is mixed in the nursery beds (1 m wide, 5 m long and 15 cm high). About 1.0-1.2 kg seed is required for one hectare and same can be sown in 15-20 such nursery beds. Nursery beds needs to be sterilized in advance with formalin and drenched with copper oxychloride (0.3%) for better results. The seeds are sown 2-3 cm deep in lines at a distance of 5 cm and opened rows are covered with fine mixture of FYM, soil and sand (2:1:1). Then beds are then covered with mulch. The sides can also be drenched with chlorpyrifos (1 ml/litre) to reduce damage by ants or other soil insects. After 4-5 days when seeds germinate, mulch or cover is removed and watering is done with a rose can. The seedlings are ready for transplanting in 3-4 weeks depending upon the climate (4 leaf stage having 10 -12 cm height).

For proper growth and development, African marigold is transplanted at a distance of 40x40 cm for winter and rainy season crop and 40x30 cm for autumn season crop. French marigold requires relatively closer spacing. Pinching can be done in African marigold wherein terminal portion is removed after 40 to 45 days of transplanting to enhance profuse branching.

Time of Planting

Season	Sowing time	Transplanting time
Rainy	End of January to First week of July	First fortnight of August
Winter	Mid of September	First Week of October
Summer	First Week of January (under protected conditions)	First Week of February

Manure and fertilizers

Twenty tonnes of well rotten FYM along with 120 kg N (176 kg Urea), 100 kg P₂O₅ (217 kg DAP) and 100 kg K₂O (166 kg MOP) can be used for open pollinated varieties in one hectare area. Half nitrogen along with full dose of phosphorus and potash need to be applied as

basal dose. Remaining half of N is given in two top dressings, one each after 25 and 50 days of transplanting.

Weeding and hoeing

It requires 3-4 hand weedings during entire growth period. Weeds can also be controlled by various pre-planting herbicides like oxyfluorfen) @ 0.50L a.i/ha or pendamethalin @1.5 L a.i/ha followed by one hand weeding after 45 days of transplanting.

Irrigation

The frequency and quantity of water mainly depends upon soil and climate. Generally, crop requires irrigation at the interval of 7-10 days.

Harvesting

Marigold flowers should be plucked when they are fully open. The productivity of plants can be increased by regular plucking of flowers. Picking should be done in plastic crates/tubs so as to avoid mutilation of flowers. Normally, late evening hours are good for picking. The flower yield varies from 150-300q/ha depending upon the variety.

Seed Production

For seed production, rouging should be done at vegetative and flowering stage. An isolation distance of 600m -1000 m between varieties also needs to be maintained. The cultural practices for flower and seed crop are almost same but main season crop raised for seed need to be protected from frost in Jammu plains. Marigold flowers should be plucked when the petals start shriveling while leaving small and underdeveloped flowers. Plucked flowers should be dried as such in shade for 10-15 days followed by 1-2 days in sunlight. Processing of crude produce gives seed yield of 2/5 (40%) of original lot of fresh flowers.

Insect-Pests

Cutworm: Larvae feed on emerging shoots at night. Grown up clay coloured larvae cut plants at ground level. Plants are vulnerable to attack up to 3 leaf stages. Poison bait consisting of malathion 50 EC @ 2ml/litre of water in wheat bran and molasses are scattered in the fields to control larvae. Broadcast cartap hydrochloride 4G @ 8 kg/acre or carbofuran 3G@ 10-12 kg/acre in the soil at the time of last ploughing. Spray of quinalphos 25 EC @ 0.05% (1.5-2 ml/litre of water) or cypermethrin 10 EC@ 1-2 ml/litre of water protect foliage.

Aphids: Aphids mainly infest lower surface of flowers and base of petals. Nymphs and adults suck the cell sap from the flowers causing discolouration and withering. Spraying of oxydemeton methyl 25 EC @ 0.03% (1-2 ml/litre of water) or dimethoate 30 EC @ 2 ml/litre of water or imidacloprid 17.8 SL @ 0.3 ml/litre of water gives good control.

Thrips: The thrips infest young leaves, buds and flowers and suck the cell sap. Affected leaves get distorted, while petals of flowers turn brown and dry. Use blue sticky drops @ 40 traps/acre for trapping maximum numbers of thrips population as they are attracted towards blue colour. Two or three sprays of oxydemeton methyl 25 EC @ 0.03% (1-2 ml/L of water) or dimethoate 30 EC @ 2 ml/litre of water at 12-15 days interval are effective against thrips.

Helicoverpa armigera: Its larvae feed on leaves and floral parts. In plains, attack is serious from March-April. The attacked flower buds remain unopened. Installation of pheromone traps

@ 2-3/acre for early detection and 5-6/acre for trapping and mass mating disruption. Install T-shaped bird perches @ 8/acre.

Foliar spray *Ha-NPV* 100-200 LE/acre (1 ml/litre of water) freshly procured and mixed with 10 g/lit gur or jaggary and tinopal blue (1ml/lit) for 2-3 times at 12 days interval at evening hours is promising.

Need based and alternative application of fenvalerate 20EC @ 1ml/litre of water or deltamethrin 2.8EC @ 1 ml/litre of water followed by dimethoate (2 ml/litre of water). Besides these, spray the crop with cypermethrin 10 EC @ 1 ml/litre or lambda cyhalothrin 5 EC @ 0.5ml/litre of water or chloropyrifos 20 EC @ 1.5-2 ml/litre of water.

Diseases

Damping off: The symptoms appear as brown necrotic spots, girdling the radicle which later on extends to plumule and causes pre-emergence mortality. Soil sterilization with formalin @ 4% 48 hours before sowing. Seed treatment with metalaxyl @ 2g/kg of seed or trichoderma spp. @ 4gm/kg of seed. Drenching of nursery beds with metalaxyl (1g/litre of water) or copper oxychloride @ 0.3%. Repeat drenching at 10-15 days depending on disease severity.

Wilt and Stem rot: The pathogen attacks root and collar region of the plant. The water-soaked lesions appear on stem, inflorescence becomes pale and whole plant wilts. For effective disease management, treat seeds with carboxin (2g/kg seed) before raising nursery. Drenching at collar region of plant with metalaxyl @ 1.0 g/litre of water or copper oxychloride @ 3g/litre of water should be done as soon as the symptoms appear.

Leaf spot and blight: The symptoms appear as minute ash-grey or brownish to black circular spots on leaves which enlarge at later stages of infection leading to premature defoliation and death of the plant. Botrytis blight mainly affects flower petals which later on turn brown and die. Watering should be done early in the day to give foliage a chance to dry before night. Application of chlorothalonil @ 0.2% or copper oxychloride @ 0.3% at 15 day's interval should be made to manage the disease.

Powdery mildew: Whitish, tiny, superficial spots appear on leaves which later on spread to whole aerial parts and look as whitish powder. Dusting with sulphur powder at fortnightly intervals or spraying with azoxystrobin @ 0.3% or difenoconazole @ 0.1% at appearance of the disease helps in managing the disease.

GLADIOLUS

Scientific name: *Gladiolus grandiflorum*

Family: Iridaceae



White Prosperity



Eurovision



Novalux



Jyotsana

Gladiolus popularly known as „Sword lily“ or Corn flag“ is a bulbous plant grown commercially as cut flower for its majestic spikes containing attractive, elegant and delicate florets. Its varieties vary according to colour, size and keeping quality of spikes. As „cut flower“ it is used either in flower vase or in bouquet. Plants are also used in borders, bedding, rockeries, pots and garden display.

Climate and soil

It can be grown in a wide range of climatic conditions. An open sunny site away from the shade of trees is ideal for its cultivation. The optimum temperature range for its growth is 25-30°C. Accordingly, its sowing can be adjusted as per demand but it may be ensured that flowering does not coincide with the rains.

Fertile, well drained sandy loam soils with pH between 6.0 and 7.0 are considered ideal. The soil should be thoroughly dug 3-4 times or ploughed 20-30 cm deep and kept open to sun for at least 15 days. After removing the weeds, the field should be reploughed and levelled.

Varieties

White Prosperity: It is shining white in color, with 100-110 cm spike length, 16-20 number of florets/spike, 10-11cm floret size, 2-3 corms /plant and 60-80 cormels/plant.

Eurovision: It is dark vermillion in colour with white vein, with 75-80 cm spike length, 14-16 number of florets/spike and 9-10 cm floret size.

Nova Lux: It is yellow in color with 85-95 cm spike length, 14-16 number of florets/spike and 9.5-10.5 cm floret size

Rose Supreme: It is pink colored variety with 100-110 cm spike length and 15-17 number of florets/spike.

American Beauty It has reddish pink florets with spike length 65-75 cm, 15-16 number of florets/spike and 9.5-10.5 cm florets/ spike.

Gunjan: It is yellow with 45-50 cm with spike length, 8-10 number of florets/spike, 9.0 - 9.50 cm floret size and a good corm multiplier.

Jyotsana: It is pink with spike length 85-95 cm, 16-18 number of florets/spike, 9.5-10.5 cm floret size and good corm multiplier.

Pusa Kiran: It bears white florets with reddish rays, spike length of 85- 95 cm and 15- 16 number of florets/spike. It produces spikes which has a vase life of 10 days.

Pusa Shubham: Its florets are cream or light yellow in colour with spike length of more than 85cm and bears 14 number of florets/spike.

American Varieties namely Candyman, Jester, Trader Horn, Vink's Sensation, Priscilla, Oscar, Souveiner, Ice Gold, Red Beauty, Summer Pearl, Melody, Snow Princess, Sylvia, Suchitra, Mayur, Pink Elegance, Punjab Flame, Glance, Lemon Delight and Chipper White are also becoming popular.

Propagation: It can be propagated by corms as well as cormels.

Corm

Corm is a thickened underground perennating structure consisting of a short vertical stem having many ring like nodes full of buds, covered with tunics all round and a disc like root zone at the base. Corms develop at the base of flowering stem, when the old corm is gradually used up. Corms of 4-6 cm diameter generally used for propagation.

Cormel

They produce in clusters on stolons between mother and daughter corms. These vary in size. Each one enclosed in hard shell which is less permeable to water and thus prolongs the dormancy. Young gladiolus cormels required 2-3 seasons of vegetative growth before flowering. The average size of cormels used for propagation as 0.5 to 1.5 cm (diameter). The cormel plants are not allowed to flower as that will reduce the production of cormels and the spike are removed carefully without injuring foliage when first floret shows color.

Dormancy

The corms and cormels after lifting from field undergo a period of dormancy, when they will not sprout even if all the favourable conditions are available. The dormant corms require 3-4 months cold storage at 2-4°C and 75 % relative humidity to break the dormancy.

Planting

For meeting demands of the spikes round the year, the planting of corms can be adjusted at fortnightly or monthly intervals from September to December in plains; February in intermediate low areas and March-May in hilly regions. Healthy corms of 4-5 cm diameter selected for planting should be dipped in a copper oxychloride @ 0.3% solution for half an hour. These are shade dried and then planted at a distance of 40 x 20 cm at 6-10 cm depth. About 6000-6500 corms/kanal are required. Avoid planting of corms in the same field every year for avoidance of corm rot disease.

Manure and fertilizers

Apply well rotten FYM 25-30 tons/ha (2.5 tons/kanal), 300kg N, 100kg P and 100kg K (Urea: 348 kg; DAP: 217 kg; MOP: 166 kg) per hectare. Full dose of phosphorus and potassium should be applied as basal application and nitrogen in two equal split doses (one each at 3 leaf and 6 leaf stage).

Weeding, hoeing and earthing up

The beds or field should be kept clean by regular weeding and hoeing manually with the help of khurpa or hand hoe. Two earthing up are required, one each at 40 and 70 days after transplanting.

Irrigation

The crop needs irrigation at one week interval during summer and two week interval during winter depending upon climatic conditions.

Harvesting

Spikes can be harvested 65-120 days after planting, depending upon the variety, size of corms and the environmental conditions. The spikes may be cut above the four leaves from the base with sharp knife or scissor after the first floret open, early in the morning and immediately kept in fresh water. Corms develop, 60 to 70 days after flowering, when the leaves start turning yellow. At this stage, plants are twisted down to ground level to allow corms to mature. Irrigation is withheld atleast 2-3 week before removal of corms. Corms after uprooting, are cleaned, dried in shade for 2-3 weeks and treated with copper oxychloride @ 0.3% solution for 1hour and again dried in shade (preferably on rotational basis). They are finally stored in cold storage at 4⁰C for next planting.

Post-Harvest Handling

Pulsing treatment of 3 % sucrose + 400 ppm 8-HQC (Hydroxy quinoline citrate) helps in extending the vase life of cut spike. About 10-12 spikes are tied in a bundle, such 20-30 bundles are packed in ventilated cardboard boxes (120x60x30 cm) and sent to market.

Insect-Pests

Thrips: Yellow coloured nymphs and black adults damage leaves, flowers and adversely affect quality of spikes. Infested corms are sticky, get shriveled and produce weak plants. Spray the crop at spike emergence with dimethoate 30EC @ 1-2 ml/litre of water or oxydemeton methyl 25 EC @ 1-2 ml/litre of water or imidacloprid 17.8 SL @ 0.3ml/litre of water or use blue sticky drops @ 40 traps/acre.

Cutworm: Plants are vulnerable to attack up to 3 leaf stage. It also damages underground corms and developing spikes. Deep ploughing during summer exposes pupae to predators. Poison bait consisting of malathion 50 EC @ 0.1% (2ml/litre of water) in wheat bran and molasses are scattered in the fields to control larvae. Broadcast cartap hydrochloride 4G @ 8 kg/acre or carbofuran 3G@ 10-12 kg/acre in the soil at the time of last ploughing. Spray of quinalphos 25 EC @ 0.05% (1.5-2 ml/litre of water) or cypermethrin 10 EC@ 1-2 ml/litre of water protect foliage.

Leaf Caterpillar: Ash coloured eggs are laid in groups on lower side of leaves. Greenish brown mature larvae feed on leaves during night. Deep ploughing in summer exposes pupae to

predators. Sprays of malathion 50 EC@ 2 ml/litre or quinalphos 25 EC @ 0.05% (1.5-2 ml/litre of water) or chlorpyrifos 20 EC@ 0.05% (2 ml/litre of water) give protection to foliage.

Diseases

Wilt and collar rot: The initial symptom is yellowing of older leaves, which become sickle shaped. Reddish brown cankers may appear on collar region. The spikes and petals develop dark colour. In advanced stages of infection, the affected plants show wilting. When cut open, corms show brown spots or streaks, usually at the base. Once the disease appears, it is difficult to manage. Therefore, efforts should be made for prevention of the disease by planting disease-free corms in the soil with no previous disease history. For effective disease management, treat seeds with carboxin (2g/kg of seed) before raising nursery. Drenching at collar region of plant with azoxystrobin @ 0.1% or copper oxychloride @ 3g/litre of water should be done as soon as the symptoms appear.

Botrytis blight: Brown or greyish brown, oval to circular lesions appear on stems and leaves. Small water-soaked lesions appear on florets that later change to form blotches. Affected flowers turn papery brown and become covered with grey masses. The disease causes heavy reduction in yield during cloudy, humid and wet weather. For disease management, plant healthy corms after treatment with copper oxychloride @ 0.3% before storage and planting 30-60 minutes. Application of chlorothalonil @ 0.2% or copper oxychloride @ 0.3% at 15 day's interval should be made to manage the disease.

Storage rot of corms: The fungi cause heavy losses in field as well as in storage. The corms harbour more than one pathogen and it is difficult to distinguish symptoms. Generally black spots appear on surface of corms which later develop as soft/corky rot with foul smell. Plants raised from diseased corm may show wilt symptoms. The disease can be managed effectively by dipping the corms in copper oxychloride @ 0.3% or chlorothalonil @ 0.2% for one hour and drying in shade before storage.

ROSE

Scientific name: *Rosa spp.*

Family: Rosaceae

Rose is universally known as „Queen of Flowers“. It occupies the first position in international market of cut flowers. Commercial rose flower growing include production and sale of plants, flower and their products. Rose flowers are marketed either as loose flowers or as cut flowers. Damask Rose (*R. damascena*) and Edouard rose (*R. bourboniana*) are cultivated for rose oil, attar, gulkand and gulabjal. Different types of roses are grown in different types of climates.



Classification:

Hybrid Teas: These roses bear large single flowers on long stems. They are developed by crossing China Tea roses and Hybrid Perpetuals. „La France“, the first hybrid tea (HT) roses developed by French rose breeder Guillot was introduced in 1867.

Floribundas: They are also known as Hybrid Polyanthas. They are developed by crossing Hybrid Tea and Polyantha. In 1912, the first floribunda rose, „Rodhatte“ was developed by Danish rose breeder Poulsen. Floribunda has the characteristic features of HT roses and perpetual flowering habits of polyantha.

Grandifloras: They are developed by crossing Hybrid Tea with Floribundas. This class produces Hybrid Tea like flowers in clusters. e.g. Buccaneer, June Bride, Montezuma and Queen Elizabeth.

Miniature roses: Miniature roses bear small size roses with small leaves. They are hardy and ideal for growing in pots. E.g. Baby Gold Star, Cinderella, Peon and Pixie.

Australian Briars: These classes belong to *R. Foetida* (also known as *R. lutea*). They are the main source of yellow colour in modern roses. This class includes Australisn Copper, Australian Yellow and Persian Yellow.

Ramblers: They are derived from mutation of *R. Multiflora* or *R.wichuriana*. e.g. American Pillar, Dorothy Perkins, Excelsa etc. They produce small flowers in large clusters. These are suited for covering fence, pergolas and trellis.

Soil and climate

Soil for rose cultivation should have proper drainage. The ideal soil should be medium loam having sufficient organic matter and pH of 6.0-7.5. The land with poor drainage where water stagnates during monsoon should not be selected for rose growing. In very heavy soils, gravel and sand may be mixed into the bed to allow drainage. Roses need bright sunshine. Sunshine for six hours is ideal for better growth and flowering. Most of the rose cultivars grow best at a temperature range of 15-27°C for producing good quality flowers. Temperate pockets of Jammu region are congenial for off-season production of roses.

Varieties

Hybrid Tea: Raktgandha, Queen Elizabeth, Super Star, Sonia Meilland, Christian Dior, Montezuma, Happiness, Kiss of Fire, First Red, First Prize, Sandra, Louisiana, Pusa Gaurav, Grand Gala, Ravel, Tineke, Noblesse

Floribunda: Sea Pearl, Ice Berg, Sada Bahar, Delhi Princess, Charleston, Arunima.

New hybrids: Pusa Arun, Pusa Ajay, Pusa Komal, Pusa Shatabdi for plains/low hills. The varieties like Raktima, Raktgandha and Arjun are suitable for protected conditions.

Propagation

Budding is the most popular and successful method for multiplying roses. It provides larger number of plants than cuttings, layering or grafting, as a single shoot of the desired scion furnishes a number of buds for budding. Shield or T-budding is the method commonly used. The best time for budding is December-February in plains/low hills and February-March/April in the hills. Budding is done about 5-8 cm above the ground level. On the selected rootstocks, the budwood (2.5 cm long) are inserted into a T-shaped incision and then tied with alkathene tapes, keeping the eye open. It takes 3-4 weeks for the buds to unite. The side branches of the stocks are removed which compete with the scion for supply of nutrients and water.

Propagation of roses by cuttings is normally done to raise rootstocks for budding. Climbers, Ramblers, Polyanthas and Miniature roses also respond well to this method. Stem cuttings give satisfactory results when rooted during the period from late June to November. Cuttings should normally be taken during the monsoon or spring. Each shoot should be cut clean just below the node and lower leaves removed. Sand is the best rooting medium.

Cuttings are usually planted 3 cm apart in a row and 8 cm between rows and watered as per the need. Within a month or so, roots and shoots will develop from the cutting and in about a fortnight, the plants may be transplanted in another well prepared bed or in pots. Hardwood cuttings taken from basal and mid-portion of the shoot shows much better rooting than those taken from apical cuttings.

Root Stocks: For budding, proper selection of rootstock is of immense importance. Rootstocks are known to impart marked effects on the vigorous, precocity, productivity, quality of flowers, longevity of bushes, disease resistance, adaptability to soil climatic conditions etc, and therefore, it is necessary to choose the most suitable rootstocks for budding or grafting roses. Some of the commonly used rootstocks are *Rosa barboniana* (Edward rose), *Rosa indica*, *Rosa manetti* and *Rosa multiflora*.

Layout of Beds

The width of the beds should be such that operations like weeding, hoeing, forking, cutting of flowers etc, can be done from both the sides of the bed, without stepping into the bed. A plot size of 6.0 x 1.2 m or 6.0 x 1.65 m is suggested for better management of rose plants. The length can be increased to a limited extent depending upon the specific situations.

Planting

The soil should be thoroughly dug or ploughed 20 - 30 cm deep and kept open to sun for at least 15 days. After removing the weeds, the field should be re-ploughed and leveled. The

land with high water table is not suitable for rose cultivation. Before planting, prepare a small pit (60 x 60 cm) to accommodate the earth ball of a new plant. In plains/low hills planting can be done from October - March. In hills, planting is done in October – November or March – April. Hybrid Tea and Floribunda roses used for beautification in the gardens are planted at a distance of 60 - 75 cm, Polyantha and Miniatures at 45 cm and Climbers/Standards at 2 meters apart. A closer planting of 30 x 40 cm is ideal for cut flower production in open and that of 30 - 40 x 20 cm in green house. *Rosa damascena* is maintained at a spacing of 75 x 75 cm.

Manure and fertilizers

Field should be thoroughly prepared by incorporating 20-25 tons/ha of FYM about 4 weeks before planting. At planting time, fertilizer dose of 125 Kg nitrogen, 80 Kg P and 90 Kg K (187 Kg Urea, 174 Kg DAP and 150 Kg MOP) per hectare is applied. After 4 - 6 weeks of planting, 57.5 Kg N (125 Kg Urea) per hectare is again applied. In established bushes, 8-10 Kg of well rotten FYM can be applied after pruning.

Weeding and hoeing

Diuron (2 kg a.i./ha) can be used before new plantations. Glyphosate (1kg a.i./ha) can also be used as post emergence application for the control of weeds in commercial plantations.

Irrigation

The frequency of irrigation depends on many factors such as growth, soil texture, climate and glass house or field conditions. Maintenance of adequate soil moisture at all stages of its growth and flowering is essential.

Pruning

The best time of pruning is when rainy season is over and winter starts in plains/low hills (October-November). For continuous production of cut flowers, pruning at 2 weeks interval can be done. Pruning in hills is done in the month of March-April. In established bushes, 8-10kg of well rotten FYM can be applied after pruning. Hybrid Teas require hard pruning while keeping 3 or 4 main shoots having 3-4 eyes. Around 40g of fertilizer mixture, 1part urea (7g) + 3 part DAP (24g) and 2 part MOP (9g) can be applied thrice at 15 days interval after pruning. Climbers and ramblers do not require pruning. Polyanthas are pruned highly while Floribundas pruned moderately. In Damask rose, pruning is done during December in plains.

Pinching and disbudding

Removal of a part of terminal growing portion of stem is called pinching which is practiced in newly budded plants to promote auxiliary branching. Disbudding is generally followed in hybrid tea roses for cut flower purpose, where only the central bud is retained and other buds are removed for quality blooms" production. Shoots or suckers of root stock emerging from base of plants should be removed as soon as these appear.

Harvesting

The flowers for decoration and marketing should be cut at the tight bud stage (when the buds show their colour but the petals have not yet started unfurling).

Cultivation of rose under protected environment

Greenhouse structure for growing roses

Generally Quonset types of green houses are used. The standard size is 30mx 40m with a height of 4m in the centre and 2.75m on the side. The roof is made in semi-round shape for easy drainage of rain water. Galvanised iron tubes or square steel tubes are used for the main frame. The covering material most commonly used is UV stabilized polyethylene.

Growing Media

The media for growing roses under polyhouses may be soil, sand, cocopeat and rockwood. The soil-less culture have less disease incidence and good drainage. The soil as a media with abundance of organic matter, good drainage and accurate dispersal of fertilizer within the growing profile is considered best. There should not be water logging in the sub-soil and the level of ground water must not fluctuate too severely. The soil sterilization is done by adding formaldehyde 5ml/litre of water and applied with the help of rose water can at the rate of 5 litres/sqm.

Bed Size and Spacing

In a bed width of 100cm, 5 rows of plants kept 30cm apart should be planted. The double row bed system is better than that of 3 or 4 row beds. Between the beds, 60 to 85 cm path is kept. Standard planting distance is 25cm in rows and spaced 30 cm apart. Usually 60,000 to 70,000 plants are accommodated per hectare.

Planting methods

The beds are prepared well before planting six month old budded plants or one year old plants with at least two shoots are ideal. To avoid diseases, the roots are soaked in a dilute solution of benlate. The base rooted plants are first dipped in clay paste for better rooting. The polyhouse should be kept warm and high humidity is to be maintained.

Varieties

Aalsmeer Gold, Cocktail, First Red, Confetti, Grand Gala, Noblesse, Texas, Papillon, Vivaldi, Yellow Success.

Frame work of Plants

Building up a strong frame work of basal shoots is very important for increasing quality flower production. Young plants should not be allowed to flower immediately after planting. The pea sized flower buds are to be removed without removing the leaves. To reduce the apical dominance, growers bend down the shoots.

Feeding of Plants

The optimum limits of nutrients in the rose plant tissue are 3 to 5 percent N, 0.25 to 0.50 percent P, 1.50 to 3.00 percent K, 1 to 2 percent Ca, 0.25 to 0.50 percent Mg, 0.25 to 0.70 percent S, 60 to 200 ppm Fe, 30 to 200ppm Mn, 18 to 100 ppm Zn, 6 to 25 ppm Cu and 30 to 60 ppm B.

Irrigation

In polyhouse, nozzles and drip system of irrigation is used. In surface irrigation, a single drip line between two rows of plants or one drip line for each row plants is used. Daily minimum water requirement per m² of roses ranges between 2 to 8 litres.

Yield

Under protected conditions, flower yield of H.T roses ranges from 100 to 200/sq mt.

Insect-Pests

Red Scale: Scale appears in severe form before and after rainy season. Both adults and young scales suck the sap from mature shoots and deplete vigour of the plant. Reddish brown encrustations appear on infested shoots and then dry in case of severe damage. For control, use scale free planting material and go for cutting and burning of infested parts. Spraying dimethoate 30EC @ 0.03 % (1-2 ml/litre of water) or oxydemeton methyl 25 EC @ 0.03% (1-2 ml/litre of water) or imidacloprid 17.8 SL @ 0.3 ml/litre of water and soil application of carbofuran 3 G @ 10-12 kg/acre helps in reducing damage by pests.

Thrips: Thrips usually attack new flush. Blackish brown adults and reddish nymphs suck cell sap from tender leaves, buds and flowers while cream coloured adults is problem in polyhouse roses. Curled leaves with brown marks and deformed buds with burnt margins are the main symptoms of damage. For control, spray dimethoate 30EC @ 0.03 % (1-2 ml/litre of water) or oxydemeton methyl 25 EC @ 0.03% (1-2 ml/litre of water) or imidacloprid 17.8 SL @ 0.3 ml/litre of water. Installation of blue sticky traps @ 40/acre.

Aphids: Aphids cluster around growing shoots and buds, both nymphs and adults suck cell sap. High humidity and cloudy weather (October-November) favours rapid buildup of aphids. Affected leaves get deformed while buds retard in growth. Spray oxydemeton methyl 25 EC @ 0.03% (1-2 ml/litre of water) or imidacloprid 17.8 SL @ 0.3 ml/litre of water or dimethoate 30EC @ 0.03 % (1-2 ml/litre of water) when infestation begins.

Hairy caterpillar: Eggs are laid in clusters on lower side of leaves. Black coloured mature larvae feed voraciously on leaves, buds and flowers, resulting in severe defoliation and flower loss. For control collect and destroy egg masses and early instars and set up light traps for attracting adult moths. Deep ploughing in summer exposes pupae to predators especially for birds. For control, spray cypermethrin 10 EC @ 1-2 ml/litre or chlorpyrifos 20 EC @ 2ml/litre or malathion 50 EC @ 2ml/litre of water or acephate 75 SP @ 1g/litre of water or quinalphos 25 EC @ 2ml/litre of water at 15 days interval.

Bud borer: Eggs are laid singly on growing buds and larvae bore into buds. Open flowers are also attacked by larvae resulting in damage to petals. For control spray malathion 50 EC @ 2ml/litre of water or chlorpyrifos 20 EC @ 2ml/litre of water on buds and tender foliage.

Rose saw Fly: Greenish spotted caterpillar completely defoliates the rose plants. The adults of rose saw fly lacerate the tender twigs for egg laying. For controlling saw fly larval damage, spray cypermethrin 10 EC @ 1-2 ml/litre of water at evening hours.

Chaffer beetle: Damage starts with the onset on monsoon when black and brown beetle emerges from soil and feed on leaves, buds and tender shoots while grubs feed on roots. Deep ploughing exposes eggs, grubs and pupae to natural enemies. Soil application of carbofuran 3 G @ 10-12 kg/acre for control of grubs and set up light traps for collection of adults. Spray chlorpyrifos 20 EC @ 2ml/litre of water or acetamiprid 20 SP @ 0.2 g/litre of water during evening against beetles.

Ash weevil: Eggs are laid in soil and grubs feed on roots. Grey coloured adults feed on leaves and cause severe foliage damage. Soil application of carbofuran 3 G @ 10-12 kg/acre for control of grubs while, or acetamiprid 20 SP @ 0.2 g/litre of water or malathion 50 EC @ 2ml/litre of water spray controls adults.

Termite: They mainly feed on roots and spread to stem and damage bark in case of severe infestations. Affected plants wilt, dry and die. Deep ploughing destroys termite colonies under dry soil conditions and timely irrigation prevents pest build-up. Drench soil with chlorpyrifos 20 EC @ 2ml/litre of water or malathion 50 EC @ 2ml/litre of water before planting for control of termite.

Diseases

Die-back: This is a very serious disease of rose. The infection occurs at the pruned ends of stems or through wounds caused due to harvesting of flowers and other operations. The infected stems dry from tip downwards, often extending to the main stem, thus killing the entire plant. For effective management, prune off the infected stems 5-10 cm below the margin of infection and pasting the pruned ends with copper oxychloride paste or chaubatia paste. Prune off the diseased parts and destroy by burning or burying deep in soil.

Black spot: The effected leaves show dark brown circular black spots on both the surfaces of leaflets. The spots enlarge and at later stage result in defoliation. The infected leaves should be collected and destroyed. Spray the affected plants with chlorothalonil (2g/litre of water) or copper oxychloride @ 0.3% immediately after pruning. Repeat sprays at 15 day's interval.

Powdery mildew: Symptoms appear as small discrete lesions on the stems, leaves or sometimes on the flower parts. The main symptom is the rolling of leaf margins, leaves turn purplish followed by the appearance of whitish or greyish spots on the leaves, stems and, sometimes, on the stalk of flower buds. The lesions rapidly coalesce under favourable environmental conditions. White powdery mass appears on the diseased parts. Spray the foliage with wettable sulphur @ 3g/litre of water or triadimefon (0.5ml/litre of water) at weekly intervals.

Downy mildew: Pinkish-brown irregular spots are formed on tender leaves. The chlorotic blotches are formed on the upper surface of matured leaves, which later become necrotic. The infection on floral buds leads to drying of flowers. Tender branches show die-back symptoms, ultimately resulting into complete defoliation and severe floral blight. The disease can be managed by spraying of chlorothalonil @ 2gm/litre of water or azoxystrobin (1ml/litre of water).

Rust: Chlorotic spots are formed on leaf surface. The infection results in defoliation of the plants. Spray plants with propiconazole (0.1%)

Grey mould: Infected buds turn brown and decay, individual petals turn brown and shrivel. Infected parts may become covered with grey to greyish brown mycelium which often sporulates profusely. Field sanitation by collecting and destroying the fallen leaves and other plant debris should be practiced. Application of chlorothalonil @ 0.2% or copper oxychloride @ 0.3% at 15 day's interval should be made to manage the disease.

Harvesting and Post-harvest Handling

The stage of harvesting the cut flower is the tight-bud stage when the buds show full colour but the petals have not yet started unfolding. If a flower bud of red cultivar cut at a little earlier stage it fails to open later. Pink and red cultivars should be allowed to develop to a stage where one or two of the outer petals begin to unfurl. Loose flowers, used for making garlands, preparing perfumes etc. are harvested only when they are fully open and collected in large open baskets.

The flowers should be cut in the early morning before sunrise or late in the afternoon when the sun is about to set as to avoid damage of buds due to high temperature during the day. If harvested flowers are not required for immediate use, the cut-flowers dipped in water in the bucket should be stored at a cool air temperature of 4.4 -7.2°C for about 6-12 hours.

Packaging

The cut blooms are graded according to the length of stem and then packed in corrugated card-board boxes. The size of box varies with the quality and quantity of roses to be packed. The inside area of the box will be cushioned with polythene or soft materials. The blooms are generally packed in bundles. The upper half of each bundle having flower buds is wrapped in a corrugated paper which is fixed with an adhesive tape. Flower bundles are placed opposite to another in such a way that their flower buds face the sides of the box and their stem ends towards the centre of the box. The inside of the box is finally covered with a sheet of tissue paper before putting on the cover of the box.

CHRYSANTHEMUM

Scientific name: *Dendranthema grandiflora*

Family: Asteraceae

Chrysanthemum is also known as “Glory of East” in English and „Guldaudi ’ in Hindi. They are used as cut flower for interior decoration and loose flower for garland making, pot culture/ hanging basket and for hair adornment. Flowers with attractive colours and long stem are suitable as cut flowers.

Climate and soil

Chrysanthemum requires long days during initial period of 2-3 months for its vegetative growth and 1-2 months of short day conditions and cool temperature (10-25⁰C) for flowering. Temperature below 10⁰C inhibits flower bud initiation and above 25⁰C affects flower bud development.



Soil should be well drained sandy loam with a pH of 6.5 – 7.0. It is highly sensitive to water logging. The soil should be thoroughly dug or ploughed 15-20 cm deep and kept open to sun for at least 15 days. After removing the weeds, the field should be reploughed and leveled.

Varieties:

Standard: Purnima, Snow Ball, Chandrama, Star Pink, Thai- Ching- Queen, White Prolific, Gulmohar, Yellow Star, Thaiching Queen

Spray: Baggi, Birbal Sahni, Maghi White, Red Gold, Ravi Kiran, Basanti, Punjab Anuradha, Mayur, Jubilee, Jaya, Lal Pari, Ajay



Snowball



Yellow Star



Thaiching Queen



Ajay

Propagation

The most common method of propagation is by suckers and cuttings

- a) **Suckers:** Once the flowering is over, the plants are beheaded to a height of about 15-20 cm from the ground level. During January- February new suckers start appearing round the base of the plant which are then separated and planted as individual plants.
- b) **Cuttings:** After pinching of the plants, new shoot arises from the leaf axils. From these shoots, young tip cuttings measuring 6-8 cm are taken just above the node. The lower leaves from the cuttings are removed and the basal portion is treated with some root promoting hormones like NAA or IBA before planting. Then the cuttings are planted in sterilized sand or coco peat. The time of raising cutting is June-July. After inserting the cutting shade should be provided for two weeks and regular misting of 2-3 times a day should be done. Rooting occur in 25-30 days.

Planting

The well rooted cuttings are planted in beds at a spacing of 30x30cm. Around 7250 cuttings are needed for planting of one „Kanal“ area. Planting should be done in the month of July-August in plains and June-July in hills.

Manure and fertilizers

Apply 25-30 tons of well rotten FYM, 100 kg of N, 200 kg P₂O₅ and 200 kg K₂O (180 Kg Urea, 434 kg DAP and 335 kg MOP) per hectare. Full dose of DAP and MOP and 1/3rd dose of urea (60 Kg) can be applied as basal dose. Remaining 2/3rd urea (60 kg each) can be applied by top dressing in two split doses one each after one and two months of planting.

Weeding and hoeing

Around 3 to 4 hand weedings are required, starting from one month of planting.

Irrigation

Due to shallow root system, crop requires frequent irrigation after every 4-5 days during hot dry summer season and 10-15 days during winter. Avoid over watering as it damages crop.

Staking, pinching and disbudding

Staking is necessary to provide the support whether the plants are grown in pot or field. There are only a few flowering varieties which neither require neither pinching nor staking.

Pinching involves removal of terminal shoot which reduces height and promotes axillary branches. This practice is done in loose flower production.

Through disbudding, undesirable immature flower buds are removed so as to allow terminal bud to obtain large and quality blooms. This practice is usually done in cut flower production.

Harvesting

It depends on the variety and time of planting. In spray varieties, fully opened flowers can be plucked by hand picking in early morning after 4 days interval. The standard varieties are harvested when ray florets are fully opened and disc florets are visible and spray variety when 40-50% of the bloom is opened.

Insect-Pests

Aphid: Four types of aphids suck sap from stem, leaves, flower buds and flowers. Damage results in loss of vigour, yellowing and premature leaf fall and stunted growth. These can be controlled by spraying dimethoate 30EC @ 1.5-2 ml/litre of water or oxydemeton methyl 25 EC @ 1-2 ml/litre of water. Installation of yellow sticky traps @ 40/acre is promising in reducing the aphid's infestation on the crop.

Thrips: Slender white nymphs and black adults feed on tender leaves causing silvering, mottling and distortion of leaves. Damaged flowers get discolored, wither and dry. For control, spraying of dimethoate 30EC @ 1.5-2 ml/litre or oxydemeton methyl 25 EC @ 1-2 ml/litre of water can be done at 15 days interval. Installation of blue sticky traps @ 40/acre is beneficial in reducing the thrips population.

Leaf folder: Eggs are laid singly or in small groups on lower side of leaves and larvae folds leave together and feed on chlorophyll. Affected leaves become skeletonised and dry. The larvae also damage flowers by feeding on petal. Cutting and burning of infected parts and two or three sprays of malathion 50 EC @ 1.5 ml/litre or quinalphos 25 EC @ 1.5 ml/litre give effective control of leaf folder.

Leaf miner: The incidence of leaf-miner is severe in March-June. Eggs are deposited in leaf tissue and larvae mine leaves by feeding on mesophyll. Severely damaged leaves show extensive mining and dry up. Removal and destruction of severely mined leaves reduces further damage. Spray of chlorpyrifos 20 EC @ 2ml/litre or fenvalerate 10 EC @ 0.5-1 ml/litre to reduce pest population.

Bud borer: Round cream coloured eggs are deposited singly on bracts and petals of buds. Larvae feed on growing flowers causing considerable flower loss. Spray malathion 50EC @ 1.5 ml/litre or deltamethrin 2.8 EC @ 1 ml/litre at appearance of eggs.

Hairy caterpillar: Pest attack starts during rainy season and continues till winter. Eggs are laid in clusters on lower side of leaves. Early instars are gregarious in habit and skeletonise leaves by scraping. Mature larvae defoliate leaves. Collection and destruction of egg masses and leaves infested with early instars. Deep ploughing in summer exposes pupae to predators. Spraying of cypermethrin 10 EC @ 1-2 ml/litre of water or chlorpyrifos 20 EC @ 2ml/litre of water or malathion 50 EC @ 2ml/litre of water or acephate 75 SP @ 1g/litre of water or quinalphos 25 EC @ 2ml/litre of water at 15 days interval controls grown up larvae.

Spider mite: Mites are usually seen on upper surface of leaves. Damage starts in March and reaches a peak during April - July. Affected leaves become discoloured, variegated due to loss of chlorophyll wilt and fall off. Two or three sprays of dicofol 18.5 EC @ 2.5 ml/litre of water or propargite 57 EC @ 1.5-2 ml/litre of water or acephate 75 WP @ 1g/litre of water or dimethoate 30 EC @ 1.5-2 ml/litre of water at 15 days interval are recommended.

Diseases

Damping-off: The seedlings are attacked by *Fusarium*, *Pythium* and other fungal pathogens. The stems are girdled at ground level resulting in toppling of seedlings. Soil sterilization with formalin @ 4% before 48 hours of sowing. Seed treatment with metalaxyl @ 2g/kg of seed or trichoderma spp. @ 4gm/kg of seed. Drenching of nursery beds with metalaxyl (1g/litre of water) or copper oxychloride @ 0.3%. Repeat drenching at 10-15 days depending on disease severity.

Septoria leaf spot: Circular and greyish brown spots are formed on the leaves, which later become dark brown and black. Withering of leaves occur in severe infestation. Application of chlorothalonil @ 0.2% or copper oxychloride @ 0.3% at 15 day's interval should be made to manage the disease. Repeat sprays at fortnightly interval.

Powdery mildew: The symptoms appear as powdery coating on the leaves often resulting in defoliation. Spray the foliage with wettable sulphur (3g/litre of water) or triadimefon (0.5ml/litre of water) at weekly intervals.

Stem rot: The symptoms appear as leaf chlorosis resulting in necrosis, decay and discolouration of pith and adjacent vascular region of cortex. When flower buds are about to open, small dark streaks are seen at the base of the stem. Root decay is noticed only in the advanced stages of infection. Adopt prophylactic measures and spray with azoxystrobin @ 0.1% or chlorothalonil @ 0.2%.

LILIUM

Scientific name: *Lilium spp.*

Family: Liliaceae



Lilium is an important bulbous plant having wide array of flower colours, mild fragrance and long vase life. Due to sturdy and long stem, liliium flowers are in great demand and fetch better price in market. All over the world the lily occupies a prominent place in floriculture as a cut flower, pot and garden plant. At present, commercial cultivation of lilium in India is centered in and around Himachal Pradesh, Uttaranchal, Jammu and Kashmir, Pune, and Delhi outskirts, from where flowers are being sent to local and international market. Among different species, Oriental and Asiatic hybrids are the most common cut-flowers. Asiatic lilies are relatively easier to grow and can be grown in elevated locations, even in the plains during the cooler months. Oriental hybrid lily can be successfully grown in cool hilly regions. Asiatic hybrids have performed well under protection in Jammu plains. The climatic conditions of mid and high hills are suitable for its cultivation whereas in plains/low hills cultivation may be done under protection.

Climate and soil

In protected conditions, temperature for growth should be maintained between 10-25°C with indirect sunlight to produce quality spike. During summer months, it should be grown under 75% shading, whereas in winter and rainy season, it may be grown under 50% shading net. Soil should be well drained, with good moisture holding capacity, rich in organic manure, having 60-90 cm depth with a pH 6.5 - 7.5.

Varieties

Most of the cultivars are interspecific hybrids and represent the most important cultivated groups which are:

1. The ***Longiflorum*** have trumpet-shaped, pure white flowers, a distinctive fragrance, year- round forcing ability and mostly outward-facing flowers. Important cultivars are: Ace, Nellie White, Snow Queen, Casa Rosa, Deliana etc.
2. The **Asiatic** hybrids have a wide colour variation in their flower tepals (orange, white, yellow, pink, red, purple and salmon) and early to late flowering. Important cultivars are: Brunello, Elite, Navona, Pollyanna, Tresser, Dreamland, Prato, Vivaldi, Toronto, Grand Paradiso, Shiraj, London, Detroit etc.

3. The **Oriental** are late-flowering, with big and showy flowers with a pleasant fragrance. Commercially important cultivars are; Star Gazer, Siberia, Tiber, Casendra, Barnini, Lombardia, Casa Blanca, Le Reve etc.

Recently, the demand of LA (Longiflorum x Asiatic) hybrids and LO (Longiflorum x Oriental) hybrids have gained momentum and replaced the Asiatic hybrids. LA hybrids are more floriferous than the Asiatic ones. Important LA-hybrids are: Pavia, Brindisi, Ceb- Dazzle, Diabolo, Fangio, Samur, Ercolano, Cilesta, Bestseller, Honesty, Indian Sunnerset, Mastermind, White Heaven etc.

Propagation

It can be propagated by asexual methods like bulblets, bulbils and scales. Explant like bulb scales, stem apices, meristem, floral organ and cotyledons have been used for the micropropagation at various institutions.

Bulblets: These are formed just below the ground level of the stem. Bulblets are detached and planted separately by dividing bulblets to produce commercial size bulbs after a year growth. On an average 2-3 bulblets/bulb can be obtained in one season.

Bulbils: Some varieties profusely form bulbils in the axil of the leaves. The bulbils can be planted in beds and takes 2 - 3 years to develop bulb of commercial size.

Scales: This is a rapid method that does not produce bulblets. The scales are removed from the outside of bulbs and are planted 5 cm apart and 4-5 cm deep in beds prepared with sand or soil mixture (2 part of soil, 1 part sand and 1 part vermicompost). This method takes 2-3 years to produce commercial size of bulbs.

Pre-planting requirements/methods of cooling liliium bulbs

Commercially four methods are used to cool liliium bulbs. These are:

1. **Natural cooling (NC):** In this case, cold treatment is given using natural temperature in the field. By natural cooling, we obtain shorter plants with more and long basal leaves and more flower number. It is dependent on the prevailing weather conditions of the areas.
2. **Controlled temperature forcing (CTF):** In this method, uncooled bulbs are planted and rooted at 17-18⁰C for 3 weeks and cold stored at 2-7⁰C for 6 weeks to develop roots. This methods leads to a higher bud count and leaf numbers. It is done by the forcer and requires a controlled temperature space.
3. **Case cooling/precooling (PC):** In this method, bulbs are left in moist peat moss in the original containers and cooled for 6 weeks. Normally, it is carried out at commercial cold storage facility. The biggest advantage of this method is that it takes small amount of refrigeration space and can be done by supplier or forcer.

Planting

In mid/high hills, liliium is planted in April-May under shade nets. In plains, it is planted in the month of October-November under protection. It can also be grown in open under higher altitudes. The optimum size of bulbs for Asiatic lily is 10-12 cm and that for oriental lily is 16 - 18 cm. Generally for high density planting, bulbs should be planted at a spacing of 10 x 15 cm

(50 bulbs/sq m or 25000 bulbs/ kanal). In beds of 1 x 9 m, spacing of bulbs should be 15 x 15 cm for small bulbs, 20 x 20 cm for medium bulbs and 30 x 30 cm for large sized bulbs.

Manure and fertilizers

Apply 25-30 tons of well rotten FYM per hectare one month before planting. Also apply 100 kg nitrogen, 50 kg phosphorus and 40 kg potash (174 kg Urea, 108 kg DAP and 68kg MOP) per hectare. Full dose of P and K and half of N should be given as basal application and remaining half of nitrogen in two parts, one at emergence of leaves (4 weeks) and other part before bud initiation.

Staking

All lilies should be staked when they reach blooming so as to avoid lodging due to heavy weight of the flower buds. For staking carnation nets can be used.

Shading

Lilies are very sensitive to the amount of light they receive. When light amount is low, like in dark winter, stems will be weak and buds can drop. And when light amount is high, like in summer, plants can remain short and high soil temperatures can cause root infection of *Pythium* or sprout infection of *Rhizoctonia*. A good screen can help to preventing all of these problems. Plants placed under the shading nets increase plant height, flower number, duration of flowering in the field, and delayed flowering up to one week. Maximum effects obtained under 50-75% shading nets.

Weeding and hoeing

Several weeds affect the crop at different stages and can be controlled by 3-4 hand weeding and hoeing.

Harvesting

Normally flowers are ready for harvesting after 90-120 days of planting. Each stem should be harvested individually when flower bud becomes loose and starts showing colour. The stem should be cut 10-15 cm above the ground level. For local market, harvesting should be done when 1-2 florets are open and for distant market, when 1-2 florets show colour. Generally six flowering stems are tied in one bundle and several such bundles and then packed in corrugated boxes for transportation.

For storage, bulbs should be dug-up, when the aerial parts have dried, after 40-50 days of flowering. They should be properly cleaned, graded and treated with copper oxychloride @ 0.3%. Then bulb can be placed either in moist peat-moss or in saw dust in alternate layer in the crates and stored at 2-4°C with 80-90% relative humidity for 8-10 weeks (2-3 months). In hilly areas, bulbs can be stored in moist moss and sand.

Post-harvest treatment of the bulbs

1. Reduce the frequency of irrigation water. Maintain soil moisture level in such a way that bulb scales should not dry out. Excessive moisture may lead to rotting of bulbs.
2. Allow bulbs to remain in the beds for 4 to 5 weeks (above ground stem portion should dry out and can be pulled out from bulb easily).
3. After 5 weeks remove the bulbs from soil along with dried stem.

4. Remove dried stem carefully without damaging the bulb.
5. Wash bulbs with clean water and treat with 3% copper oxychloride solution for 10 minutes.
6. Remove the bulb from solution and air dry in shade. Too much drying may lead to loosen root skin. Such bulbs after planting may develop root rot.
7. Immediately after air drying pack the bulbs in plastic crates with moist coco peat wrapped with perforated plastic sleeves.
8. Keep the crates in cold storage at 2⁰C for 6-8 weeks or 2 weeks and then at -1⁰C for 6 weeks for longer storage.

Insect-pests

Aphids: Aphids mainly infest lower surface of flowers and base of petals. Nymphs and adults suck the sap from the flowers causing discolouration and withering. Spraying of oxydemeton methyl 25 EC @ 1 ml/litre of water or imidacloprid 17.8 SL @ 0.3 ml/litre of water gives good control. Installation of yellow sticky traps @ 40/acre is beneficial.

Thrips: Thrips infest young leaves, buds and flowers and suck the sap. Affected leaves get distorted, while petals of flowers turn brown and dry. Two or three sprays of oxydemeton methyl 25 EC @ 1 ml/litre of water and dimethoate 30 EC @ 1.5-2 ml/litre of water at 10 days interval are effective against thrips. Installation of blue sticky traps @ 40 /acre is promising.

Leaf miner: The larvae mine leaves by feeding on mesophyll. Severely damaged leaves show extensive mining and dry up. Removal and destruction of severely mined leaves reduces further damage. For control, spraying of chlorpyrifos 20 EC @ 2 ml/litre of water or imidacloprid 17.8 SL @ 0.3 ml/litre of water to reduce pest population.

Diseases

Botrytis rot: Small dark brown dots are visible on the foliage. The infection starts from middle of the blade and plant growth retarded. Application of chlorothalonil @ 0.2% or copper oxychloride @ 0.3% at 15 day's interval should be made to manage the disease.

Rhizoctonia rot: The younger leaves and growing points are usually damaged. Lower buds dry at an early stage. Application of chlorothalonil @ 0.2% or copper oxychloride @ 0.3% at 15 day's interval should be made to manage the disease.

Soft bulb rot: It occurs on bulbs either due to injury or excessive moisture. The fungal pathogen spreads due to excessive moisture resulting in total collapse of roots and shoots. Intercultural operations should be carried out very carefully to avoid bulb injury and optimum soil aeration in the soil should be maintain

CARNATION

Scientific name: *Dianthus caryophyllus*

Family: Caryophyllaceae

Carnation is one of the leading cut flower crop in India. It can be grown in almost every part of the country. In temperate zone, it is being grown in polyhouses whereas in tropical climate, it can be grown in shade houses. It is gaining popularity due to beautiful cut flower production and rooted plant business. At present enormous varieties are available with many attractive colors, remarkable ranges of shape and sizes.



Types of Carnation

Standard Type: In standard type, flowering buds formed on short lateral shoots arising from the axis of the upper leaves are removed to leave one large terminal flower on a long leafy stem. It has one large flower on an individual stem.

Spray Type: In spray type, terminal flower bud is removed at an early stage to encourage more even development of the lateral flowers, which then produce a multiple flower stem.

Varieties of Carnation

Standard varieties:

Red: Master, Domingo, Aicardi, Gaudina, Espana

White: White Liberty, White Wedding, White Dona, Alibaba

Pink: Dona, Pink Dona (Light Pink), Charmant, Dover, Farida (Dark Pink), Pink Shiva

Orange: Malga, Solar. Star, Folgore, Firato

Yellow: Liberty, Diana, Tobago, Yellow Firato

Double Color: Tempo, Tundra, Raggio-di-Sole, White Tundra

Spray varieties:

Red: Red Eye, Red Vital

White: White Prestige, Milky Way

Pink: Celebration, Superma, Spur

Orange: Sunshine, Autumn, Fancy

Yellow: Stella, Prestige

Double Color: Picaro, Orbit Plus, Nadeja

Climate

Carnation requires high light intensity during winter and mild summer. The difference between day and night temperatures should not be more than 10°C. Ideal day and night temperature is 28°C and 18° C respectively. The optimum CO₂ concentration on cloudy days should be 300-500 ppm whereas for sunny days it is 750-1500 ppm. The relative humidity level inside the polyhouse should be 60-65%.

Growing medium

Carnation can be successfully grown in a well drained loamy soil. The pH of growing medium should be between 5.5-6.5. Disinfection of soil before planting is necessary. Sterilization can be done by plastic mulching for 6-8 weeks or with the application of formalin @ 7.5 l/100 m² area.

Propagation

It is commercially propagated through rooted cuttings. For propagation, terminal cuttings (8-10 cm) are taken from healthy mother plants. 1-2 pairs of the lower leaves are removed and dipped in 0.3 % copper oxychloride solution for 5 minutes. After treating with the fungicides, the cuttings are treated with 500 ppm NAA for 5 seconds. Cuttings are planted at 3x3 cm distance in trays or propagation beds containing sterilized sand. The cuttings normally develop good root system within 21 days.

Planting Time

In plains, it is grown in October-November whereas in hills it is grown during February-March. Rooted cuttings should be planted on raised beds of 1 m width with 0.5 m path between beds.

Planting density

For commercial cultivation of carnation, 20x20 cm spacing is optimum accommodating 25 plants per square meter area.

Staking

Carnation crop has the tendency to bend unless supported properly. Hence the crop needs support while growing. Wire mesh, plastic nets, string or bamboo canes are used to support plants. For an optimum support, an increasing width of the meshes can be used. Bottom net can be of 10x 10 cm, then two nets of 12.5x12.5cm and the upper most can be 15x15cm, which are erected at 15, 30, 45 and 60 cm above the ground level with the growing plants.

Fertilizer application

To create favourable growing conditions a good quantity of organic matter along with basal dose of fertilizers should be applied and mixed well into the soil. FYM 25 kg per sq. m. 2.5 ton/ha, Phosphorus 400g/100 sq. feet and magnesium sulphate 0.5 kg/100 sq. feet are applied as basal. Calcium ammonium nitrate and MOP at 5:3 ratio is mixed and applied @ 2.5 g/plant/month as top dressing.

Pinching

Depending upon the need of crop spread, single, one and a half or double pinch method is adopted. Ideal time for pinching is early morning. When the plant attains 5 nodes, the first pinch is given. This is called „single pinch“. This would give rise to six lateral shoots. With a „one and half pinch“, 2-3 of these lateral shoots are pinched again. For the „double pinch“, all the lateral shoots are pinched off.

Deshooting

Unwanted shoots should be removed when they are 2-3 cm long. Generally in standard cultivar, terminal shoots are retained while in spray, axillary shoots are retained.

Disbudding

Disbudding refers to removal of unwanted buds, so that the retained bud receives maximum food for the full development. In standard carnations, side buds should be removed whereas in spray carnations, the terminal bud is removed. The best time for disbudding is when the terminal flower bud is about 15 mm in diameter.

Flower harvesting

Standard cultivars are harvested at paint brush stage while spray cultivars are harvested when two flowers have opened and others have shown colour. Best time of harvesting is in morning hours. As soon as the flowers are harvested they should be placed in water.

Packaging, transportation and storage

Twenty stems are firmly tied at the base with tape or rubber bands and wrapped in cellophane paper. These bunches of flowers are packed in a standard size carton of 120 x 60 x 30 cm. Carnation flowers can be stored at 5-8°C for 10 days after wrapping in cellophane paper.

Post harvest treatment

Citric acid is added to water to make the pH 4.5 to 5 and 5 mg of sodium hypochloride is added to 1 litre of water. Cut flower stalk is soaked in this solution for 4 – 5 hours to improve vase life.

After harvest, the flower stems should be immediately placed in a bucket of preservative solution of warm and deionized water. A good preservative solution for carnations should be acidic (pH 4.5) with 2-5% sucrose. After keeping in preservative solution for 2 to 4 hours, flowers should be placed in a refrigerated room at 0-2°C for 12-24 hours. The flowers can be stored for two to four weeks before marketing. For this, the flowers have to be packed in cartons lined with polyethylene film. These cartons should have sufficient vent holes. The full cartons should be pre-cooled without lid. The plastic is then loosely folded on top of the stems and the lid is closed. These cartons are stored in cool chambers designed to maintained 0°C with good air circulation and a constant relative humidity of 90-95%.

Yield of Carnation

15 flowers/plant (350-375 flower stems/m²) in 2 years period.

Physiological disorder

Calyx-splitting:

As the flower buds opens calyx may split down either half way or fully. Use rubber bands to prevent Calyx-splitting. Night temperature should not be below 10°C; extreme fluctuation in temperature should be avoided.

Curly Tip

This disorder affects the growing tips which curl and become distorted. Tips of the young shoots fail to separate and continuation of growth results in a characteristic curvature. Poor light and other adverse conditions are thought to be the causes of the disorder. Water stress and potassium deficiency are suspected causes for a physiological curly tip and die-back of carnation flowers.

Insect pests

Thrips

They suck the sap from the leaves, causing them to turn yellow and patchy often with black specks. Spraying the plants with dimethoate 30 EC @ 1.5-2 ml/litre is suggested.

Helicoverpa: Caterpillars are mostly a problem of the carnation buds. Installation of pheromone traps @ 2-3/acre for early detection and 5-6/acre for trapping and mass mating disruption. Install T-shaped bird perches @ 8/acre. Foliar spray *Ha*-NPV 100-200 LE/acre (1 ml/lit) freshly procured and mixed with 10 g/litre gur or jaggary and tinopal blue (1ml/lit) for 2-3 times at 12 days interval at evening hours is promising. Need based and alternative application of fenvalerate 20EC @ 1 ml/litre or deltamethrin 2.8 EC @ 1 ml/litre of water followed by dimethoate (2 ml/litre of water). Besides these, spray the crop with cypermethrin 10 EC @ 1 ml/litre or lambda cylothrins 5 EC @ 0.5ml/litre of water or chloropyrifos 20 EC @ 1.5-2 ml/litre of water.

Red Spider mites

They are first found under the leaves and can cover the entire leaf, the stem and the whole plant with their web. Two or three sprays of dicofol 18.5 EC @ 2.5 ml/litre of water or propargite 57 EC @ 1.5-2 ml/litre of water or acephate 75 WP @ 1g/litre of water or dimethoate 30 EC @ 1.5-2 ml/litre of water at 15 days interval are recommended.

Diseases

Basal rots or Collar Rot (*Alternaria dianthi*)

The rot occurs at the leaf base and around the nodes, usually the leaves and branches are affected. Spots are first ash grey but later become dark brown or black. Spraying the plants with azoxystrobin @ 0.1% at fortnightly interval before disease establishment is effective.

Fusarium wilt (*Fusarium oxysporum* f. sp. *dianthi*)

Affected roots and shoots wither and die. Drenching of soil around the plant base with copper oxychloride 0.3 % or azoxystrobin @ 0.1% are suggested. Propagative material must be disease free.

GERBERA

Scientific name: *Gerbera jamesonii*

Family: Asteraceae

Gerbera commonly known as Transvaal Daisy or African Daisy is an important attractive cut flower. Its flower lasts for longer duration in a vase.

Climate and soil

Gerbera cultivation can be done under wide range of climatic conditions. In tropical climate, gerbera flowers are grown in the open but in subtropical and temperate climate, they are protected from frost and cultivated in greenhouse/shade net house. Production of quality flowers requires shade house (50%) or naturally ventilated polyhouse. Day temperature of 22-25°C and night temperature of 12°C-16°C is considered ideal for its cultivation.



Deep, well drained, rich, light, neutral or slightly alkaline soil with pH range of 5.5 - 7.0 is ideal for gerbera cultivation. Land should be ploughed deep and brought to a fine tilth. Raised beds upto 30 cm high and 1.0 -1.2 m wide should be prepared. Length may vary depending upon the convenience or the area available for cultivation. Growing media consisting of FYM: sand: cocopeat/paddy husk (2:1:1) is ideal.

Varieties

- Pink - Terraqueen, Valentine, Flamingo, Fredaisy
- Red - Dusty Beauty, Impulse, Blorosa, Rosabella, Lilabella
- Yellow - Fredking, Doni, Pana, Gold Spot, Marleen, Horizon
- White - Delphi, Maria, Presti
- Orange - Lily, Maron Clementine, Mirage

Propagation

It is propagated through division of larger clumps into smaller units usually in September when the plants are to be set out in the fields and can also be propagated through micro-propagation. Division of mother plants at the end of February produces 5-6 plants. These start flowering at the end of May. The roots and leaves of suckers should be trimmed before transplanting, keeping the central shoot intact and covered with soil. Division of clumps needs to be practiced after 2-3 years of planting.

Planting

Before starting gerbera cultivation, disinfection of the soil is necessary to minimize the infestation of soil borne pathogens like *Phytophthora*, *Fusarium* and *Pythium* which could otherwise destroy the crop completely. The beds should be drenched/fumigated with 2% formaldehyde (100 ml formalin in 5 litres of water/m² area) or methyl bromide (70g/m²) and

then covered with a plastic sheet for a minimum period of 2 to 3 days. The beds should be subsequently watered thoroughly to drain the chemicals before planting. Well developed tissue culture plants having 4-6 leaves can be planted firmly without burying the crown. The best planting time is September to October in plains and February to March in hills under protection, maintaining a distance of 40 cm from row to row and 30 cm from plant to plant

Manure and fertilizers

Add 25-30 tones of well rotten FYM or vermicompost along with 217 kg of DAP (100 kg P) and 165 kg of MOP (100 kg K) per hectare as a basal dose at the time of preparation of beds. Urea @ 120 kg/ha (90 kg N) should be applied in 4 split doses (3 doses at monthly interval during vegetative phase and one dose during flowering period). In soils deficient in iron, apply ferrous sulphate @10g/sq. m to check yellowing of leaves.

Weeding and hoeing

Around 2-3 hand weedings are sufficient for controlling weeds under protected conditions

Irrigation

It may be done at an interval of 5 days during summer and 10 days during winters.

Summer-shading/ winter-covering

Cover beds with plastic sheets from November to March. It gives quality blooms from November to December and February to March. The plants can also be covered with shading nets from April to September to reduce light intensity to increase flower yield. Gerberas do perform better in low cost polyhouses than those grown under shade net and open

Harvesting

Harvesting of flowers is done when outer 2-3 rows of disc florets start opening and are perpendicular to the stalk. The stalk should be cut about 2-3 cm above the base and kept in fresh chlorinated water (1%). Gerbera flower heads can be packed in plastic coated metal or cardboard grids or in mini polythene sleeves and stored at 2-4°C.

Insect-pests

Aphids: These mainly infest lower surface of flowers and base of petals. Nymphs and adults suck the sap from the flowers causing discolouration and withering. Spraying of oxydemeton methyl 25 EC @ 1-2 ml/litre or imidacloprid 17.8 SL @ 0.3 ml/litre of water gives good control.

Thrips: These infest young leaves, buds and flowers and suck the sap. Affected leaves get distorted, while petals of flowers turn brown and dry. Two or three sprays of oxydemeton methyl 25 EC @ 1-2 ml/litre of water or dimethoate 30 EC @ 2 ml/litre of water at 10 days interval can be given for their control. Use blue sticky drops @ 40 traps/acre for trapping maximum numbers of thrips population as they are attracted towards blue colour.

White flies: They are very minute insects and responsible for transmitted the viral diseases in gerbera. They also covered the crops especially leaves with their honeydew secretions which favours the growth of sooty mould on leaves that reduces the photosynthetic area of plants. Spraying of dimethoate 30 EC@ 2ml/litre of water or malathion50 EC@ 2ml/litre of water or

imidacloprid 17.8 SL@ 0.3 ml/litre of water or acetamiprid 20 SP @ 0.2g/litre of water or thiamethoxam 25 WG@ 0.2 g/litre of water is effective way to control whiteflies.

Leaf miner: The larvae severely damage leaves through extensive mining and then leaves dry up. Removal and destruction of severely mined leaves reduces further damage. Spray chlorpyrifos 20 EC @ 1.5 ml/litre of water or malathion 50 EC @ 1.5- 2ml/litre of water to reduce pest population.

Yellow mites or Broad mites: They are very minutes and continuously sucking the saps from underside of leaves and buds. The leaves become curled, distorted and leathery. The flowers often found half opened or may not be open completely. Spraying of acephate 75 SP @ 1g/litre of water or dicofol 18.5 EC @ 2.5 ml/litre of water or quinalphos 25 EC @ 2ml/litre of water or propargite 57 EC @ 1.5-2 ml/litre of water may be beneficial in suppressing the mites populations and managing such problems.

Diseases

Foot and crown rot: Infected leaves become red violet and show necrotic symptoms. The symptoms of the disease are slow but progressive wilt often results in death of the plant. The disease can be managed by planting healthy corms in sterilized soil. Removal of infected plants and soil solarization with transparent polythene sheets during hot summer months for at least 15 days, followed by drenching with iprovalicarb+propineb @ 0.4% reduces the disease infection.

Wilt: The infected plants show yellowing of lower leaves. The collar portion shows vascular discolouration. Roguing of wilted plants and soil application of copper oxychloride (0.3 %) or azoxystrobin @ 0.1% is suggested. Propagative material must be disease free. Since nitrate forms of nitrogen favour fungal growth, ammonical forms of fertilizers are recommended. Soil pH should be maintained above 6.5 as acidic soils favour growth of *Fusarium*.

Root rot: The plants show reduced growth, smaller leaves and flowers with weak stems. Leaves show purple discolouration, rotting of both feeder and main roots. Drenching with metalaxyl (1g/litre of water) or iprovalicarb + propineb @ 0.4% near the affected plant roots helps in managing the disease.

Powdery mildew: The infection causes white powdery coating on the foliage leading to malformation of flowers and the foliage. azoxystrobin @ 0.3% or difenoconazole @ 0.1% or sulphur @ 0.25% at appearance of the disease helps in managing the disease

Phyllody: The leaves become small and more in number, which give the cluster like appearance. All the flower parts lose their attractive colour and become leaf like, small and narrow. Uproot and destroy the infected plants.

Yield: Under open condition, 130 -160 flowers/m²/year and under greenhouse condition, 175 - 200 flowers /m²/ year can be obtained.

TUBEROSE

Scientific name: *Polianthes tuberosa*

Family: Amaryllidaceae



Tuberose (*Polianthes tuberosa*)-commonly known as Rajnigandha belongs to family Amaryllidaceae and produces waxy, white and fragrant flowers on long spikes used as cut flowers for making garlands and extracting essential oil. Tuberose blooms during July-October in northern plains when there is no flowering in other cut flower crops. Flowers remain fresh for long time and are suitable for long distance transport. The crop can remain well for 3 years in the field and afterwards it should be replanted to reduce damage by pests and diseases.

Climate and Soil

It grows in wide range of agro-climatic conditions. Its commercial cultivation is mostly confined to warm, humid areas with average temperature of 20-35⁰C and in sunny situations. Well drained loam and sandy loam soils having a pH range of 6.5-7.5 with good aeration are considered suitable for its cultivation. Field should be prepared by giving 2-3 ploughings and incorporating well rotten FYM at the time of field preparation.

Varieties

Both single and double varieties are popular. Single variety bears one row of corolla segment and has pleasant scent. It is used as both loose and cut flower. Double variety bears 2 to 3 rows of corolla segment and is usually used as cut flower.

Calcuttia Single: It bears single white scented flowers with 60 cm spike length.

Calcuttia Double: It bears double white flowers with 80 cm spike length.

Suvasini: It has double scented white flowers with 50 cm spike length.

Shringar: It has single white and slightly scented flowers with 40 cm spike length.

Prajwal: The variety is tolerant to nematodes.

Propagation

It is commercially propagated through bulbs. Bulbs with 2.3 to 3cm in diameter have been found best as planting material. Bulbs of 2-3cm size can also be cut vertically with 2-3

sections each containing a bud and a part of basal plate. Micro-propagation protocol for tuberose multiplication has also been standardized at this institution.

Planting

Best time for planting of tuberose bulbs is March-April in plains with a spacing of 30x20 cm and 5-7 cm depth. Bulb weighing 40-50 g is suitable for planting. Treat the bulbs with copper oxychloride @ 0.3% for 30 minutes before planting in the field. Bulbs can be planted at distance of 20x15cm with population of over 3 lakh bulbs per hectare area.

Manure and fertilizers

25-30 tons well rotten FYM, 200 kg N, 100 kg P and 100 kg K (347 kg Urea, 217 kg DAP and 170 kg MOP) per hectare should be applied in the field. Full P and full K and one third N should be given as basal dose. Rest half of N should be given in 3 split doses at 25 days interval starting first 45 days of after planting.

Irrigation

It requires sufficient soil moisture for its growth and flower production. The irrigation is done at weekly intervals during April-June and at fortnightly interval during October-March.

Weeding and earthing up

Hand weeding should be done at fortnightly intervals. The plants can be earthed up when they attain a height of 30 cm. Process is repeated after 2-3 weeks.

Harvesting

For loose flowers, individual floret should be picked when they are fully opened while for cut flowers, spikes should be harvested when lower pair of florets is fully open. For packaging, the spikes are tied in a bundle of 100 spikes, wrapped in wet newspaper sheet and finally packed in cartons. The loose flowers are usually packed in baskets.

Flower and bulb production

About 9,000 spikes and 80,000 bulblets per kanal can be obtained per year. One bulb of 40-50 g produces 10-12 bulblets in two years. These should be dug out in February-March when the leaves become dry and are replanted within 25-30 days of digging. Treat the bulbs with copper oxychloride @ 0.3% for 30 minutes before storage.

Insect-pests

Thrips: Thrips are the main insect pests of tuberose which causes. Spraying of dimethoate @ 1ml/litre of water or oxydemeton methyl 25 EC @ 1-2ml/litre of water is the effective control for thrips.

Nematode: These can be controlled by dipping of bulbs in 0.2% chlorpyrifos/dichlorvos 40 EC (0.02%) for half an hour or soil application of carbofuran @ 1 kg/kanal.

Diseases

Bulb rot: Bulbs of tuberose usually rot due to infection caused by *Fusarium* and *Botrytis*. These rots can be managed by dipping the bulbs in iprovalicarb + propineb @ 0.4% or chlorothalonil @ 0.2% reduces the disease infection before planting. The disease on the affected plants can be managed by spraying with chlorothalonil @ 0.2% at fortnightly intervals

JASMINE

Scientific name: *Jasminum spp.*

Family: Oleaceae

Jasmine is an evergreen perennial shrub. It bears single, double and semi-double white flowers becoming purplish with age. Flowers appear in clusters and have short post harvest life. It is widely cultivated for highly fragrant flowers used during marriages, festivals, garland making and perfumes. It has got many species and those commercially important include *Jasmine auriculatum* (Juhi), *Jasmine sambac* (Mogra/Motia) and *Jasmine grandiflorum* (Chameli)



Climate and soil

Climate of Jammu is highly suitable for the cultivation of Jasmine. Well drained soils having assured irrigation facilities especially during summer months are ideal. Field needs to be well prepared before planting by giving 3 to 4 thorough ploughings.

Varieties

Selection J.S.L. 1: It produces fully double flowers, round buds having 1.25 cm diameter and 1.55 cm length.

Selection J.S.L. 2: It produces double pointed buds of 1.00 cm diameter and 12.75 cm length. Gundumalli- Flowers are round with good fragrance. The average yield of flowers is 7-8 tonnes/ha while the estimated concrete yield is 15kg/ha.

Ramban & Madanban- This is a high yielding variety with long flower buds.

Double Mogra - The flowers of this variety have 8-10 whorls of petals with excellent fragrance resembling that of white rose

Propagation

It is propagated by rooting of semi-hard wood cuttings and through ground layering mainly in rainy seasons in plains/low hills.

Planting

Jasmine can be planted both during rainy (July-August) and summer season (February – March). Pits of 45 x 45 cm size are dug and filled with soil + FYM mixture. Maintain row to row distance of 1.8 meters and bush to bush distance of 1.2 meters. Add 50-100 ml of chlorpyrifos 20 EC to each pit for control of termites and other soil insect pests.

Manure and fertilizers

For one year old established bushes, add 21 g DAP (9 g P) and 30 g MOP (18 g K) in 1st week of March and 13 g Urea (9g N) four times at 30 days interval. From second year onwards, 42 g DAP (18 g P) and 60 g MOP (36 g K) is applied in 1st week of March and 26 g Urea (18 g N) four times each at 30 days interval. About 4 kg well rotten FYM or vermicompost per bush is also incorporated in the soil after every annual pruning in February - March.

Weeding and hoeing

Two to three hand weedings are sufficient for controlling weeds under protected conditions

Irrigation

It may be done at 5 days interval during summer and 10 days interval during winters.

Pruning

No pruning is done during the first year. In plains/low hills, regular pruning should be practiced in first fortnight of February from second year onwards. It encourages growth of new shoots and increases flower yield.

Harvesting

Flowering starts in the month of April and continues upto May-June and sometimes extend to July. Production of flowers increases with the increase in size of the bushes. After the rainy season sets in, production goes down and practically ceases after August. Flower buds are picked in slightly tight stage in the early morning hours with slight pulling using thumb and fingers. Buds are kept in moist cloth under shade till the picking is complete. One person can collect 3-4 kg buds in 3-4 hours. If the flower buds are required to be transported to a distant market, keep them at 10⁰ C in thermocol box or cold chambers where they remain fresh for about 24 hours.

Yield

Flowers yield: 739 to 8129 (kg/ha)

Concrete recovery: 0.14 to 0.19 (%)

Insect-pests

These infest young leaves, buds and flowers and suck the sap. Affected leaves get distorted, while petals of flowers turn brown and dry. Two or three sprays of dimethoate 30 EC @ 1.5 ml/litre of water at fortnightly interval are effective against thrips. Alternatively oxydemeton methyl 25 EC @ 1ml/litre of water can be sprayed.

Leaf web worm

Hand picking of larvae & pupae reduces insect. Its caterpillar feeds on leaves and flower buds making a network of webbing of leaves especially in hot and humid weather. It can be controlled by spraying chlorpyrifos 20 EC @ 2ml/ litre or malathion 50 EC @ 2ml/litre of water.

Diseases

Wilt and stem rot

The plants show wilting and ultimately fail to survive. The disease can be checked by drenching the base of the plants with copper oxychloride (0.3 %) or azoxystrobin @ 0.1% is suggested. Propagative material must be disease free.

Leaf spot and rust

Spray propiconazole @ 1ml/litre of water at regular intervals.

SEASONAL FLOWERS



Seasonal flowers or annuals are a group of herbaceous plants which grow from seeds, produce flowers, set seeds and die down (or complete their life cycle) within one season or one year. People prefer growing annuals in pots, beds, borders, hanging baskets or as cut flower. They provide a beautiful display of colours in garden and without annuals garden is incomplete.

Winter season annuals: Winter annuals are sown in the month of September-October and transplanted in the field during October-November. These include Antirrhinum, Calendula, Stock, Lupin, Larkspur, Marigold, Pansy, Phlox, Garden Poppy, California Poppy, Sweet Pea, Verbena, Cineraria, Dianthus, Hollyhock, Petunia, Sweet William, Sweet Alyssum, Sweet Sultan, Echium, Nasturtium, Linaria, English Daisy, Annual Chrysanthemum, Corn Flower, Helichrysum, Salvia, Ice plant, candytuft, Arctotis, Brachycome, Molucella, Gazania, Wall flower, Dimorphotheca, *etc.*

Summer season annuals: These are sown in the month of February-March and transplanted in the field during March-April. These include Zinnia, Cosmos, Gaillardia, Kochia, Portulaca, Tithonia, Gomphrena *etc.*

Rainy season annuals: These annuals are grown in rainy season and can withstand heavy rains and high humidity. Seeds are sown in June and seedlings are transplanted in July. It includes all summer season annuals and others like Amaranthus, Balsam, Celosia, Kochia, Zinni *etc.*

Climate and soil

Annuals can be cultivated in a wide range of climatic conditions ranging from subtropical to temperate region. Well drained sandy-loam soils with medium fertility, pH between 6.0-7.5 and adequate water-holding capacity are considered ideal.

Varieties

Many varieties/hybrids of summer, winter and rainy season annuals representing public and private sector are available in local markets.

Propagation:

Most of the annuals can be propagated through seeds.

Nursery raising and transplanting

The common practice is to raise seedlings in beds and then go for transplanting. A few annuals which have either bold seeds like Sweet pea, Morning glory, Lupin and Nasturtium are

difficult to transplant such as *Linaria* and *Eschscholzia* may be sown directly at the permanent sites where they are spaced adequately by thinning out after germination. For nursery raising, seeds are sown in 1m wide and 20cm raised nursery beds prepared after mixing equal quantity of garden soil, sand and well-decomposed FYM or vermicompost. The seeds should be sown in lines 4-5cm apart and then cover with a mixture of soil, fine leaf-mould or vermicompost mixture up to a half to 1cm and apply water gently. The seeds germinate in 3-4 days during summer and in 5-8 days during winter. The seedlings are ready for transplanting in 21–28 days after sowing in summer and 28-35 days in winter.

In plains/low hills of Jammu, annuals are grown in their respective seasons while in hills; annuals are grown during summer season. The seedlings are transplanted preferably in evening or during day time on cloudy days. The distance for tall annuals (*coreopsis*, *gaillardia* and *helichrysum*) is usually maintained at 60cm × 45cm; for medium height annuals (*petunia*, *verbena*, *phlox* and *eschscholzia*) at 45cm × 45cm and that for dwarf annuals (*pansy*, *portulaca*, *mesembryanthemum* and *alyssum*) at 25cm × 25cm.

Manure and fertilizers

Apply well rotten FYM @ 3-5 kg /sq m at the time of bed preparation. Use urea, DAP and MOP @ 25 gm, 80gm and 50 gm, respectively (26.5g N, 36 g P and 30 g K) per sq. m area (12.5 kg Urea, 50 kg DAP, 25 kg MOP; N:15 kg; P:23 kg; K:15 kg per kanal). Full dose of DAP and MOP along with half of urea should be given as basal application and remaining half immediately after the establishment of the plants in the beds.

Weeding and hoeing

Around 2-3 hand weedings, as per specific need of each annual are sufficient for controlling weeds.

Irrigation

The flower crops need light and frequent irrigations usually at an interval of 4–5 days during summer and 7–10 days in winter.

Pinching and disbudding

Marigold and *Dianthus sp.* can be pinched when 15-20 cm tall while *Aster*, *Cosmos* and *Zinnia* at 5-10 cm height. For production of large flower needed for exhibition, axillary buds should be removed at pea size stage.

Seed production

Pods are harvested individually by hand or in some cases with sickle when their colour changes from green to dark brown or when they shows signs of slight splitting and drying. For drying, the pods are spread over tarpauline in a well-ventilated room for a week and reshuffled daily. The seeds are sieved and then finally cleaned by hand-winnowing or a table fan. These are packed at appropriate moisture in plastic bags or other containers and stored properly for use in next year.

Insect-Pests

Helicoverpa

The *Helicoverpa spp.* generally attacks helichrysum, antirrhinum, coreopsis, dianthus and cosmos. The caterpillars can be controlled by spraying of cypermethrin 10EC 1ml/litre of water.

Aphids:

Aphids attack stock, nemesia, calendula and alyssum. Spraying of dimethoate 30EC @ 1.5 ml/litre of water or methyl demeton 25EC @ 1ml/litre of water is effective to control aphids.

Diseases

Damping off: It is the most common disease at the seedling stage. Soil sterilization by formalin @ 4% before 48 hours of sowing. Seed treatment with metalaxyl @ 2g/kg of seed or trichoderma spp. @ 4gm/kg of seed. Drenching of nursery beds with metalaxyl (1g/litre of water) or copper oxychloride @ 0.3%. Repeat drenching at 10-15 days depending on disease severity.

LAWN

Lawn is the green carpet for landscape. It improves the appearance of the house or garden, enhances its beauty, increases convenience and usefulness. The lawn provides a perfect setting for a flowerbed, border, shrubbery or specimen tree/shrub. The site should receive full sun and should preferably be on the southern or south east side of the building with no big tree near the site. It is always necessary to have a perfectly leveled lawn. Lawn can also be laid in undulated land but there should not be any depression.



Uses:

1. It is used for soil stabilization i.e., to prevent soil erosion from wind and water.
2. Lawn grasses provide a cooling effect during warm weather.
3. The uniform green appearance of the lawn enhances the beauty of the landscape.
4. Lawn provides a perfect background setting for flower beds, borders, a shrubbery, a specimen tree or a shrub.
5. Lawn also provides arenas for recreational activities and relaxation.
6. Healthy lawn absorbs rainfall four to six times more effectively than farm fields.
7. They also reduces glare from the sun and helps to remove air pollutants and dust from the atmosphere.

Soil

The soil should be fertile, well drained having good water holding capacity with pH 6.0-8.0. In northern plains, soil can be dug during summer's upto 45 cm depth and exposed to scorching sun for killing weeds and harmful pathogens. A few days before the rainy season starts (during June), add well rotten FYM and mix well with soil while picking out stones, roots of weeds and other undesirable materials. Add well rotten FYM or preferably vermicompost @ 20-25q/kanal and incorporate well in soil. Subsequently, light rolling should be done. During rains, soil settles down and weeds emerge out which should be removed. Manually ground should be leveled giving a gentle slope (2-3 cm) for drainage of extra water during excessive rains.

Grasses suitable for lawn

- a) **Doob Grass** (*Cynodon dactylon*): It is commonly known as Doob, Bermuda or Haryali. It is hardy grass for lawn making, play grounds and parks. Pusa selection -1, Calcuttia and Haryali are the important varieties adapted to Jammu region.
- b) **Korean grass** (*Zoysia japonica*): It makes cushion like turf and is highly suitable for smaller areas. It is a tough grass but grow slowly. Water requirement of this grass is comparatively more. When established, it looks good but maintenance is problem. It may be used for areas having no termite problem.

- c) **Grasses for shady areas:** In partial shade grasses like Fescue grass (*Festuca sp.*) and St. Augustine grass or Buffalo Grass (*Stenotaphrum secundatum*) can be grown.

Methods of planting lawn grass

- a) **Seeding:** Around 1.5 kg seed of grass is required for one kanal area. Seeds should be uniformly and evenly sown on a windless day. Bulk material like sand or ash should be used for even distribution of seeds. The ground should be lightly rolled again. Watering should be done with a watering-can fitted with a spray nozzle for small lawns and preferably with sprinkler for bigger lawns. Flood irrigation should be avoided before germination of seeds.
- b) **Dibbling:** It is the most common method. Six to seven bags of grass scrapped from old lawn are sufficient for planting of one kanal area. It can be planted in February/March and also in July/August. But best time for dibbling is rainy season and planting can be extended upto September. The roots and stem portions are dibbled into soil and then pressed and then light watering is given. The newly planted grass gets established within 2 to 3 months time.
- c) **Turfing:** The pieces of uniform thickness of turf along with soil are scrapped made from the place where grass is compact and free from weeds. These are then spread on the ground evenly and beaten with a stick or covered with fine soil and liberal watering given. Grass starts growing in relatively short period by this method.
- d) **Bricking:** It is done to replace the few unhealthy patches in well-established lawn. A piece of lawn along with soil in the shape of bricks is taken out and planted and watered immediately.

Cutting and rolling of new lawn

When cutting a new lawn for the first time, do not use a lawn mower but trim with the help of sharp scythe. The grass should be cut at a height of 3 cm. Subsequently, lawn should be rolled slightly. The roller should never be run on wet lawn. The mowing may be done at an interval of 10 to 15 days, depending upon the season.

Manure and fertilizers

Apply urea @ 85g (40g N) per square meter in four times, one each in February, May, September and November. Apply urea, when the soil is wet otherwise apply water immediately. The nitrogen can also be applied in the form of liquid fertilizer by dissolving 22g of Urea in five litres of water and sprinkling the same uniformly in one square meter area.

For top dressing, mixture of half part sieved well rotten FYM or vermicompost and loamy soil can be applied in the beginning of February or September so as to make a layer of 1 cm.

Watering

Irrigation may be given twice a week in dry hot weather and once in a week in winter.

Mowing and weeding

Regular mowing helps to control the population of weeds. The left over weeds can be removed by hand weeding. Alternatively, 2, 4-D @ 1 kg/ha can be applied thrice at 3 weeks interval during rainy season and twice during February - March for controlling broad leaved weeds.

Insect-pests

Termites and other soil insects: The attack starts generally under dry soil conditions. The termites mainly feed on the roots, spread to stem and damage bark in case of severe infestation. Affected plants wilt, dry and die consequently. Deep ploughing destroys the termite colonies. Timely irrigation prevents pest build up. Drenching soil with chlorpyrifos 20EC @ 0.05% is also effective. Incorporate sand treated with chlorpyrifos 20 EC @ 4ml/kg in soil during last ploughing or alternatively chlorpyrifos 20EC @ 3-4ml/litre of water can be drenched on leveled field. Besides, imidacloprid 17.8 SL @ 0.3 ml/litre of water is also effective against termite infestation in lawn.

SPECIAL PRACTICES

It is sometimes necessary to supplement primary cultural practices with additional operations to sustain lawn grass at a desired level of quality. These special practices become necessary when problems arise, or are anticipated because of unfavourable developments in the lawn.

1. **Aeration:** Most lawn needs regular aeration by making holes in the surface with a spiked implement. This not only improves surface drainage but also enables soil to take in more air.
 - a) Coring or core cultivation is the practice by which hollow tine or spoons are used to extract cores from the lawn. Core size varies from 0.25 to 1 inch in diameter depending upon the size of the spoon. Coring is also known as aerification as soil aeration is directly improved by coring. Advantages of coring includes release of toxic gasses from the soil, improved wetting of dry soil after irrigation, increased infiltration capacity, accelerated drying of persistently wet soil, stimulated root growth within the holes, increased shoot growth above the holes, control of thatch and improved fertilizer use efficiency.
 - b) Slicing is another process by which a lawn is penetrated to a depth of 3 to 4 inch by a series of V-shaped knives mounted on a disk. Slicing is done on a heavily trafficked lawn during midsummer stress period when coring might be disrupting or injurious. Spiking is also a similar process in which the penetration is limited to 1 inch.
 - c) Vertical mowing is also an aeration procedure involving the use of vertically oriented knives mounted on a rapidly rotating, horizontal shaft. It is also known as power raking or dethatching. Vertical mowing can reduce grain, break up the core to reincorporated into the soil after coring, removal of thatch etc. All these methods improve aeration of an already established lawn.

2. **Brushing:** Brushing of lawn is usually done in spring to remove winter debris before mowing. Brushing in an established lawn can be achieved by brushes, brooms, mats and rakes.
3. **Rolling:** After planting, the purpose of rolling is to anchor the grass firmly in the soil. It also levels the surface to facilitate uniform mowing. Extensive rolling may cause compaction of soil. The soil should be moist at the time of rolling. Dry soil resists the pressing of plants into the soil, while excessively wet soils are highly susceptible to compaction from rolling. Similarly, heavy soil should not be rolled when they are wet.
4. **Soil top dressing:** Top dressing is the practice by which a thin layer of soil is applied to an established lawn or a new lawn grass planting. Its purpose is to partially cover and stabilize the planting material and to retard desiccation during grass establishment. On established lawn, top dressing is performed to control thatch, smoothing a playing surface, protecting greens in winter and promoting recovery from injury or disease. The rate and number of applications are limited by the capacity of the lawn to absorb the material; excessive amount of top dressing soil can prevent light from reaching the lawn grass leaves and leads to substantial losses of lawn.
5. **Scraping a lawn**
After two or three years when the grass become old, scrapping should be done in the beginning of February or September and then top dressed with mixture of 21.7g Urea, 26g DAP and 15g MOP per square meter.
6. **Use of growth regulators and micronutrients:** Growth regulators are used to slow down the growth rate and reduce the need for mowing. Growth retardants are mostly used. Treated plants have shortened cells and are more compact. Their use on fine lawn has been limited because of their potential to reduce lawn grass quality. When growth is slowed, plants become more susceptible to stress and less able to recover from injury. GRs should not be applied to areas that receive much traffic. They may initially discolour the lawn, and mixed stand of grasses can have an uneven appearance if one species is inhibited more than another.

LAWN MOWING

The main objective of mowing is to keep the grass even and attractive. Mowing stimulates tillering of grasses and the sod becomes thicker and denser. Mowing causes a decrease in leaf width, increases leaf succulence and weakens the roots. Close clipped grasses need better care because of their poor root system. Weed population usually decreases due to increased lawn density and continual removal of the terminal growing point from broad leaf weeds. Disease problem however increases as mowing leads to wounding of tissues causing pathogens to enter through the wounds.

Not more than $1/3^{\text{rd}}$ or $1/2$ the height of the grass should be removed at one mowing. If the grass is mowed too low, the crown can be damaged and too much photosynthetic surface will be removed resulting in depletion of food material and weakening of the grass. Severe

defoliation resulting from such faulty mowing practice is termed as *scalping*. Cutting grass too high results in shaggy and puffy look. Also thatch layer may increase in thickness and shoot density may decrease. Mowing height differ with the species used due to their tolerance limit to mowing. Lower limit of mowing tolerance is inversely proportional to the magnitude of environmental stress. Mowing height of some of the important lawn grasses are given below:

Grass species	Mowing height (inches)	Grass species	Mowing height (inches)
Bahia Grass	2.0-4.0	Carpet Grass	1.0-2.0
Colonial Bentgrass	0.5-1.0	Tall Fescue	1.5-3.0
Creeping Bentgrass	0.2-0.5	Manila Grass	0.5-0.8
Bermuda Grass	1.0-1.5	Perennial Rye Grass	1.5-3.0
Kentucky Blue Grass	1.5-3.0	St. Augustine Grass	2.0-3.0
Buffalo Grass	2.0-3.0	Japanese Lawn Grass	0.5-2.0

In late spring when growing conditions are favourable, mowing should be done twice in a week. However, in late autumn, once in every three to four week may be enough. Leave the grass slightly longer when the growing conditions are poor to avoid over-stressing it. Lawn that is heavily fertilized and irrigated grows faster and requires frequent mowing than lawn that receives minimal maintenance.

The grass should not be mowed in the same direction each time it is cut. Grass tends to lean or grow in the direction in which they are mowed. The horizontal orientation of grass foliage in one direction is called *grain*. Grain results in less even cut, streak appearance, and poor putting quality on golf greens. Alternating mowing direction reduces grain.

MOWING EQUIPMENTS:

The first mechanical mower was the scythe which requires great skill and considerable labour in mowing. In 1830, Edwin Budding developed the first reel mower. In due course of time the mowing equipments become more sophisticated and efficient. The major types of mowers are:

- a) **Rotatory type:** It has a horizontally mowing high speed blade which cut grass by impact. It does not produce a sharp, clean cut. The mowing quality is not good enough for high maintenance areas. However, if the blade is kept sharp, it is quite satisfactory for use on most lawns and lower maintenance areas. Rotaries are more versatile type of mower. They can mow very tall grass and cut through tough stalks and weeds.
- b) **Reel type:** It has fixed blades, part of a turning cylinder (reel) which moves down and back against a stationary blade at the base of the mower. The reel mower exhibit better mowing quality than the rotary mower. It produces a sharp and clean cut. It is the most commonly used type of mower on high-quality lawn areas such as golf course greens, tees, fairways etc. Some disadvantages of using reel mower are difficulty in cutting seed stalks, cannot mow tall grasses that is higher than 4-6 inches

- c) **Flail mower:** A flail or hammer knife mower has numerous, loose-hanging small knives, which are held out by centrifugal shaft rotaries at high speeds. The blades cut the grass by impact. This type of mower is occasionally used on low maintenance, utility sites that are cut less frequently. They can mow grass that is 12 inches high. One disadvantage is the amount of time it takes to sharpen the many small blades on the machine. Mowing quality is inferior compared to reel or rotary mower.

Choice of mowing equipment is based on the operational requirements and costs. Other factors include size of the area, number and location of obstructions, cultural intensity, and lawn grass species, frequency and intensity of lawn use and maintenance requirement of mower.

Grass species	Suitable type of mowing	Grass species	Suitable type of mowing
Bahia Grass	Rotary	Carpet Grass	Rotary
Colonial Bentgrass	Reel	Tall Fescue	Reel or rotary
Creeping Bentgrass	Reel	Manila Grass	Reel
Bermuda Grass	Reel or rotary	Perennial Rye Grass	Reel or rotary
Kentucky Blue Grass	Reel or rotary	St. Augustine Grass	Rotary
Buffalo Grass	Reel	Japanese Lawn Grass	Reel

Diseases/Disorders

Fairy rings: Fungal pathogens spread from point of infestation in rings, an attack on grass turning it brown and then moves outwards in an ever-widening circle. This may be managed by spraying metalaxyl (2.5 g/litre) or azoxystrobin @ 0.1%. Repeat sprays at 10-15 days interval depending upon the disease severity.

Pale or yellow lawns: A lawn may turn yellow due to water-logging, poor drainage, nutrient deficiency, sun-scorching or inadequate irrigation. Calcuttia grass also turns yellow during winter season. Drain excess water in case of water-logging and irrigate the lawn as per requirement.

PROTECTED CULTIVATION OF FLOWER CROPS

The term „protected cultivation' involves a series of techniques for the modification of the natural environment of the plants, which totally or partially alter the microclimate conditions with the aim of improving their productive performance. The main objectives of protected cultivation is to create a microclimate that allows for the improvement of productivity and quality, thereby contributing to a better use of resources viz a viz. to protect the crops from adverse climatic conditions such as wind, cold, precipitation,



excessive radiation, extreme temperature, insects and diseases. Technology for production is well known and has been utilized to the maximum extent in many countries. Since the beginning of agriculture, farmers had to cope with the growing conditions given to them by mother nature. In some of the temperate regions where the climatic conditions are extremely adverse and no crops can be grown, man has developed technological methods of growing some high value crops by providing protection from the excessive cold and excessive heat. This is called Greenhouse Technology which includes the production of high value flowers and vegetable crops.

A greenhouse is a framed structure covered with a transparent or translucent material in which crops could be grown under the condition of at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations. Cut flower production is a growing business in most Asian countries as a result of higher per capita income of people. As a consequence, cut flowers are commercially produced in larger quantities in these countries resulting in surpluses during the normal periods of blooming, the end result of which is a lower price for cut flowers. On the other hand, such prices are much higher during the periods of needs such as certain special occasions, or off-season.

Specific-Date Production: The demand for cut flowers is quite high during certain occasions, such as Christmas Celebration, New Year's Day, Mother's Day, Memorial Day, Valentine's Day, Graduation Exercise Day, Buddhist Lent's Day, etc. Thus, it will be profitable to the farmers if they could produce cut flowers on these occasions.

ADVANTAGES OF PROTECTED CULTIVATION

The advantages of growing crops under protected structures are:

- a) Crop cultivation under unfavorable climatic conditions.
- b) Crops cultivation throughout the year to meet market demands.
- c) High value and high quality crops grown for export markets.
- d) Higher income per unit area
- e) Specific date production.

- f) Higher input use efficiency
- g) Easy to manage insect-pest and diseases
- h) Minimum water requirement
- i) Less labour requirement
- j) More self-employment opportunities for educated youth.

Limitations

- High cost of initial installation
- Non-availability of various components
- Needs a special postharvest facility
- All the operations are very intensive

CHOICE OF CROPS FOR CULTIVATION UNDER GREENHOUSES

The basic purpose for adoption of greenhouse technology is to control the climatic factors in favour of optimal growth of the crop to be grown under green house. As the greenhouse cultivation is much costlier than that of open field cultivation, crops with the following criteria have to be selected:

1. Crop that cannot be produced in open condition.
2. Crops whose quality can be maintained in protected cultivation to fetch more price.
3. Crop having potential to yield manifold times which otherwise is not possible in open condition.
4. Off- season production of crop.
5. Spreading of growing season of crop.
6. Specific-date production of crop

Greenhouses classification

Greenhouse structures of various types are used 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 constituted as the best. Different types of greenhouses are designed to meet the specific needs. The different types of greenhouses based on shape, utility, material and construction are briefly given below:

A. Based on shape

- **Lean to type:** When a greenhouse is to be constructed against the side of an existing building so that the plants can make the best use of sunlight and the owner can minimize the requirement of roof support, this design is used.
- **Even span (A-Frame):** An even span or A-frame style of greenhouse has both side of the roof equal in length. Even spans are popular in northern areas because they are not conducive to snow accumulation.
- **Uneven –span:** Uneven-span greenhouse style consists of one side of the roof being longer than the other. These are used to accommodate the slant of the ground in hilly areas.
- **Ridge and furrows:** These are „A“ designed greenhouses which are connected to one another along the length of the eave. Eave serves as furrow or gutter to carry rains and melted snow away. The side wall is eliminated between the greenhouses resulting in a structure with a single large interior. Design reduces fuel consumption because it has less exposed wall area through which heat escapes.

- **Saw toothed:** This type is similar to Ridge and Furrow except that there is a provision for natural ventilation in this type.
- **Quonset type:** This kind of greenhouse is constructed by using pipe arches or trusses for support. These greenhouses are constructed either in free style or arranged in an interlocking ridge and furrow. This kind of greenhouse provides sufficient area to plants to grow between the overlapping portions of the adjacent houses. They are better adapted to automation and movement of labourers.

B. Based on covering material

Greenhouse is to be covered with covering materials, which have direct influence on the greenhouse effect inside the structure. They alter the air temperature inside the house. Based on the type of covering materials used the greenhouses are classified as rigid, plastic film and rigid panel greenhouses.

- **Glass greenhouses/ glasshouses:** Earlier only glasshouses with glass covering were constructed, because glass provides 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 design are used for construction of glass greenhouse.
- **Plastic film greenhouses/ polyhouses:** These greenhouses are covered with flexible plastic films (polythene, polyester, polyvinyl chloride). Plastic covering of greenhouse is popular because it is cheap and the cost of heating is less when compared to glass greenhouses, but such films have short life. For e.g. the best quality UV stabilized film can last for 4 years only. Quonset design as well as gutter connected design is suitable for making polyhouses.
- **Rigid panel greenhouses:** Polyvinyl chloride rigid panels, fibre glass reinforced plastic, acrylic and polycarbonate rigid panels are employed as the covering material in this type of greenhouses. 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 advantage is that these panels tend to collect dust as well as to harbour algae, which results in darkening of the panels and subsequent reduction in the light transmission. There is significant danger of fire hazard.
- **Shadehouse:** Shade houses are used for the production of plants in warm climates or during summer months. Nurserymen use these structures for the growth of hydrangeas and azaleas during the summer months. Apart from nursery, flowers and foliage which require shade can also be grown in shade houses. E.g. Orchids, These shade structures make excellent holding areas for field-grown stock while it is being prepared for shipping to retail outlets. Shade houses are most often constructed as a pole-supported structure and covered with either lath (lath houses) or polypropylene shade fabric. Polypropylene shade nets with various percentages of ventilations are used. Black, green, and white coloured nets are used, while black colour is the most preferred as it retains heat outside.

C. Based on utility

Design of such greenhouses depends on the functions or utilities. The utilities include artificial cooling and heating of the greenhouse

- **Greenhouses for active cooling:** In winter, air temperature inside greenhouse decrease during the night time, therefore, to avoid freezing injury to plants, some artificial heat has to be

supplied. To compensate the heat loss, various methods have been adopted to reduce that heat loss viz., using double layer polyethylene, thermo pane glass (two layers of factory sealed glass with dead air space) or to use heating systems such as unit heaters, central heaters, radiant heaters and solar heating systems.

- **Greenhouses for active heating:** In summer for plant survival, it is necessary to reduce the temperatures of greenhouse for effective crop growth. Therefore, suitable modifications are made so that a large volume of cooled air is drawn in to greenhouse. This type of greenhouse consists of either evaporative cooling pad with fan or fog cooling. This greenhouse is designed in such a way that it permits a roof opening of 40% and in some cases nearly 100%.

D. Based on construction material

The type of construction, structural and covering material used for greenhouse are important factors. Based on construction material greenhouses can be broadly classified as Wooden framed, Pipe framed and Truss framed greenhouses

- **Wooden framed greenhouses:** This type of greenhouse is made when the clear span is less than 6m and only wooden framed structures are used. Side posts and columns are constructed of pinewood without the use of a truss. It has required strength and less expensive. Timber locally available, with good strength, durability and merchantability can also be used for the construction.
- **Pipe framed greenhouses:** This kind of greenhouse is made when the clear span is around 12 m. For this purpose pipes are used for construction. In general the side posts, columns, crossties and purlins are constructed using pipes. In these types also the trusses are not used. The pipe components are not interconnected but depend on the attachment to the sash bars for support.
- **Truss framed greenhouses:** This kind of greenhouse is made when the greenhouse span is greater than or equal to 15 m. For this purpose truss frames are used. Flat steel, tubular steel or angle irons are welded together to form a truss encompassing rafters, chords and struts. Struts are support members under tension. Angle iron purlins running throughout the length of greenhouse are bolted to each truss. When wide truss frame houses of 21.3 m or more are to be constructed, columns are used. Most of the glass houses are of truss frame type, as these are best suited for pre-fabrication.

LANDSCAPING



The application of garden elements and design principles for the beautification of a landscape is known as landscaping.

Importance of Gardens

1. It provide a space for recreational activities
2. It gives aesthetic appeal to a piece of land
3. A garden where different plants have been grown prevents the land from erosion
4. It helps in ameliorating the environment by controlling different types of pollution
5. It gives health benefits
6. It serves the purpose of enjoyment and relaxation
7. It creates a bridge between the man made world and the nature

Elements and principles of landscape design

Elements refer to the basic visual materials used to establish a design. Everything that can be seen has either an inherent or an intended design, or a combination of both. Landscape design is defined by manipulating any of its five elements: color, line, form, texture, and scale. The design process begins by determining the needs and desires of the user and the conditions of the site. With this information, the designer then organizes the plants and hardscape materials, which are collectively referred to as the features. The features can be physically described by the visual qualities of the elements of design. The principles are the fundamental concepts of composition-proportion, balance, repetition, and unity-that serve as guidelines to arrange or organize the features to create an aesthetically pleasing or beautiful landscape. Knowledge of the elements and principles of design is essential for designing a landscape and working through the design process.

The elements of composition are the visual qualities that people see and respond to when viewing a space. Visual qualities can illicit many different emotions and feelings, and the more positive those feelings, the more likely people are to enjoy and use a space.

1. Line

Line creates order by directing eye movement or flow. Lines in a landscape design give the eye directions about where to look. Lines may be used to draw attention to an object, divide a space, group related objects together, or separate unrelated objects in landscape design. In

landscape design, these can be achieved through the arrangement of plants and borders. Line in the landscape is created by the edge between two materials, the outline or silhouette of a form, or a long linear feature.

Lines are a powerful tool for the designer because they can be used to create an infinite variety of shapes and forms, and they control movement of the eye and the body. Landscape designers use lines to create patterns, develop spaces, create forms, control movement, establish dominance, and create a cohesive theme in a landscape.

The properties of lines determine how people respond to the landscape, both emotionally and physically. **Straight lines** are structural and forceful; they create a formal character, are usually associated with a symmetrical design, and lead the eye directly to a focal point. Straight lines are most often found in hardscape edges and material. **Curved lines** create an informal, natural, relaxed character that is associated more with nature and asymmetrical balance. Curved lines move the eye at a slower pace and add mystery to the space by creating hidden views.

Vertical lines move the eye up, making a space feel larger. An upward line can emphasize a feature and has a feeling of activity or movement. Vertical lines in the landscape include tall, narrow plant material, such as trees, or tall structures, such as an arbor or a bird house on a pole. **Horizontal lines** move the eye along the ground plane and can make a space feel larger. Low lines are more subdued and create a feeling of rest or repose. Horizontal lines can spatially divide a space or tie a space together. Low lines are created by low garden walls, walkways, and short hedges. Lines are used to draw forms on a plan.

2. Form

Form defines the shape and structure of an object. In landscape design, form indicates the shape of a plant and the structure of its branching pattern. Tree forms are defined by branching pattern, while shrub forms are determined by growth pattern. Shape is created by an outline that encloses a space, and form is the three-dimensional mass of that shape. Form is found in both hardscape and plants, and it is typically the dominant visual element that spatially organizes the landscape and often determines the style of the garden. Formal, geometric forms include circles, squares, and polygons. Informal, naturalistic forms include meandering lines, organic edges, and fragmented edges.

Circles are a strong design form because the eye is always drawn to the center, which can be used to emphasize a focal point or connect other forms. **Squares** are used for a variety of features, including stepping stones, bricks, tiles, and timber structures. Unlike circles, squares are stronger on the edges, which can be lined up or overlapped to create unique patterns and more complex forms.

Common plant forms are well established and standardized, as form is the most consistent and recognizable characteristic of plants. Form can also be created through the massing of plants, where the overall mass creates a different form than an individual plant. A strong form that contrasts with the rest of the composition will have greater emphasis within the composition. Vertical forms add height; horizontal forms add width.

Common tree forms include round, columnar, oval, pyramidal, vase shaped, and weeping. Different tree forms are used for visual appeal, but the form is also important for function. Creating a shady area in the garden requires a round or oval tree, while a screen usually requires a more columnar or pyramidal form, and a weeping tree form makes a good focal point.

Shrub forms include upright, vase shaped, arching, mounding, rounded, spiky, cascading, and irregular. Choosing shrub forms often depends on whether the shrub will be used in a mass or as a single specimen. Mounding and spreading shrubs look best in a mass, and cascading and vase-shaped shrubs do well as specimen plants. Groundcover forms include matting, spreading, clumping, sprawling, and short spikes.

Repetition of form is essential to the creation of pattern, which is the basic organizational structure of the landscape. Form is also the primary determinant of a formal or informal garden. Geometric forms with straight edges are typical of formal gardens that are based on an established style, such as contemporary or Italian gardens. An informal garden has more naturalistic forms that are normally found in gardens that mimic nature. Form compatibility is also a major component of unity in design—one or two strikingly different forms are good for contrast and emphasis, but generally all other forms should have some similarities for a unified look.

3. Texture

Texture is the surface quality of an object. Texture is how something feels when it is touched or looks like. Both animate (plants) and inanimate objects (buildings and structures) in landscape design have texture. The coarseness or smoothness of the leaf, bark, and foliage of plants and trees and of buildings, patios, and walkways define texture in landscape design. Texture refers to how coarse or fine the surface of the plant or hardscape material feels and/or looks. Texture is used to provide variety, interest, and contrast. The plant's foliage, flowers, bark, and overall branching pattern all have texture. Coarse texture is more dominant than fine and also tends to dominate color and form, while fine texture is more subordinate to other qualities and tends to unify compositions. Coarse-textured plants attract the eye and tend to hold it because the light and dark contrasts of the shadows provide more interest. Fine texture exaggerates distance and gives the feeling of a larger, more open space. Rough texture minimizes distance—plants appear closer and the space feels smaller, or enclosed.

Plant characteristics that create coarse texture include large leaves; leaves with very irregular edges; bold, deep veins; variegated colors; thick twigs and branches; leaves and twigs with spines or thorns; and bold, thick, and/ or irregular forms. Examples of plants with coarse texture include philodendrons, agaves, bromeliads, hollies, palms, and hydrangeas. Hardscape with coarse texture includes roughcut stone, rough-finished brick, and unfinished wood with knots and a raised grain. Characteristics that create fine texture includes small foliage; thin, strappy leaves (grasses) or tall, thin stems; tiny, dense twigs and small branches; long stems (vines); and small, delicate flowers. Plants with a fine texture include grasses, ferns, Japanese maples, many vines, and junipers with fine needles. Hardscape with fine texture includes

smooth stone, wood or ceramic pots, and glass ornaments. Smooth water, such as that found in a reflecting pool, or water with a very fine spray is considered fine textured.

Medium texture is characterized by medium-sized leaves with simple shapes and smooth edges. The average-sized branches are not densely spaced nor widely spaced, and the overall form is typically rounded or mounding. Medium-textured plants act as a background to link and unify the coarse- and fine-textured plants. Plants with medium texture include agapanthus, ardisia, camellia, euonymus, pittosporum, and viburnum. Hardscape with a medium texture includes standard flagstone pavers, broom-brushed concrete, and finished woods.

Texture affects the perception of distance and scale. To make a space feel larger, locate plants so that the fine textures are along the outer perimeter, the medium textures are in the middle, and the coarse textures are closest to the viewer. The small size of the fine texture recedes in the landscape and is perceived as being farther away. To make a space feel smaller, place the coarse textures along the outer perimeter and the fine textures closest to the viewer. The detail of the coarse texture makes the plants appear closer and makes the space feel smaller. Plants that are coarse close-up can look fine textured from a distance.

4. Colour

Colour is used to convey emotion and influences the mood and character of the overall landscape design or parts of the design. It has three properties: hue or chroma, value, and intensity. **Hue** or chroma refers to the relative purity or strength of the color. **Value** determines how light or dark the color is, whereas **intensity** refers to how bright or dull it is. Color in plant material and hardscape adds interest and variety to the landscape. Color is the most conspicuous element in the landscape; however, it is also the most temporary element, usually lasting only a few weeks a year for individual plants. The use of color is guided by the use of the **color wheel** to create color schemes. A simple description of the color wheel includes the three primary colors of red, blue, and yellow; the three secondary colors (a mix of two primaries) of green, orange, and violet; and six tertiary colors (a mix of one adjacent primary and secondary color), such as red-orange. Color scheme explains the relationship of colors to each other and how they should be used in a composition. The basic color schemes are monochromatic, analogous, and complementary.

A **monochromatic** color scheme uses only one color. In landscaping, this usually means one other color besides the green color in the foliage. A garden that is all green depends more on form and texture for contrast and interest. One color can have many light and dark variations, which can add interest. An example of a monochromatic scheme is a white garden with white flowers, white variegated foliage, and white garden ornaments.

Analogous color schemes are any three to five colors that are adjacent on the color wheel, such as red, red-orange, orange, yellow-orange, and yellow, or blue, blue-violet, and violet. **Complementary** colors are those that are opposite each other on the color wheel. They tend to have high contrast between them. The most common sets are violet and yellow, red and green, and blue and orange. Complementary colors are often found naturally in flowers.

Color is found in the flowers, foliage, bark, and fruit of plants. Green foliage in all its various shades is the dominant color by quantity, but other colors capture attention more readily because of their high contrast to the color green. Color is also found in buildings, rocks, pavers, wood, and furniture. Most colors in natural materials, such as stone and wood, are typically muted and tend to be variations of brown, tan, and pale yellow. Bright colors in the hardscape are usually found in man-made materials, such as painted furniture, brightly colored ceramic containers or sculptures, and glass ornaments.

Color is an important element for creating interest and variety in the landscape. Colors have properties that can affect emotions, spatial perception, light quality, balance, and emphasis. Cool colors tend to be calming and should be used in areas for relaxation and serenity. Warm colors tend to be more exciting and should be used in areas for entertaining and parties. Cool colors also tend to recede and are perceived as being farther away, making a space feel larger. Warm colors tend to advance and are perceived as being closer, making a space feel smaller.

Focal points can be created with bright colors. For example, bright yellow, which has the highest intensity, also has a high contrast with all other colors. A small amount of intense color has as much visual weight as a large amount of a weaker colour. Colour schemes in the garden can change with the seasons. Summer colors are usually more varied and bright with more flowers, while winter colors tend to be monochromatic and darker with more foliage.

5. Scale

Scale refers to the size of an object in relation to its surroundings. Scale in landscape design is inferred by the size relationship between adjacent objects. As a general rule in landscape design, plants and structures in landscapes should be proportional to the human scale.

Principles of Design

Principles refer to standards for working with or arranging various elements to produce the intended landscape design. Good landscape design follows a combination of seven principles: unity, balance, proportion, focalization or emphasis, sequence or transition, rhythm, and repetition.

Design principles guide designers in organizing elements for a visually pleasing landscape. All of the principles are related, and applying one principle helps achieve the others. Physical and psychological comforts are two important concepts in design that are achieved through use of these principles.

1. Proportion

Proportion describes the size relationship between parts of the landscape design or between a part of the design and the design as a whole. A large fountain would cramp a small backyard garden, but would complement a sprawling public courtyard. Relative proportion is the size of an object in relation to other objects. Absolute proportion is the scale or size of an object.

Proportion can be found in plant material relative to people, the surrounding plants, and the house. When all three are in proportion, the composition feels balanced and harmonious. A feeling of balance can also be achieved by having equal proportions of open space and planted space. Using markedly different plant sizes can help to achieve dominance (emphasis) through contrast with a large plant. Using plants that are similar in size can help to achieve rhythm through repetition of size.

Human scale is also important for psychological comfort in voids or open spaces. People feel more secure in smaller open areas, such as patios and terraces. An important concept of spatial comfort is enclosure.

2. Simplicity

It is actually one of the principles in design which means to avoid unnecessary details. Simplicity in planting, for instance, would be to pick two or three colors and repeat them throughout the garden or landscape. Keeping decor to a minimum and within a specific theme as well as keeping hardscapes such as boulders consistent is also practicing simplicity.

3. Balance

Balance gives the landscape design a sense of equilibrium and symmetry in visual attraction. **Symmetrical** or formal balance is achieved when the mass, weight, or number of objects both sides of the landscape design are exactly the same. This type of balance is used in formal designs and is one of the oldest and most desired spatial organization concepts. **Asymmetrical** or informal balance in landscape design suggests a feeling of balance on both sides, even though the sides do not look the same. This type of balance is informal and is usually achieved by masses of plants that appear to be the same in visual weight rather than total mass. To create asymmetrical balance, features with large sizes, dense forms, bright colors, and coarse textures appear heavier and should be used sparingly, while small sizes, sparse forms, gray or subdued colors, and fine texture appear lighter and should be used in greater amounts.

4. Rhythm

Rhythm creates a feeling of motion which leads the eye from one part of the landscape design to another part. Repeating a color scheme, shape, texture, line or form evokes rhythm in landscape design. Proper expression of rhythm eliminates confusion and monotony from landscape design.

5. Transition

Gradual change obtained by the arrangement of objects with varying texture, forms or sizes in a logical sequential order eg. Coarse-medium-fine, round-oval-linear etc.

6. Unity

Unity refers to the use of elements to create harmony and consistency with the main theme or idea of the landscape design. Unity gives the landscape design a sense of oneness and interconnection. Unity in landscape design can be achieved by using plants, trees, or material that have repeating lines or shapes, a common hue, or similar texture. However, too much unity in landscape design can be boring. Therefore, it is important to introduce some variety or contrast into the landscape design. Unity is achieved by linking elements and features to create

a consistent character in the composition. Unity is sometimes referred to as harmony-the concept of everything fitting together. The simplest way to create unity is through the use of a design theme or a design style. Design themes and styles have a well-defined set of features that have maintained their popularity over time because they are visually pleasing to many.

7. Focalization

Focalization is created as a visual break in the sequence and flow of the landscape. The focal point is the point or area of the landscape that attracts the viewer's eyes. The visual break captures the attention of the viewer and draws it to the focal point. Use the design elements (line, form, texture, and color) to move the viewer's eyes through the landscape to the place of the focal point. Create a focal point with a contrast in spacing between the plants or by grouping several plants together. Most landscapes usually contain visual focal points such as plants and structures. However, running water and rustling leaves are effective as focal points, capturing the sense of sound. The focal points in a landscape may also be focal areas. These focal areas may change throughout the year. For example, the trees with their changing foliage are the focal area during the autumn. In the spring and summer the focal area changes between colorful groups of annual bedding plants and groups of blooming trees and shrubs in the landscape. The focal area attracts the viewer's eyes in the same manner as the focal point. However, the focal area consists of more than a single element or component. Focal areas consist of a group of parts or components. Minor focal points are effective in advancing the viewer's eyes through the landscape to the main attraction or dominant focal point. When incorporating minor focal points into a design, take caution so as not to confuse the viewer. Keep the minor focal points minor, compared to the dominant or major focal point. If color is the element to be used as the focal point on a site with great depth, use blues or whites as minor focal points. Advance these minor focal points to a dominant red, orange, or strong yellow focal point.

Planning of gardens:

Layout steps:

1. Develop a plot plan
2. Conduct a site analysis
3. Assess the family needs and desire
4. Locate activity area
5. Design activity area
6. Plant selection and placement

Develop a plot plan

The designer should make the plan on paper with drawings and symbols. The plan should consist of accurate house placement on the plot, dimension of the plot and the house, existing features like walks, paths, driveways etc.

Site analysis

It refers to the complete survey of the area here a garden is to be developed. This includes topography, existing vegetation, drainage pattern, rainfall distribution, existing building and other architectural features, location of utility lines and pipes above and below the ground, soil type, wind direction etc. Existing plants and other feature should be examined for its condition,

location and potential use at the particular place. Only the desirable ones should be retained. Wind direction and soil condition helps in selection and placement of planting material. Undesirable views should be screened and desirable ones should be promoted.

Assess the family needs

A landscape garden is the extension of indoor living to outdoor. It should provide space for family activities. The family needs and requirements should be determined before making any plan.

Locate activity area

Once the family need is identified, different activity area must be located appropriately in the plan. Activity areas include public area, living area, service area, vegetable garden. Two major considerations for placement of these areas are:

- Place outdoor area in relation to indoor activity area. Examples: Outdoor living area is the extension of indoor living room and service area is the extension of kitchen.
- Arrange area relative to the activities in the adjoining areas. Examples: Do not put play zone adjacent to the quiet zone.

Design activity area

Determine the objectives of design, established a general plan-formal or natural, plan for structural needs, land form modifications and go for planting.

Plant selection and placement

Plant selection is done on the basis of its adaptability, availability, aesthetic values and functional needs. Plants should be spaced with respect to their mature size.

Styles of gardens

Formal style

It is the oldest style of garden. Symmetry is the main characteristic of this style. The Persian garden, Spanish garden, Mughal garden and the Italian garden are the example. Geometrical shapes like; square, circle, triangle, rectangle etc. are commonly found in this style. The outline of the whole garden as well as flower beds, hedges, lawn, paths etc. are in geometrical shapes. In formal garden, the land is forced to fit into the design. Trimmed hedges, formal beds, straight line planting are the main feature of this style. Formal gardens are generally enclosed. One half of the design is the counterpart of the other.

Informal style

This style is aimed to imitate nature. There is not much symmetry in the design. The garden plan is made to fit the land. Good examples of this style of garden are Japanese and Chinese gardens. Curved lines are predominant in this style. Planting is of mixed type and informal in nature. Balance is asymmetrical. Straight lines are avoided and irregular beds are used. In this design, nature is preserved in an artificial way.

Free style

Here, formal, informal as well as naturalistic features are aesthetically mixed together to create a picturesque scene. This style can be adopted to suit the needs of almost all situations.

Wild garden style

The concept of wild garden is against formalism. Such gardens enable growing of many plants which are never trimmed. Grasses remained unmowed and bulbous plants should be grown scattered in the grass to create a wild effect. The passage to the garden is generally opened in woodland.

PLANT MATERIAL FOR LANDSCAPING

TREES

Trees are tall, woody perennials with a spreading crown and single trunk which exceeds a diameter of 15 cm and attains a certain height. These are an essential feature of a landscape garden. These can be used for planting on roadside, public parks, along railway lines, in schools and colleges. In landscape plan, trees are used for aesthetic and functional purposes; in gardens as specimen, for avenue plantation, as wind breaks, for screening, shade and reducing air pollution.

Preparation of ground

Pits of 60x60x60 cm size may be dug. Refill pits with mixture of soil and 10-15 kg well rotten FYM along with 50-100 ml chlorophyriphos 20 EC.

Propagation

It is possible through seeds/ cuttings/ air layering.

Planting Time

In plains, evergreen trees preferably be planted during rainy season (July-August) and alternatively in February - March, in areas having irrigation facilities. In the mid hills, planting should be done in spring season (April - May) and can be continued throughout the rainy season.

Management

In plains, all newly planted trees should be protected in hot summer (March - June) and during winter. Protection during hot summer can be done by thatching with paddy or wheat straw. Similarly during winters, young trees need to be protected by covering them from all sides with paddy or wheat straw during night.

SHRUBS

These are woody, semi- woody, herbaceous perennial plants that grow up to a height of 0.5 m to 4 m. There is large variation in size, shape and colour of flowers. Shrubs are classified for foliage, flowering and fragrance and arrangement on the basis of height and colour. They serve both for aesthetic and functional purposes in the landscape

Preparation of ground

Prepare 60 cm deep pits and expose the soil to the sun for at least 2 weeks. Refill the pits with the mixture of soil and FYM (2-4 baskets) with 50-100 ml chlorophyriphos 20 EC.

Planting time

In plains, evergreen shrubs can be planted in rainy season (July– August/ September)

Propagation

It is possible through seeds/cuttings/layering.

CLIMBERS/ TWINERS

Climbers are the group of plants which have weak stems and ability to climb up the support with the help of modified organs for sunlight and air. “Twiners” differ from climbers in the way that they don’t possess such modified organs but twine around the support, cover it and

reach the top. Climbers and twiners are important group of plants which add beauty and colour in striking way or fragrance in gardens and artificial structures like wall, arches, pergola, pillars, cascades and topiary.

Preparation of ground

Pit of 60x60x60 cm size should be dug and filled with soil and well rotten FYM with 50-100 ml chlorophyriphos 20 EC.

Planting time

Evergreen plants are planted in July/Sept and Feb/March and Deciduous plants are planted in the month of December/ January in plains.

INDOOR PLANTS

Indoor plants grow well in partial shade. These are grown under green houses or in the verandah of the buildings and for interior decoration. There is a wide choice of such plants and their varieties, which provide a good opportunity for selecting a right plant material to suit different situations.

Potting Mixture

Generally potting mixture consists of 2 parts garden soil, 1 part coarse sand and 1 part well rotten farm yard manure. Bottom portion of pot is filled with crocks and brick pieces to facilitate drainage. Half portion of the pot is first filled with sterilized potting mixture (5% formalin). A plant selected is to be placed centrally inside the pot and then fill the remaining portion upto the brim and firm the plant after tapping the pot, irrigate it lightly and continue till the plant gets fully established. If the plants are being kept inside the room, they should be transferred to airy environment before any symptoms of sickness are exhibited and thereafter shifted inside again.

Repotting

Repotting is done when pot becomes pot bound. It should be done in rainy season. At the time of repotting, extra roots should be cut away and refilled with fresh potting mixture. Dry leaves should be removed from time to time. Feed the pot plants with liquid manure and adopt plant protection measures for control of diseases and pests.

Annexure-I
LIST OF PLANTING MATERIAL FOR LANDSCAPE AND INDOORS FOR
VARIOUS AGROCLIMATES OF JAMMU REGION

A. SUBTROPICAL PLAINS/ LOW HILLS**TREES**

Botanical Name	Common/ Local Name	Family	Method of Propagation
<i>Acacia auriculiformis</i>	Australian wattle	Leguminosae	Seeds
<i>Albizia lebbek</i>	Siris tree	Mimosaceae	Seeds
<i>Alstonia scholaris</i>	Devil's tree	Apocynaceae	Seeds
<i>Araucaria cookii</i>	Monkey puzzle tree	Araucariaceae	Seeds
<i>Azadirachta indica</i>	Neem	Meliaceae	Seeds
<i>Bauhinia blackeana</i>	Kachnar	Leguminosae	Seeds
<i>Bauhinia variegata</i>	Kachnar	Leguminosae	Seeds
<i>Bombax ceiba</i>	Semal	Bombacae	Seeds/cuttings
<i>Butea monosperma</i>	Flame of forest/Dhak/Palash	Fabaceae	Seeds
<i>Barringtonia acutangula</i>	Hijjal	Barringtoniaceae	Seeds
<i>Callistemon lanceolatus</i>	Bottle brush	Myrtaceae	Seeds/ layers
<i>Cassia fistula</i>	Amaltas	Caesalpiniaceae	Seeds
<i>Cassia javanica</i>	Java Divani	Leguminosae	Seeds
<i>Cassia nodosa</i>	Pink modar	Leguminosae	Seeds
<i>Casuarina equisetifolia</i>	Jortor/Jhau	Casuarinaceae	Seeds
<i>Chorisia speciosa</i>	Mexican silk Cotton Tree	Malvaceae	Seeds
<i>Crataeva nurvala</i>	Barna/ capar tree	Caparidaceae	Seeds/ suckers
<i>Cupressus sempervirens</i>	Cypress	Coniferae	Seeds
<i>Delonix regia</i>	Gulmohar	Caesalpiniaceae	Seeds
<i>Erythrina variegata</i>	Coral tree	Leguminosae	Seeds /cutting
<i>Ficus benghalensis</i>	Bargad/ Banyan	Moraceae	Seeds/cutting during rainy season
<i>Ficus infectoria</i>	Pakar	Moraceae	Seeds
<i>Ficus religiosa</i>	Peepal	Moraceae	Seeds
<i>Ficus retusa</i>	Chilkan	Moraceae	Seeds
<i>Grevillea robusta</i>	Silver oak	Proteaceae	Seeds
<i>Jacaranda acutifolia</i>	Neeli Gulmohar	Bignoniaceae	Seeds
<i>Kigelia pinnata</i>	Balam kheera	Bignoniaceae	Seeds
<i>Lagerstroemia speciosa</i>	Queens flower	Lythraceae	Seeds

<i>Magnolia grandiflora</i>	Him Champa	Magnoliaceae	Seeds
<i>Madhuca indica</i>	Mahua	Sapotaceae	Seeds
<i>Mimusops elengi</i>	Maulsari	Sapotaceae	Seeds
<i>Millingtonia hortensis</i>	Tree Jasmine	Bignoniaceae	Seeds
<i>Milletia ovalifolia</i>	Rose wood	Leguminosae	Seeds
<i>Peltophorum pterocarpum</i>	Yellow Gulmohar	Leguminosae	Seeds
<i>Plumeria alba</i>	Pagoda tree	Apocynaceae	Seeds
<i>Polyalthia longifolia</i>	Ashoka	Anonaceae	Seeds
<i>Pongamia pinnata</i>	Sukh chain	Leguminosae	Seeds
<i>Putranjiva roxburghii</i>	Jiva pota, Jalpatri	Euphorbiaceae	Seeds
<i>Pterospermum acerifolium</i>	Kanak champa	Sterculiaceae	Seeds
<i>Sweitenia mahagani</i>	Mahagony	Meliaceae	Seeds
<i>Tamarindus indica</i>	Imli	Leguminosae	Seeds
<i>Tecomela undulata</i>	Lahura	Bignoniaceae	Seeds/ cuttings
<i>Thespesia populnea</i>	Tulip tree	Malvaceae	Seeds/cuttings

SHRUBS

Botanical Name	Common/ Local Name	Family	Method of Propagation
<i>Acalypha hispida</i>	Acalypha	Euphorbiaceae	Cuttings
<i>Artabotrys odoratissimus</i>	Hari Champa	Annonaceae	Seeds/layerings
<i>Bougainvillea</i>	Bougainvillea	Nyctaginaceae	cuttings
<i>Buddleia asiatica</i>	Buddleia	Loganiaceae	Cuttings
<i>Caesalpinia pulcherrima</i>	Gulmohri	Leguminosae	seeds
<i>Calliandra haematocephala</i>	Powder Puff Tree	Fabaceae	Seeds/layering
<i>Cassia glauca</i>	Dadmurdan	Leguminosae	cutting
<i>Cestrum diurnum</i>	Din-da-raja	Solanaceae	Cuttings
<i>Cestrum nocturnum</i>	Rat-di-rani	Solanaceae	cutting
<i>Clerodendron inerme</i>	Forest Jasmine	Verbenaceae	Cutting
<i>Daedalacanthus nervosus</i>	-	Acanthaceae	Cuttings
<i>Dodonea viscosa</i>	Alier, Saintha	Sapindaceae	Seeds/Cuttings
<i>Dombeya spectabilis</i>	Dombeya	Sterculiaceae	Cutting
<i>Duranta repens</i>	Neel kanta	Verbenaceae	Seeds/Cuttings
<i>Euphorbia pulcherrima</i>	Poinsettia	Euphorbiaceae	cuttings
<i>Ervatamia divaricata</i>	Chandni	Apocynaceae	cutting
<i>Galphimia garcilis</i>	<i>Galphimia</i>	Malpighiaceae	Seeds
<i>Gardenia jasminoides</i>	<i>Gardenia</i>	Rubiaceae	Airlayering/ cuttings

<i>Hamelia patens</i>	Hamelia	Rubiaceae	cutting
<i>Hibiscus rosa-sinensis</i>	China Shoe flower	Malvaceae	cutting
<i>Hiptage benghalensis</i>	Madhvi lata	Malpighiaceae	Seeds/layering
<i>Holmskoildia sanguinea</i>	Cup and saucer	Verbenaceae	Cuttings
<i>Jacobinia coccinea</i>	Jacobinia	Acanthaceae	Cuttings
<i>Ixora parviflora</i>	<i>Ixora</i>	Rubiaceae	Layering/ cuttings
<i>Jasminum multiflorum</i>	Bela, Kund	Oleaceae	Ground layering
<i>Jasminum humile</i>	Peeli chameli	Oleaceae	Ground Layering/ cutting
<i>Jasminum sambac</i>	Motia	Oleaceae	Suckers/cuttings
<i>Jatropha panduraefolia</i>	Jatropha	Euphorbiaceae	Seed/cuttings
<i>Lagerstroemia indica</i>	Panjtara, Shravani	Lythraceae	Cuttings/seed
<i>Lantana camara</i>	Lantana	Verbenaceae	Seed/cutting
<i>Lawsonia inermis</i>	Mehandi	Lythraceae	Seed/cutting
<i>Murraya paniculata</i>	Kamini, Mock Orange	Rutaceae	Seed/cutting
<i>Malvaviscus arboreus</i>	Sleepy Mallow	Malvaceae	Root cuttings/ cuttings
<i>Nerium indicum</i>	Kaner, Red Oleander	Apocynaceae	Cuttings
<i>Nyctanthus arbortristis</i>	Harshingar, Tree of Sadness	Oleaceae	Seed or cuttings
<i>Poinsettia pulcherrima</i>	Christmas flower	Euphorbiaceae	Cuttings
<i>Russelia juncea</i>	Coral plant	Scrophulariaceae	Division of roots
<i>Tecoma stans</i>	Cape honey Suckle/Tecoma	Bignoniaceae	Air layering/seed
<i>Thevetia peruviana</i>	Peeli Kaner	Apocynaceae	Seeds
<i>Thunbergia erecta</i>	Meyenia	Acanthaceae	Cuttings

CLIMBERS

Botanical Name	Common/ Local Name	Family	Method of propagation
<i>Adenocalymma alliaceum</i>	Garlic vine	Bignoniaceae	Layering/cutting
<i>Allamanda cathartica</i>	<i>Allamanda</i>	Apocynaceae	Cuttings
<i>Antigonon leptopus</i>	Coral vine	Polygonaceae	Cuttings/seeds
<i>Beaumontia grandiflora</i>	Nepal Trumpet	Apocynaceae	Air layering/seed/ cutting

<i>Bignonia gracilis</i>	<i>Bignonia</i>	Bignoniaceae	Cuttings/air layering
<i>Bougainvillea sp.</i>	Bougainvillea	Nyctaginaceae	Cuttings/air layering
<i>Clerodendron splendens</i>	Bower's Glory	Verbenaceae	Suckers/cuttings
<i>Ficus repens</i>	Atha bor	Moraceae	seed/ cutting
<i>Hiptage benghalensis</i>	Madhvi Lata	Malpighiaceae	layering/seed
<i>Ipomea palmata</i>	Railway creeper	Convolvulaceae	Cuttings
<i>Jasminum humile</i>	Jasmine	Oleaceae	Cuttings
<i>Jasminum grandiflorum</i>	Chameli	Oleaceae	cuttings/ layering
<i>Jasminum primulinum</i>	Peeli chameli	Oleaceae	cuttings/ layering
<i>Jasminum sambac</i>	Motia	Oleaceae	cuttings/ layering
<i>Passiflora racemosa</i>	Passion flower	Passifloraceae	Seeds/layering
<i>Petrea volubilis</i>	Purple wreath	Verbenaceae	Cuttings/layering
<i>Pyrostegia venusta</i>	Golden shower	Bignoniaceae	Ground layering
<i>Quisqualis indica</i>	Rangoon creeper	Combretaceae	Cuttings/layering
<i>Thunbergia grandiflora</i>	Clockvine/ Heavenly blue	Acanthaceae	Seed/cuttings/layering during rainy season
<i>Vernonia elaeagnifolia</i>	Curtain Vine	Compositae	Cuttings
<i>Wisteria sinensis</i>	Chinese wisteria	Leguminoseae	Cuttings

B. INTERMEDIATE ZONE

TREES

Botanical Name	Common Name/ Local Name	Family	Method of Propagation
<i>Bauhinia purpurea</i>	Bauhinia or Kachnar	Caesalpiniaceae	Seeds
<i>Callistemon lanceolatus</i>	Bottle Brush	Myrtaceae	Seeds
<i>Chorisia speciosa</i>	Mexican silk Cotton tree	Malvaceae	seeds
<i>Cupressus sempervirens</i>	Cypress	Pinaceae	Seeds
<i>Grevillea robusta</i>	Silver Oak	Proteaceae	Seeds
<i>Jacaranda mimosaefolia</i>	Nili Gulmohar	Bignoniaceae	Seeds/semi hardwood cuttings
<i>Koelreuteria paniculata</i>	Chinese Rain tree	Sapindaceae	Seeds/cuttings

<i>Lagerstroemia speciosa</i>	Pride of India	Lythraceae	Seeds
<i>Magnolia grandiflora</i>	Himchampa	Magnoliaceae	Layering/grafting
<i>Melia azedarach</i>	Drek	Meliaceae	Seed
<i>Tecoma stans</i>	Tecoma, Yellow bells	Bignoniaceae	Seeds

SHURBS

Botanical Name	Common Name	Family	Method of Propagation
<i>Achaenia spp.</i>	Achania	Malvaceae	Cuttings
<i>Buddleia asiatica</i>	Buddleia	Loganiaceae	Cuttings
<i>Euonymus japonicus</i>	Euonymous, Spindle bush	Celastraceae	Seeds/cutting/ air layering
<i>Euphorbia pulcherrima</i>	Poinsettia	Euphorbiaceae	Cuttings
<i>Gardenia florida</i>	Cape jasmine	Rubiaceae	Air layering
<i>Hibiscus mutabilis</i>	Changeable rose	Malvaceae	Cuttings
<i>Hibiscus rosa-sinensis</i>	China shoe flower	Malvaceae	Cuttings
<i>Holmskioldia sanguinea</i>	Cup & Saucer	Verbenaceae	Cuttings
<i>Hydrangea hortensis</i>	Hydrangea	Hydrangeaceae	Cuttings
<i>Jasminum humile</i>	Yellow jasmine	Oleaceae	Ground layering
<i>Jasminum sambac</i>	Motia or Mogra	Oleaceae	Ground layering
<i>Lawsonia inermis</i>	Mehandi	Lythraceae	Seeds/Cuttings
<i>Ligustrum japonicum</i>	Japanese privet	Oleaceae	Cuttings
<i>Nerium indicum</i>	Kaner, Red Oleander	Apocynaceae	Cuttings
<i>Sambucus nigra</i>	Dwarf Elder	Caprifoliaceae	Cuttings/seeds
<i>Spirea corymbosa</i>	Spirea	Rosaceae	Seeds/Cuttings/ layering

CLIMBERS

Botanical Name	Common/ Local name	Family	Method of propagation
<i>Adenocalymma calycina</i>	Adenocalymma	Bignoniaceae	Layering/cutting
<i>Allamanda cathartica</i>	Har Kakra /Golden Trumpet	Apocynaceae	Cutting/layering
<i>Antigonon leptopus</i>	Lover`s chain	Polygonaceae	Cuttings/seeds
<i>Aristolochia elegans</i>	Birthwort	Aristolochiaceae	Seeds/layering
<i>Aristolochia grandiflora</i>	Swan Flower/ Hansalata	Aristolochiaceae	Seeds

<i>Beaumontia grandiflora</i>	Nepal Trumpet climber	Apocynaceae	Air layering
<i>Campsis grandiflora</i>	(Chinese Trumpet creeper)	Bignoniaceae	Cutting
<i>Ficus repens</i> (Creeping fig)	Indian Ivy	Moraceae	cuttings
<i>Gloriosa superba</i>	Glory lily	Liliaceae	Tubers
<i>Ipomea palmata</i>	Railway creeper	Convolvulaceae	Cuttings/layering
<i>Jasminum grandiflora</i>	Italian Jasmine (Swarn Chameli)	Oleaceae	Cutting/layering
<i>Jasmine humile</i>	Yellow jasmine	Oleaceae	Cutting
<i>Jasminum sambac</i>	Motia	Oleaceae	Cutting/layering
<i>Lonicera japonica</i>	Japanese Honey-suckle	Caprifoliaceae	Cutting/layering
<i>Passiflora caerulea</i>	Passion flower	Passifloraceae	Seeds /Layering
<i>Rosa wichuriana</i>	Rose	Rosaceae	Cutting / Seed
<i>Solanum jasminoides</i>	Potato vine	Solanaceae	layering
<i>Thunbergia grandiflora</i>	Heaven's blue or Sky flower	Acanthaceae	Cutting/layering

TEMPERATE ZONE TREES

Botanical Name	Common/ Local Name	Family	Method of Propagation
<i>Aesculus indica</i>	Horse chestnut tree	Sapindaceae	Seed
<i>Albizia julibrissin</i>	Pink Silk tree	Fabaceae	Seed
<i>Catalpa bignonioides</i>	Indian bean tree	Bignoniaceae	Seed
<i>Cercis siliqustrum</i>	Judas Tree	Fabaceae	Seed
<i>Magnolia grandiflora</i>	Him champa	Magnoliaceae	Seed/Air layering.
<i>Platanus orientalis</i>	Chinar tree	Platanaceae	Seed/Cutting/Layering
<i>Prunus pissardii</i>	Ornamental plum	Rosaceae	Budding
<i>Salix babylonica</i>	Weeping willow	Salicaceae	Hardwood cutting
<i>Sophora japonica</i>	Chattrikul	Fabaceae	Budding

SHRUBS

Botanical Name	Common/Local Name	Family	Method of Propagation
<i>Abelia x grandiflora</i>	Abelia	Caprifoliaceae	Hardwood/ Softwood Cuttings
<i>Buxus sempervirens</i>	Buxus, Box Wood	Buxaceae	Softwood cuttings
<i>Chaenomeles speciosa</i>	Ornamental Quince	Rosaceae	Seed/stem cutting/ suckers
<i>Eunymous japonicus</i>	Eunymous	Celastraceae	Hardwood/Softwood cuttings
<i>Forsythia intermedia</i>	Golden bell	oleaceae	Hardwood cuttings
<i>Hydrangea grandiflora</i>	Hydrangea	Hydrangeaceae	Soft/Hardwood cuttings
<i>Hydrangea macrophylla</i>	Hydrangea	Hydrangeaceae	Soft/Hardwood cuttings
<i>Kerria japonica</i>	Japanese rose	Rosaceae	Hardwood/suckers.
<i>Ligustrum vulgare</i>	Japanese privet	Oleaceae	Hardwood cuttings)
<i>Magnolia soulangeana</i>	Jahuri champa	Magnoliaceae	Air layering/Softwood cuttings.
<i>Nerium indicum</i>	Kaner	Apocynaceae	Seed/cutting
<i>Lagestromea indica</i>	Crape myrtle, Panjtara	Lythraceae	Hardwood cuttings
<i>Rosa spp</i>	Rose/Gulab	Rosaceae	Budding/cutting
<i>Syringe vulgaris</i>	Yousumam	Oleaceae	Cutting/layering
<i>Viburnum opulus</i>	Dastar Posh Guelder Rose	Caprifoliaceae	Cutting

CLIMBERS

Botanical Name	Common/ Local Name	Family	Method of Propagation
<i>Lonicera japonica</i>	Giant Honeysuckle	Caprifoliaceae	Hardwood cutting/Air layering.
<i>Wisteria sinensis</i>	Wisteria	Papilionaceae	Seed/cutting

Annexure II
IMPORTANT INDOOR PLANTS

S. No.	Indoor plant	Mode of propagation
1.	<i>Aglaonema spp.</i>	Cuttings
2.	<i>Agave spp.</i>	Suckers
3.	<i>Araucaria cookie</i>	Seeds
4.	<i>Aralias spp.</i>	Cuttings
5.	<i>Asparagus spp.</i>	Tubers
6.	<i>Beloperone guttata</i>	Cuttings
7.	<i>Coleus blumei</i>	Seeds or stem cuttings
8.	<i>Cordyline spp.</i>	Cuttings and air layering
9.	<i>Croton spp.</i>	Layering/Cuttings
10.	<i>Cycas revoluta</i>	Seeds/suckers
11.	<i>Dieffenbachia spp.</i>	Stem cuttings and suckers
12.	<i>Dracaena spp.</i>	Stem cuttings
13.	<i>Euphorbia spp.</i>	Cuttings
14.	<i>Ficus elastica</i>	Air layering
15.	<i>Ficus benjamin</i>	Cuttings
16.	<i>Kalanchoe spp.</i>	Leaf cutting
17.	<i>Maranta spp.</i>	Tubers
18.	<i>Monstera spp.</i>	Cuttings and air layering
19.	<i>Nephrolepis spp.</i>	Rhizome
20.	<i>Nephrolepis bostoniensis</i>	Division of rhizome
21.	<i>Philodendron spp.</i>	Cuttings
22.	<i>Phoenix spp.</i>	Seeds
23.	<i>Ruscus eculeatus</i>	Leaf cutting
24.	<i>Raphis excelsa</i>	Suckers
25.	<i>Sansevieria spp.</i>	Division
26.	<i>Scindapsus aureus</i>	Stem cuttings
27.	<i>Syngonium podophyllum</i>	Aerial roots/ stem cuttings
28.	<i>Schefflera actinophylla</i>	Cuttings
29.	<i>Tradescantia spp.</i>	Stem cuttings
30.	<i>Zebrina pendula</i>	Cuttings

Annexure-III
LIST OF WINTER ANNUALS

Scientific Name	Common name	Family	Height (cm)
<i>Agrostemma githago</i>	Corncockle	Caryophyllaceae	60-90
<i>Arctotis grandis</i>	African daisy		45-60
<i>Antirrhinum majus</i>	Dog flower/ Snapdragon	Scrophulariaceae	30-50
<i>Bellis perenis</i>	English daisy	Losaceae	20-30
<i>Brachycome iberdifolia</i>	Swan river daisy	-do-	30-50
<i>Calendula officinalis</i>	Pot marigold	Asteraceae	30-50
<i>Centaurea cyanus</i>	Corn flower	Asteraceae	30-90
<i>Cheiranthus cheiri</i>	Wall flower	Brassicaceae	30-50
<i>Chrysanthemum coronarium</i>	Annual chrysanthemum	Asteraceae	30-70
<i>Coreopsis tinctoria</i>	Coreopsis	-do-	30-90
<i>Delphinium ajacis</i>	Larkspur	Ranunculaceae	60-120
<i>Dianthus barbatus</i>	Sweet William	Caryophyllaceae	15-45
<i>Dianthus chinensis</i>	Indian Pink	-do-	30-45
<i>Digitalis purpurea</i>	Foxglove	Scrophulariaceae	30-90
<i>Dimorphotheca sinuate</i>	Star of Veldt	Asteraceae	30-60
<i>Echium platagineum</i>	Viper's Bugloss	Boraginaceae	20-30
<i>Eschscholtzia californica</i>	California poppy	Papavaraceae	25-50
<i>Gazania splendens</i>	Treasurer Flower	Asteraceae	20-35
<i>Helichrychem bracteatum</i>	Straw flower	-do-	60-90
<i>Iberis umbellata</i>	Candytuft	Brassicaceae	20-35
<i>Lathyrus odoratus</i>	Sweet pea	Papilionaceae	120-250
<i>Linaria maroccana</i>	Toad flax	Scrophulariaceae	20-40
<i>Linum grandiflorum</i>	Scarlet flax	Linaceae	40-60
<i>Lupinus luteus</i>	Lupine	Papilionaceae	30-60
<i>Mathiola incana</i>	Stock	Brassicaceae	30-70
<i>Mesembryanthemum criniflorum</i>	Ice plant	Aizoaceae	10-15
<i>Molucella laevis</i>	Bells of ireland	Lamiaceae	60-80
<i>Nicotiana glauca</i>	Tobacco plant	solanaceae	50-80
<i>Papaver rhoeas</i>	Shirley poppy	papaveraceae	60-90
<i>Petunia hybrida</i>	Petunia	solanaceae	15-20
<i>Phlox drummodii</i>	Phlox	Polemoniaceae	15-45
<i>Tropaeolum majus</i>	Nasturtium	Tropaeolaceae	50-150
<i>Verbena x hybrida</i>	Verbena	Verbenaceae	20-40

Summer-Rainy annuals

<i>Celosia argentia</i>	Cock,s comb	Campanulaceae	20-80
<i>Cosmos bipinnatus</i>	Cosmos	Asteraceae	80-120
<i>Cosmos sulphureus</i>	Cosmos	-do-	60-120
<i>Gaillardia aristata</i>	Blanket Flower	-do-	30-60
<i>Godetia grandiflora</i>	Godetia	Onagraceae	30-80
<i>Gomphrena globosa</i>	Bachelor's Button	Amaranthaceae	30-50
<i>Impatiens balsamina</i>	Balsam	Balsaminaceae	20-60
<i>Kochia elegans</i>	Summer Cypress	Chenopodiaceae	40-80
<i>Portulaca grandiflora</i>	Portulaca	Portulaceae	15-30
<i>Zinnia elegans</i>	Zinnia	Asteraceae	50-120