

INTRODUCTION

In these days of increased pollution, floriculture and landscaping hold promise as eco-friendly, high profit futuristic industries. In Himachal Pradesh floriculture and landscaping are becoming fast growing commercial enterprises. The climate of our State is quite congenial for the production of Gladiolus, Carnation, Chrysanthemum, Marigold, Tuberose, Aster and various bulbous flowers which can fetch high prices in big cities especially during the off-season. The commercial production of cut-flowers in the state has steadily picked up with ample of technology generated by this department and at present about 500 hectares of area is under commercial flower cultivation. The area under protected cultivation is about 70 hectares. With the recent changes in the govt. policy, floriculture should attract more talent and capital to develop this industry for gearing it to the export market. Other fields for commercial exploitation include production of flowers, seeds, rooted cuttings, pot plants and landscape nursery plants as well as production of micro-propagated ornamental plants. Providing landscape consultancy for residential/ industrial/public areas also needs to be encouraged for boosting up the tourist industry in the state and for general aesthetic improvement of the environment.

GLADIOLUS

Gladiolus is a commercial crop and can be grown in varying climatic conditions. The cultivation of Gladiolus is important in Himachal Pradesh as it becomes an off-season crop to the plants. It is being grown commercially almost in all districts of the state on an area of 60 hectares.

Climate

Gladiolus can be grown upto an altitude of 2,500 m amsl and in plains also. This crop likes sunny situations and an average

temperature 15°C-20°C is necessary for proper growth of the plant.

Soil

It prefers sandy-loam soils for its cultivation. The pH value of soil should be 5.5 to 6.5. Proper facilities for water drainage is must.

Cultivars

Colour	Cultivars
Yellow	Aldebaron, Jester, Nova Lux, Top Brass, Topaz, Vink's Glory
White	Americian White, White Friendship, White Prosperity
Pink	Friendship Pink, Suchitra, Spic & Span
Red	Americian Beauty, Oscar, Red Majesty
Purple	Blue Lilac, Red Beauty, Interpid, Trader Horn, Mayur, Marvellous

Planting and Flowering time

	Planting time	Flowering time
Low Hills	July-Aug, Sept.-Oct	Nov-March
Mid Hills	Feb-March, May	May-Oct
High Hills	April-May	July-Nov

Planting density/sq m : 25x15 cm (1 m wide beds, 0.75 m wide path) for intensive cultivation; 45x45 cm (under normal conditions).

Planting depth : Plant at 8 cm deep in soil (full size i.e. 4 cm and above). Planting depth slightly shallower on heavy soils than on lighter soils.

Propagation

Planting stock - By cormels

Flowering stock - By corm (size 4 cm & above)

Treat the corms and cormels with 0.1% Bavistin for one hour, dry in shade before planting.

Dormancy breaking of corms : For breaking dormancy of corms, treat the corms with 150 ppm ethrel solution for 24 hours for earlier sprouting or a combination of ethrel (150 ppm) treatment + storage of corms at 5°C for a week, is more effective for causing earlier sprouting and flowering in gladiolus.

Cultural Practices

Manures and fertilizers : Fertilizer Basal dose per square meter bed area :

FYM	5 kg
N	30 g
P ₂ O ₅	30 g
K ₂ O	20 g

Also apply 30 g N/m² at 6 leaves stage

Earthing

When plants attain a height of about 30 cm, they should be earthed up and process repeated after 2-3 weeks to get a final height of 15 cm and staking should be done after spike emergence or when required.

Weeding

Weeding can be done by two ways

- i) Hand weeding - once in fortnight
- ii) Weedicide spray

A) Pre-emergence

- a) Atrazine @ 1-2 kg/ha
- b) Pendimethalin @ 1.5-2 kg/ha

B) Post-emergence

- a) Paraquat @ 1.5 kg/ha
- b) Glycel @ 1kg/ha

Plant Protection

Spray Indofil M-45 (2g/L) in combination with Bavistin (1g/L) at fortnight interval against corm rot throughout the cropping season after plants are 15 cm tall. Similarly spray the crop with Malathion (0.05%) or Nuvan (0.05%) against insect/pests.

Off-season flowering

Using portable polythene tunnels of size (3x1.5x1.5m³) placed over the crop planted in October-November, produced quality flowers in February-March. Off-season flowers of Gladiolus can be produced under mid hill conditions successfully.

Planting time

Oct-Nov

Flowering time

Feb-March

Cultivars viz. White Friendship and Suchitra produced quality flowers from Feb onwards under polyhouse.

Irrigation

- i) Sept 15th to March 30th - Twice a week with running tap water in rubber pipes.
- ii) April 1st to June 30th - thrice a week in a similar manner.
- iii) July 1st to Sept 15th - once in 15 days depending upon weather.

Harvesting

For distant markets spikes should be cut at tight bud stage with two to three leaves remaining on the stem when the lowest bud shows colour. For local market, cut the spike when lower flower has started opening. Harvest the spikes during morning or evening hours. The cut spikes may be pulsed with 400 ppm, 8-HQC + 3% sucrose for 3 hours before packing.

Grading

International			HP State	
Grade	Spike length (cm)	Min. number of florets	Grade	No. of flowers/ Spike
Fancy	>107	16	Exhibition	14 and above
Special	96 to 107	15	Standard	11 to 13
Standard	81 to 96	12	Commercial	8 to 10
Utility	<81	10	Utility	Less than 8

Presently only two grades are popular in the market.

- A. Above 9 florets/spike
- B. Less than 9 florets/spike

Packaging

Cut-flowers in ten spike bunches are packed without water in hamper made of cardboard or wood which measures 33x33x120 cm. Tube light boxes or gunny bags can also be used.

Harvesting of corms

Corms are harvested when leaves start drying. The corms and cormels are treated with 0.1% bavistin for one hour and dried in shade, pack in wooden trays or gunny bags with proper aeration and store in cold storage at 5-10°C.

Yield of flowers	:	20,000 spikes/bigha
Yield of corms	:	19,000 corms/bigha
Cormels	:	50 kg/bigha

PLANT PROTECTION

Diseases	Control Measures
1. Fusarium yellows and corm rot (<i>Fusarium oxysporum f. sp. gladioli</i>) : Roots may show discrete brown lesions or a general rotting, leaf infection is basal and associated with corm rot. Leaf yellowing, starting with oldest leaves, is seen occasionally. Corm rot in the field is soft, invaded by other organisms and is associated	<ol style="list-style-type: none">1. Treat the corms by dipping in carbendazim (1 g/L water) or captan (2 g/L water) for 60 minutes after harvesting and before storage.2. Use disease free corm stock.3. Drench the soil around the infected plant base with carbendazim (1 g/L water) when the disease appears.

with brown wiry roots. In storage, rotting may begin anywhere on corm surface, but most spots are found at base next to the core, by scrapping, browning can be seen.

2. Grey mould (*Botrytis chinerea*) : On leaves, large oval to round, brown spots appear. spots occur on flowers and stems also. At first the spots are pale brown and then become dark. A soft, brown rotting at the base of florets may develop after rainfall. In a moist, cool atmosphere, the whole flower becomes covered with brownish grey growth of the fungal spores.

1. Remove old flowers spikes and destroy.
2. Hot water treatment (52°C) of corms with carbendazim (1 g/L water) added to the water, is effective in eradicating the pathogen from planting stock.
3. Control of the disease on flowers depends on controlling leaf infection . Spray of carbendazim (1 g/L water) and mancozeb (2 g/L water) during all stages of plant growth prevents disease infection.

CARNATION

Carnation is becoming a leading cut flower crop in Himachal Pradesh. It is gaining popularity due to beautiful cut flower production and rooted plant business. There are large scopes of its cultivation. It is cultivated in polyhouses/polytunnel in order to get quality flowers throughout the year.

Climate

Carnation being a crop of polyhouse requires a day temperatures of 20 to 24°C and night temperature 13 to 16°C. 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 60-70%.

It is a winter loving crop and can be successfully grown in mid-hill zone (1200-1500 m amsl) of Himachal Pradesh. The temperature range for its cultivation should be 18-23°C.

Growing medium

Carnation does well in a well drained soil. Loamy soils are preferred for its cultivation. the pH of growing medium should be between 6-7. However, growing medium consisting of soil + FYM + cocopeat (2:1:1, v/v) is recommended for quality flower production under naturally ventilated polyhouses.

Cultivars

Colour	Standard Types
Red	Master Rubesco
White	Niva, White Wedding
Yellow	Liberty, Sunrise
Peach	Madras, Farida, Malga
Purple	Marathona

Normal planting and flowering time

	Planting time	Flowering time
Low hills	Sept-Nov	Feb-March
Mid hills	Jan-Feb	April-May-June
High hills	March-April	July-Oct

Rooted cuttings should be planted on raised beds of 1.2 m width with 0.75 m path between beds.

After planting, 3-4 flushes of flowers may be taken continuously from the same plants.

Planting density

For commercial cultivation of carnation, 25-32 plants should be accommodated/m² in rows. For standard types 20x20 cm spacing is optimum (2500 plants/100 sq m).

Propagation

Take terminal cuttings (8-10 cm) from healthy mother plants. Remove 1-2 pairs of the lower leaves and dip in 0.1 per cent bavistin + 0.15 per cent Indofil M-45 for 5 minutes and shake them properly to remove the solution and treat the cut ends with 500 ppm NAA for 5 seconds. Plant at 3x3 cm distance in treys of propagation beds containing sterilized sand. Rooting is obtained in 20-30 days with manual misting in a polythene chamber.

After rooting the cuttings should be transferred in hardening chamber containing sterilized mixture of sand : Soil : FYM : rice husk ash (1:1:1:1). Keep the cutting under metallic mini portable tunnel of the size 3x15 cm covered with a layer of hessian cloth and transparent polythene, respectively. During first week, keep the sides held open

and later open both the sides. The cutting are ready for sale/transplanting into the fields after 3 weeks of hardening period.

About 1,50,000 cuttings can be accommodated in a medium sized chamber (10x4 m). The optimum temperature inside the chamber should be maintained between 20-30°C. In winter, 100 watts bulbs can be hung 1 meter above the cuttings at 1.5 meter apart during night.

The rooting and hardening media is to be treated with 5% commercial formalin before planting (one litre of formalin in 7 litre of water). After treating the media with formalin, it should be covered with polythene for 7 days. Later on, it must be raked daily for 10 days to release the formalin gas.

Fertilizer application

Standard

Basal dose of NP&K

Biofertilizers

Water soluble fertilizers

Spray

10 g/m² each (to be mixed in the growing medium)

VAM + Azospirillum + PSM (5-10 g of this mixture is to be applied in the root zone of the plant at the time of planting)

100 ppm N & 140 ppm K (apply twice in a week after 40 days of planting)

for 100 ppm N : by dissolving 315 mg of Multi K & 112 mg of Calcium nitrate in one litre of water will give 60 ppm N. Rest 40 ppm Ammonical nitrogen should be given in the form of urea i.e. 87 mg in one litre of water.

for 140 ppm K : by the application of Multi K (N-13, P₂O₅ - 0 , K₂O - 45)

Pinching

First pinching (removal of tip portion should be done at 5-6 pairs of leaves) 30-35 days after planting.

For early crop - Single pinch (First pinch)

For spreading harvest : Pinch and a half. It means a single pinch of a main stem, and later when the resulting shoots are long enough (6-8 cm or 45-50 days after first pinch), half of the largest shoots on each plant are pinched. The half pinch, actually is the two or three pinches per plant at the later pinching time. The system reduces the amount of first crop and provide steady production of flowers.

For late harvest - Double pinch

(Single pinching followed by another pinching of all the shoots, when they are 6-8 cm in length).

Desooting

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

In standard, remove the lateral buds and retain the compact terminal on each shoot. The best time for disbudding is when the terminal flower bud is about 15 mm in diameter. In spray types, the main flower bud (terminal) is removed to encourage lateral floewr buds to develop.

Staking and supporting

1. Individual plant staking with wooden or iron rods.

2. Wire mesh sytem (15x15 cm mesh) supported bys takes of metal or fixed at the corner of beds. Make 2-3 layers of mesh laid together on the soil surface (15 cm above the soil) and upper layers are separated 20 cm apart. As the plant grow, the stems must be constantly stalled or caged within the respective mesh opening to maintain straight stems. A temporary mesh can be made by using nylon chord.

Off-season flowering/schedulling/programming

Under mid-hill conditions, flowers can be produced practically round the year. Some suitable cropping schedules are described below :

Flowering time

Pinching Methods

Planting time	Single pinch	Pinch and a half		Double Pinch
		Ist	IInd	
Oct	IIIrd WK April to IVth WK May	IInd WK April to Ist WK May	IIIrd WK May to Ist WK June	IIIrd WK May to IVth WK June
Dec	IIIrd WK May to IVth WK June	Ist WK May to Ivth WK May	Ist WK June to Ist WK July	Ist WK July to IInd WK Aug
Feb	IInd WK July to IInd WK Aug	Ist WK July to IInd WK Sept	IInd WK Aug to IInd WK Sept	IIIrd WK Aug to IVth WK Sept
April	Ist WK Aug to Ist WK Sept	IIIrd WK Aug to IInd WK Sept	IIIrd WK Sept to IInd WK Oct	Ist WK Oct to Ist WK Nov

Generally single pinch, pinch and half methods produces excellent quality flowers. Double pinching delays the flowering and produces weak shoots.

Growth regulators

Chamatkar (Mepiquat choride)

Two sprays 300 ppm, first when axillary shoots are 8-10 cm in length and second at flower bud initiation, reduce calyx splitting and produce healthy stems.

Benzyl Adenine

50 ppm spray at monthly interval increases yield of cuttings.

Gibberellic Acid (GA₃)

Two sprays (100 ppm) first at first pinch and second when axillary shoots are 8-10 cm in length, produce early flowering and long stems.

Supplementary Lighting

It has been found very effective for increasing stem length, flower size and early flower production. 100 w incandescent bulbs, hung at 1.5 m above the beds at 1 m spacing during Nov-Jan for 12 hours.

Flower harvesting

The flowers of standard carnations are harvested at paint brush stage.

GRADING

A. American Grade Factors

	Grades		
	Blue (Fancy)	Red (Standard)	Green (Short)
Mini flower diameter (mm)			
tight	50	44	None
fairly tight	62	56	None
open	75	60	None
Mini stem length (cm)	55	43	30

B. Local Grades

Grade	Stem length (cm)
A	> 45
B	< 45 > 30
C	< 30

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 cartan of 120 x 60 x 30 cm. Carnation flowers can be stored at 1°C for 296 hours after wrapping in cellophane paper.

Pulsing

It is the pe-shipment/pre-transportation treatment given to flowers immediately after harvesting. Lower portion of stem of flowers should be kept for 6 hrs in a solution containing 10 per cent sugar +

4 mM silver thiosulphate for 16 hours. However, for pulsing of cut flowers of 'Impala' and 'Tasman' lower portion of cut stems of flowers should be kept in a solution containing sucrose (10%) + STS (2m M) for 8 hours or GA₃ (10 ppm) + kinetin (2 ppm) + Alar (900 ppm) + AOA (450 ppm) + Triton-X (1000 ppm) for 6 hours.

Holding solutions

Flowers are kept in this solution by the florist or consumers. The preservative or vase solution for prolonging the vase life of flowers is sugar 2% + 0.5 mM silver thiosulphate. For maximum vase life of cut flowers of carnation cultivar 'Impala', holding solution containing sucrose (2%) + silver thiosulphate (50 ppm) + 8-hydroxy quinaline citrate (50 ppm) have been recommended. Similarly, such solution for 'Tasman' is GA₃ (1 ppm) + kinetin (0.2 ppm) + Alar (90 ppm) + AOA (45 ppm) + Triton-X (100 ppm).

Physiological Disorder

Calyx - splitting : Use rubber bands to prevent Calyx-splitting. Night temperature should not be below 10°C; extreme fluctuation should be avoided.

PLANT PROTECTION

Diseases	Control Measures
<p>1. Branch rot (<i>Alternaria dianthi</i>) : 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.</p>	<p>Spray the plants at 15-day intervals either with mancozeb or captan (2 g/L water) before disease establishment.</p>
<p>2. Fusarium wilt (<i>Fusarium oxysporum f. sp. dianthi</i>) :</p>	<p>Propagative material must be disease free. Avoid use of</p>

Initial symptoms of the disease is chlorosis and wilting of lower leaves and shoots. Typically, only one side of the plant is affected. Affected leaves and shoots wither and die. After symptoms appearance, stunting of plants may occur. When cortical tissues are peeled away to expose the vascular cylinder, cambial area appears brown and dry.

3. Root rot (*Sclerotium rolfsii*) : Yellowing and curling of leaves, plants can be easily uprooted. Around the infected roots, cottony growth of the fungus and brown coloured sclerotia can be seen.

4. Stem rot (*Rhizoctonia solani*) : Complete and sudden wilting at or just below soil level, lesions develop on the stem but roots are not often affected, the stems rot at soil level which causes the stems to break.

Insect-Pest

1. Mite : Suck sap from the underside of the leaves which result in downward curling, yellowing and bending of leaves.

contaminated soil. Drenching of soil around the plants base with carbendazim (1 g/L water) is quite effective.

Grow the crop in raised benches which can be treated with formalin (500 ml/10 kg soil) to remove all the pathogens. Drench the infected plant either with carbendazim (1 g/L wter) or copper oxychloride (3 g/L water).

Drench the soil around the plant base either with thiram (2 g/L water) or carbendazim (1 g/L water).

Spray profenophos (0.05%) when the mite population reaches 2-5 adults/plant followed by ethion (0.05%) after 10 days. Repeat the above schedule of spray if needed.

CHRYSANTHEMUM

Chrysanthemum is a short day plant. It is an important cut flower due to its wide colour range and varying forms. Both standard and spray type of Chrysanthemum are being grown in Himachal Pradesh.

Climate

Chrysanthemum can be grown easily under outdoor conditions except during critical stages. (Extreme temperature, hot-sun, rains etc.) and polythene cover may be provided.

Light and temperature are two important environmental factors influencing growth and flowering. The optimum day and night temperature for chrysanthemum are 18-21°C and 10-16°C, respectively.

Soil

Sandy loam soils are preferred for the cultivation of chrysanthemum because they retain sufficient moisture and provide optimum aeration essential for proper root growth. Chrysanthemum thrive best in slightly acidic soils with pH ranging between 6.2 to 6.7.

Cultivars

Standard

Name of the Cultivar	Colour
Purnima	White
Yellow Star	Yellow
White Star	White
Snow Ball	White
Tata Century	Pink

Thai Ching Queen	Orange
Fiji	Pink
Fiji Yellow	Yellow
Sonar Bangla	Yellow
Mountaineer	Yellow

Spray

Birbal Sahni	White
Baggi	White
Surf	White
White Bouquet	White
Ajay	Yellow
Nanako	Yellow
Kundan	Yellow

Propagation and Planting Time

- (i) Suckers - Feb to April
- (ii) Cuttings - May-July

Suckers

After flowering, dried flowering stems are cut above 3-4 inches from ground level. The plants should be irrigated twice a week and supplemented with 5 kg of FYM/m². The suckers can be separated from February onwards.

Terminal cuttings

These cuttings are taken from healthy stock plants from end of April to middle June. Five to seven cm long cuttings are made by shearing the basal leaves. For enhancing rooting these cuttings can be treated with 500 ppm NAA for 10-15 sec before planting in sand and pots or beds kept in partial shade. Water is sprayed for 4-5 times a day. Rooting takes place within 3-4 weeks. To avoid the

rotting of cuttings, Captan (0.3%) or Bavistin (0.1%) should be applied in irrigation water once a week.

Cultural practices

Pinching and disbudding

Soft pinching is done when the plants are 15-20 cm tall. In standard types, allow terminal bud and remove axillary buds while in spray types, terminal bud is removed and axillary buds are allowed to bloom.

Staking

When shoots are 30 cm tall provide the support. In standard cultivars, number of stakes depend upon the number of side branches.

In spray types, 3-4 stakes are inserted on the bank of the pot and are tied with string from the bottom to top which gives good support to developing branches and finally to flowers.

Irrigation

The plants should be watered twice in a week or depending upon the soil moisture conditions.

Manures and Fertilizers

5 kg/m² well rotted FYM and 30 g/m² each of N, P₂O₅ and K₂O as a basal dose are applied for improved growth and flowering of chrysanthemum. However, 1/2 dose of N should be applied as basal dose and remaining 1/2 dose after 45 days of planting.

Off-season flowering/programming/scheduling

It can be obtained by either selecting suitable cultivars or by controlling photoperiod

A. Cultivars

Early (70-100 days)	Jaya, Jubilee
Mid season(100-130 days)	Ajay, Kundan, Mountaineer, Shyama,
Late (more than 130 days)	Gulmohar

B. Controlling photoperiod

Flowering in chrysanthemum can be regulated by controlling photoperiod. Artificial lights are provided for getting vegetative growth and artificial short days are provided for getting flowering. These both are provided during the times of unfavourable natural photoperiod.

Procedure of controlling photoperiod

1. Artificial long days : Artificial long days are provided with the help of 60 watt incandescent lamps (one/m²) at 80-120 cm above the plant tip during night for 4 hours (12-4 A.M.)

2. Artificial short days : Artificial short days are provided by covering the plants completely with thick dark coloured tarpaulin cloth for 16 hours (5 P.M. to 9 A.M.).

Year-round flower production

Using artificial and/or natural photoperiod, following cultivars have been found suitable for year-round flowering during different times of the year

For year round flower production of Chrysanthemum, 30 cultivars namely; Fiji, Mountaineer, Snow Ball,, Sonar Bangala, Tata Century, Thai Ching Queen, Ajay, Baggi, Birbal Sahni, Delilah, Charm, Fun Shine, Glance, Jubilee, Majoor Bosshardt Wit, Nanako, Mini Queen, Rage, Ravi Kiran, Regal Davis, Reagan Emperer, Reagan Wit, Rita, Santa Dina, Shyama, Surf, V₃ (local collection), Vymini, West

Land Yellow and Yellow Gold were found suitable when these are planted during December, February, April and June months. For August planting only 14 cultivars namely; Fiji, Snow Ball, Thai Ching Queen, Ajay, Delilah, Fun Shine, Glance, Majoor Bosshardt Wit, Nanako, Rage, Regal Davis, Santa Dina, Surf and West Land Yallow have been found suitable for off season flowering. For October planting, 7 cultivars namely; Ajay, Glance, Majoor Bosshardt Wit, Reagan Emperor, Reagan Wit, Santa Dina and Surf have been found suitable for off season flowering. Growth retardants like; B-9 (2500 ppm) for all plantings & CCC (300 ppm) for December, February and June plantings are recommended for keeping the plants dwarf in pots and improve the flower quality.

Harvesting

Spray cultivars are cut when the lower 2-3 flowers are opened, whereas standards are picked at the unopened stage when only a few outer ray florets are unfurled, during evening or morning hours. For distant market both types are cut at half open stage and kept in bud opening solutions i.e. 200 ppm 8 HQ citrate + 2-5% sucrose for 24 hrs at 21°C in continuous light. Vase-life can be increased by 50 ppm 8-HQC + 1% sucrose.

Packaging

Gunny bags, bamboo boxes or cartons measuring 91 x 43 x 15 cm are used for packaging. Cushion of rolled newspaper is placed at the bottom of box and the flowers are placed with the neck resting on the cushion. Next row of flowers is laid in such a way that the heads rest on the neck of those below and a sheet of waxed paper is placed under each layer to prevent drying and brushing.

Yield

About 42,560 blooms/bigha with 4 blooms per plant.

PLANT PROTECTION

Diseases	Control Measures
<p>1. Leaf blight (<i>Septoria</i> sp.) : The disease appears after the onset of monsoon. The symptoms are manifested as black, circular or elliptical lesions on leaves which are surrounded by narrow chlorotic halo. These lesions enlarge to form irregular brown patches, resulting in premature defoliation.</p>	<p>Spray carbendazim (0.5 g/L water).</p>
<p>2. Phyllosticta chrysanthemum : Severe tiny necrotic spots of black colour and irregular shape appear on leaves and restricted in size to 2-3 mm in diameter.</p>	<p>Spray carbendazim (0.5 g/L water).</p>
<p>3. Leaf blight (<i>Alternaria</i> spp.) Small, circular, brownish black spots appear on leaves.</p>	<p>Spray mancozeb (2 g/L water).</p>
<p>4. Wilt (<i>Fusarium oxysporum</i>) : Conspicuous, yellowing and browning of leaves start from base of the plant upwards. Infected plants stunt and fail to produce flowers.</p>	<p>Drench the plant basin with carbendazim (1 g/L water).</p>
<p>5. Powdery mildew (<i>Erysiphe cichoracearum</i>) : Both surfaces of the leaf become covered with a whitish ash grey powdery growth.</p>	<p>Spray with karathane (0.5 ml/L water) or wettable sulphur (3 g/L water) at weekly interval.</p>

ROSE

Rose is one of the leading long stemmed cut flower in India. The climate of Himachal Pradesh is quite congenial for its cultivation. Its different types having beautiful flowers of exquisite shape, different sizes, colours and delightful fragrance has made it an important cut flower for its varied use.

Climate

Rose requires full sun. In the northern plains, rose bloom best during winter, whereas, in the temperate hilly region, best rose flowers are produced in summer.

Soil

Sandy loam soils are required for the cultivation of rose. The soil should be well drained and is sunny situation. The pH of soil vary between 6.0-7.5.

Cultivars

Hybrid Teas

Colour	Cultivars
Red	American Heritage, Christian Dior, Happiness, Raktima
Pink	Preyasi

Floribundas

Red	Banjaran, Zambra
Pink	Banzamine pal, Manasi, Lahar

Time of Planting

Low Hills	September-December
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Mid Hills	September-November, February-March
High Hills	March-April

Spacing

Hybrid Tea & Floribunda	80x80 cm (ordinary conditions closure in case of protected cultivation)
Climbers and Ramblers	90-120 cm (according to situation)

Propagation

- a) T-budding on root stock of *Rosa indica*. Edward Rose and *Rosa multiflora*

Budding should be done 25-30 cm above the ground level. When the new shoots from the top portion of the stock above the union is cut off and the polythene tape is removed. It takes 3-4 weeks for the bud to unite.

Time of budding

Plains	:	Dec-Jan (for Jachh area - Feb 3 rd week to March 1 st week)
Hills	:	Jan-March

Stenting method

It is the advanced and quickest method of rose propagation. In this method buds of suitable cultivars are budded on local unrooted rootstocks and kept in IBA (500 ppm) for 15-20 min. The budded unrooted rootstocks are kept for rooting under mist in polybags. Rooting and bud union takes place simultaneously. Then plants become ready for plantation in 6-8 weeks.

Cultural Practices

1. Manure and fertilizers (per Sq. m. after pruning)

FYM	-	5 kg
P ₂ O ₅	-	50 g
K ₂ O	-	25 g

2. Pruning

		Time of pruning
Low Hills	:	Oct-Nov (Sept 3 rd week to Oct 1 st week in Jachh area)
Mild Hills	:	Sept-Feb
High Hills	:	March-April

Retain 4-5 shoots per plant each shoot should have 5-6 buds. Give a slanting cut above a bud heading outward and paint the cut ends with Boardeaux paste.

Harvesting

Harvest flowers in semi-tight bud stage either in the morning or evening. Flowering stem should be cut always above a healthy outward pointed bud.

Grading

The flowers, which are uniform in colour, stem length and development are grouped together. International recognized grades are as follows :

Varieties	Stem length (cm)	Bud size (cm)
Large flowered	60-90	3.0-3.5
Small flowered	40-50	2.0-2.5

The red, pink and orange colours are mostly preferred. There is less demand for yellow and white roses. The bicoloured roses are not preferred in the markets.

Protected cultivation of Rose

Protected cultivation of Rose can be done successfully in the areas of Kangra, Mandi, Solan, Kullu and Una.

Cultivars

The suitable cultivars for protected cultivation are : First Red, Grandgalla, Noblesse, Vivaldi, Konfetti, Ravel, Grand Prix and Renate.

Climatic requirements

Temperature	Night temperature - 16°C Day temperature - 25-30°C
Humidity	60-70%
Light	12 hours
CO ₂	1000-3000 ppm

Propagation

Time of propagation	-	October-February
Methods of propagation	-	T-Budding and Grafting
Rootstocks	-	<i>Rosa indica</i> & <i>R. multiflora</i>

Planting

Time of planting	-	October-November
Planting distance	-	Plant to plant - 15 cm Line to line - 40 cm
Path	-	40 cm
Total plants required for 100 sq metre area	=	1200

Growing medium

Soil : FYM : Saw dust (2:1:1, v/v) or
Cocopeat : Soil : Rockwool : Sand (1:1:1:1)
with 10-12% humus.
pH of the medium should be 5.5-6.0

Fertilizers

Basal dose per 100m²
CAN - 10 kg
P₂O₅ - 20 kg
K₂O - 5 kg

Application of fertilizers in irrigation water

Nitrogen - 150 ppm
Potassium - 200 ppm

Irrigation : Drip and sprinkling methods.

Harvesting of flowers and storage

1. Flowers are harvested when it starts opening.
2. Harvesting should be done in the morning hours and kept in bucket containing water. These flowers can be stored at 2-4°C.

Yield

249 cut flowers per m²/year

PLANT PROTECTION

Diseases	Control Measures
1. Black leaf spot (<i>Diplocarpon rosae</i>) : Dark brown, circular spots with fringed margin appear on both sides of leaflets. In advanced stage of infection, the spots coalesce and later on defoliation occurs.	Collect infected leaves and destroy. Protect newly emerging foliage by spraying carbendazim (0.5 g/L water) or captan (2 g/L water) two weeks fortnightly.
2. Powdery mildew (<i>Sphaerotheca f. sp. rosae</i>) : Early symptoms is curling of younger leaves which turn purplish. Symptoms appear as small, discrete lesions on the stems, leaves or sometimes on the flower parts. The lesions rapidly coalesce under favourable environmental conditions. Production of numerous conidia gives affected parts a white powdery appearance.	Spray carbendazim (0.5 g/L water) or karathane (0.5 ml/L water) or wettable sulphur (3 g/L water) at weekly interval. or Spray the plants with triadimefon (0.1%) and repeat at 10 days interval.
3. Grey mould (<i>Botrytis cinerea</i>) : This disease prevents the blooms to open. Buds turn brown and decay, individual petals turn brown and shrivel. Infected parts may become	All fallen leaves and other plant debris should be removed and destroyed. Spray either with carbendazim (1 g/L water) or thiophanate methyl (1 g/L

covered with grey to greyish brown mycelium which often sporulates profusely.

water) at weekly intervals. Protect plants from disease by spraying.

4. Die back (*Diplodia* spp. and *Colletotrichum* spp.) : Death of plant parts from top to downwards occurs. It starts from pruned surface, diseased twigs become black in colour.

Pruning should be done in oblique way. Apply Bordeaux paste on pruned surfaces. Collect all dead twigs and destroy.

Insect-Pests

1. Mite : Leaves turn light green, yellow and finally bronze and gets curled.

Spray profenophos (0.05%) when the mite population reaches 2-5 adults/plant followed by dicofol (0.037%) 10 days after the first spray. Repeat the above schedule of spray, if needed.

2. White fly : Suck sap of the leaves which become yellow and ultimately get dried.

Spray imidacloprid (0.08%) when the whitefly population reaches 1-2 adults/plant followed by dichlonos (0.0076%). Install yellow sticky traps for monitoring and reducing the incidence of whitefly's adult at the rate one trap/4m² area.

MARIGOLD (*Tagetes* spp.)

Marigold is one of the important crop among stemless cut flowers and the hardiest one. The plants with their attractive flower colours bloom for a considerable long period and the flowers keep remarkably well when cut.

Climate

They can be grown in various types of climates almost round the year except in cold winter when the plants are likely to get damaged by frost.

Soil

Marigold prefers well drained soil and a sunny position. French marigolds perform well on a light soil while African marigold need well manured and moist soils.

There are two major types

- i) African marigold (*T. erecta*) - Tall plants with large flowers (dia)
- ii) French marigold (*T. patula*) - Dwarf plant with small flowers (dia)

Planting and Flowering time

	Planting time	Flowering time
Low Hills	Sept-Oct	March-April
Mid Hills	Jan-Feb	June-July
High Hills	May-June	Oct-Mid Dec.

February planting of Marigold with Nitrogen 30g/m² in the form of CAN resulted in maximum (1992.00 g) flower production/ m². July planting with Nitrogen 30g/m² in the form of CAN resulted in maximum (167.90 g/m²) flower seed yield.

Spacing

	Under intensive cultivation	Under ordinary conditions
African marigold	40 x 40 cm	60 x 60 cm
Dwarf marigold	30 x 20 cm	60 x 40 cm
Propagation :	by seeds	

Cultural Practices

Manures and Fertilizers :

	Per ha	Per Bigha
FYM :	50 tonnes	40q
CAN :	600 kg	48kg
Single Super-phosphate:	1200 kg	96kg
Muriate of Potash :	333 kg	27kg

Apply whole FYM, Superphosphate and Muriate of Potash and half of CAN at the time of field preparation and remaining quantity of CAN be top dressed 1 month after planting.

Weeding & hoeing

Weeding can be done by two ways :

- 1) Hand weeding - once in a fortnight
- 2) Weedicide sprays -

A) pre-emergence

- a) Atrazine @ 1-2 kg/ha
- b) Pendimethalin @ 1.5-2 kg/ha

B) Post-emergence

- a) Paraquat @ 1.5 kg/ha
- b) Glycel @ 1 kg/ha

Irrigation

Planting time	Frequency
Sept-Oct	Once a week
March-April	Thrice or four times a week
May-June	Depending upon weather conditions

Yield : 8 to 10 tonnes/bigha

Net income : Rs. 15,000/bigha

PLANT PROTECTION

Diseases	Control Measures
1. Stem rot (<i>Sclerotinia sclerotiorum</i>) : Sunken, water soaked lesions appear on stem which collapse under moist conditions, inflorescence becomes pale and whole plant wilts.	Drench the base of plants with carbendazim (0.5 g/L water) when the symptoms start to appear.
2. Leaf spot (<i>Alternaria spp.</i> and <i>Cercospora spp.</i>) : Ash grey or brownish to black circular lesions appear on leaves.	Spay with mancozeb (2 g/L water) at 15 days interval.

SEASONAL FLOWERS

Winter season

Antirrhinum, calendula, candytuff, corn flower, clarkia, Annual Chrysanthemum, California poppy, Pansy, Dianthus, Dimorphotheca, Gazania Godetia, Hollyhock, Helichrysum, Larkspur, Lupin, Mesembryanthemum, Nasturtium, Nemesia, Daisy, Poppy, Phlox, Schizanthus, Stock, Sweet Alyssum, Sweet Sultan, Sweet pea, Varbena.

Summer/rainy season

Aster, Amaranthus, Balsam, Celosia, Cosmos, Coreopsis, Campanula, Gomphrena, Gaillardia, Kochia, Marigold, Morning Glory, Petunia, Sunfloewr, Salvia, Zinnia.

Nursery Raising

Prepare raised nursery beds/plots of 1 sq m add well rotten farm yard manure to it and mix the. Preferably sterilize the soil with formalin 5% (i.e. add 1 litre of formaldehyde to 7 litres of water) upto a depth of 20 cm. Immediately cover it with terpoulene and keep it as such for 72 hrs. Remove the cover, rake it and leave it exposed for atleast three days. In absence of sterilization, the soil may be drenched with Bavistin 0.1% (i.e. 1 g of Bavistin in 1 litre of water). Make 1-2 cm deep furrows about 6 cm apart sow the seed thinly in furrows. If the seed is very fine, mix it with equal quantities of sand before sowing. Cover the furrows with well sieved FYM and sand mixture. Finally the beds may be covered with dry grass or the hession cloth and irrigate it with a fine rose. The cover may be removed as soon as seeds start germinating.

Time of sowing

Region	Winter season	Summer/raining season
Low Hills	Sept-Oct	March-April
Mid Hills	Sept-Feb	April-May
High Hills	Sept-Oct	April-May

Transplanting

Transplant healthy seedlings to well prepared beds in evening hours during summer while preferably in morning during winter season. Irrigate the crop immediately after planting.

Planting distance

Tall group	:	30 x 30 cm
Medium	:	20 x 20 cm
Dwarf	:	15 x 15 cm

After care

During winter months, irrigate the crop after one week. While in summer after 2 or 3 days. Avoid excessive wtering & irrigation should be done in evening and morning hours. Foliar spray of 0.1% urea is very helpful. Weeding and hoeing should be done to avoid weed.

PLANT PROTECTION

Diseases	Control Measures
Dog Flower/Antirrhinum	
1. Root rot (<i>Pellicularia praticola</i> , <i>Rhizoctonic solani</i> ,	Avoid heavy watering and drench the soil around the plant base with carbendazim (1 g/L

Fusarium solani f. sp., martia) water) when the diseases have
Plants suddenly wilt and die. started to appear.

2. Stem rot

i) (*Sclerotinia sclerotiorum*) Remove infected plants and
Sunken, water soaked lesions burn. Fumigate the soil with
appear on the stem which formalin (500 ml/10 kg soil). If
collapse under moist and shady the infection appears, drench the
conditions. Plant become soil around the plant base either
covered with a fluffy white with mancozeb (2 g/L water) or
mucelium, inflorescence carbendazim (1 g/L water).
becomes pale and ultimately the
whole plants wilts.

ii) *Phytophthora pini* var. **antirrhini**

Symptoms appear as above but
no sclerotia are formed.

Larkspur/Delphenium

1. Crow rot (*Pellicularia rolfii*) : Lower leaves become
yellow in early stage of disease. Disinfect the soil with formalin
Severely infects plants can be (500 ml/10 kg soil). Drench the
easily pulled up, as much of the plants either with carbendazim (1
root system and parts of the g/L water) or thiophanate solution
crown are destroyed. Ultimately (1 g/L water).
there is sudden wilting and death
of plants.

2. Powdery mildew Avoid planting where the soil is
(*Leveillula taurica*) : Mildew too wet or aeration is poor. Spray
forms a white powdery coating either with karathane (1 ml/L
on both surfaces of leaves and water) or wettable sulphur (3 g/

young stems. In severe cases, L water).
young leaves and growing tips
become curled and stunted.

3. Smut (*Urocystis sporosporiodes*) : Swellings on
Remove and burn affected
parts.
the leaves and petioles are
caused by this fungus.

III. Pansy

**1. Leaf spot (*Cercospora violae*, *Phyllosticta tricoloris*,
P. violae, *Septoria hyalina*, *S. violae*)** : Small circular, ash grey
Destroy the old infected leaves
and spray with mancozeb (2 g/L
water).
or brown spots appear on
leaves).

2. Rust (*Puccinia violae*) : Pale -do-
green spots develop on the under
surface of the leaves. Rust
pistules develop on opposite side
which contain yellow spores.
Petioles and stems are also
susceptible. late in the season,
brown uredospores and still later
dark brown or black teliospores
develop.

Sweet william

1. Wilt

**i) *Fusarium oxysporum* f. sp. Disinfect the soil with formalin
*barbati*** : Yellowing of the new (500 ml/10 kg soil) or drench
growth, leaves point downwards with carbendazim (1 g/L water).
and stuning of plants takes place.

-do-

ii) *Sclerotium rolfsii* : Yellowing of the leaves and brown sclerotia appear in the vicinity of soil base.

2. Branch rot (*Alternaria dianthi*) : Leaf base and body are girdled. The spots are first ash grey but become dark brown or black due to presence of number of spores attached in chains.

Sweet Pea

1. Powdery mildew (*Erysiphe polygoni*) : The leaves shrivel and dry due to presence of white greyish mouldy growth.

Spray the plants at weekly intervals either with mancozeb (2 g/L water) or captan (2 g/L water) before the establishment of the disease.

Spray either with Karathane (0.5 ml/L water) or wettable sulphur (3 g/L water) at weekly intervals before the disease appears.

2. Downy mildew (*Pernospora lathyripalustris*) : Young plants are susceptible under moist conditions, leaves become covered with greyish mouldy growth and within the mouldy tissue, thick walled brown resting spores are developed.

Destroy infected plants. Use disease free seeds. Spray the plants with copper oxychloride (3 g/L water) at weekly intervals.

Candytuff

1. Powdery mildew (*Erysiphe polygon*) : White greyish mouldy growth appears on infected leaves and stems.

Spray either with Karathene (1 ml/L water) or wettable sulphur (3 g/L water) at weekly intervals. Avoid spray when temperature is too high.

2. Root rot (*Sclerotinia sclerotiorum*) : It attacks the main stem near soil line, resulting in sudden collapse of the plants.

Drench soil around the plant base captan (2 g/L water).

Zinnia

1. Leaf spot (*Cercospora zinniae*) : On the lower leaves, small, circular spots appear which grow bigger and form ash grey spots resulting in defoliation.

Spray the plants with carbendazim (0.5 g/L water) immediately after the appearance of the disease and subsequent sprays be given at 15 days interval.

2. Powdery mildew (*Erysiphe cichoracearum*) : White powdery growth appears on the leaves of zinnia near maturity.

Spray either with wettable sulphur (3 g/L water) or karathane (0.5 ml/L water).

3. Angular leaf spot (*Xanthomonas campestris* pv. *zinniae*) : Angular brown spots appear on leaves and flowers.

Trimming of diseased leaves should be followed by foliar spray of streptomycin (100 mg/L water) immediately after the first appearance of symptoms.

4. Blight (*Alternaria zinniae*): It causes pre-emergence and post-emergence death of seedlings.

Spray either with mancozeb or thiram (2 g/L water).

LAWN

GRASSES

A) For Cooler Areas

1. Kentucky Blue grass (*Poa pratensis*)
2. Red Top Grass (*Agrostis alba*)
3. Rye Grass (*Lolium Perenne*)

B) For Warmer Areas

- 1) Bermuda grass (*Cynodon dactylon*)
- 2) Korean grass (*Zoysia japonica*)

Planting Time

High Hills	:	Feb-March
Mid Hills	:	Feb-March and July-August
Low Hills	:	July-August

Planting Method

- i) **Seed sowing** : Seed is broadcasted @ 10-12 kg/acre in soil.
- ii) **Dibbling of roots** : In this method, grass pieces alongwith roots taken from area free from weeds are dibbled at a distance of -10-15 cm both ways. After planting, rolling is done and irrigate the lawn.

Mowing and rolling

The height of lawn grass can be maintained by adjusting the height of shears of lawn mower but it should not be more than 5-6 cm. Mowing should be done at an interval of 2-3 weeks depending upon the season and growth of grass.

Irrigation

During autumn and winter months, watering is done at an interval of 10 days, whereas in spring and summer months it should be done at an interval of 7 days.

Fertilization

Apply 50-60 g of a mixture of two part CAN, one part SSP, 1 part Potassium sulphate during rainy season. Spraying of urea (30 g/10 L of water) is also useful for the growth of grass.

Scrapping of Lawn

It should be done after 3-4 years during summer months. Lawn should be scraped completely with the help of Khurpa and raking should be done both ways.

Diseases & other problems

Fiary ring

Symptoms are circular rings of dead grass. Ring may not be completed and given the appearance of an arc or horse shoe.

Control

Drench the soil the Blitox (0.15%).

Yellowing

This problem arise due to poor drainage or lack of water. Deficiency of nitrogen is also responsible for yellowing of grass.

Control

Loose the soil with the help of khurpa or rake and make small holes with dibbler.

HOUSE PLANTS

Name of plant (species)	Propagation methods	Time of propagation
A) Foliage		
Agloanema	Cutting, division	February-March
Araucaria	Seeds	-do-
Calathea	Seeds, division	
January-February		
Chlorophytum	-do-	February-June
Codaeium	Stem cuttings	March-April
Coleus	Seeds and stem cutting	
February-March		
Dieffenbachia	Stem cutting and suckers	-do-
Dracaena	Stem cuttings	-do-
Ficus elastica	-do-	March-April
Haworthia	Division	March-April
Marata	-do-	-do-
Monstera	Cutting and layering	March-April
Pilea cadierei	Stem cutting	-do-
Scindapsus	-do-	February-March
B) Flowers		
Amaryllis	Bulbs	February-March & Sept.-Oct.
Cyclamen	Seeds	August-Sept.
Fuchsia	Cuttings	February-March
Gerbera	Seeds, division	-do-
Impatiens	Seeds, stem cuttings	-do-
Jacobinia	Stem cuttings	-do-
Pelargonium	-do-	-do-
Peromia	Seeds, cuttings	-do-

Cultural Hints

All the pot/house plants given in the table are grown successfully in the potting mixture of garden soil, sand and well rotten farm yard manure (seived) in equal parts (by volume). The lower holes of pots are covered with 1-2 pebbles/small stones and then the mixture is filled. Two-three g of BHC is added/pot. In case of selected species (like Geranium, Fuchsia and Begonia semperflorense). Fertilizers are also added alongwith the mixture in the post.

@	CAN(g/plot)	SSP (g/pot)	MOP (g/pot)
Geranium	1	3.12	1.66
Fuchsia	3.2	7.75	3.86
Begonia	3	0.56	0.36

All these plants performed very well under the temperature range of 120C to 250C. Pots are irrigated atleast once a day in summers and every alternate day during winters. Spray of Indophil M-45 and Bavistin @ 1 g each in 1 litre of water should be done at monthly intervals. Apply insecticides as soon as attack is observed. These house plants have specific requirements for light but most of them require high to medium light. Some plants like Aspidistra and Araucaria grow very well under low light conditions also. Regular repotting once a year in the month of March-April is required to cut away dried roots and other unwanted growths.

Cultural hints

Landscape plants include trees shrubs and climbers. All deciduous plants are planted in Oct-Nov, Feb-March after the leaf fall and evergreens are planted in March-April in hills and July-Aug in plains. Staking of all plants should be done after planting. Other important operations including removal of suckers, deshooting, pruning and training etc. Watch on diseases, insects and pests is kept and are controlled by spray of Indophil M-45/Bavistin (0.1%); insecticides like Melathion and Metasystox (0.1%). After care in winers include thatching of plants with grass/bamboo hay or initial 2-3 years of establishment.

Diseases

Stem rot (Rhizoctonia)

Symptoms : Complete and sudden wilting. The stem rot at soil level and causes the stem break.

Control

Drench the beds with 0.2% Indophil M-45.

Insect-Pests

1. Red spider mite : The mites are minute red insects when spread in the undersides of the leaves, suck the sap and eventually the leaves turn pale yellow and have a dusty coating and fine webs.

Control

Spray 0.1% Dicofol when flower buds starts forming.

2. Caterpillars : Usually injury found at growing points of the shoots and in the flower buds.

Control

Spray 0.2% Rogor at fortnightly interval when flower buds become visible.

PELARGONIUMS

Importance and Uses

Pelargonium is the botanical name for a group of plants which includes geraniums or zonal pelargoniums, regal pelargoniums, ivy leaf pelargoniums, scented leaf pelargoniums and miniature pelargoniums. They are most important spring and summer flowering plants suitable for both pot and bedding culture although most of the modern day hybrids have the tendency to bloom almost throughout the year specially in frost free areas. This group of plants enjoys worldwide popularity although they are not winter hardy in temperate regions. The important cultivated pelargoniums fall into four major groups. The most widely cultivated is the “zonal” or “fish” geranium, *Pelargonium hortorum*. These cultivars have a characteristic dark band or “zone” within each leaf. The “Regal” or “show” geranium (*P. domesticum*) is grown to a much lesser extent but is gaining in popularity because of its beautiful and unusual flowers. The ivy leaved pelargoniums are excellent cascading plants, suitable for growing in hanging baskets, window sills and wall climbings under sheltered locations. The fourth group (scented) is a series of species (or their derivatives) having pungent or fragrant leaves.

Cultivars

The important zonal/hybrid pelargonium series are listed below:

1. Avanti series
1. Bandit series
2. Care free series
3. Century series
4. Challenge series
5. Cherrio series

6. Dynamo series
7. Elite series
8. Flash series
9. Horizon picottee series
10. Irene cultivar series
11. Multi bloom series
12. Orbit series
13. Pinto series
14. Ringo series
15. Ripple series
16. Sprinter series
17. New tetraploids for example: Freckles and Classic scarlet
18. Sensation series
19. Maverick series

Agro Techniques

Pelargoniums as bedding plants

All pelargoniums can be grown outside during the summer but the latest hybrids are more suited for outdoor bedding culture as they are vigorous, compact, dwarf, profuse flowering with an ability to withstand the rains and hail storms better than the traditional pelargoniums.

Soil Conditions: Pelargoniums do well in well aerated sandy loam soils. They do not like high moisture retentive soils as water logged conditions are not conducive for good vegetative growth and flowering. The optimum soil pH is 6.0 to 6.5. In heavily manured soils, pelargoniums do not perform well. It is therefore advisable to add minimum level of organic manure (Well decomposed farm yard manure) in the soil before planting seedlings or rooted cuttings. Five kg of farm yard manure, 30 gms of N, 20 gms of P₂O₅ and 25

gms of K_2O should be added per square meter area at the time of bed preparation.

Light: Pelargoniums like sunny locations for best results. At least 3 to 4 hours of direct sun light will be sufficient for getting good bedding crop of hybrid pelargoniums. Eastern exposures are better than the Western aspects. Pelargoniums give poor flowering performance in full shade, so do not select such areas for plantings.

Time of Planting: Under North Indian Hill conditions, pelargonium seedlings or rooted cuttings should be planted outdoor in the first week of April as by that time, the danger of late spring frosts will be over. In slightly cooler conditions, this planting can be delayed to last week of April and cuttings should be planted at a distance of 25×25 cm.

Culture: Immediately after planting, the seedlings/rooted cuttings should be thoroughly watered so that the plants get ample opportunity to establish themselves in the soil. Next watering should be given only after examining the soil moisture status. Pelargoniums grow and flower better under slightly dry soil conditions. After one month of transplanting, the plants should be pinched to encourage axillary shoot branching for getting well spread and evenly balanced flowering plants. Most of the modern hybrids do not require this early pinching as they have natural inherent tendency to form axillary shoots and make presentable flowering specimens. Manual pinching will also delay the flowering. Bedding pelargoniums will keep on blooming till the onset of first winters. Day temperatures below $10^{\circ}C$ and night temperatures below $5^{\circ}C$ will certainly force the plants to wither and die.

For saving valuable specimens, the plants should be uprooted in October from the ground and potted on into 15 cm plastic pots for keeping them in protected glasshouses and conservatories for over wintering.

Pelargoniums as Flowering Potted Plants

They are also one of the best and highly rewarding spring and summer flowering potted plants in the U.S.A., U.K. and other European countries.

Growing Media: The choice of media depends on many factors such as the availability of material, size and type of container for growing, handling of the materials by the grower and method of watering. For the consumer, media should be low in soluble salts and high in aeration. Commercial mixes for pelargoniums contain 2 to 4 of the following components-Sphagnum peat moss, Vermiculite, Perlite, aged pine bark, Calcined clay, sand, and mineral soil. Most commercial mixes also contain some fertilizers such as calcium nitrate, potassium nitrate, super phosphate, trace elements and a wetting agent. A compost containing equal parts of sieved soil, sand and FYM produced best presentable pots of pelargonium. The pH should be 5.5 to 6.5 for zonal pelargoniums, 5.3 to 5.8 for ivy leaved pelargoniums and approximately 6.0 for regal pelargoniums.

PROPAGATION

1) Vegetative Propagation:

Stock plant cuttings can be started as early as May to August for cuttings in the next spring, though usually stock plants are received after the Christmas crops are finished. Rooted cuttings are placed in 1 to 1.25 gallon containers or directly in benches. Plants must be pinched regularly to develop as many shoots as possible.

2) Seed Propagation:

The best time for seed sowing is April-May for hills of North India and in the Northern plains, seed can be sown in August- September.

Germination medium consists of sieved mixture of garden soil, farm yard manure, leaf mould and sand in equal proportions. Such mixture is put either into plastic trays having minimum 15 cm depth or 20 cm earthen pots. Seeds are sown in these trays or pots at depth of 8-10 mm and then covered with sieved mixture which is finally mulched with sphagnum moss in second fortnight of April. After sowing, a thorough irrigation with fine mist sprayer is applied to the trays or pots which are ultimately kept in protected glass houses where average day temperatures should range in between 20-22°C and average night temperatures should hover in between 16-18°C. Approximate light intensity levels should be around 4000 to 5000 foot candles with 70-75% RH around the seed trays/pots. Humidity can be maintained by manual misting three times a day. First seedlings will usually start coming out after 7-8 days of sowing followed by the remaining ones and the complete germination percentage can be noted after 30-35 days of seed sowing. Maximum 60-65% seed germination has been obtained at Regional Horticultural Research Station Mashobra, Shimla with hybrid zonal seeds of Horizon Picottee and Ripple Series while a slightly higher seed germination of 70-75% has been achieved with own selfed seed, collected from existing germplasm. The seedlings with minimum two leaves should be transplanted into 10 cm pots which after about one month, should be shifted into 15 cm pots. Saleable plants in 15 cm pots usually take 11-13 weeks from transplanting under Mashobra conditions whereas in controlled conditions, seed pelargoniums can be finished in 6-8 weeks from plug transplanting.

Pinching : Modern seed hybrids produce compact dwarf plants with basal branching. These cultivars do not need any pinching i.e. removal of terminal shoot in a plant to encourage side/axillary branching. In fast crop schedules, pinching is not practiced as such procedure will delay the flowering and crop maturity. But with specimen plants to be kept in glass houses, conservatories and for plants required for flower show displays, pinching will, no doubt, improve the over all appearance and presentability of plants as

each side shoot formed in a plant after pinching will bear a bloom, thereby, increasing the number of blooms per plant. Rooted cuttings planted for making stock plants also require a number of pinchings in the initial stages so as to form a net work of side shoots from where more number of cuttings per plant can be taken out.

Diseases

1. Foliar Diseases

a. Botrytis blight: Botrytis blight, a disease caused by an airborne fungus called *Botrytis cinerea*, lives on aging tissue such as old leaves, blooms and debris.

Botrytis is always present in the greenhouse environment. The best way to control botrytis is to make conditions less favorable for its growth and development. Flowers should be removed while in the bud stage. All dead and infected plants, parts, leaves and blooms must be cleaned up and removed from around the plants and under the benches. This reduces the sources of infection and therefore the load of spores present in the greenhouse

b. Alternaria leaf spot (*Alternaria alternata*)

Symptoms: Initial symptoms develop on lower leaf surfaces as small, raised, water soaked-appearing spots that resemble blisters. Some have white centers. Leaf lesions may develop within 20 hours after the start of a continuous rain. Spots on the upper leaf surface usually aren't distinct at this time, but with time they become visible. Within a day the centers of the raised, blister-like spots start to collapse, resulting in sunken centers. These "new" lesions, 1 to 3 mm in diameter, may be numerous on a given leaf. Some spots develop a light yellow halo. They may increase in size up to 10 mm in diameter.

Control: Removing infected leaves from plants and the ground to reduce airborne spores is very important in controlling this disease.

Spray with mancozeb @ 2gms per liter of water in alternation with captan @ 1.5 gms per liter of water at fortnightly intervals is effective for controlling this disease.

c. Bacterial leaf spot (*Pseudomonas syringae*)

The appearance of leaf spots caused by the bacterium varies depending on weather conditions. When plants are outside in the rain, dark brown to black, irregularly shaped necrotic areas 5 to 10 mm or larger develop. Few hours after a rain, the spot margins appear water-soaked. Spots may extend or enlarge along the veins. They may coalesce and encompass large leaf sections. In some instances, the entire leaf may become necrotic and curled up. Leaves also curl and bulge when extensive infection and necrosis develops on leaf margins.

Control: Sanitation is an important disease management principle and is particularly pertinent to bacterial problems. Discard plants that develop symptoms in the greenhouse. Workers should wash hands after handling diseased plants or soil. Remove diseased plant debris from the growing area as much as possible. Bacteria are easily splashed from plant to plant by irrigation water. Consider practices that minimize splashing and reduce the leaf wetness period. Avoid handling plants when they are wet. Copper sprays are only marginally effective in controlling bacterial disease and may be phytotoxic to pelargonium.

2. Vascular Wilt Diseases: The most destructive pelargonium disease is bacterial blight, a vascular wilt caused by *Xanthomonas compestris* pv. *Pelargonii*. The disease has also been called bacterial stem rot, bacterial wilt or bacterial leaf spot, but the disease has so many different symptoms that the more comprehensive name “blight” is preferable.

a. Bacterial Blight

Symptoms: Bacterial blight symptoms vary, depending on the

cultivar and species affected and greenhouse environmental and cultural conditions. Symptoms alone aren't sufficient for making a diagnosis of bacterial blight: A laboratory diagnosis is necessary.

Control: Strict adherence to good sanitation practices, as well as a carefully administered culture-indexing program are the propagator's sole tools for supplying healthy cutting stock

Crop arrangement may also minimize bacterial blight losses. Don't place hanging ivy pelargonium baskets directly above bench- or floor-level pelargonium from cuttings.

Insect-Pests

1. Aphids (Green peach aphid-*Myzus persicae* ; Geranium Aphid-*Acyrtosiphon malvae*; Glasshouse potato aphid- *Aulacorthum solani*) : Aphids injure plants by piercing and sucking the sap from the plant, which causes the leaves to curl. This affects the appearance and the performance of the plant. Aphids can effectively be controlled by giving weekly sprays of Rogor or Metasystox each @ 1 ml per liter of water.

2. Whiteflies (Greenhouse whitefly-*Trialeurodes vaporariorum*): Whiteflies can be a problem on pelargoniums, particularly regal pelargoniums. The adult whitefly is a tiny, white moth-like insect that can fly short distances in the greenhouse. The whitefly adults and nymphs feed by piercing and sucking on the underside of the plant leaves. Damage due to whitefly can be in the form of a stunted and yellow plant. Effective chemical spray schedule includes first spraying with summer oil @ 10 ml in one liter of water followed by weekly sprays of cypermethrin @ 0.5 ml in one liter of water or monocrotophos @ one ml in one liter of water. Clean greenhouse cultivation will help to a great extent in reducing the whitefly population.

3. Two-spotted spider mite (*Tetranychus urticae* Koch): Two-spotted spider mites, nearly invisible to the naked eye, are persistent pests with pelargoniums. The adults and nymphs suck the sap from the plant, resulting in mottled, bleached-appearing foliage. If a plant is heavily infested, its photosynthetic rate is decreased, resulting in minimal new growth. Under average green house conditions, the spider mite requires about 11 days to develop from egg to adult. As with whitefly, the recommended chemicals for spider mite attack only certain stages of the insect's life cycle. This must be taken into consideration when setting up spray schedules to control this pest. The varieties that are susceptible to spider mites include Red Perfection, Cardinal and most of the ivy pelargoniums, especially Sybil Holmes. A spray schedule consisting of summer oils viz. Orchex 796, DC-Tron Plus, I Pol @ 1% can be used against the motile stages and eggs of two spotted mite *Tetranychus urticae*. Besides this, Fenzaquin 0.001% (Magister 10 EC) followed by Dicofol 0.04% (Colonel-S-18.5 EC) and propergite 0.0285% (Omite 57 EC) have been found highly effective against eggs and motile stages of two spotted mite. Spray applications should be repeated at 10 days interval in case of severe infestations. Occasional misting in the vegetative stages will also help to reduce inoculum of pest. Greenhouses should always be kept free of grasses and other weeds.

4. Catterpillars (*Heliothis armigera*): In the past few years, heliothis pod borer has established itself as one of the major pests of pelargoniums particularly hybrid and zonal pelargoniums. Its attack is noticed in late spring when adult moths migrate from plains to the hills of Northern India. Female adults after detecting pelargonium host lays eggs individually or some times in group of maximum of 2-3 eggs on the developing inflorescences and occasionally on leaves in late spring. These eggs will develop into small larvae in 10-15 days and immediately each larva bore into the developing buds and start eating these buds one by one. In seven to ten days after boring, a single caterpillar can damage the whole inflorescence, thus inflicting heavy crop damage. The

caterpillars will also feed on the leaves making big holes behind or some times, can eat whole leaf. The presence of caterpillars can easily be noticed by detecting the black excreta.

It is very difficult to chemically control eliothis pod borer once the adult moths have laid eggs on the developing buds. Following integrated approach will greatly help to reduce the attack of this pest :

- a. Don't allow the entry of adult moths in the glasshouses. The presence of moths in particular area can easily be detected by laying light traps.
- b. Switch off all the lights of glasshouses and surroundings in the night and this should begin from second fortnight of February to end of May as this is the peak period for heliothis migration and its subsequent infestation.
- c. Even if some of the adults have become successful in penetrating the glasshouses and are hiding in the canopy of pots, they should immediately be killed by spraying monocrotophos @ 1 ml per liter of water as this will help to stop egg laying by the intruding moths. Also try to ensure that no more moths can enter the pelargonium glasshouses.
- d. Even after following the above precautionary measures, if some of the moths have already laid eggs on the buds and leaves, keep on watching the development of eggs and when the first larva emerges from the eggs, immediately spray with triazephos @ 1 ml per liter of water and after seven days, again spray with monocrotophos @ 1 ml per liter of water to get the insect killed.
- e. Once the presence of eggs and adult moths have been noticed, spray of summer oil @ 10 ml in 1 liter of water can be given to kill the eggs.

TUBEROUS BEGONIAS

Introduction

Tuberous begonias are excellent summer flowering plants, valued mainly for their giant attractive flamboyant flowers of various colours. They are best grown in pots, tubs, troughs, window boxes or hanging baskets in green houses, conservatories, balconies and window sills protected from direct sun and rain during summer months in places where average day temperatures during this period hover between 15-20°C.

Cultivars

A vast range of tuberous begonia hybrids with the large single and double blooms are available nowadays. The singles are brilliantly coloured in red, pink, white, yellow or orange, some with the edges of the petals ruffled and crinkled. In addition, the large flowered begonias come in various shapes and colours as mentioned for singles. Following is the description of important cultivar groups :

- (i) **Traditional Giant Flowered Begonias** : They are large (10-12 cm across), camellia flowered, rosebud type, fimbriate type or marmorate type begonias with spectacular colour combination, grown mainly from tubers. They are available in a wide range of colours and some have ruffled edges to the petals (list of B&L).
- (ii) **Pendula Begonias** : These have long pendulous stems and make extremely showy plants for hanging baskets. The description of the important hybrids will be followed by the list of B & L.
 - 1 **Begonia F1 hybrid, 'Illumination** : Probably one of the best new flowers is this gorgeous new begonia for hanging baskets and window-boxes

with cascades of lovely, large double blossoms in shades of pink.

- 2 **Begonia F1 hybrid 'Illumination Orange'** : This is a new colour in Illumination with blazing cascade of flaming orange flowers, produced in the late summer to early autumn in both sunny and partially shaded locations.
 - 3 **Begonia F1 hybrid 'Illumination Apricot'** : This lovely variety produces showers of large double flowers in splendid shades of apricot to yellow.
 - 4 **Begonia F1 hybrid 'Illumination Rose'** : This is a very distinct shade for the Illumination class of pendulous begonias. Flowers of striking deep rose shade are produced in late summer in window boxes and hanging baskets (List of B &L).
- (iii) **Picotte Pendula Begonias** : The lovely picotte pendulas are ideal for spectacular display in hanging baskets, patio pots, etc.
 - (iv) **Picotte Lace Begonias** : They have exotic, fully-double, extra large 15 cm flower heads with layers of elaborate ruffle-edged petals in red, pink and apricot. They are more suitable for growing in patio container.
 - (v) **Multiflora Tuberous Hybrids** : They are more popular as summer bedding plants but can be grown equally well in containers also. The famous non stop varieties of this group are suited for the above schedule. They are readily grown from seed to flower in the first season and form tuberous in the open ground or pots which may be stored over the winter for use in the subsequent years. Non Stop series have following two sub-groups :-
 - 1 **Non Stop Mixed F1** : Soft crumpled heads can grow to 10 cm across to nestle against the glossy

green foliage. Vigorous, free flowering and base branching. Pot specimens and bedding plants flowering in late summer to autumn.

- 2 Non Stop Ornament Mixed F1** : The qualities of the famous non stop above, with brown bronze leaves, some with light greenish veins. Profuse double blooms in vibrant colours create a dramatic focal point.

Agrotechniques

Growing Medium

Growing medium for begonias should be sufficiently porous with a optimum pH of 6.0.

For mass display of begonias in the borders, a sandy loam soil with good aeration and plenty of organic matter in the form of either well decomposed leaf mould or farmyard manure is most desirable. To grow begonias in open ground, the simplest procedure is to set the tubers in the garden as soon as there is no more fear of frost, taking care to place the concave part upwards and to plant shallowly at distance of 15×20 cm and a depth of 5-6 cm, depending upon the tuber size, having incorporated a good dose of farmyard manure and leaf-mould at the rate of 15-20 kg per m² into the soil beforehand. The tubers may also be planted in February in flat boxes filled either with moist cocopeat or a compost consisting of equal parts of sieved soil and well decomposed leaf mould. After watering, these boxes should be stored in a light warm place, and the compost kept damp, but not too damp. In a little while the begonias will start growing, shooting ahead fairly rapidly. When frosts are over the plants can be bedded out of doors. In this way their flowering will be hastened by several weeks. The plug seedlings of named varieties can also be planted outdoors to get the same display of flowers as will be given by the tuber grown plants.

For container plantings, the growing medium should consists of equal parts of sieved garden soil, well decomposed farmyard manure, leaf mould and sand. The potting mixture should preferably be solar sterilized, potted and finally drenched either with captan at the rate of 4gm per litre of water or a combination of fungicidal mixture consisting of carbendazim at the rate of 2gm and mancozeb at the rate of 3gm per litre of water.

Environmental Factors

(A)**Light** : Maximum light levels during summers should not exceed 2500 to 3000 fc. During warm summers, shading of the green house by plastering lime on the roof of green house or by planting 30 percent plastic shading net on the green house roof is required to avoid burning of the plants and to improve temperature control. Bright filtered light with good ventilation is a prerequisite for successful begonia cultivations. Long days (more than 12 hours) are required for flower initiation and short days (less then 10 hours) are required for tuber formation.

(B) **Temperature** : Recommended temperatures after transplanting are 23° C during days and 18° Cat nights Larger plants and more flowers will develop at 23°C day and 18°C night temperatures compared to 27°C day and 18°C night temperatures. To increase flower size and intensify flower colour after the buds are formed, the plants can be finished at 15°C to 17°C. Night temperatures below 14°C should be avoided as growth will be inhibited and tubers may form . This is the reason why most of begonias start forming tubers in October- November under wet temperature zone of H.P. Cooler temperatures (15°C -18°C) are more desirable when flowers begin to develop, but it will slow flower production.

(C) **Humidity** : To start the tubers and seedlings into faster growth, a high humidity of 75 to 85 percent is considered ideal

coupled with warm temperatures of 15 to 20°C. With sufficient number of leaves (5-9) on each plant, a humidity of 60-70 percent is more beneficial. At the time of flowering, humidity should preferably be reduced to 50-60 percent. Good ventilation followed by proper plant spacing and sanitation practices will help to achieve the desired level of humidity during rainy season. While storing tubers in the winter, humidity should be kept at 25-35° C with tubers stored in a complete dried stage.

Cultivation

Propagation

(A) **Sexual/Seed Propagation** : The commercial method for building huge quantities of tuberous begonias is chiefly through seeds which are very small, reddish in colour, containing approximately 25,000 seeds per gram. Tuberous begonia seedlings require higher humidity levels (80-95 percent) and a longer growth period than most other seedlings.

Seeds of tuberous begonia are sown in March-April in wooden trays each 3 ft long, 2 ft wide and 1 ft high, containing the germination medium consisting of equal parts of sieved soil, farmyard manure, leaf mould and coarse river sand . The base of each tray is covered with a 10 cm layer of sphagnum moss. Utmost care is taken to drop the seed uniformly all over the surface and finally about 1 mm layer of sieved mixture of sand, loam, FYM and leaf mould in equal parts is used for seed covering. Finally, seed is covered with 3 to 5 cm layer of sphagnum moss. Covering seeds trays with clear plastic will also ensure desired humidity levels. High relative humidity of 80-90 percent is maintained at all times by using fine mist sprayer twice a day. After about 20 to 25 days, very small (1 to 2mm large) first true leaves start appearing on the surface of medium after the moss was removed. Greatest care should be taken to irrigate these small seedlings with a fine mist

sprayer so that there is no splashing of medium particles. A soil temperature of 20 to 25°C along with high relative humidity of 80 to 90 percent resulted in fastest growth of seedlings. The bigger seedlings each containing atleast one true leaf (each leaf 1 to 2 cm wide) can be shifted into plastic plug trays before finally transplanting into 10 cm plastic pots at a stage when the third true leaf in each seedling is atleast 2-3 cm wide. Depending on temperature and light conditions prevailing during propagation, 5-9 weeks are required to reach proper seedling size for transplanting. The potting mixture is the same as used for germination. More than 50 percent of the seedlings from mass pollinated or hybrids will give rise to first blooms in the same season and will perish in winters leaving small (atleast 1 cm dia) tubers which from the second year onwards, will profusely bloom to give a magnificent display of flowers. The seedlings which did not flower in the first season will also form small tubers at the end of first season and can be very well utilized for next year plantings. Plug seedlings of tuber begonia are available from commercial nurserymen and are usually 5-9 weeks old at the time of purchasing .

Although they can stand the sun, tuberous begonias do best in a semi-shady position, sheltered from strong winds. To obtain really fine plants the ground must be kept moist by frequent watering, taking care not to asphyxiate the roots. At the first sign of frost, watering should be stopped, and immediately the nights turn cold, it is time to think of putting the begonias into hibernation. In order to be sure of tuber perennation, certain precautions must be taken. The plant should be dug up in its entirety without damaging the foliage or the roots, then it must be stored in a dry place where it will be safe from frost. In a little while the plant will have withered; the stems can now be cut off an inch above the tuber and the roots shaken free of earth. The tubers should then be placed in flat boxes filled with dried peat and stored during winter in a dry cellar, if possible at a temperature over 6° C. (42° F). Obviously, to keep

track of the colours the begonias must be carefully labelled when lifted, and stored separately.

Diseases: Common diseases of tuberous begonias are Powdery mildew, Botrytis blight and tuber soft rot.

Insect-Pests: Aphids, thrips, slugs and snails are most important enemies of begonias.

CYCLAMEN

Introduction

Cyclamen is the most popular and colourful flowering pot plant, suitable for temperate climate. It remains in flowering from late autumn to early summer in cooler areas of the country but in plains, flowering starts from December and lasts till February.

Modern Cultivars

Modern cultivars have come from one of the following series :

Opera Series, Sierra Series, Mirabelle Series, Laser Series, Concerto F1, Rondo F1, Dixie F1, Latinia Series F1, Metis series, Diva series, Halios series

Varieties

Cut Fire. Junior White, Junior Rose, Senior Rose with eye, Senior Deep Rose and Senior Salman with eye responded very well to 8-10 months crop schedule

Climatic Requirements

a) Light

Cyclamen should be given bright light without direct sunlight from March to October and direct full sunlight during winter months. Bright light (20-25% of direct sunlight) is found mainly in areas close to those reached by direct sunlight.

b) Temperature

Cyclamen should be kept cool at all times. A temperature between 13⁰ C to 18⁰ C is considered ideal. Temperatures above 25⁰ C will greatly shorten the life of these plants.

c) Humidity

Maintain high relative humidity of 80-90 % during germination of seedlings. Keep humidity at 70-80 % during most of the times except during dormancy by keeping the upper surface of potting mixture moist.

Production Technology

Propagation : Propagation is primarily from seed. The optimum temperature for germination of cyclamen seeds is 20°C under dark conditions. Under glasshouse conditions, with September sowing, 87 per cent germination was recorded at a soil temperature range of 15-25 °C.

Fresh seeds (dark brown to black in colour) are selected. No after-ripening and special pre-germination treatment is required. However, soaking of seeds for 12 hours in water before sowing helps in seed germination. Cyclamen seeds germinate best at 19⁰ C-20⁰ C in the dark where as temperatures above 22⁰ C and more may be inhibitory. The flats should immediately be watered after sowing. Maintain relative humidity of seed trays at 80-90%. Maintain the pH of growing medium at 5.5 to 6.0. First, the primary root penetrates the soil, then the hypocotyl begins to swell to form the basal tuberous stem(corm). At two to three leaf stage, the seedlings are either shifted to 4" pots or to bigger trays. 20⁰ C night temperature should be maintained for optimum growth. Germination percentage upto 95% is expected. The seedlings which take more than 45 days to germinate are usually weak and it is better to discard them. Storage of seedlings for upto 5 weeks is possible in moist peat or moss in polythene bags kept in refrigerator.

Potting and Pot Mixture

At 17 weeks after sowing, plants of most cultivars should average

approximately six to seven unfolded leaves. They are then ready for potting. Plants should be transplanted in medium which consists of Loam, leaf mould and FYM (1:1:1) in equal proportions. The tuber top is kept flush with the surface of the growth medium. Some sphagnum moss can be placed in the pot bottom for good results.

Watering

Following round the year scheduled for watering of Cyclamen plants was found suitable for successful growing and recycling. At flowering stage, irrigate the plants after every two days. From April to July, daily irrigation is required. During dormancy, irrigate once in a week. After new flush emerges in later August or in 1st week of September, irrigation is applied twice in a week till the commencement of flowering.

Post production handling of finished pots

Stage of harvesting

For local market, sell the pots when atleast 5-7 flower buds have fully opened. But for distant markets, finished pots should be sold when atleast 3-4 flower buds have just started opening.

Transportation

Cyclamens start blooming when optimum day temperatures vary between 13-16⁰C and optimum night temperatures move between 6-9⁰C. In the temperate areas of the country, such conditions normally start prevailing from second fortnight of September and thereafter, they will keep on blooming till such a range of temperatures is maintained in the natural environment (up to end of April). In the plains, such temperature ranges are achieved normally in the months of December and January. Flowering pots

of cyclamen, therefore, should be transported by the commercial growers to the cities like Delhi, Chandigarh, Bangalore & Bombay in the winter months to earn maximum profits. It is advisable to transport the pots in the plastic crates after wrapping them in newspaper sheets or inserting small freshly cut green bamboo sticks with foliage in the pots so as to avoid physical damage to the flower buds. It is better to transport finished pots in the refrigerated trucks (under temperature range of 7-10⁰ C). In the absence of refrigerated transport, growers should ensure that pots are not exposed to the direct sun light otherwise shelf life of the pots will be adversely affected.

Retail Care

Retailers/Florists are advised to keep the finished cyclamen pots in the shade house with good ventilated conditions. The maximum day temperatures in the shade house should not exceed 17⁰ C under any stage and the optimum day temperatures should be maintained at 10-14⁰ C for prolonged flowering. At temperatures above 17⁰ C, shelf life of the pots will be decreased drastically.

Consumer/Individual Handling

Consumers should buy well grown healthy specimens without any disease, insect invasion, with sufficient number of flowers buds ready to burst open. They should keep these pots in well ventilated shady indoor areas of their homes where average day temperatures hover is between 10-13⁰ C and average night temperature range in between 6-8⁰ C. Such conditions will greatly enhance the shelf life of pots and they will remain presentable for longer durations (2-3 months).

Keeping quality, display life of pots and presentability

Well grown specimens of 14 varieties, tested at RHRS, Mashobra

have remained in flowering from 90 days to even 150 days. Display life of pots of most of varieties vary from 100 days to even 175 days.

Diseases

Cyclamen is prone to many diseases. Growers should disinfect everything from potting bench to growing bench and pots. Some of the more common and important disease problems are as under :

1. Fungi :

a) **Crown rot or Botrytis Blight** : It is caused by *Botrytis cinerea*.

Symptoms : Petals, petioles and leaves are susceptible to *B. cinerea*. On petals, the initial flecks enlarge to 1-4 mm, progressing from water-soaked lesions to tan, necrotic spots. Coloured petals show rings of intensified colour around the lesions.

Management : For chemical control, give drenching of Mancozeb @ 2 gm per litre of water in alternation with benomyl spray @ 1.5 gm per litre of water at fortnightly intervals. A spray of Thiophanate-methyl @ 1.5 gm per litre of water can also be given under extreme cases of infection.

b) **Corm rot/Fusarium wilt** (*Fusarium oxysporum*, *F. cyclaminis*). Fusarium wilt is an important and prevalent vascular wilt disease of *Cyclamen persicum* Mill.

Symptoms : Symptoms may appear at any stage of plant growth and are strongly dependent upon inoculum level and growing conditions. The leaves of young seedlings may turn yellow and wilt when the roots are rotted, even though the corms have not yet developed vascular discoloration.

Management : Chemical drenching of combination mixture of carbendazim @ 1 gm plus Mancozeb @ 2 gm in one litre of water alternated with Ridomyl-MZ @ 1.5 gm per litre of water at 20 days interval should be given during the crop cycle. An additional spray of thiophanate-methyl @ 1.5 gm per litre water in the case of extreme infection should be given. Since there are no available cyclamen cultivars with resistance to Fusarium wilt and chemical controls are not entirely effective, sanitation and fumigation of soil-containing media have been recommended.

2. Bacteria

a) Soft Rot (*Erwinia carotovora*).

Symptoms : A sudden wilting and plant collapse characterises this disease, a part of the tuber may become soft and slimy while the roots are intact. Petioles and flower scapes may also become soft and slimy. Corms develop a cheesy, often foul-smelling rot under hot weather conditions.

Management : Stock plants should not be too soft or have excessive or deficient levels of nitrogen. Proper spacing, avoiding splashing water, discarding diseased plants immediately and applying streptomycin @ 1 gm in 10 litres of water will reduce the severity of this disease.

Insects-Pests

Emulsion formulations frequently injure cyclamen leaves and flowers while wettable powder formulations of many insecticides are not phytotoxic.

1. Mites (*Steneotarsonemus pallidus* and *Tetranychus urticae*)

Symptoms : These mites cause curling and distortion, some

discolouration and stiffening of young leaves and flowers. Mites are tiny, not visible to the naked eye and semi-transparent with a brownish tinge. With infestation of red spider mites, yellow or brownish patterns develop on the foliage and in advanced cases, strands of silky webs are formed. Red spider mites are usually found on underside of leaves.

Management : Spray with Dicofol @ 2.5 ml per litre or Thiodan @ 1.5 gm per litre of water at fortnightly intervals. Frequent syringing of the plants helps to create humid conditions which are not liked by these mites.

2. Aphids

The most common is the green peach aphid (*Myzus persicae*). Symptoms include crinkling and distortion of foliage, usually accompanied by shiny specks of honey dew, a sugary excretion. They are visible to the naked eye. Control measures include chemical spray of Dimethoate or Malathion @ 1.5 ml per litre of water at fortnightly intervals.

3. Thrips

White, silvery or brownish streaks develop in somewhat stippled pattern. Thrips are small, narrow, elongated insects of various colours and are visible but often over-looked. They are often hidden in buds and flowers. Control measures are same as those for aphids.

C) Physiological Disorders

There are variety of physiological disorders known to reduce the quality of cyclamen plants.

1. Blasting of flower buds may be caused by high temperatures, insufficient light and water, or excessive soil fertilizer levels.

2. Delayed flowering may be caused by growing the wrong cultivars, high or low temperatures, faulty nutrition, oversized pots or insufficient light.
3. Small flowers may be caused by high temperatures, excessive soil fertilizer levels or growing the wrong cultivars.
4. Stretched plants (too tall) may be caused by insufficient space per plant, excessive soil moisture, insufficient light or high temperatures.
5. Stunted plants may be caused by stunt disease or excessive soluble salt levels in the soil.
6. Weak growth may be caused by high temperatures, diseases, genetic variability, faulty nutrition, crowding, insufficient light or application of excessive concentrations or quantities of GA₃.
7. Hardened, dull blue-green under sized foliage may be caused by applying only the ammonium form of nitrogen.
8. Wilting and soft plants may be caused by dry soil, excess soluble salt levels in the soil, extreme temperatures, poor light or disease.
9. Yellow or chlorotic foliage may be caused by lack of nutrients, high pH, excessive light intensity, dry soil, or disease.
10. Excessive leaf size may result from applying optimum levels of nitrogen, potassium or both or excess soil moisture.

PRIMULA

Importance

These are excellent winter and spring flowering herbaceous plants, with a collection of over 400 species, found throughout the temperate regions of the Northern Hemisphere, both hardy as well as some requiring protection from severe winters and frosts. Their compact dwarf habit of growth and their freedom of flower production make them especially desirable. They are almost indispensable in gardens where a spring display of flowers in formal or informal beds is wanted.

Species of *Primula* grown as late autumn, winter and early spring greenhouse flowering potted plants are *Primula obconica*, *Primula malacoides*, *Primula sinensis*, *Primula kewensis* and *Primula acaulis*. *Primula obconica* and *Primula vulgaris* remain in flowering in winter and spring months in temperate areas of India and have started gaining popularity for their use as excellent flowering and bedding plants.

Commercial Cultivars

Primula vulgaris (syn. *Primula acaulis*) (1,000 seeds per g)
 The common primrose has become a welcome winter-guest in many houses all over the world. This attractive pot plant comes in many bright and pastel colours and is often chosen by growers for its low energy input. Since growers want to produce primroses in various different areas and over a period of several months from autumn into spring, different breeding companies have developed a series of hybrid primroses. Some of the most famous series are Peso, Lira, Corona, Crescendo, Primera, Twilight, Sterling, Joker, Finesse, Lucento and Finale. Each series has a number of colourful hybrids, suitable for various purposes and locations.

Primula obconica (5,000-7,000 seeds per g)

This is the most common of frost tender primulas known for their long flowering period ranging from autumn to spring. Some of the famous cultivars of this species belong to following series :

1. Twilly Series
2. Juno Series
3. Libre Mix Series
4. Ariane Series

Propagation

All Primulas are primarily propagated from seed.

Seed Germination

Seeds may be sown in pans or small shallow flats in a mixture of loam, leaf-mould and sand of about equal proportions, making the surface very fine, pressing the seeds evenly into the soil and covering with about ¼ inch of the finely sifted mixture. Place the flats or pans in a warm greenhouse at a temperature of 12°C to 14°C at night with a rise of 5°C by day. In two or three weeks, the seedling should begin to appear. As soon as they are large enough to handle, they may be pricked out into other flats in a similar soil, about 2 inches apart each way. By the middle of October, they will be good plants, and may be planted out in lines in some sheltered part of the glasshouse. They may be lifted and planted where they are wanted to flower in spring. Propagation by division is practiced when the plants become rather large, or to perpetuate some very fine variety.

Individual Culture

Primula acaulis (syn. *Primula vulgaris*)

Primula acaulis is probably the most widely grown of all the

primulas. Their leaves form compact rosettes, and flowers grow on stalk with many blooms radiating from the centre of the plant. These make excellent 4-inch or 6-inch pot crops as well as wonderful bedding plants in areas where spring is mild.

For best results, keep humidity high, temperatures constant 15°C to 20°C, and never allow the seed to dry out. Seed also requires light to germinate, so do not cover. Since sowings should be done during summer months to produce a crop for sales in the following spring, it is often difficult for growers in warm summer climates to maintain ideal growing conditions. Plugs can be brought in from a specialist propagator to avoid risks.

Primula malacoides

Primula malacoides is fondly known as the Fairy Primrose. These primulas make excellent pot crops and are used as bedding plants in mild winter areas (plants will only take a light frost).

They germinate under conditions similar to *Primula acaulis*. They should be ready to transplant after seven weeks. Plant into a well-drained, light soil mix with a pH of 5.5 to 6.5. Grow at 14°C until established, then drop night temperatures to 10°C to 12°C. Fertilise with a low-nitrogen, high-potash mix. *Primula malacoides* are very sensitive to high soluble salts and water stress, so leach plants every third watering and do not allow to wilt. They are responsive to B-Nine, but if grown with adequate space, a growth regulator is not necessary.

Primula obconica

With the introduction of the Juno series, there has been a resurgence of this old-fashioned pot plant. *Primula obconica* is also known as the German Primrose, and is a very free blooming. The Juno series offers a full complement of seven pastel colours along with a mix,

and is known for its early flowering and uniform plant habit. Cold temperatures are not needed for flower induction, so crops can be grown year round. Allow five to seven months finish time from seed. These attractive plants have round, soft, hairy leaves and full upright trusses of flowers that can provide show in a pot or in a garden in mild climates. Pot mixture-1 (leaf mould, FYM and loam 1:1:1) in 30 cm plastic and 20 cm earthen pots were found best. *Primula obconica* germinates at slightly warmer temperatures than other varieties of primula-try 20°C for best results. Nearly 95 per cent germination was recorded when seed was sown in August-September. It took 25-30 days for germination at a temperature range of 18-23°C. After about eight weeks, transplant one plant per 6-inch pot, or three per 12-inch pot. Use a well drained, light soil mix. Keep growing temperature warm; grow at 20° to 22° C and then, when plants have filled the pot, drop temperatures down to 12° to 15°C for highest quality.

Media

Primula are grown in a wide variety of media, all of which are well drained. For *Primula vulgaris* and *Primula obconica*, the pH of the germinating medium should be between 5.0 and 5.7.

Potting mixtures (1) leaf mould, FYM and soil (1:1:1), (2) moss, sand, soil (2:1:1), and (3) peat, sand and moss (2:1:1) were tried. Pot mixture-I in 30 cm plastic and 20 cm earthen pots were found best for optimal growth and flowering.

Post Harvest Technology

Harvesting should commence when the first five to seven flowers are open. Primula are considered to be highly sensitive to ethylene. Silver thiosulfate (STS) sprays of 0.2 to 0.5 m M increase longevity. Ship at 36° to 43° F (2° to 6°C) and do not allow media to dry because foliage will deteriorate.

Diseases and Pests

Common biotic problems of primula are alfalfa mosaic, anthracnose, aster yellows, bacterial fasciation, Botrytis blight, crown gall, cucumber mosaic, downy mildew, impatiens necrotic spot, Phyllosticta leaf spot, Phytophthora crown and root rot, powdery mildew, primula mosaic, Primula mottle, Pseudomonas leaf spot, Pythium root rot, Ramularia leaf spot, Rhizoctonia root and crown rot, rusts, tobacco necrosis, tomato bushy stunt and tomato spotted wilt. Pythium root rot and Botrytis can develop during periods of high humidity and cold production temperature.

Insects: White flies and Aphids are common problems, and thrips, caterpillars and mites can also occur. Unfortunately, the western flower thrips carry tomato spotted wilt virus. Sometimes bulb and stem nematode, lesion nematode, foliar nematode and root-knot nematodes also infest this flower crop.

GERBERA

Gerbera is one among the top ten cut flowers which are in demand and traded in the world market. Gerbera is also ideal for beds, borders, pots and rock gardens besides as cut flower since cut flowers have long vase life and suit very well for floral arrangements. It belongs to family asteraceae. Based on flower heads, they are grouped into single, double and semi-double cultivars. Commercially semi-doubles are preferred.

Cultivars

A wide range of cultivars is available for commercial cultivation. It is important to select exotic high yielding hybrid varieties with desirable characters such as large sized flowers, long stalk length, semi double/single types of various colours having black centre which have demand in the market. Some of the cultivars grown for commercial purpose are Dalma, Goliath, Savannah, Amulet, Thallasa, Tara, Sangria, Sunset, Ornello, Pink Elegance, Twiggy, Paganini etc.

Propagation

Gerbera is commercially propagated through division of clumps (suckers). However, tissue cultured plants can also be used for commercial production of flowers.

Climate

Day temperature of 22-25°C and night temperature of 12°C to 16°C is ideal for growth and flower production. Shadenet (50%) has to be provided to regulate excess light and temperature. Humidity has to be maintained at 60%.

Growing media

Cocopeat + sawdust + sand (1:1:1) growing media was found best with respect to days required for bud formation, flower diameter, flower stalk length, flower weight, number of flowers per plant,

number of flowers/m² and flower vase life for gerbera cv. Paganini.

Land preparation and sterilization

The land should be ploughed deep 2 to 3 times and brought to a fine tilth. Raised beds of 25-30 cm height, 1 m width and convenient length should be prepared leaving 30 cm passage between the two beds. Well decomposed farm yard manure, sand and coconut coir pith/paddy husk in 2:1:1 proportion should be added to the beds and mixed well with the soil.

Before starting gerbera cultivation, disinfection of the soil is absolutely 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 per 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.

Planting

Gerbera planting is normally done in two seasons i.e. January to March and June to August. Growing of gerbera in raised beds improves drainage and aeration. The plants should not be planted too deep.

Spacing : 30x30 or 30x40 (6-9 plants/m²)

Manures and Fertilizers

FYM	:	7-8 kg/m ²
NPK (12:32:16)	:	250 gm/m ²

Irrigation

Providing sufficient irrigation soon after planting and thereafter

regularly through drip irrigation system is desirable. The average requirement is about 500-700 ml/day/plant (4.5 to 6 l/m² area) depending on the season and stage of the crop.

Harvesting and Yield

Gerbera starts flowering in about 3 months after planting. The average yield under greenhouse is around 175-200 flowers/m²/year of which 85% of grade 1 quality. Harvesting is done when outer 2-3 rows of disc florets are perpendicular to the stalk. The heel of the stalk should be cut about 2-3 cm above the base and kept in fresh chlorinated water.

Insect-Pests

White fly (*Trialeurodes vaporariorum*) : Nymphs and adults sucks sap from lower portion of the leaves. Spray of Malathion @ 0.1% effectively controls the pest.

Leaf Miner (*Liriomyza trifolii*) : The insect bores tunnels in the leaves. Spray of Dimethoate 0.1% helps in reducing infestation.

Diseases

Grey Mould (*Botrytis cineria*) : The fungus infects young apical portion of the plants and also flowers. Humid conditions are favourable for the disease and white powdery coating can be seen on leaves. Spray of carbendazim @ 0.1% controls the disease.

Downy Mildew (*Bremia actuae*) : High humidity favours the growth of the fungus. Spray Ridomil 25 WP (0.1% - 0.15%), 3-6 times at fortnightly intervals.

Root Rot (*Pythium sp, Sclerotinia sp, Rhizoctonia sp.*) : Fungus infection causes rotting of the roots and underground portion. Soil must be sterilized before planting and regular application of copper oxychloride to soil may help in controlling the disease.

CHINA ASTER

China Aster is one of the most important annual flower crops. It belongs to family Asteraceae and is native to China. In India, it is widely grown in Karnataka, Tamil Nadu, West Bengal and Maharashtra.

Soil and Climate

Well drained red loamy soils are desirable, alluvial soils are generally used. Very heavy soils with high calcium content are not suitable. Soil with pH 6.8-7.5 is the most suitable. The flower colour is well developed in the temperature range of 20-30°C during day and 15-17°C during night with relative humidity 50-60%.

Growing Season

Aster can be grown in varied months in all major growing areas depending on prevailing weather and climatic conditions. For maximum flower yield, the best planting time is March-April. For seed yield best time for planting is July.

Propagation

China Aster is propagated through seeds. The seeds loose viability at a faster rate if stored in ordinary conditions, therefore, it is advisable to use fresh seeds. Normally the seeds germinate at a temperature range between 10-35°C, optimum being 21⁰ ± 4°C. The seed rate requirement is 2.5-3.0 kg ha⁻¹. The seeds can be stored in polythene bags and kept in cold store at 2°C.

Sowing

For commercial cultivation, seed is sown in raised beds measuring 120x60x10 cm. Finely prepared beds are drenched with 25 g Captan

or Dithane M-45 in 10 l water before sowing the seeds. The seeds are sown thinly in rows across the length at 10-12 cm apart and covered with a mixture of soil and FYM.

Transplanting

Usually seedlings are ready for transplanting within 30-45 days. The seedlings are hardened sufficiently before transplanting. Transplanting should be done in the early morning or evening to avoid bright sunshine.

About 10-15 tonnes of well decomposed farmyard manure may be incorporated in the soil at the time of soil preparation. Although the practice of spacing varies with the habits of cultivars but generally a spacing of 30x30 or 30x20 is practised.

Fertilizer Requirement

In Bangalore the recommended fertilizer dose is 90 kg Nitrogen, 60 kg Phosphorus and 50 kg Potash per hectare at the time of preparation of land. A top dressing of N @ 90 kg/ha 40 days after transplanting proved beneficial.

Irrigation

Irrigation requirement depends upon the weather, type of soil and season of crop grown. Since it is a shallow rooted crop, it needs continuous soil moisture throughout the period of crop growth. It requires irrigation at intervals of 7-10 days.

Varieties

Important varieties of China Aster recommended for cultivation of various parts of the country are Kamini, Poornima, Shashank, Violet Cushion, Phule Ganesh White, Phule Ganesh Violet, Phule Ganesh Pink and Phule Ganesh Purple.

Growth Regulators

Application of GA₃ 200 ppm as foliar spray improves flower yield and seed yield.

Insect Pests

Chrysomelid beetle (*Aulacophora foveicollis*) : Grubs feed on roots and underground stems leading to wilting and drying of attacked plants. Soil application of phorate or carbofuran @ 1.0 kg/ha gives effective control.

Semilooper (*Ctenoplusia albostrigata*) : It attacks during June, loopers feed extensively on leaves. Spray of carbaryl 0.1% or chlorpyrifos @ 0.05% gives effective control.

Diseases

Collar Rot (*Phytophthora cryptogea*) : Fungus causes rotting of roots and collar portion of the stem. Disease becomes severe during high humid condition. Avoid excess moisture along ridges. Spray fungicides like Captan or Mancozeb.

Wilt : It is caused by *Fusarium* sp. Symptoms include yellowing of leaves and rotting of collar portion. Soil sterilization before planting and application of Benlate or Carbendazim drench helps reducing soil inoculum.

ALSTROEMERIA

Alstroemeria, commonly known as Peruvian Lily is fast gaining popularity as a commercial cut flower and pot plant. Alstroemerias are grown primarily for their beautiful cut flowers of different colours, red, pink, purple, lavender, white, orange, yellow and bicolor. There is large scope for its cultivation in Shimla, Solan, Kullu, Sirmour, Mandi, Palampur areas of Himachal Pradesh.

Cultivars

The important cultivars as per their flower colour are :

Red	Carmen, King, Cardinal, Rrd Sunset, Valiant
Pink	Capitol, Fiona, Olympic, Rito, Trident, Veronica
White	Amanda, Monalisa, White wings
Yellow	Canaria, Eleanor, Friendship, Orchid
Lavender	Barbara, Butterfly, Jupiter
Bronze	Butterscotch
Orange	Harlequin, Sunrise

Propagation

Alstroemeria is propagated by seed, but it is uncommon due to variability and longer time required for germination. The most common method of propagation for cut flower production is by rhizome divisions. For better establishment of Alstroemeria plants, the rhizome portion should have rhizome tip and tuberous roots. The rhizome portions having rhizome tip and storage roots produced highest number of shoots. To produce new rhizomes, nodal segments with or without tuberous roots should be used. For multiplication of rhizomes of Alstroemeria, growing media consisting cocopeat + peat (1:1, v/v) and sand + soil + FYM (1:1:1, v/v) were best for propagation. Micropropagation is also a successful method for mass multiplication.

Environmental Requirement

Temperature : The greenhouse temperatures should be maintained, at night temperature of 10 to 13°C and day temperature should be in the range of 18-22°C.

Light : Lighting hastens flower production. In general, about 13 hours of photoperiod is required for flower initiation. In Norway, supplementary lighting of 900 foot candle from light pressure sodium lamps is used in the winter. A night interruption using 1000 watt incandescent light 87.5 cm apart and 82.5 cm above the plant can be used.

Irrigation: Alstroemerias are grown under slightly dry conditions. Water should be applied through drip irrigation. Excess of water encourages root rot. Overhead watering should be avoided as it causes botrytis disease in dense lower foliage. Optimum humidity about 80-85 per cent should be maintained.

Agronomic requirements

Soil/media : Alstroemeria rhizomes should be planted in a loose, well drained medium, which should be sterilized to prevent soil borne diseases, which cause serious damage to the crop. Chemically, the growing medium is sterilized using Formalin in the ratio of 1:7 (formalin : water). The mixture is tightly covered with polythene and kept for one week. After one week, raking is done and the mixture is again covered. This mixture is kept for another 15-20 days. Other method is the solar radiation, which raises the soil temperature in closed greenhouse conditions during summers. Soil or media should be thoroughly drenched with water and covered with a polyethylene to seal completely all the open ends. The beds are covered for 6 to 8 weeks. It controls weeds, insect and most of the disease causing organisms.

The ideal pH for crop is 6.5 but can vary between 6 to 7. If needed the soil can be amended to the desired texture with the use of peat, perlite and a variety of organic and inorganic amendments. The beds are normally prepared 30 to 40 cm or greater in depth. The plants are spaced at 45x50 cm thereby accommodating 4-5 plants m².

Nutrition

Alstroemeria is a heavy feeder. They are responsive to nitrate nitrogen which is responsible for dark green foliage. Weekly application of nutrients when the medium becomes dry are recommended. Generally 200 to 280 ppm N has been used which is supplied through calcium and potassium nitrate. In general it require N-4.90 to 5.14%, P 0.31 to 0.36%, K-3.69 to 3.90%, Ca-1.42 to 1.48%, Mg-0.44 to 0.62%, Fe-175 to 217 ppm, Mn-195 ppm, Zn-84 to 101 ppm, Cu-6.1 to 7.1 ppm, Boron 0.6 to 27.9 ppm for its growth.

After Care

Height control : Research on height control of Alstroemeria with growth regulators is still in the early stages. Chemicals such as triazoles, Bonzi, Sumagic an A-rest create a 'Cauliflower effect' and prevent flowering. The cultural practices are still the best way to control height. Therefore, for best results one need to adopt some of the measures like grow genetically dwarf cultivars, grow the plants at full light, spacing of the plant should be done adequately, grow at proper temperature and do not keep the plant wet.

Pinching and Disbudding : Generally, pinching and disbudding are not needed however, shoot removal is required as large number of stem that emerge are vegetative. Because of branched growth and the presence of an axillary bud on the rhizomes, stems must be regularly removed to maintain production and to stimulate axillary

shoot elongation. Monthly removal or thinning of old and weak shoots is necessary.

Staking : Three to four layers of supports are required for staking the plants. Normally, first 2 layers of netting consisting of 20x20 cm mesh opening are spread every 20-30 cm above soil line and subsequent layers are 50 cm in height. Supports should be placed over the beds at the time of planting.

Mulching : Mulching with polythene sheet or dry grass has been found beneficial, as in winter it increases soil temperature and in summer it reduces soil temperature. It also reduces population of weeds.

Pot Culture

Alstroemeria cultivars 'Selection No. 14' and 'Riana' have been found suitable for pot culture. Growing medium consisting of soil + sand + cocopeat + vermicompost + FYM, in equal proportions by volume was the best substrate for vegetative parameters like plant height, shoot length, spread, and number of leaves, stem thickness and chlorophyll content. Advanced flowering with greater number of cymes per inflorescence, more duration of flowering and better pot presentability were also recorded with the same medium. Increased rhizome production could also be obtained in this medium : Cyclic lighting with high pressure sodium lamps @ 200-250 fc 30 cm above each plant significantly increased plant height, shoot length, plant spread, number of leaves per generative shoot and stem thickness in both the flushes. It also resulted in earlier flowering, greater number of cymes per inflorescence, increased flower duration and better pot presentability than the natural lighting. Both the cultivars viz., 'Selection No. 14' and 'Riana' responded favourably to retardant treatments. However, 'Selection No. 14' was genetically taller, had thicker stems, flowered earlier, produced more number of cymes per inflorescence and had better pot presentability in

both the flushes than cultivar Riana. Drench and spray application of PP333, Alar and Cycocel resulted in maximum height reduction and best pot presentability in both the cultivars.

Post Harvest Handling

Harvesting : The flower are harvested when colour appears on first flower or when four to five flowers are open in the cluster. To overcome the problems of poor flower opening and leaf yellowing, the flowers (cymes) are not harvested too prematurely.

Long term storage of flower for two weeks at 2 to 4°C has been reported to be successful if stems are pretreated in a silver thiosulphate (STS) and sucrose solution for 24 hours and it also reduces ethylene production. The use of sucrose + 8 HQC + GA₃ has been reported to increased vase life.

Diseases, Insect and Physiological Disorders

Diseases : Alstroemeria are generally attacked by a number of diseases and pests. The major disease, that commonly occurs is Botrytis (*Botrytis cinerea*). The symptoms include blight, leaf spots, tuber rot and finally damping off of the young seedling. It prevails during high humidity. It can be managed by following cultural practices such as restricted watering, improved ventilation, prevent condensation of water drops on flowers.

Pythium (*Pythium* spp.) affects juvenile or succulent tissues and causes rotting. It is managed by sterilizing the growing media and drenching with copper fungicides. Rhizoctonia (*R. solanii*) also attacks small as well as mature plants and causes rooting of roots. It is managed by drenching with carbendazim @ 0.1 per cent or thiram @ 0.2 per cent.

Insects : Aphids, white flies and spider mites are the major pests in Alstroemeria. Aphid and white flies can be controlled by spraying

Rogor or Metasystox @ 2 m/l. For mites control, Metacid @ 0.1 per cent or Dicofol @ 2.1 per cent should be sprayed.

Disorders : Flower abortion or blasting may occur due to low light or when roots are damaged by excessive salts or over watering. Therefore, precautionary measure should be taken to control the disorder.