Protected Cultivation of High Value Cut flowers

Floriculture is fast emerging money spinning component in agriculture sector, growing at a modest rate throughout world and has become the potential agricultural activity especially for the developing countries. Total value of different floricultural products at wholesale level has been estimated to be over 50 billion US$ from about 2 million hectare area in the world.

In India, floriculture is also being viewed as a high growth industry in agriculture sector and this can be judged from the fact that the acreage under floriculture has increased from 30 thousand ha in 1990-91 to 2.54 lakh hectares in 2011-12. Indian floriculture industry is also fast becoming aware of the importance of offering products as per the wishes of consumers. But, with the fast changing trends and a constant urge for new innovative products in domestic and leading international flower markets, the flower growers have to respond promptly.

<table>
<thead>
<tr>
<th>State</th>
<th>08-09</th>
<th>09-10</th>
<th>10-11*</th>
<th>11-12*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tamil Nadu</td>
<td>29.1</td>
<td>32.0</td>
<td>32.0</td>
<td>32.3</td>
</tr>
<tr>
<td>Karnataka</td>
<td>26.0</td>
<td>27.0</td>
<td>27.0</td>
<td>29.2</td>
</tr>
<tr>
<td>West Bengal</td>
<td>19.5</td>
<td>21.9</td>
<td>23.1</td>
<td>23.9</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>21.1</td>
<td>21.4</td>
<td>21.8</td>
<td>64.2</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>16.4</td>
<td>17.5</td>
<td>17.5</td>
<td>18.9</td>
</tr>
<tr>
<td>Total</td>
<td>166.5</td>
<td>182.9</td>
<td>190.9</td>
<td>253.65</td>
</tr>
</tbody>
</table>

*Source: NHB, Gurgaon
Himachal Pradesh has been endowed with a variety of agro-climatic conditions, which makes it possible to grow a large number of flower crops with excellent quality throughout the year in one or other part of the state. The climate in the state ranges from sub-tropical to wet and dry temperate. Flower cultivation has a great role in addition to amelioration of the hill environment to boost the rural economy of the state which owes to the following points:

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area</td>
<td>914 ha</td>
</tr>
<tr>
<td>Total Flower Growers</td>
<td>3500</td>
</tr>
<tr>
<td>Total revenue</td>
<td>Rs. 98.98 crores</td>
</tr>
<tr>
<td>Leading Flowers</td>
<td>Chrysanthemum, Marigold, Gladiolus and Carnation</td>
</tr>
<tr>
<td>Leading Districts</td>
<td>Sirmaur, Kangra, Solan, Chamba, Bilaspur, Shimla and Kullu</td>
</tr>
<tr>
<td>Protected Area under flowers</td>
<td>120+ ha (Approx.)</td>
</tr>
</tbody>
</table>

- Generation of the sources of cash income to the rural people
- Generation of employment opportunities in pre and post harvest activities in this sector
- Satisfying the aesthetic needs of the people
- Development of sustainable system of permanent agriculture in hilly areas

The farmers and horticulturists are in general reluctant to take up flower cultivation on commercial scale, as flowers are highly perishable commodities. But, lucrative governmental policies, higher returns per unit area and time have attracted the selected group of farmers to take up flower cultivation on commercial scale, as Floriculture industry in our country is growing at a modest rate, which has attributed because of the following points:

- Per capita income particularly disposable income has increased
- Individual purchasing power has increased
- Social values of people have changed
- Population specially in cities has increased
- Number of Hotels and Tourists have increased every year
- Increasing air pollution and awareness among peoples to improve deteriorating environment
Favourable conditions for flower cultivation in Himachal Pradesh:

The favourable environmental conditions of mid and high hills are ideally suited for flower cultivation on commercial scale in naturally ventilated greenhouses. High temperature coupled with hot winds during June to September makes it difficult to grow quality flowers in north-western plains, therefore, causes shortage of flowers in the major cities like Delhi, Chandigarh, Amritsar, Ludhiana and Pathankot, where flower prices shot up sharply during this period. The farmers from mid and high hills can take this advantage of congenial mild climate during May to November and can earn higher profit. It is evident from the progress made in flower cultivation in the state that the area under flowers has gone up from 30 ha in 1993-94 to around 813 ha in 2010-11 and more than 3000 farmers have taken up flower cultivation. The total area under protected cultivation in the state has been estimated around 100 ha. The major flower crops being grown under greenhouses in the state are Carnation, Lilium, Gerbera, Chrysanthemum, Rose, Alstroemeria, Daffodils, etc. During 2010-11 floricultural products of about Rupees Seventy-seven crores were sold from the state.

Protected cultivation:

It is the technique of providing favourable environmental or growth conditions to the plants. In greenhouses, the growing environment is altered to suit the specific requirements of plants. It is rather used to protect plants from the adverse climatic conditions by providing optimum conditions of light, temperature, humidity, CO₂ and air circulation for the best growth of plants to achieve maximum yield and best quality.

Principle of greenhouse cultivation:
- The greenhouse is covered with a transparent material such as plastic, pvc sheet or polycarbonate sheet or FRP (Fiber reinforced plastic) or glass.
- Based upon its transparency the greenhouse cover transmits most of the sunlight.
• The crop, floor and other objects inside the greenhouse absorb the sunlight admitted inside the greenhouse.
• These objects in turn emit long wave thermal radiations for which the greenhouse covering material has lower transparency and as a result of this the solar energy is trapped thus leading to increased temperature inside the greenhouse.
• This is known as greenhouse effect.

History of protected cultivation of ornamentals in India:
• Indo-American Hybrid Seeds Company has made greenhouses for cultivation of ornamental plants before 1970.
• M/s Feroz Masani and Sons of Nasik started growing carnations in greenhouses during 1980.
• M/s Pune flowers started growing roses on rock wool in 1/4th acre greenhouse in late eighties for export at Pune.
• Presently over 250 private companies have started producing flowers in greenhouses in India.
• Total area under greenhouses in India has been estimated over 700 ha.

Advantages of growing flower crops in greenhouses:
• Ensures the production of any plant at any place and throughout the year
• Blemish-free high quality product
• Easy to control insect-pests and diseases
• Water requirement reduces
• Labour requirement is less
• Earliness as it reduces crop duration

Advantages of protected cultivation under Indian context:
• Abundant sunshine throughout the year especially in autumn and winter
• The average radiation received at Quito-Equator and Nairobi is 434 and 462 cal/cm²/day, respectively at 1800m AMSL the best centres in the world producing quality cut flowers, which is at par with radiation received at Bangalore (450 cal/cm²/day at 1000m AMSL)
• Ideal temperature
• Shorter production cycle
• Good production during the main international events when demand for flowers is high in Europe and USA.

Basic considerations for flower cultivation in greenhouses:
• Feasibility study
• Type of greenhouse structures
• Planting material
• Growing system
• Plant protection
• Post harvest handling
• Supporting facilities for analyzing quality of water and growing media
• Management and coordination

Growing systems for flower crops in greenhouses:
• Ground beds
• Raised beds
• Benches
• Pots

Characteristics of growing medium:
• Provide adequate nutrients to the crop
• Support or anchorage the plants grown
• Good moisture holding capacity
• Sufficiently porous
• Not saline
• Withstand pasteurization with steam or solarization
• Free from weed seeds, nematodes, etc.

Decontamination of growing medium:
• Chemical drenching/ fumigation: formaldehyde, chloropicrin, hydrogen peroxide, captan and vapam
• Steaming
• Pasteurization
• Solarization

Managing High Temperature:
• Using Naturally ventilated polyhouses with side (1.5m) and top (1m) ventilation
• Use of fan and pad system for cooling
• Use of 50% intensity shade nets (12 noon to 4 pm) installed inside the polyhouses
• Use of foggers/ misters during afternoons once/ twice only in vegetative phase of flower crop
• Photo-selective shading paints with less reduction of PAR allowing 69% light and are useful in late spring and summer@ 450kg/ha in a ratio of 1:3 (paint : water) says Evans, 2009.

Important flower crops commercially grown in greenhouses:
• Cut flowers (Rose, Carnation, Chrysanthemum, Lilium, Gerbera, Tulip, Anthurium, Orchids, Alstroemeria, Eustoma, Gypsophila, Statice, etc.)

1. Rose:

Rose is the leading cut flower in the international cut flowers trade and is also the leading cut flower exported from India. In India, over 90 per cent greenhouses grow rose as cut flower. The leading export cultivars of rose are Cora, Corvetti, Diplomat, Femma, First Red, Grand gala, Kiss, Konfetti, Lambada, Laser, Nicole, Noblesse, Osiana, Papillon, Parea, Passion, Pavrotte, Rodeo, Rossini, Sacha, Samura, Sandy, Sangaria, Soledo, Susanne, Texas, Tineke, Vivaldi. The salient characters of rose cultivars for cut flowers are:

- More number of petals
- Petals open slowly
- More longevity
- Attractive colour
- Long and strong stem

Environmental factors:
- Temperature (Day: 18-28 and night: 15-18° C)
- Light (Photoperiod over 12 hours and intensity: 6000-8000 foot candles)
- Relative humidity (50-60 %)
- Aeration (Good in air and soil)
- CO₂ (1000-3000 ppm)

Soil and growing medium:
Light, well drained
pH - around 6.5
EC less than 1.0
Humus 10-12%

Soilless growing medium:
- sand
- coco-peat
- rock-wool

Optimum spacing and planting density:
- In greenhouse single, double or four row planting system in bed is being followed and spacing of 30 x 25 cm is kept.
- Optimum plating density in greenhouse is 60-70 thousand per hectare.

Propagation:
- Shield or T-Budding (Commercial method)
- Stenting method (Budding done on cuttings, which are planted for rooting in mist chamber)
- Cuttings (Propagation of rootstocks- 15 to 20 cm long stem cuttings of pencil thickness having at least three buds)
- Micro-propagation

Important root stocks:
- Rosa bourboniana
- Rosa indica var. Odorata
- Rosa multiflora

Budding and pruning time:
- Low hills: Dec.-Feb.
- Mid hills: Jan.-Mar.
- High hills: Feb.-April.

Optimum nutrients (ppm) status:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH: 6.2-6.8</td>
<td>Calcium: 55</td>
</tr>
<tr>
<td>EC: 0.7</td>
<td>Magnesium: 20</td>
</tr>
<tr>
<td>Nitrate: 180</td>
<td>Ammonium: 2</td>
</tr>
<tr>
<td>Phosphate: 4</td>
<td>Iron: 0.39</td>
</tr>
<tr>
<td>Potassium: 45</td>
<td>Manganese: 0.04</td>
</tr>
<tr>
<td>Nutrient</td>
<td>Amount</td>
</tr>
<tr>
<td>-------------</td>
<td>--------</td>
</tr>
<tr>
<td>Sodium</td>
<td>25</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.07</td>
</tr>
<tr>
<td>Chloride</td>
<td>35</td>
</tr>
<tr>
<td>Boron</td>
<td>0.08</td>
</tr>
<tr>
<td>Sulphate</td>
<td>105</td>
</tr>
<tr>
<td>Copper</td>
<td>0.05</td>
</tr>
<tr>
<td>Bi-carbonate</td>
<td>30</td>
</tr>
<tr>
<td>Calcium</td>
<td>55</td>
</tr>
</tbody>
</table>

Pruning:
- Cultivar
- Class or category of rose
- Health and vigour of plant
- Spacing
- Soil fertility
- Desired quality

Other plant management practices:
- Pinching
- Disbudding
- De-shooting
- Defoliation
- Removal of faded flowers
- Bending of shoots (about 25 %)

Irrigation:
- Irrigation is done through drip irrigation with one line along every row.
- One drip if inserted about 15cm below the soil level helps to maintain optimum moisture around root zone.
- Daily water requirement varies with the outside temperature from 2 to 5 litres/m².
- Water soluble fertilizers are also given along with irrigation.
- During vegetative phase irrigation through sprinkler/ mister/ fogger is beneficial.

Diseases:
- Die back (*Diplodia rosarum, Colletotrichum sp.*)
- Black spot (*Diplocarpon rosae*)
- Powdery mildew (*Spaerotheca pannosa*)
- Downey mildew (*Peronospora sparsa*)
- Gray mould (*Botrytis cinerea*)
- Rust (*Phragmidium sp.*)
- Crown ball (*Agrobacterium tumefaciens*)
- Wilt (*Marmor flaccumfasciens*)
Insect-pests:
- Red scales
- Red spider mites
- White ants
- Aphids
- Thrips
- Jassids
- Chafer beetles
- Mealy bugs
- Stem girdler
- Sawflies

Physiological Disorders:
- Bull head
- Bent neck
- Limp neck
- Blind shoot
- Vascular plugging

Stage of flower harvesting:
- For local market: When outer one/two petals start unfurling.
- For distant market: Fully coloured tight buds
- White, pink and yellow cultivars are harvested earlier to red as red may not open if harvested at tight bud stage

Popular grades:
- Large flower cultivars: Stem length 60-90 cm and bud size 3-3.5 cm.
- Small flower cultivars: Stem length 40-50 cm and bud size 2-2.5 cm.

Packaging of cut flowers:
- In bundles of 10, 12, 20 or 25.
- In corrugated card board boxes of 100 x 32.5 x 20 cm (L x W x H) accommodates about 80-100 cut roses of 60-65 cm length.
- Wrap flower bunches in cellophane sleeves.
- Inline the boxes with tissue paper or news paper.

Average yield:
- Indian greenhouses: 150-200 stems/m²/year.
- European greenhouses: 350-400 stems/m²/year.

2. Carnation:
Carnation is the leading cut flower grown in 52 ha area during 2009-10 under greenhouses in Himachal Pradesh. This has become popular on account of its following qualities:

- Excellent vase life
- Wide range of flower colours and forms
- Ability to withstand long distance transportation
- Rehydrate easily
- Lighter weight

Florist carnations:
- Standard
- Spray
- Mini
- Micro

Popular carnation cultivars:
- Dona, Pink Dona, Malaga, White Dona, Rony, Rhodos, Lipstick, Empire, Romana, White Tendra, Corleone, Design, Natila, Dark Tempo, Bagatel
silvery pink, Solar, Cobra, Pendy, Lorella, Cabaret, Tanga, Sonsara, Dakar, Liberty, Solar, Green Lady, Tempo, Varna, Sun Shine and Charment.

Environmental factors:
- Light: Photoperiod (long days over 16 hours) and intensity (100 watts bulb spaced at 10.5m at 1.5m height)
- Temperature: Night (winter: 10-11° C, spring: 12.7° C and summer: 13-15.4° C) and day (18-23° C)
- Ventilation: Free circulation of air
- Relative humidity: 50-60%.
- CO₂: 500-1500 ppm

Propagation:
- Terminal stem cuttings (8-10 cm long with 4-6 leaf pairs)
- Micro-propagation

Soil and growing medium:
- Light texture loam or sandy loam soil which is well drained and aerated.
- Soil pH: 6-7

Planting time:
- Low hills: Sep.-Nov.
- Mid hills: Jan.-Feb.
- High hills: Mar.-April
- Staggered planting at 15 days interval ensure regular supply of cut flowers.

Planting density and spacing:
- Ordinary: 25-32 plants/m²
- High: 40 plants/m²
- Standards: 20 x 20 cm
- Spray: 30 x 30 cm

Optimum nutrition:
- N: 5.4%, P: 0.31%, K: 3.8%
- Standards: FYM: 5 kg, N: 30g, P: 20g, K: 10g/ m²
- Spray: FYM: 5 kg, N: 40g, P: 20g, K: 10g/ m²
- Now commercially nutrition is given through fertigation
Fertigation schedule 500 m²

- Day 1: 19/19/19 - 800g
- Day 2: plain water
- Day 3: 0/52/34 - 700g
- Day 4: plain water
- Day 5: Ca(NO₃)₂ - 800g
- Day 6: plain water
- Day 7: 13/0/45 - 400g
- Day 8: plain water
- Day 9: MgSO₄ - 350g + Micronutrient - 300g
- Day 10: plain water

Soil moisture and irrigation:
- Optimum soil moisture is 300-500 cm tension
- Irrigation is done through drip irrigation with three lines in five rows in a bed.
- Daily water requirement varies with the outside temperature from 2 to 3 litres/m².
- Water soluble fertilizers are also given along with irrigation.
- During vegetative phase irrigation through sprinkler/mister/fogger is beneficial.

Pinching:
- In pinching terminal growing shoot about 2-3 cm long is removed to overcome apical dominance and to promote side branching when the plants are at 6-8 leaf pair stage.
- Pinching types:
  - Single
  - Pinch and half
  - Pinch plus pull pinch
  - Double

De-shooting:
- When the side shoots after pinching are 3-5 cm long then retain 3-5 shoots per plant in standard cultivars.
- When the side shoots after pinching are 3-5 cm long then retain 6-10 shoots per plant in spray cultivars.
**Staking:**
- Wire mesh, plastic nets, string or bamboo canes are used to support plants.
- Wire mesh or plastic nets having inner size of 10-15 cm squares are placed on the ground in three layers, which are erected at 20, 35 and 50 cm above the ground level with the growing plants.
- String or rope is erected in three rows at the same distance along the rows.

**Disbudding:**
- Disbudding is the removal of visible (5-10 mm diameter) undesirable buds.
- In standard cultivars terminal bud is retained and all the lateral buds are removed.
- In spray cultivars terminal bud is removed and lateral buds are retained.

**Weeding:**
- Three-four hand weeding.
- Chemicals viz., oxidaizon and napropamide @ 2.2 and 4.5 kg a.i. per hectare are good in greenhouse.
- In open fluchloralin (basalin) and pendimethalin (stomp) @ 1.0 a.i. per hectare each are effective.

**Stages of flower harvesting:**
- Standard cultivars for local market are harvested when flowers are half opened or at painting brush or outer petal is perpendicular to stem, while for distant market cross is developed on buds and colour is visible.
- Spray cultivars are harvested for local market when two flowers have opened and others have shown colour, while for distant market when 50% flowers have shown colour.

**Popular international grades:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Grade</th>
<th>Grade</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bud diameter (mm)</td>
<td>Blue or</td>
<td>Red or</td>
<td>Green or</td>
</tr>
<tr>
<td></td>
<td>Fancy</td>
<td>Standard</td>
<td>Short</td>
</tr>
<tr>
<td>Tight</td>
<td>50</td>
<td>44</td>
<td>None</td>
</tr>
<tr>
<td>Fairly tight</td>
<td>62</td>
<td>56</td>
<td>None</td>
</tr>
<tr>
<td>Open</td>
<td>75</td>
<td>60</td>
<td>None</td>
</tr>
<tr>
<td>Stem length (cm)</td>
<td>55</td>
<td>43</td>
<td>30</td>
</tr>
</tbody>
</table>

**Common grades in India:**
- A: over 45 cm
- B: 30-45 cm
- C: less than 30 cm

Packaging:
- In bundles of 10, 12, 20 or 25.
- In corrugated card board boxes of 120 x 60 x 30 cm (L x W x H) accommodates about 800-1000 cut flowers of carnation.
- Wrap flower bunches in cellophane sleeves.

Diseases:
- Wilt (*Fusarium oxysporum f. sp. dianthi*)
- Foot-rot (*Phytophthora, Pythium, Rhizoctonia solani, Sclerotinia sclerotiarum*)
- Stem rot (*Fusarium roseum*)
- Flower bud rot (*Alternaria dianthi*)
- Bacterial wilt (*Pseudomonas caryophyllii*)
- Rust (*Uromyces caryophyllinus or U. dianthi*)
- Flower blight (*Botrytis cinerea*)
- Fairy ring spot (*Heterosporium echinulatum*)
- Viral diseases

Insect-pests:
- Red spider mites
- Thrips
- Nematodes
- Aphids
- Helicoverpa/ Heliothis/Spodoptera caterpillars

Physiological disorders:
- Calyx splitting
- Grassiness
- Sleepiness
- Splitting at nodes and bushiness
- Small narrow leaves and tied tips

Tinting in carnation:
- A concentrated liquid or powder colour is mixed in small amount of warm pure water (37°C) and stems are placed in it. The colour develops in different patterns on the petals after 10-24 hours.
Average yield:
- 200-300 flower stems/m²/year.

3. **Chrysanthemum:**

Chrysanthemum (*Dendranthema grandiflora*) has origin in Northern hemisphere in China. Chrysanthemum is grown for cut flower, loose flower, pot mum, hanging baskets and bedding and border plant. It has become popular on account of its excellent vase life, wide range of flower colours and forms and lighter flower weight. It is classified on the basis of inflorescence, photoperiod and temperature.

The important cultivars of chrysanthemum for export are Snow ball, Snow Don White, Mountaineer, Sonar Bangla, Bright golden, Anne, Chandrama, Ajay, Birbal Sahni, Lehmans, Nanako and Sonali Tara. Although, chrysanthemum is a short day plant flowering when the critical day length is less than 9.5 hours. However, now the cultivars have been developed which can flower in any season. The important off-season blooming cultivars of chrysanthemum are given below:
- April-June: Himanshu, Jawala, Jyoti
- July-Aug.: Phuhar
- Sep.-Oct.: Ajay, Sharda
- Oct.-Nov.: Makhmal, Megami, Mohini, Sharad har
• Nov.-Dec.: Normal season cultivars
• Jan.-Feb.: Jaya, Lilith, Suneel, Vasantica.
• Feb.-Mar.: Maghi.
• Flowering of these cultivars is recorded at NBRI, Lucknow as these cultivars are developed in this institute.

**Soil:**
Sandy-loam having pH 6.2-6.7 is ideal for growing chrysanthemum.

**Climate:**
- Light (Intensity: 1.2-1.6 MJ/m²/day, Quality: 600-800nm, Photoperiod: less than 9.5 hours)
- Temperature (night: 10-16°C, day: 18-21°C)
- CO₂: 500-1000ppm

**Propagation:**
- Terminal stem cuttings (4-5 cm) during June-July, and
- Suckers during February to April

**Planting density and spacing:**
- Greenhouse cut flowers: 40-54 plants/m².
- Loose flowers: 30 x 20 cm or 20-25 plants/m²
- Standards: 20 x 20 cm
- Sprays: 30 x 30 cm
- Pot mums: 3-5 cuttings/pot (15 cm)

**Nutrition:**
- FYM: 3-5 kg/ m²
- N:P:K::30:10:15g/m² at monthly interval
- Loose flowers: FYM: 10-15 ton, N: 150kg, P: 100kg, K:120 kg/ ha)
- Spray of light solution of cake + SSP at bud developing stage is very beneficial. Apply nitrogen through CAN source as urea causes phyto-toxicity.

**Pinching:**
Twice after 4 and 8 weeks of transplanting

**De-shooting:**
Retain 4-5 shoots in standard and 8-12 shoots in spray cultivars.

**Disbudding:**
Remove lateral buds in standard and terminal bud in spray cultivars.
Irrigation:
Soil should have 60-70 per cent moisture. Depending upon weather 8-10 irrigations of 2.5-5 cm depth are required.

Staking:
Wire mesh, plastic nets, string or bamboo canes are used to support plants. Wire mesh or plastic nets having inner size of 10-15 cm squares are placed on the ground in three layers, which are erected at 20, 35 and 50 cm above the ground level with the growing plants. String or rope is erected in three rows at the same distance along the rows. In pots for standard cultivars single bamboo stick is used and in spray cultivars 3-4 sticks are placed on the sides to protect the plant.

Weeding:
Three-four hand weedings are sufficient. Atrazine @ 1.0 a.i. per hectare is effective before transplanting.

Diseases:
- Wilt (*Fusarium oxysporum f. sp. chrysanthemi*)
- Stem and foot rot (*Rhizoctonia solani*)
- Root rot (*Pythium, Phytophthora spp.*)
- Bacterial rot (*Erwinia chrysanthemi*)
- Powdery mildew (*Oidium chrysanthemi*)
- Leaf spot and flower blight (*Alternaria, Septoria spp.*)
- Gray mould (*Botrytis cinerea*)
- Viral diseases (chrysanthemum stunt, tomato spotted wilt, tomato aspermy, flower distortion, chrysanthemum mosaic and chrysanthemum rosette)

Insect-pests:
- Aphids
- Red spider mites
- Hairy caterpillars
- Thrips
- Grubs
- Leaf miners, and
- Nematodes

Disorders:
- Premature budding
- Quilling of florets
- Crown bud formation
- Heat delay, and
• Petal burn

**Harvesting Stages:**
Standards: When outer row of florets start unfurling for distant market and for local market half opened flowers.
Sprays: Harvested for local market when two flowers have opened and others have shown colour, while for distant market when 50% flowers have shown colour.
Loose flowers: Fully open flowers
Pot mums: 50% buds have developed colour.

**Grades of chrysanthemum cut flowers suggested by Society of American Florists:**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Grade</th>
<th>Blue</th>
<th>Red</th>
<th>Green</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stem length (cm)</td>
<td></td>
<td>75</td>
<td>75</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Flower diameter (cm)</td>
<td></td>
<td>15</td>
<td>12.5</td>
<td>10.0</td>
<td>------</td>
</tr>
<tr>
<td>Stem strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Strong</td>
</tr>
</tbody>
</table>

**Packing:**
In bunches of 10, 20 or 25 in corrugated card board boxes of 91 x 43 x 15 cm (L x W x H) accommodates about 80-100 cut flowers of chrysanthemum. Wrap flower bunches in cellophane sleeves.

**Yield:**
- Standard: 2.5 to 4.5 lakh/ ha
- Spray: 1.5-1.75 lakh/ ha
- Yield in Greenhouse: 150-250 flower stems/m²/year.

**4. Gerbera:**

Gerbera is commonly known as Transvaal daisy or Barberton daisy or African daisy. Its name was coined in honour of German naturalist, Traugott Gerber and it has origin in Natal and Transvaal in South African and Asian region. Important species in genus Gerbera are given below:
- asplenifolia
- aurantiaca
- jamesonii
- *kunzeana*
- *viridifolia*

Important cultivars of *Gerbera*:

Factors affecting growth and flowering of gerbera:
- Light (Long days are good)
- Temperature (Day: 16-22°C and night: 12-15°C)
- Growth regulators (GA₃ and CCC)

Propagation:
- Seeds
- Division of plants
- Cuttings
- Micro-propagation

Ideal planting density and spacing:
- 8-10 plants/m² or 30 X 30 cm or 40 x 25 cm

Nutrient status in gerbera:
- N: 2.7-3.1%, P: 0.19-.0.35%, K: 3.06-3.64%, Ca: 1.66-2.18% and Mg: 0.3-0.48%.

Ideal fertilizer application schedule in gerbera:
- Vegetative stage: N: P: K: Ca: Mg:: 3: 2: 3: 1: 1 @ 75g/m²
- Flowering stage: N: P: K: Ca: Mg:: 3: 2: 4: 1: 1 @ 75g/m²

Diseases:
- Root rot (*Pythium irregularae, Rhizoctonia solani*)
- Foot rot (*Phytophthora cryptogea*)
- Sclerotium rot (*Sclerotium rolfsii*)
- Blight (*Botrytis cinerea*)
Powdery mildew (*Erysiphe cichoracearum, Oidium crysiphoides*)

Leaf spots (*Phyllosticta gerberae, Alternaria spp.*)

Viral disease (Cucumber mosaic virus and Tobacco rattle virus)

**Insect-pests:**

- White fly
- Red Spider Mites
- Nematodes
- Aphids
- Leaf miner
- Caterpillars

**Harvesting stages of cut flowers:**

- Before outer row of ray florets show pollen
- When outer row of petals is perpendicular on stalk.

**Packaging of cut flowers:**

- In insulated boxes to avoid freezing injury
- Plastic coated metal grids 50 x 70 cm with mesh size of 2 x 2 cm.

**Average yield of gerbera cut flowers:**

- Greenhouse: 200-250 flowers/ m²/year
- Open field: 120-150 flowers/ m²/year

**5. Lilium:**

Lilium species has origin in Asia (49), Europe (12) and North America (24). The genus *Lilium* has two distinct groups as Oriental and Asiatic. The cultivars which do not stain clothes and table with their pollen like Tiara (pink single), Aphrodite (pink double) and sphinx (red double) are preferred by most of the flower lovers.

**Characteristics of Oriental lilies:**

- Derived from species *Lilium aurantium, L. speciosum* and *L. rubellum*.
- These are late flowering lilies.
- Flowers are mostly white and pink.
- Flowers are mostly fragrant.
- Leaves are broader and almost parallel to ground, and
- Bulbs are large 16-22 cm.
The important export cultivars are Star Gazer, Macropolo and Casablanca.

**Characteristics of Asiatic lilies:**
- Derived from hybridization of 12 species viz., *Lilium amabile*, *L. bulbiferum*, *L. concolor*, *L. dauricum*, *L. davidii*, *L. hollandicum*, *L. maculatum*, *L. leichtlinii*, *L. pumilum* and *L. tigrinum*.
- These have extended range of flowering period.
- Flower colour varies from orange, red, yellow, etc.
- Flowers are mostly odourless
- Leaves are narrow and upward growing, and
- Bulbs are small 10-16 cm.
- Important export cultivars are Connecticut King, Gran, Paradiso, Elite, Pollyana, Prato and Solemio.

**Soil or growing medium:**
Well drained soil, rich in organic matter and having pH 6.5-7.5. Adequate growing medium is soil: peat moss:: 1:1 or soil: peat moss: perlite:: one part each.

**Climate:**
- Temperature (Day: 18-25°C and Night: 12-18°C)
- Partial shade (40-50%)
- Good aeration/ ventilation

**Propagation:**
Bulbs
Bulblets
Scales, and
Bulbils in *L. bulbiferum*, *L. sargentiae*, *L. tigrinum* and *L. wallichianum*

**Planting time:**
- Low hills: Oct.-Nov.
- Mid hills: Feb.-Mar. and July-Sep.
- High hills: March-April

**Treatment of Bulbs:**
Dip bulbs for about 20 minutes in a solution of Emisan (0.2%), Thiram (0.3%), Captan (0.2%), Bavistin (0.2%) or Benlate (0.2%). Dry in shade before planting or storing. Before planting treat bulbs in systemic fungicide and before storing in contact fungicide. These must be thoroughly dried before planting or storage.
Planting density and spacing:

Planting density and spacing depends upon group of Lilium, bulb size and place of cultivation. In open planting density is 20-40 bulbs/m² and spacing is 40 x 15 cm.

Oriental:

<table>
<thead>
<tr>
<th>Bulb size (cm)</th>
<th>16-18</th>
<th>18-20</th>
<th>20-22</th>
<th>&gt;22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulbs/m2</td>
<td>40-50</td>
<td>35-45</td>
<td>30-40</td>
<td>25-35</td>
</tr>
</tbody>
</table>

Asiatic:

<table>
<thead>
<tr>
<th>Bulb size (cm)</th>
<th>10-12</th>
<th>12-14</th>
<th>14-16</th>
<th>&gt;16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulbs/m2</td>
<td>65-90</td>
<td>55-80</td>
<td>45-70</td>
<td>40-65</td>
</tr>
</tbody>
</table>

Nutrition:

NPK:: 30: 20: 20 g/m² and for liquid feeding of NPK::14: 10: 14. Fertilizers should not come in direct contact with bulbs as it leads to rotting.

Weeding:

Three-four hand weedings and herbicides like Propyzamide @ 2.25kg/ha and chloropham 3.5 l/ha are applied as pre-emergence.

Irrigation:

Soil should have 60-90 per cent moisture and no watering is required until bulbs sprout. Depending upon weather 8-12 irrigations of 2.5-5 cm depth are required.

Staking:

Wire mesh or plastic nets having inner size of 15-20 cm squares are placed on the ground in three layers, which are erected at 20, 35 and 50 cm above the ground level with the growing plants. String or rope is erected in three rows at the same distance along the rows.

Diseases:

- Gray mould (*Botrytis elliptica, B. cinerea*)
- Soft bulb rot (*Rhizopus stolonifer*)
- Fusarium bulb rot (*Fusarium oxysporum f. lilië*)
- Brown scale (*Colletotrichum lilië*)
- Root rot (*Pythium splendens*)
- Bacterial soft rot (*Pseudomonas* spp.), and
- Viral diseases (mosaic)

Insect-pests:

- Aphids
- Thrrips
• White flies, and
• Mites

**Disorders:**
Leaf scorch: It is due to deficiency of Mn, Al which occur at over dose of nitrate level and add lime @ 10 ton/ha.
Bud blast: It is due to storage of water at top of plant, competition for nutrients, fluctuating carbohydrate level, low light intensity and high nitrate level.
Puffy foliage: It is due to frost injury and stunting of plants.

**Harvesting Stages:**
Local market: When 1-2 florets open
Distant market: When 1-2 florets show colour.
Cut stems few centimeter above ground level for increasing bulb size.

**Storage of Flowers:**
Store flowers at 1-2°C.

**Harvesting and Storage of Lilium Bulbs:**
Harvest bulbs after 40-50 days of flowering or foliage start turning yellow. Store the bulbs in moist sand at -2°C for initial three weeks and later on at 0-2°C until two weeks before planting. In hilly areas, bulbs can be stored in moist moss and sand.

6. **Alstroemeria:**
Alstroemeria was named in honour of Klas von Alstroemer who brought rhizomes of Alstroemeria pelegrina to his tutor father of plant taxonomy Linneaeus in 1754. Alstroemeria species have origin in countries like Chile, Brazil, Bolivia, Peru, Paraguay, Venezuela and Argentina. Presently maximum acreage under this flower crop is in the Netherlands, USA and UK. The different uses of Alstroemeria are cut flower, pot plant, herbaceous border and garden flower, as it is regarded as herbaceous perennial in warmer climatic regions. In India, so far it has not gained popularity and no effort has been made to popularize it as either cut flower or pot plant. Recently, Directorate of Horticulture, Himachal Pradesh has made an attempt to popularize it among the flower growers after importing few cultivars from the Netherlands. Mid and high hill areas of the state are very suitable for growing Alstroemeria. Its cut flowers are finding good market in the adjoining flower markets in Delhi and Chandigarh and lucrative price of Rs. 200-300 per dozen is being earned. Individual plant of this is sold by nurserymen @ Rs. 75-100. The flower lovers or consumers prefer to keep it in their homes or offices because of its uniqueness and longer vase life up to 2-3 weeks in ordinary tap water in comparison to lily or other cut flowers. There is also significant prospectus for export, as demand in international market for the last one decade showed progressive increase in its marketing. The important cultivars of Alstroemeria for export are Sangria, King cardinal, Tiara, Mona Lisa, Jessica,
Gold finger, Aladdin, Victoria, Diana, Ursula, Azula, Amanda, Rostita, Jupiter, Purple sensation and Granada.

**Soil/ Growing Medium:**
Cool well drained rich in organic matter medium is good for Alstroemeria. The optimum soil pH is 6 to 7. The ideal medium has one part each of sphagnum peat-moss, soil and sand or Soil, perlite, expanded clay and gravel.

**Climate:**
Alstroemeria prefers cool climate with partial shade. The control of flowering process requires thermo and photo-phase and thermo-phase requirement must be fulfilled before photo-phase. The optimum temperature in greenhouse during night and day is 15 and 18°C, respectively. The newly planted rhizomes/plants should not get more than 13 hours light at least for 6-8 weeks, which will allow the roots to develop sufficiently before flowering. After which supplementary light of more than 16 hours a day ensures early, profuse flowering for longer duration. During summer, when the air- temperature exceeds 30°C and soil temperature exceeds 18°C, the plants become dormant and should normally be divided.

**Propagation:**
The traditional method to propagate Alstroemeria is by division of rhizomes preferably during dormancy. However, continuous division after 10 to 12 weeks in greenhouses is practiced. The plants are cut back to 10 to 15 cm height several days before division. At the time of division older part of rhizomes are removed.

**Planting Time:**
September-October or February-March

**Planting Methods:**
Alstroemeria is planted in the field and greenhouse conditions in the beds which should be 15 to 20 cm deep allowing the roots to grow during the three- four year production cycle. The growing-point of rhizomes is planted 7 to 10 cm deep.

**Spacing:**
The spacing varies with cultivar and purpose whether cultivation is for cut flower or planting material production or both. The optimum spacing between plant to plant and row to row is 40 to 50 cm. For growing Alstroemeria in pots the rhizomes should be plated shallow with growing tips 2.5 to 3 cm deep from the surface of soil, which allows plants to produce more branches, therefore, the pot looks filled.
**Nutrition:**

As Alstroemeria prefers soil with rich in organic matter, therefore, leaf mould or well rotten farm yard manure @ 3 to 5 kg/m² should be added to the soil. The recommended dose of nutrients is N (3.8-5.6%), P (0.3-0.7%), K(3.7-4.8%) Ca (0.6-1.8%) and Mg (0.2-0.4%). The mixture of (20N: 8.8P: 16.6K) @ 2.5g per litre is also ideal for growing Alstroemeria. The nitrogen should be applied in nitrate form. The soluble salt reading should always be less than 1.5m mhos/cm.

**Irrigation:**

Irrigation depends upon the prevailing weather condition. However, to keep the soil/medium moist is beneficial for better growth, flowering and development of rhizomes for which irrigation at 7-10 days interval is ideal. Nutrients can also be applied with the irrigation water.

**Staking:**

Galvanized or plastic wire mesh having a square of 20x20 cm should be erected in three rows at 30 cm height from one another. Bamboo sticks along with string can also be used in the beds in three rows for supporting Alstroemeria plants.

**Diseases:**

Root rot (*Rhizoctonia* and *Pythium*) and plant or flower rot, (*Botrytis* spp.) are important diseases of Alstroemeria.

**Insect-pests:**

- Thrips (These thrips also carry Tomato Spotted Wilt Virus)
- Caterpillars
- Spider mites
- Slugs
- Snails
- Aphids, and
- White fly

**Disorders:**

Flower abortion or blasting: May occur due to low light or when roots are damaged by excessive salts or over-watering. The aborted florets appear as small brownish bumps on the tip of shoot within the whorl of cymes. Fluctuating humidity as very high or very low within 24 hours causes blasting in which fully developed flower buds senesce before reaching complete development, which is even not reduced by increasing light intensity as well as duration.
Harvesting Stages:
Harvesting of spikes depends upon cultivar, market and consumer preference. For local market the shoots/spikes are cut when 4-5 florets have opened. For distant market when first floret has started opening and others have developed 50% colour. Shoots/spikes should be pulled rather cut which will encourage further shoot production.

Post-harvest Handling:
Flowers are very sensitive to ethylene injury, therefore, spray of 0.5 mM Silver Thiosulphate (STS) before harvesting protect the plants from wilting. The 0.5mM STS + 2% sucrose is ideal vase solution. Normally in fresh water the shoots/spikes remain presentable for 2-3 weeks and vase life further increases a week by using preservative solution. The flowers can be stored as wet at 4°C for 2-3 weeks in water buckets. These are packed in bunches of 10/20 in corrugated cardboard boxes. The boxes should be transported vertically to avoid negative geotropism of spikes.

References:

www.apeda.com
www.floraholland.nl
www.nhb.gov.in