

ORNAMENTAL CROPS



Communication Centre
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA

Publication No. : PAU/2022/F/792/E

ISBN:

First Edition : 2022 (..... copies)

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Edited by

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Price : Rs

Printed and Published by Additional Director of Communication
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PREFACE

The state of Punjab has witnessed increase in flower cultivation in the last couple of decades due to the efforts of the Punjab Agricultural University and support by the Govt. of Punjab. Flowers are being used as loose flowers for making garlands, as cut flowers to be used for making flower arrangements or bouquets, for oil extraction, for bedding purpose in landscaping, etc. Different types of flowers have been adopted for open cultivation (Marigold, Gladiolus, Chrysanthemum, etc.) and protected cultivation (Gerbera, Rose, Lilium, Carnation, etc.) by the farmers commercially due to their high demand in the cities. Flower cultivation gives tremendous opportunity in diversification of agriculture, which is also one of the mandates of Govt. policies. The department is making consistent efforts since its inception at the University level to create awareness about the flowers and their role in improvement of environment through landscape use.

Author

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INTRODUCTION

After successful outcome of green, white and blue revolution in terms of production, the people are thinking multicolored revolution i.e. flower cultivation for commercial purpose. Due to hefty international trade of flowers and other floricultural products the farmers in India have started flower cultivation. It is estimated that the world trade of floricultural products is around 50-60 billion US\$. Indian domestic market is estimate to the tune of 3700-3800 crores annually. Punjab state has also considerable area under flower crops which is increasing steadily. Punjab has taken lead in seed production of flowering annuals and their export. Due to various government schemes operation time to time the farmers get motivated for flower cultivation. Punjab Floriculture is characterized by subtropical type of floriculture which gives immense opportunity for wide range of flower crops which includes fresh flowers (marigold, gladiolus, rose, etc), dry flowers, seed production, bulbous ornamentals, pot Plants, essential oil from flowers. Landscaping also part of floriculture involves utilization of planting material for beautification, also holds good potential for income and employment generation in the state.

GLADIOLUS

Gladiolus is an important cut flower which is extensively cultivated in almost all the states of India. The cultivation of gladiolus fits well in the rotation of grain crops under North Indian plains and is considered important in the diversification. It is becoming more popular due to wide range of colours of the spikes and longer vase life in the flower arrangements and bouquets. It possesses great potential for export particularly to temperate countries from sub tropical regions of India during November to April.

Climate and Soil

The day temperature up to 25°C and the night temperature up to 16°C is optimum for proper growth and flowering of gladiolus. Minimum illumination of 8 hours per day is essential for most of the gladiolus varieties. Quality of flower spikes and yield are better in long day conditions whereas corm and cormel production is enhanced under short days. Corm storage at 4-7°C is good for better growth and flower production.

It requires fertile, well-drained and sandy soil for quality spikes and production of corms/cormels. Water logged or heavy sticky soil results in decaying of corms as well as delay in growth of plants. The texture of heavy soils with poor internal drainage can be improved by mixing organic manure such as compost, FYM peat moss or sawdust. The soil with a pH between 6.0 and 6.5 having medium fertility is optimum.

Improved Varieties

1. *Punjab Glad-3 (2019)*: The leaves are dark green and sword shaped. Its spike length is 103 cm with 17 florets facing towards one side in alternate row arrangement. The florets are bright yellow with 17 days vase life. It takes 105 days to flower, produces 1 corm, 22 cormels per corm and is suitable for cut flower production.
2. *Punjab Glad-2 (2016)*: The leaves are dark green and sword shaped. Its spike length is 86 cm with 17 florets facing towards one side in alternate row arrangement. The florets are bright yellow with 16 days vase life. It takes 93 days to flower and produces 1 corm, 47 cormels per corm and is suitable for cut flower production.

3. *Punjab Glad-1 (2013)*: The leaves are pale green and sword shaped. Its spike length is 85 cm with 15 florets facing towards one side in alternate row arrangement. The florets are orange coloured with yellow centre with 16 days vase life. It takes 99 days to flower and produces 1 corm, 44 cormels per corm and is suitable for cut flower production.
4. *Punjab Pink Elegance (2010)*: The leaves are pale green and sword shaped. Its spike length is 85 cm with 18 florets facing towards one side in alternate row arrangement. The florets are soft pink coloured with magenta spot in the centre and have 17 days vase life. It takes 86 days to flower and is suitable for cut flower production.
5. *Punjab Glance (2010)*: The leaves are green, thick and sword shaped. Its spike length is 85 cm and 12 florets per spike facing on front side in alternate row arrangement. The florets are bright orange with yellow centre and suitable for bedding.
6. *Punjab Lemon Delight (2010)*: The leaves are dark green with brown tinge. Its spike length is 84 cm with 12 florets facing towards front in alternate row arrangement. The florets are of lemon yellow colour and suitable for bedding.
7. *White Prosperity (2001)*: The spike length is 96 cm with 17 florets per spike. The florets are white and it takes 110-120 days for flowering and produces 65 cormels per plant.
8. *Nova Lux (2001)*: The spike length is 79 cm with 15 florets per spike. The florets are deep yellow and take 110-120 days for flowering and produce 47 cormels per plant.
9. *Suchitra (1996)*: The spike length is 83 cm with 15-16 florets per spike. The floret are light pink with deep pink blotches and take 90-95 days for flowering and produces 85 cormels per plant.
10. *Sylvia (1987)*: The spike length is 75 cm with 13-15 florets per spike. The florets are brick red to maroon and take 120 days for flowering and produces 15 cormels per plant.

Agronomic Practices

Planting Time

Optimum planting time for commercial crop is September-October. Staggered planting can, however, be done at 10-15 day intervals from mid-August to mid-December to get continued supply of spikes over a longer period and to match the market demand and avoid glut in the market. For early flower production, planting the corms is done in first week of July to third week of August. It will be ready for harvesting during October-November and helps the farmers to fetch better profits and reduce glut in market during main season. Punjab Glance and Punjab Lemon Delight are most suitable for early planting.

Method of Planting

Gladiolus is propagated through corms which are planted at spacing of 30x20 cm accommodating 60,000-70,000 corms in an acre. The depth of planting depends more on the corm size and it should be 7-10 cm. However, high density and ridge/bed plantation can also be practiced depending upon the nature of soil.

GA₃ treatment for flowering grade corm production

Treatment of small cormels with GA₃ @200 mg/l for 24 hrs as dip treatment turn them into flowering grade corm in 2 years as compared to four years required for producing flowering grade come through natural multiplication in gladiolus.

Irrigation and Fertilizers

Gladiolus requires frequent irrigation at an interval of 7-10 days from October to February; afterwards the irrigation is given after 4-5 days depending on the temperature in March-April. The plant stage immediately after sprouting and 4-6 leaf stage are very sensitive to water deficiency. Irrigation should be withheld at least 4-6 weeks before lifting of corms.

The application of 20 tonnes FYM, 40 kg potassium and 40 kg P₂O₅ per acre should be applied at the time of field preparation as basal dose. The nitrogen should be applied in two splits doses i.e. 80 kg per acre at 3-leaf stage and 80 kg and 40 kg potassium per acre at 6-leaf stage.

Interculture Operations

This crop requires 2-3 hoeings, first two during vegetative phase and third after the flowering is over at the time of corm development. Earthing up to 10-15 cm height is done when plants are at 4-6 leaf stage or when plants are 15-20 cm high to avoid crop lodging.

Spike Harvesting and Yield

Gladiolus produce spikes in 60-120 days (2-3 months) depending upon the variety. The spikes should be harvested with secateurs in early morning or late in the evening and immediately kept in water for obtaining better quality. For local market, spikes are harvested when basal one floret is fully opened whereas, for distant market, harvest spike when basal 1-3 florets show color (tight bud). In normal planting density of 60,000 corms/acre, the spike yield is 70,000-75,000 per acre and corm yield is 70,000-80,000 per acre.

Post Harvest Handling

Vase Solution: The spikes kept in vase solution containing sucrose (4%) + aluminum sulphate (400 ppm) or sucrose (4%) + NaOCl (50 ppm) improve post storage keeping quality of gladiolus spikes harvested at tight stage (when 1-2 basal florets showed colour) up to 4 days.

Wet refrigerated storage of spikes: The optimum harvesting stage of gladiolus and storage of gladiolus spikes have also been standardized to store surplus produce and to regulate the supply in market. The spikes of gladiolus should be harvested when 5-7 florets show colour which can be stored at 40° C for 9 days.

Dry refrigerated storage of spikes: Pre-storage pulsing of gladiolus spikes with sucrose (20%), $(Al_2(SO_4)_3 \cdot 16 H_2O)$ (300 ppm) and GA_3 (50 ppm) for 24 hours significantly improves their post storage vase life and per cent opening of florets. Then these spikes could be dry-stored in polypropylene sleeves for 14 days with vase life up to 6 days with 60 per cent opening of florets.

Modified Atmospheric Storage of spikes: The gladiolus spikes harvested at tight bud stage (basal 1-2 florets show colour) are

packed in bundle of 10 spikes in polypropylene sleeve (PP 100 gauge having 120 cm length, 18 cm width and 50 perforations) and stored vertically in cold room ($5\pm 0.5^{\circ}\text{C}$) for 10 days. These spikes can be utilized for other 13 days with acceptable flower quality.

Corm Harvesting and Storage

The corms are ready to harvest after 8-10 weeks of spikes harvesting when the leaves start yellowing and shows drying symptoms. After harvesting, corms and cormels are separated and graded, cleaned in water and dried in shade for 7-10 days. The temperature rise in May results in desiccation of corms at room temperature so these dried corms and cormels are then packed in gunny bags/perforated nylon mesh bags and stored in cold storage ($4-7^{\circ}\text{C}$) up to next planting season i.e., September October.

Plant Protection

Diseases	Symptoms	Epidemiology/ Etiology	Management
Fusarium wilt and corm rot <i>(Fusarium oxysporum f.sp. gladioli)</i>	Disease shows typical symptoms of yellow and wilt. Infected plants also develop sickle shaped leaves. In storage, the fungus produces brown lesions on corms which later turn into hard, dry and brownish-black structures.	The fungus survives in infected corms as well as in soil. Disease appears in severe form when temperature is between $25-30^{\circ}\text{C}$. Fungus propagules spread from infected plant to healthy ones through irrigation, rain splash or surface run off.	i. Use corms of healthy and disease-free plants. ii. Check water flow to uninfected field. iii. After harvesting, cure the corms at $30-35^{\circ}\text{C}$ for 7 to 10 days and discard the corms having rot lesions before storage.

<p>Botrytis blight (<i>Botrytis gladiolorum</i>)</p>	<p>On leaves, small oval to round shaped yellowish-brown lesions with greyish-brown center develop.</p> <p>Water-soaked lesions also appear on floral spike. Later on whole spike is covered with greyish conidial mass.</p> <p>Fungi also produces black coloured sclerotia on rottened corms.</p>	<p>The fungi survive in soil as sclerotia or mycelium on plant debris.</p> <p>The optimal temperature for disease development was found to be 20 ± 5 °C along with leaf wetness up to 96 h.</p>	
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MARIGOLD

Marigold, native of Central and South America, is an important commercial crop grown primarily for loose flower production in Punjab. Marigold flowers hold religious significance and the demand varies according to the festival seasons. Marigold flowers are used mainly for making garlands and decoration for weddings, festivals and religious offerings. Marigold flower colour ranges from yellow, gold to orange, red and mahogany. The flowers are also being used for extraction of yellow dye which is commercially used in pharmaceuticals, as food supplements, animal feed additives and colorants in food and cosmetics. Marigold plants have anti-nematicidal properties and thus are used as an intercrop or in rotation to protect crops from nematode attack. There are three main seasons for marigold cultivation in Punjab i.e. winter, rainy and summer.

Climate and Soil

Marigold requires full sun and grows best in well-drained soils with plenty of organic matter. A wide range of soils with good drainage is suitable for cultivation of marigold. Sandy loam soil with pH 5.6 to 6.5 is ideal for its cultivation.

Improved Varieties

African marigold: These marigolds have large, double flowers around the year. African marigolds are excellent bedding plants and tall varieties can be used as background plantings. eg. Punjab Gainda No. 1, Pusa Narangi, Pusa Basanti etc.

Punjab Gainda No.1 is Open pollinated, heat tolerant variety with fully double medium sized orange coloured flowers. It is suitable for flower production during summer and rainy season. It attains height of 69 cm and flowers in 82 days with flower yield of 11 tons per hectare.

Pusa Narangi Gainda is open pollinated variety with fully double medium sized orange coloured flowers, suitable for flower production during winter season. It attains height of 80-85 cm and flowers in 125-135 days with flower yield of 10-11 tons per hectare.

Pusa Basanti Gainda is open pollinated variety with fully double medium sized yellow coloured flowers, suitable for flower production during winter season. It attains height of 60-65 cm and flowers in 140-145 days with flower yield of 7-8 tons per hectare.

French Marigold: French marigolds are small, bushy plants with single or double, yellow, orange, mahogany-red or bicolored. French marigolds bloom during winter season.

Pusa Arpita is open pollinated variety with dense foliage fully double medium sized orange-coloured flowers suitable for flower production during rainy season. It attains height of 55-60 cm and flowers in 120-125 days with flower yield of 8-9tons per hectare.

Agronomic practices

Field preparation

The field should be well prepared by ploughing and mixing 20 tons of well rotten FYM per hectare.

Planting

Marigold is commercially cultivated through seed. For raising seedlings for one hectare, about 400 g seed is required and the seed is sown on raised nursery beds of 15 cm height. The width of nursery beds should be 1 m and length 5 m. Five to six such beds are required to raise seedlings for one hectare. Nursery beds should be well prepared by mixing 50 Kg of leaf mould/vermicompost. Seed should be covered with this prepared soil and the sides should be drenched with any systemic insecticide so that the seeds are not carried away by ants.

Nursery is to be raised under polythene cover for sowing in January, so that seedlings are ready for transplanting by 25th February for summer crop. For rainy season crop, the time of nursery raising is end June and seedlings are ready for transplanting in first fortnight of August. For winter season, nursery is raised in mid September and seedlings are transplanted by mid-October. Plant spacing is 40x40 cm and 60x60 cm for African and French marigold, respectively. The seedlings should preferably be transplanted during evening hours and are watered immediately. Water the plants thoroughly during the first 10 to 12 days.

Intercultural Operations

Pinching

Pinching is removal of terminal portion of the plant to induce more branching. African marigold plants require pinching 30 days after transplanting.

Irrigation and Fertilizers

Marigold crop requires 100 kg N (220 kg urea), 40 kg P₂O₅ (250 kg single superphosphate) and 40 kg K₂O (67 kg Muriate of potash) per hectare. Both P and K should be applied at the time of field preparation whereas N should be applied in two equal splits first at the of pinching and second one month after first application. The interval of irrigation depends upon season and soil type. Generally, marigold crop needs irrigation at an interval of 7 to 10 days. Drip irrigation at 100% ETC (Crop Evapotranspiration) along with fertigation of 100 Kg N/ha twice a week during vegetative phase, results in 20 percent higher number of flowers per plant.

Weeding

One of the major constraints affecting marigold flower production is the emergence of variety of weeds in the field. Weeds should be removed as early as possible. Two to three weeding are required to raise good crop. Manual weeding is time consuming and costly due to requirement of labour. Uniform spreading of Silver-black polythene mulch (25 µm) or Paddy straw mulch (4 t ha⁻¹) at the time of transplanting provides effective control of weeds in marigold for both summer and rainy season. Chemical weed control is an alternate method of weed control.

Harvesting and Yield

Marigold flowers will be ready for harvest in about 2½ months time from the date of transplanting. The plant continues to bear flowers for another 1½-2 months from the date of first harvest. The flowers are harvested when they fully open. The flowers should be harvested either in the early morning or late evening hours to maintain quality. The flower should be kept at cool place after plucking and covered with moist gunny bags to avoid the loss of moisture. The flower yield during summer season is approximately 100 q/ ha. However during rainy season higher yield is obtained.

Packaging

The flowers are packed in baskets covered with moist gunny bag or moist loose cloth for transportation & marketing. The flowers packed in thermocol box and corrugated fiber box (CFB) performed better among all packages up to 3 days of storage. However, packaging in CFB is economical and preferable over thermocol boxes.

Seed Production

The isolation distance of 1000 meters should be maintained for producing a pure seed crop of marigold. Single flowering plant and other off types should be rouged out. The seed should be collected from rainy season crop, which is harvested in November-December. The dried flowers are harvested and the seeds are separated by removing dry petals and sepals. The dried and cleaned seeds are stored in cool and dry place.

Plant Protection

Diseases	Symptoms	Epidemiology/ Etiology	Management
Leaf spot and floral blight (<i>Alternaria tagetica</i> , <i>Septoria</i> , <i>Botrytis</i>)	Necrotic lesions of dark brown colour are formed on stems, pedicels, calyxes and petals. Floral buds fail to open under severe infection.	Disease development found to be favoured by temperature of 25 ± 1 °C and leaf wetness period of 12 h.	Adopt optimum spacing for air circulation that fastens the leaf drying.

FLOWER SEED PRODUCTION

Flowering annuals are being grown commercially for seed production in northern states of country during the last two decades. The key component of area expansion under flower seed crops is mainly ideal climatic conditions, soils, natural resources and availability of labour. India covers about 1000 ha area in Punjab, Haryana, Andhra Pradesh and Uttar Pradesh under flower seed production with more than 50 % share from Punjab.

Climate and Soil

Most of the perennial flowers of temperate climate behave as annual crops in sub tropical climatic conditions of India and are grown as winter season crops. The ideal temperature range for growing these winter annuals is from 25-30°C during the day and 17-18° C at night for seed germination, growth and flowering. These annuals pass their juvenile phase in December-January, bloom profusely during February-March and set seed in March-April.

These annuals prefer sandy loam, well drained neutral to slightly acidic soils with good water holding capacity. Addition of well rotten farm yard manure or leaf mould in the top provides adequate organic matter and improves the soil quality.

Agronomic Practices

Seed Sowing and Transplanting

The seeds are sown in well prepared nursery beds measuring 1 m wide and 15 cm high from the ground level. The seeds start germinating within one week in summer and two weeks in winter depending upon the nature of crop and prevailing environmental conditions. Seedlings are transplanted after 35-40 days of sowing at 4 leaf stage as per the planting distance recommended. Direct sowing is done in bold seeded crops like sweet peas, *dimorphotheca*, *calendula*, *nasturtium* and *linum*. In flowers with small seed like *Papaver* spp., *Escholtzia californica*, *alyssum*, *nemesia*, *clarkia* and ice plant, the seed is mixed with sand and sown in the field at required distance.

Planting and Fertilizer

1. **Coreopsis:** The *Coreopsis lanceolata* produces sulphur yellow flowers whereas; *Coreopsis tinctoria* produces yellow flowers with maroon center. The optimum time for transplanting of *Coreopsis lanceolata* is the first week of November and of *Coreopsis tinctoria* is the third week of November for seed production. As the planting is delayed by mid November, the seed yield decreases considerably. The seedlings are transplanted at 60 x 40 cm apart. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 120 kg/acre in two splits- after one month of transplanting and remaining half at appearance of bud in the end of February. The seed yield of *Coreopsis lanceolata* is 250-275 kg/acre and of *Coreopsis tinctoria* is 300 kg/acre.
2. **Phlox:** This is pale blue, violet, pink, bright red or white colored flower with slightly scented. The optimum time for transplanting is the first week of November for seed production. Delay in planting after first fortnight of November results in reduction in seed yield. The seedlings are transplanted at 30 x 30 cm apart. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 120 kg/acre in two splits- after one month of transplanting and remaining half at appearance of bud in the end of January. The seed yield is 250-275 kg/acre.
3. **Helichrysum:** This is golden yellow, cream, pink and magenta coloured flower having shining papery petals. The optimum time for transplanting is first week of November for seed production. Delay in planting results in reduction in seed yield. The seedlings are transplanted at 60 x 40 cm apart. This flower has a longer flowering duration from March till mid-May. The seed yield is 70-80 kg/acre.
4. **Gaillardia:** This is yellow, orange, scarlet, or combination of these colors with single or double flowers. The optimum time for transplanting is the third week of November. The seedlings are transplanted at 60 x 40 cm apart. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 120 kg/acre

in two splits- February and March. The seed yield is 200 kg/acre.

5. **Antirrhinum:** This is yellow, red, pink, magenta, scarlet, cream and white colored flower. The flowering is at peak in April. The optimum time for transplanting is during October-November. The seedlings are transplanted at 40 x 40 cm apart. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 100 kg/acre in two splits- one and two months after transplanting. The seed yield ranges between 80-100 kg/acre.
6. **Nasturtium:** This yellow, orange to scarlet coloured flower with trailing habit. The seeds are directly sown in beds in mid-November at 30x 30cm apart and plants come in bloom after mid-March. The flowering is at peak from end March to mid-April. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 140 kg/acre in two splits- one and two months after transplanting. The yield of seed is around 250 kg/acre.
7. **Petunia:** This is white, cream, pink, magenta, mauve or bicolor flower in single and double form. The right time for transplanting is from end October to first week of November. The seedlings are transplanted at 45 x45 cm. This crop comes in bloom during March and has long flowering duration till June. The application of 50 kg P_2O_5 and 50 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 140 kg/acre in two splits- one month after transplanting and February. The seed yield is around 70-80 kg/acre.
8. **Calendula:** It is orange and yellow colored winter season flower. The seedlings are transplanted in October- November at 45x30 cm distance. The plants have a long blooming period from December till April with peak flowering in March. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at time of field preparation as basal dose. The urea is applied as 120 kg/acre in two splits- one month after transplanting and end of December. The seed yield of open pollinated varieties is around 160-170 kg/acre.

9. **Sweet Alyssum:** This is white or purple coloured flower with dwarf growth habit. The seedlings are transplanted from end October to first week of November. The plants are transplanted at 30x20 cm in raised beds, the flowering is at peak from end February to mid-March. The estimated seed yield of this crop is 50-60 kg/acre.
10. **Pansy:** This is violet or yellow colored flower with marking of contrast colour or blotches. The optimum time of transplanted is mid November. The seedlings are transplanted at 30x20 cm in raised beds; the flowering is at peak in March. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 100 kg/acre in two splits- one month after transplanting and end of January. The average seed yield is 70-80 kg/acre.
11. **Ice plant:** This is a dwarf plant bearing pink, magenta, purple, white, cream and peach flowers in March. The seedlings are transplanted from end October to first week of November. The plants are transplanted at 30x20 cm. The application of 40 kg P_2O_5 and 40 kg K_2O per acre is done at the time of field preparation as basal dose. The urea is applied as 120 kg/acre in two splits- one month after transplanting and end of January. The seed yield is 150 kg/acre.

Pollination behavior and Isolation distance

The self-pollinated flowering annuals like balsam, lupin, sweet peas and cleome do not require any isolation distance, often cross pollinated crops like antirrhinum, salvia, linum, linaria and aster have 5-10% chances of seed set due to cross pollination hence require at least 100 meter planting distance. In case of cross pollinated crops like sweet alyssum, calendula, *Coreopsis lanceolata*, *Coreopsis tinctoria*, gaillardia, helichrysum, corn flower, delphinium and verbena, 500 meter to one kilometer of isolation distance is required for maintaining the seed purity of a crop species and varieties.

Seed Collection and Cleaning

Method of seed collection depends on flowering behavior and maturity of flowering annuals. The mature pods with pale yellow to brown colour become dry and show the signs of splitting are

picked individually or mass harvesting is done accordingly. In longer duration crops like coreopsis, gaillardia, helichrysum, the pods are picked in initial 3-4 pickings followed by mass collection from end April to mid-May. The pods of calendula, pansy, petunia, helichrysum and poppy are handpicked, kept under shady well ventilated place, followed by cleaning with sieving and winnowing. This is practiced in *Coreopsis lanceolata*, *Coreopsis tinctoria*, phlox, nasturtium, ice plant, phlox, linaria, gamolepis, candytuft, nemesia and *alyssum*, antirrhinum etc. However in crops like, candytuft, phlox, nasturtium, ice plant and *Coreopsis tinctoria*, only single harvesting with sickle is done when the flowers start fading and petals droop down. The harvesting duration in each crop varies from 15 to 45 days.

PANSY

Pansy is one of the most popular garden flowers which are perfectly suited for planting in pots, window boxes, as bedding plant for landscaping. The wide range of flower colours including yellow, chocolate, red, maroon, cream, purple, blue, orange in self or with contrasting blotch along with different sizes of the flower are the desirable characteristics for the popularity of bedding plants.

Climate and Soil

The ideal temperature range for growing pansies is from 25-30°C during the day and 17-18° C at night for seed germination, growth and flowering. Pansy is grown as winter season annual under sub tropical conditions of Punjab and adjoining areas. Sparse flowering initiates by end December, but the plants remain in juvenile phase during chilling days of December – January and bloom profusely in February- March in northern states of India.

Pansies prefer sandy loam, well drained soils with good water holding capacity. Addition of two inches of well rotten farm yard manure or leaf mould in the top provides adequate organic matter and improves the soil quality. The soils with high pH can be corrected with the addition of peat moss.

Improved Varieties

1. *Punjab Sunaina (2017)*: Its plants are dwarf, leaves light green and flowers purple and yellow colour. It is an early variety and bears small sized flowers for four months. It is suitable for pot culture and bedding.
2. *Punjab Neelma (2017)*: Its plants are dwarf, leaves dark green and flowers purple colour. It is an early variety and bears small sized flowers for four and half month. It is suitable for pot culture and bedding.
3. *Punjab Purple-Wave (2013)*: Its leaves are dark green with purplish tinge. The plant height is 30 cm, takes 64 days to flowering and flowering duration is 76 days. The flowers are purple with dark purple blotch and one plant produces about 71 flowers. This variety is suitable for pot culture and bedding.

4. *Punjab Choco-Gold (2013)*: Its leaves are light green. The plant height is 31 cm, takes 66 days to flowering and flowering duration is of 83 days. The flowers are yellow with prominent chocolate blotch and one plant produces about 83 flowers. This variety is suitable for pot culture and bedding.

Agronomic Practices

Seed Sowing and Transplanting

The optimum time for sowing seeds of pansy is the last week of September. The seeds are sown in well prepared nursery beds measuring 1m wide and 15 cm high from the ground level. The seeds start germinating within 7-10 days. Seedlings are transplanted after 35-40 days of sowing upon attaining 3- 4 leaves in the last week of October to first week of November.

Irrigation and Fertilizers

The first irrigation is given immediately after transplanting and subsequent irrigations are given at an interval of 6-7 days from November to February. As the flowering is at peak in March, special care is taken for maintaining proper moisture for the regular production of flowers and seed setting. Therefore succeeding irrigations are scheduled and given after 4-5 days interval for best results.

Addition of 15-20 tons farmyard manure per acre three months before transplanting is quite beneficial for initial establishment of seedlings. At the time of final field preparation add 40 kg/acre each of phosphorus and potash. Nitrogen @ 40-50 kg/acre should be applied in three splits from end January to mid March at an interval of 20 days at the time of hoeing.

Weeding

At the same time crop needs regular removal of weeds throughout the growing season. Three to four hand weedings are required initially after one month of transplanting and then in February March for proper aeration and to loosen the soil texture.

Seed Harvesting

In pansy the flowers are produced by the end of December

to mid April, similarly the pods get mature over a period of time requiring staggered picking. These seed pods are then dried in shade for 3-4 days and seed is extracted and cleaned manually.

Seed Production

Pansy is often cross pollinated flower and requires hand cross pollination for proper seed set. For hand pollination, the flowers at half open stage are pollinated by taking pollen from the socket enclosing pollen grains and applying it to the stigma with very small match stick or small brush. This is practiced daily throughout the flowering period preferably in the morning hours from 8.00 am to 12.30 pm for obtaining desirable results.

SWEET PEA

Sweet pea is a tall sweet scented flowering annual with plant height around 1.5-2 m and excellent for herbaceous border as colourful background plant. There is a wide range of flower colours varying from white, blue, crimson, red, peach, pink, magenta etc. which are widely grown in border, trellis, fences and screening purpose in the garden. The individual flowering stems of sweet pea are used as cut flowers for making small flower arrangements, bouquets, etc. For cut flower production, plants are trained as single stem to individual canes with side shoots and tendrils to improve the quality of blooms.

Climatic and Soil

The ideal temperature range is from 25-30°C during the day and 17-18° C at night for seed germination, growth and flowering.

Sweet pea requires sandy loam fertile and well drained soil. Clayey soil should be avoided to minimize the losses due to fungus attack. The soil may be deeply digged and incorporated with well rotten farm yard manure or leaf manure to a depth of two feet almost one month before planting. The seedlings may grow weak and leggy under insufficient light and shady area therefore sunny place should be preferred.

Improved Varieties

1. *Punjab Sweet Pea-1 (2016)*: Its plants are tall and climbing. Leaves are light green and flowers of magenta colour. It takes 102 days to flowering and duration of flowering is 42 days.
2. *Punjab Sweet Pea-2 (2016)*: Its plants are tall and climbing. Its leaves are light green and flowers of pink colour. It takes 105 days to flowering and duration of flowering is 45 days.
3. *Punjab Sweet Pea-3 (2016)*: Its plants are tall and climbing. Its leaves are dark green and flowers of maroon colour. It takes 106 days to flowering and duration of flowering is 47 days.
4. *Punjab Sweet Pea-4 (2016)*: Its plants are tall and climbing. Its leaves are dark green and flowers of purple colour. It takes 105 days to flowering and duration of flowering is 47 days.
5. *Punjab Sweet Pea-5 (2016)*: Its plants are tall and climbing.

Its leaves are light green and flowers of cream colour. It takes 106 days to flowering and duration of flowering is 48 days.

Agronomic Practices

Seed Sowing

The seeds of sweet pea are bold enough to handle and are directly sown in situ in moist soil in first fortnight of October under North Indian conditions. The seeds are soaked in water for 24 hours before planting to soften the hard seed coat. The seeds are sown in lines about 1.0-1.5 cm apart and covered with mixture of soil and fine sieved manure. Seeds start germinating within 10 days of sowing.

Irrigation and Weeding

Regular watering should be ensured for proper vegetative growth to get best flower crop. Three to four hand hoeing are done in December-January at the juvenile stage of crop to ensure aeration. At the same time, excessive watering before and after flowering should be avoided which results in rotting of roots and stems thus reducing the flower and seed yield of commercial crop.

Training

The plants attain 1.5 to 2.0 feet height by December and start bearing the tendrils which are then trained. Sweet pea are generally allowed to scramble up the support like wooden sticks, plastic fences or trained around trellis, pergolas depending upon the individual choice. It can be trained by fixing the wooden poles, galvanized pipes and chicken wire netting and thin gauze wires may be fixed to these pipes. The flowering starts by last week of March and goes up to end April. For enhancing the flower beauty, faded and mature flowers are removed regularly to prolong flowering period.

Seed Harvesting

The pods containing 5-6 seed each, get mature in the second fortnight and are picked individually in the month of May. These seeds are then cleaned and stored in air tight containers for next season crop.

ANTIRRHINUM

Antirrhinum, commonly known as snapdragon, is a perennial plant but treated as an annual or biennial. Antirrhinum is one of the principal cut flower crops grown in many parts of the world, in suitable environment during the growing period, in tropical, subtropical and temperate countries. Magnificent flowers are borne on terminal long spikes of many colours with good keeping quality for several days. These qualities make it an excellent cut flower. It is also highly suitable for various landscape uses such as bedding, in rockeries, pots or herbaceous borders.

Climate and Soil

The optimum temperature of 18°C is required for successful growth of the plants. It grows best in full sun.

It requires soil having pH 6.0-6.5 with good water holding capacity.

Improved Varieties

1. Punjab Antirrhinum-1: Its plants are tall, leaves are dark green and flowers of yellow colour. It takes 91 days to flower, produces 12 racemes and flowering duration is 72 days.
2. Punjab Antirrhinum-2: Its plants are tall, leaves are dark green and flowers of cream colour. It takes 92 days to flower, produces 15 racemes and flowering duration is 77 days.
3. Punjab Antirrhinum-3: Its plants are tall, leaves are dark green and flowers of magenta colour. It takes 87 days to flower, produces 16 racemes and flowering duration is 81 days.
4. Punjab Antirrhinum-4: Its plants are tall. Its leaves are dark green and flowers of pink colour. It takes 89 days to flower, produces 14 racemes and flowering duration is 75 days.

Agronomic Practices

Seed Sowing and Transplanting

The seeds can be mixed with little amount of sand and sown during September-October in nursery beds/ or seedling trays. Seeds start germinating in 6-7 days and seedlings of 7-8 cm tall are transplanted in pots or flower beds at 30-40 cm apart.

Irrigation and Weeding

The plant does not thrive well during the rains as a certain amount of dryness around the root region is preferred by the plant and over-watering cause rotting. Three to four hand hoeing are done in December-January at the juvenile stage of crop to ensure aeration.

Seed Harvesting

The pods are pinched from the plant when completely dried and then shaken to remove the dry and brittle seeds. If the seeds do not produce rattling sound in the pods, let the pods dry for few more days before harvesting. If harvesting is delayed for too long, the pods will burst and the seeds will fall on the ground.

CHRYSANTHEMUM

Chrysanthemum is an important crop grown as loose flower, cut flower, pot culture and bedding plant. It is highly suitable for floral decoration in marriage palaces, social functions, for making garlands and worship at religious places, bouquet making and flower arrangements.

Climate and Soil

Chrysanthemum normally flowers during November and December under Punjab conditions, while some varieties may flower early in the month of October. The optimum temperature requirement for this crop is 25°C during the day and 15°C during night and the day light for good quality flower production is 13.5 hours.

Light to heavy textured well drained, sandy loam soil rich in organic matter having pH of 6.5 is ideal soil for chrysanthemum. Chrysanthemum is a shallow and fibrous rooted plant and is very sensitive to water logged conditions.

Improved Varieties

1. *Punjab Shingar (2018)*: It requires 122 days for flowering after transplanting. Plants are about 62 cm tall having upright growth habit. Flowers are white in colour, decorative type and 7.0 cm in diameter. Its flower yield is 179.5 q/ha and suitable for loose flower production.
2. *Punjab Mohini (2018)*: This variety requires 93 days for flowering. Plants are 15 cm tall. Flowers are single Korean type, white in colour with yellow center. This variety produces 331 flowers per plant and suitable for pot culture.
3. *Punjab Shyamli (2015)*: This variety requires 117 days for flowering. Plants are about 75 cm tall. Flowers are pompon type, purple with dark purple center and 5.3 cm in diameter. This variety produces 4 sprays per plant and suitable for cut flower production.
4. *Reagan White (2008)*: This variety requires 103 days for flowering. Plants are 83 cm tall. Flowers are single Korean type, white in colour and 8.43 cm in diameter. This variety produces 4 sprays per plant and suitable for cut flower production.

5. *Reagan Emperor (2008)*: This variety requires 104 days for flowering. Plants are 79 cm tall. Flowers are single Korean type, purplish pink in colour and 8.5 cm in diameter. This variety produces 4 sprays per plant and suitable for cut flower production.
6. *Kelvin Mandarin (2008)*: This variety requires 102 days for flowering. Plants are 48 cm tall. Flowers are copper in colour, pompon type and 4.5 cm in diameter. This variety produces 4 sprays per plant and suitable for cut flower production.
7. *Kelvin Tattoo (2008)*: This variety requires 101 days for flowering. Plants are 41 cm tall. Flowers are cadmium yellow with red center in colour, pompon type, and 3.37cm in diameter. This variety produces 4 sprays per plant and suitable for cut flower production.
8. *Yellow Charm (2008)*: This variety requires 101 days for flowering. Plants are 17 cm tall. Flowers are single Korean type, bright sulphur yellow in colour. This variety produces about 287 flowers per plant and suitable for pot culture.
9. *Mother Teresa (2008)*: This variety requires 119 days for flowering. Plants are 37 cm tall. Flowers are anemone type, white with cream center. This variety produces about 136 flowers per plant and suitable for pot culture.
10. *Anmol (2007)*: This variety requires 144 days for flowering. Plants are 50 cm tall. Flowers are anemone type, bright yellow in colour. This variety produces about 208 flowers per plant and suitable for pot culture.
11. *Royal Purple (2007)*: This variety requires 141 days for flowering. Plants are 45 cm tall. Flowers are anemone type, purplish pink in colour. This variety produces 201 flowers per plant and suitable for pot culture.
12. *Yellow Delight (2007)*: This variety requires 88 days for flowering. Plants are 66 cm tall. Flowers pompon type, bright yellow in colour having 5.2 cm diameter. This variety produces 5 sprays per plant and suitable for cut flower production.
13. *Autumn Joy (2007)*: This variety requires 101 days for flowering. Plants are 58 cm tall. Flowers are decorative type, pink in colour. This variety produces 283 flowers per plant and suitable for garden decoration.

14. *Garden Beauty (2007)*: This variety requires 132 days for flowering. Plants are 70 cm tall. Flowers are spoon type, dark maroon in colour. This variety produces 73 flowers per plant and suitable for garden decoration.
15. *Winter Queen (2007)*: This variety requires 128 days for flowering. Plants are 75 cm tall. Flowers are spoon type, pink in colour. This variety produces 125 flowers per plant and suitable for garden decoration.
16. *Punjab Gold (2001)*: This variety requires 76 days for flowering. Plants are 23 cm tall. Flowers are semi - double coppery red at tight-bud stage changing to yellow at full bloom. This variety produces 84 flowers per plant and suitable for pot culture.
17. *Birbal Sahani (1997)*: It requires 121 days for flowering. Plants are 65 cm tall having upright growth habit. Flowers are compact, pompon type, snow white in colour having 4.8 cm diameter. Its flower yield is 32.0 q/ha and suitable for loose flower production.
18. *Baggi (1997)*: It requires about 137 days for flowering after transplanting. Plants are 65 cm tall having upright growth habit. Flowers are snow white in colour, decorative type and 5.1 cm in diameter. Its flower yield is 143.0 q/ha and suitable for loose flower production.
19. *Ratlam Selection (1997)*: It requires about 138 days for flowering after transplanting. Plants are 57 cm tall having upright growth habit. Flowers are creamish white in colour, decorative type and 8.1 cm in diameter. Its flower yield is 175.0 q/ha and suitable for loose flower production.

Agronomic practices

Field Preparation

The field is ploughed two to three times before planting. The planting beds are well prepared after incorporating well rotten farm yard manure @ 20 tones / acre at least one month before planting of rooted cuttings. At the time of final field preparation, add 80 kg P_2O_5 (500 kg Single Super Phosphate) and 80 kg K_2O (133 kg Muriate of Potash) per acre as basal dose.

Method of Propagation

Chrysanthemum is propagated through terminal cuttings or suckers under partial shade conditions. Five to seven cm long terminal cuttings are taken from the healthy mother plants from mid June to end of July. Basal 2-3 leaves are clipped off and cuttings are planted in propagation trays filled with burnt rice husk or sand as rooting medium. The trays are kept under shade net and cuttings are watered 2-3 times daily to maintain high humidity which is highly desired to prevent desiccation of the cuttings and for the formation of roots. The cuttings root in 2-3 weeks and are ready for transplanting in field, pots or beds.

Maintenance of mother stock plants

Healthy suckers sprout from plants after flowering in the month of February. During this period healthy suckers are uprooted from the main field and again planted on raised beds. Pinching is done during April and May to get sufficient number of terminal cutting in the month of June.

Planting

Rooted cuttings are transplanted in the field in the end of July to first week of August at a distance of 30x30 cm in the evening hours to avoid desiccation. Spacing may be reduced up to 30x15 cm if planting is delayed. Irrigate the field immediately after transplanting. Pots are prepared by transplanting one rooted cutting of standard varieties and three cuttings of spray varieties per pot of 8 inch size. Pots are filled with 2 parts of garden soil, 1 part of sand, 1 part of leaf mould or 1 part of well rotten farm yard manure.

Irrigation and Fertilizer

Chrysanthemum needs frequent irrigations at regular intervals during August - October through flood irrigation. Overwatering should be avoided as this crop is very sensitive to water logging. 40 kg of N (160 kg CAN or 87 kg Urea) should be applied in two supplemental doses of 20 kg N each (80 kg CAN or 44 kg Urea) one and two months after transplanting of rooted cuttings.

Intercultural Operations

Chrysanthemum requires three to four hand weeding to keep the crop free from weeds and to get quality flowers.

Pinching is practiced in small-flowered spray type varieties and growing tips of the plants are removed. Pinching helps to produce more number of side shoots. The plants should be subjected to pinching when they attain the height of about 15 cm and all plants should be pinched at the same time to promote uniform growth. Normally pinching is done 4 weeks and 7 weeks after transplanting that leads to the emergence of side shoots and also increases the number of flowers on the plant. Disbudding is practiced in standard varieties to allow the development of a single terminal large sized flower bud by removing all side buds. Staking of chrysanthemum plants can be done with sticks or plastic nets to provide support. The net levels are first raised at 15 cm, second 30 cm and third 45 cm from ground level in field area. The standard varieties with large-sized flowers require staking and single stake with stick is enough. In spray varieties, 2-3 stake are required that are given in the periphery of the pot to give support to the outer growing branches which will give a globular appearance to the plant.

Harvesting and Yield

For loose flower purpose, flowers are harvested when fully opened without taking any portion of their stalks in the cool hours of the day. Standard chrysanthemums are harvested fully open but before the central disc florets begin to elongate and spray chrysanthemums are harvested when 50% flowers show colour. The yield varies from 80,000-90,000 cut flower stems per acre, whereas for loose varieties, 15-80 q/acre flowers can be produced.

Plant Protection

Diseases	Symptoms	Epidemiology/ Etiology	Management
<p>Leaf spot (<i>Septoria chrysanthemella</i>, <i>Bipolaris setariae</i>, <i>Phoma chrysanthemicola</i>)</p>	<p>Dark brown-black coloured spots are formed on the leaves that lead to premature withering. Lower leaves are infected first then infection proceeds upward. Sometimes these spots may have yellowish margins.</p>	<p>Cool-wet periods of rainy season enhances the disease development.</p>	<p>i. Provide good air circulation to minimize leaf wetness. ii. Avoid overhead irrigation in the morning.</p>

ROSE

Rose is one of major loose flower crop grown in Punjab. It is also cultivated as cut flower but under protected conditions. Rose is perennial in nature. Desi Rose produces flowers almost throughout the year. It is cultivated in almost all the districts of Punjab with major cultivated areas in Ludhiana, Fazilka, Patiala, Amritsar and Bathinda.

Climate and Soil

Rose requires open and sunny conditions for its better growth. Temperature range 15-25⁰C is most ideal for flower production but can tolerate upto 38-40⁰C with reduction in flower production. Deep, well drained soils with good water holding capacity and ample organic matter are ideal for its cultivation. Ideal soil PH range is 6.0 -7.5 for its cultivation.

Improved Varieties: Local varieties are being cultivated for loose flower production.

Agronomic Practices

Field Preparation

Field is thoroughly ploughed and 20 tons of well-rottened FYM is incorporated in one acre at least one month before planting. Inorganic fertilizers can also be added at the time of field preparation.

Planting

Desi rose is propagated from stem cuttings. Generally, one year old, pencil thick, 10-15 cm long cuttings with 5-6 buds are taken. These cuttings are planted in sand beds under shade. The rooted are transplanted in polybags for planting in the next season. The best time for propagation is November-December.

The plants generally planted in two row system at a planting distance of 60x100 cm, leaving 150 cm space between two rows. The rose plants can be planted in the months of October to February whereas bare rooted plants can be planted only in the months of November -December.

Irrigation and Fertilizers

Irrigation is applied at 10-15 days interval in winter and 5-6

days interval during summer. Drip irrigation system can have added advantages. Nitrogen @100 kg per acre at monthly interval improves growth and flower yield.

Intercultural Operations

Roses require annual pruning. Pruning practice improves flower yield and quality. Time for pruning is December-January. When the plants are dormant, they are cut upto 45 cm from ground level with sharp secateurs. All the diseased, dead, weak and criss-cross branches are removed. The centre of the plant is kept open. Fungicidal paste is applied on the cut ends to avoid die back disease.

Hand weeding is generally done as per need. Since there is sufficient space between rows and plants, mulching can also be practiced with paddy straw or polythene.

Harvesting and Yield

It produces flower almost throughout the year but peak flowering is observed during March-April and fully opened flowers are harvested early in the morning for marketing. Flower yield is around 30 quintals per acre.

Plant Protection

Diseases	Symptoms	Epidemiology/ Etiology	Management
Black spot (<i>Diplocarpon rosae</i>)	Black spots having fringed margins appear on the leaf. Under favorable weather, spots coalesce to make large irregular spots. Infection may extend to peduncle and stem.	Rainfall along with temperature between 10 to 25 °C encourages the disease.	i. Avoid overhead watering that keeps plants wet for extended periods of time. ii. Prune canes back to two buds if canes are infected

Powdery mildew <i>(Podosphaera pannosa)</i>	Whitish powdery fungal mycelial growth appears on the leaves. Young leaves show distortions.	Conidial germination and growth are favored by high humidity and temperature near 21 °C.	
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TUBEROSE

Tuberose (**Rajani gandha**) a bulbous flowering plant is widely grown for its fragrant flowers. It is commercially grown for making garlands, floral ornaments, gajras, cut flower, bouquets, flower arrangements and extraction of essential oil for cosmetics and perfumery industries. Flowers are of single and double types. Single type varieties are more fragrant, white in colour with one row of petals. Double type varieties are also white in colour with pink tinge but have more than three rows of petals and mild fragrance.

Climate and Soil

The tuberose requires open sunny location and can grow well in warm and humid climate for quality flowering. The temperature for growth ranges from 20°C to 30°C. Temperature above 40°C affects the spike length and flower quality. The tuberose grows on a wide range of soil but well-drained sandy loam soil rich in organic matter with pH range from 6.5-7.0 is the best soil.

Improved Varieties

1. Arka Prajwal: Flowers are of single type with single layer of petals, more fragrant and used for loose, cut flower purpose and oil extraction. The flower buds are slightly pinkish in colour while the flowers are white after opening.
2. Suvasini: Flowers are of double type with 2-3 layers of petals and used for cut flower purpose. The flowers buds are pure white in colour.

Agronomic practices

Field Preparation

Soil should be ploughed two to three times and leveled properly before planting of tuberose and add well rotten farm yard manure @ 20 tones /acre one month before planting. Add 60 kg of phosphorous and 80 kg potash (MOP) /acre as a basal dose at the time of planting (SSP).

Planting

Tuberose is propagated through bulbs and division of bulbs. Bulbs should be planted on raised beds for heavy soil and on flat

beds for sandy soils. The best time of planting of bulbs is March-April under Punjab conditions. The bulbs are planted at a spacing of 30 x 30cm and depth should be 5-7cm. Tuberose crop requires moist soil conditions for proper growth and flowering.

Irrigation and Fertilizer

Frequency of irrigation or quality flower production may depend upon the weather conditions and moisture level of the soil. Soil should be kept moist but waterlogged conditions should be avoided. During early growth phase, 60 kg Nitrogen/acre may be applied in two split doses at monthly interval for better vegetative growth. The fertilizer dose can be reduced depending upon the fertility of the soil.

Intercultural operations

Tuberose requires three to four hand weeding to keep crop free from weeds and to get good quality flowers.

Harvesting and Yield

Tuberose flowers are ready to harvest from June to October. The flower spikes for cut flowers are harvested when the basal florets are fully open, whereas for loose flower purpose and for extraction of essential oil, flowers are harvested at fully open stage. The yield varies from 10-20 tonnes loose flower /ha and 1-1.5 lakhs spikes/ha.

Ratoon Cropping

After harvesting the main crop, about 2-3 ratoon crops can be taken from a single planting. The fertilization, irrigation, weeding, hoeing and all other cultural practices should be practiced for proper growth and development of plants. The ratoon crop results in more number of spikes but number of florets, length of spikes and weight of flowers may be reduced.

Harvesting of Bulbs

The bulbs are harvested after 40-45 days, when the flowering is over and the leaves become yellow and start drying. At this stage, irrigation is withheld and the soil is allowed to dry before digging out the bulbs. The leaves are cut off at the ground level and the bulbs are lifted. The bulbs or bulblets are separated out and kept in shade for 4-5 days for drying and can be used for

planting. These cleaned bulb and bulblets can also be planted after 4-6 weeks or kept as stock material for the next season planting.

Plant Protection

Diseases	Symptoms	Management
Leaf blight (<i>Alternaria polyanthi</i>)	Brown spots appear with light concentric ring on the mid-rib. Due to infection, margins become rough and blighted.	i. Adopt optimum spacing and remove infected leaves.
Root knot nematode (<i>Meloidogyne incognita</i>)	Roots of infected plants showed gall formation. Infected plants were stunted in growth. Flower stalks become deformed and zig-zag.	i. Destroy root at the time of harvesting. ii. In case of heavy infestation, avoid ratoon crop.

PROTECTED CULTIVATION ORCHIDS

Orchids belong to the largest and most diverse family Orchidaceae, consisting of about 700-800 genera and more than 25000 species. The genera of orchids that are of commercial importance are Dendrobium, Cymbidium, Phalaenopsis, Oncidium, Vanda, Mokara, Arachnis and Cattleya. Orchids vary in their growth habits. Orchids are divided into two types namely sympodial and monopodial based on their growth habit. Orchids are monocot plants. They may be epiphytic, terrestrial or lithophytic. Among these genera, Dendrobium are the most popular tropical orchids getting fame as cut flower as well as pot plants in the world. They are preferred for their beauty and long vase life.

Climate

Orchids can grow over wide ranges of climatic conditions. Majority of the cultivated orchids are native to tropical countries and are found in humid tropical forests of South and Central America. Dendrobium species perform well under temperature range of 18-28°C (with 21-29°C day and 18 to 21°C night) with 75% shade net and 70 - 80% humidity. Light intensity of 1500–2000 foot candles is ideal for its optimum growth and flowering. Under Punjab conditions orchids can be cultivated only under controlled environmental conditions of greenhouse.

Improved Varieties

The following two varieties of Dendrobium spp. are suitable for cultivation under Punjab conditions.

Sonia Red: Medium in growth habit, suitable for year-round flowering, bi-colored (purple and white) 7-8 florets per spike.

Sonia White: Plants with fast growth habit, flower colour white with 9-10 florets per spike.

Agronomic Practices

Potting and Repotting

Orchids require perforated plastic pots as they have better drainage and aeration for roots than mud pots. The potting mixture

comprising of coconut hulls, vermicompost and charcoal in equal proportion is suitable for its growth. Orchid pots need repotting when either the plants or the flower quality start to decline. Generally, this happens after 3-4 years of planting. At the time of repotting, plants can also be divided for multiplication and planted in newly filled pots.

Planting

They are propagated mainly through tissue culture, but can also be propagated vegetatively from keikis, stem cutting, pseudo-bulbs and division during July-August. Ideal time for planting of orchids under hi-tech polyhouse is February-March

Irrigation and Fertilizers

Since Dendrobiums are grown in perforated pots filled with porous media that hold little water, they should be irrigated on daily basis during summer months and on alternate days during rainy and winter season. Orchids require considerably copious amount of nutrients for their growth and flowering. Nutrition application in the form of liquid is found to be much effective in orchids. Orchids are slow growing in nature; therefore, slow releasing fertilizer mixtures (NPK) should be applied @ 1g/litre twice a week through fertigation in liquid form either through drippers or foliar application to get the best result.

Harvesting and Yield

Orchid flowers are harvested when 75 per cent of the flowers on the spike are fully open. Plants produce on an average 3-4 spikes per year.

Gerbera

Gerbera is an important commercial crop grown under naturally ventilated polyhouses for cut flower production. Cut flowers of gerbera are used in flower arrangements, bouquet making as well as for decoration of walls during social functions. Gerbera plants are also grown as pot plants and bedding plants for landscape purpose. Gerbera flowers are available in different shades including red, yellow, orange, white, cream, pink, terracotta, orange, intermediate and bicolour.

Climate and Soil

The optimum day temperature of 20-25°C and night temperature of 12-15 °C is ideal for gerbera cultivation. Relative humidity inside the polyhouse should be 70-75% with good air circulation. To prevent the crop from scorching sunlight in summers, 50 per cent shade nets are used.

The soil should be well drained, light, fertile and slightly acidic in nature. The pH range of 5.5 to 6.5 and EC less than 1 ms/cm is the most ideal for gerbera cultivation. As the roots of plants go as deep as 45-50 cm, the plants should be grown on the raised beds.

Improved Varieties

Tissue cultured plants of different colours depending upon market need are to be procured for planting. The popular varieties cultivated are Julia, Amlete, Snow Flake, Winter Queen, Hawana, Pink Elegance etc

Agronomic Practices

Field Preparation

Add well rotten FYM @ 10 tonnes along with SSP 100 kg (P_2O_5) and MOP 66 kg per acre as a basal dose. Add sand or rice husk, if the soils are clayey. Beds of 70 cm width, 45 cm height, leaving 40 cm between two beds are prepared. To protect the crop from soil borne diseases, soil sterilization must be carried out well for gerbera cultivation.

Planting

Gerbera is commercially propagated through tissue culture. Optimum time for planting is February-March or August-September. Keep the crown of gerbera plants 1-2 cm above the soil level at the time of planting to avoid rotting of crown. Plants are planted at 35 x30 cm spacing in two row planting system.

Irrigation and Fertilizers

The average requirement of water is 300- 700 ml/day/plant. For better plant growth and flower yield apply NPK in 1:1:1 (19:19:19) ratio @ 0.4 g/plant every day for first three months. Afterwards, apply NPK in 2:1:4 (15:8:35) ratio @ 0.4 g/plant every alternate day.

Intercultural Operations

Hand weeding should be done whenever required. Remove flower buds up to 8 weeks of plantation. Hoeing is done once in 2 weeks to provide proper aeration and older leaves are periodically removed for the growth of new leaves.

Harvesting and Yield

The plants start flowering 2 months after planting. Flowers should be harvested by pulling gently or bending the stem when 2-3 rows of disc florets are fully open. Flowers are graded for uniformity and individual flower head is packed in 4.5 inches poly sleeves. Bundles of 10-12 flowers each are made and packed in corrugated boxes. Average yield is 225 -250 cut flowers/square meter/year and productive life of plants is 3-4 years.

Plant Protection

Diseases/ Nematode	Symptoms	Management
Leaf blight (<i>Alternaria alternata</i>)	Brown-black coloured necrotic spots having a yellow halo and concentric rings appear on the leaves. Lesions coalesce leading to leaf chlorosis and defoliation. During severe infections, necrotic portion falls off giving “shot holes” symptoms.	Reduce relative humidity inside the polyhouse.

FERNS

Ferns are an attractive addition to any home or office. They are used in planters, in hanging basket, or can even be used to give the mass effect as fillers, as specimens in atriums, greenhouses and conservatories. Ferns are widely distributed world over and are the important foliage plants. They are highly valued florist greens for the elegant symmetry of their fronds, usually green foliage, form and freshness of leaves. Different spp. of ferns can be grown in Punjab. The least costly greenhouse (Shade net house) could be used for commercial cultivation of ferns.

Climate and Soil

The ideal temperature range for most interior foliage plants is between 15°C and 28°C, similar to that found under the canopy of trees. Chilling injury occurs below 10°C for some tropical ferns. Ferns are moisture loving plants. These plants perform well if relative humidity is above 50 per cent. They thrive best where relative humidity is often 80% or greater like in their native environments. The humidity level in houses is very low especially during winter so, double pot your plants by placing the main growing container inside a second container lined with moist sphagnum moss to help provide extra moisture.

Ferns are shade loving plants and require 50-75% shade for their proper growth and development. Direct sunlight damage the foliage. The best colour intensity of the ferns plants is produced under low light intensity. In Boston fern, frond (leaves) production is maximum under 75% shade.

Agronomic practices

Field Preparation

Ferns grow best in an organic-medium similar to the soils in their natural habitats. In Boston fern, FYM should be applied at 10t/acre as basal dose at the time of field preparation. Ferns can also be grown in pots so the potting media should be porous that facilitate quick drain of excess water.

Planting

Ferns are easily propagated through division of mother plants. One year old mother plant can be divided into 15-20 new plants

which are used for planting. Ferns are planted in the months of February-March or July-August at spacing of 30x30 cm.

Irrigation and Fertilizers

During active growth, these plants should be watered on regular basis in order to keep the soil moist. These plants need grooming periodically to help them maintain health and vigor. A balanced fertilizer of N, P and K is needed for proper growth. Fern plants should be fertilized lightly once a month from April through September. No fertilization is needed during winter months. In Boston fern, N should be applied at 50 kg/acre in 4 equal splits at 3 months interval.

Harvesting

Fully expanded mature and dark green fronds are harvested and packed in bunches of 80-100 fronds.

VALUE ADDITION OF ORNAMENTALS

The flowers lose their freshness very quickly and this is the major loss in floriculture industry. So to reduce this loss, different value added products can be prepared from flowers and other plant parts besides being used as fresh. Different value addition techniques- drying, dehydration, flower processing, packaging, tinting etc. could add value up to 5-10 times to the floral products.

Drying and Dehydration of flowers and foliage

The use of dry flowers and foliage in floral arrangement has increased considerably due to their non-perishable nature and availability, especially when there is scarcity of flowers during summer season. Different value added products such as bouquets, greeting cards, wall hangings, potpourri, collages and decoration of gift boxes could be prepared from dry flowers.

The common methods of drying include air drying, press drying, silica gel drying, oven drying and microwave drying. Air drying is one of the cheapest and easiest methods of drying flowers. The press drying is one of the oldest methods in which flowers and foliage are simply placed in between the layers of old newspaper and pressed under light weight for 4-5 days. Microwave or Oven drying is done by embedding flowers horizontally in desiccants like silica, sand, borax etc in trays and drying them in oven or microwave.

Technologies for drying of flowers

Briza - The flowers are tied in bunches of 15-20 and dried by hanging in inverted position for four to five days in a well ventilated dark room.

Bromus - The flowers are tied in bunches of 15-20 and dried by hanging in inverted position for four to five days in a well ventilated dark room.

Gomphrena –The flowers are tied in bunches of 10-15 and dried by hanging in inverted position for four to five days in a well ventilated dark room.

Golden Rain Tree - The flowering stems with seed pods are tied

in bunches of 4-6 and dried by hanging in inverted position for four to five days in a well ventilated dark room.

Laguras - The flowers are tied in bunches of 10-12 stems and dried by hanging in inverted position for four to five days in a well ventilated dark room.

Larkspur - The flowering stems are dried by burying them in silica gel (60-120 mesh) for six days. The flowers are placed in horizontal position in plastic trays with 2 cm layer of silica gel at the base. Holes and crevices in between the flower petals are properly filled with silica gel by shaking to avoid the shriveling of petals and proper shape retention.

Golden rod - The panicles are tied in bunches of 8-10 and dried by hanging in inverted position for four to five days in a well ventilated dark room.

Statice - The flowers are tied in bunches of 8-10 stems, and dried by hanging in inverted position for five to six days in a well ventilated dark room.

Technologies for dehydration of foliage

Asparagus – The leaves are completely immersed in tray having 20% glycerin solution(20 ml of glycerin is thoroughly mixed with 80 ml of warm water) for 7-8 days. The dehydration process is complete when the whole leaf becomes soft and flexible. The dehydrated leaves are then hung upside down for 3-4 days in a well ventilated dark room for removal of glycerin solution from their surface.

Fern –The leaves/fronds are completely immersed in tray having 20% glycerin solution(20 ml of glycerin is thoroughly mixed with 80 ml of warm water) for 7-8 days. The dehydration process is complete when the whole leaf becomes soft and flexible. The dehydrated leaves are then hung upside down for 3-4 days in a well ventilated dark room for removal of glycerin solution from their surface.

Silver Oak –The leaves are completely immersed in tray having 20% glycerin solution(20 ml of glycerin is thoroughly mixed with 80 ml of warm water) for 7-8 days. The dehydration process is complete when the whole leaf becomes soft and

flexible. The dehydrated leaves are then hung upside down for 3-4 days in a well ventilated dark room for removal of glycerin solution from their surface.

Tinting of flowers

Tinting is a value addition technique of adding colour to white or light coloured flowers. The colours can be synthetic dyes or food colouring agents. The flowers can be tinted by spraying dye or dipping in dye. Tinting enables the farmers and florists to fulfill the demand of desired colour for attractive flower arrangements.

Tinting of tuberose spikes

The spikes of tuberose could be tinted by dipping 5-7 cm of basal portion of spikes in dye solution having 1% food dye of desired colour, 2% sucrose and 300mg/ L citric acid for 2 hrs. The florets of the spikes will have desired colour after 2 hrs.

ANNEXURE-I
Nomenclature of important flower crops

S. No.	Common name	Botanical name
1.	Rose	<i>Rosa hybrida</i>
2.	Gladiolus	<i>Gladiolus grandiflorus</i>
3.	Chrysanthemum	<i>Dendranthema grandiflora</i>
4.	African marigold	<i>Tagetes erecta</i>
	French marigold	<i>Tagetes patula</i>
5.	Gerbera	<i>Gerbera jamesonii</i>
6.	Tuberose	<i>Polianthes tuberosa</i>
7.	Orchids	<i>Dendrobium sp.</i>
		<i>Cymbidium sp.</i>
8.	Boston fern	<i>Neprolepis exaltata</i>
	Maiden hair fern	<i>Adiantum aethiopicum</i>
	Bird's nest fern	<i>Asplenium nidus</i>
9.	Coreopsis	<i>Coreopsis tinctoria, Coreopsis lanceolata</i>
10.	Helichrysum	<i>Helichrysum bracteatum</i>
11.	Phlox	<i>Phlox drummondii</i>
12.	Gaillardia	<i>Gaillardia pulchella</i>
13.	Antirrhinum	<i>Antirrhinum majus</i>
14.	Nasturtium	<i>Tropaeolum majus</i>
15.	Petunia	<i>Petunia hybrida</i>
16.	Calendula	<i>Calendula officinalis</i>
17.	Sweet alyssum	<i>Lobularia maritima (syn. Alyssum maritimum)</i>
18.	Pansy	<i>Viola x wittrockiana</i>
19.	Ice plant	<i>Mesembryanthemum criniflorum</i>
20.	Larkspur	<i>Delphinium ajacis</i>
21.	Statice	<i>Limonium sinuatum</i>
22.	Gomphrena	<i>Gomphrena globosa</i>
23.	Golden rod	<i>Solidago canadensis</i>
24.	Briza	<i>Briza maxima</i>
25.	Bromus	<i>Bromus inermis</i>
26.	Lagurus	<i>Lagurus ovatus</i>
27.	Asparagus	<i>Asparagus setaceus</i>
28.	Silver oak	<i>Grevillea robusta</i>
29.	Golden Rain Tree	<i>Koelreuteria paniculata</i>