



GOOD AGRICULTURAL PRACTICES FOR COMMERCIALY IMPORTANT FLOWER CROPS



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Importance and Scope of Good Agricultural Practices for Flower Crops

Good Agricultural Practices (GAP) is a code of crop production practices that ensure sustainable production of flower crops, that are environment friendly, economically viable, socially acceptable and complies with the legal standards. The set of prescribed practices must address efficient resource management besides ensuring higher yields and good quality on a sustainable basis, must take care of the welfare and safety of persons working or living in the farm. Use of quality planting material that follow the prescribed standards of uniformity, tolerance to biotic and abiotic stress must be adhered to, so as to ensure input use efficiency and sustainable production. The cultural practices must not have adverse effects on the environment, like pollution of land, water and air.

The following aspects must be addressed for GAP in commercial flower crop production:

- The farm should have a proper site history to understand the microclimate and other associated factors which may affect the productivity, safety and quality of the produce to avoid or minimize contamination.
- The grower should have a clear identity in the form of registered grower as an individual, group or society.
- Record maintenance is must and cultivation sheets on crop production, cropping sequences, crop rotations and systems.
- Record of the variety used for production, names of root stock and scion in case of grafted varieties have to be maintained. Record of periodical soil and water analysis has to be maintained.
- Documentation of manures and fertilizers applied and plant protection chemicals will help in understanding its response in terms of yield and quality and further management practices.
- The produce must be traceable to the farm where it has been originally produced.
- Safe production must adopt integrated pest, disease, weed and nematode management approaches.
- For safe handling of chemicals proper measuring devices and mixing equipment should be used and appropriate method of disposal of containers and obsolete plant protection gear should be adopted to avoid any kind of contamination and pollution.
- Documentation of plant protection chemicals used and adopting safety measures like using protective gear during application of these chemicals to avoid health hazards to the workers is important. Additionally, ensure availability of first-aid kit at the farm.
- Record maintenance by the farms must be up-to-date and the records must be maintained and retained for at least 2 years unless otherwise stipulated by any specific legislation. The records shall be accessible and audited.

Rose under open cultivation

Rose (*Rosa hybrida* L.) is the 'Queen of Flowers' which is cherished for its intrinsic beauty, mesmerizing aroma and stupendous health benefits. Roses are grown under open cultivation for loose flowers which are used for religious offerings, for preparation of garlands, extraction of essential oils, rose water, rose syrup, gulkhand etc.

Importance and scope of Good Agricultural Practices:

- Farmers use a lot of plant protection chemicals to get quality produce in commercial cultivation of rose.
- Since edible value added products are prepared from rose beside pigment and essential oil extraction, GAP assumes a greater significance in commercial production of rose.
- For economical and sustainable production and use of quality inputs at critical time, a set of practices is enlisted below for GAP in rose.

Soil and climate

- Deep loamy soil rich in organic matter with pH of 5.5-6.5 is suited for rose cultivation
- Rose cultivation can be taken up ideally in cooler climate with bright sunlight
- Places with day temperature ranging between 25-30°C and night temperature of 15°-18°C are suitable for rose production.
- At temperatures lower than the ideal, interval between flushes become longer. When the temperature increases above 30°C, care has to be taken to provide high humidity and to reduce the evaporation loss.

Planting material

- Improved varieties / hybrids released by research organizations or planting material produced by registered nurseries should be used for commercial production
- The planting material should meet the minimum requirement of the standards with regard to uniformity, size, vigour, it should be true to type and free from pest and diseases
- As far as possible varieties/hybrids which are resistant to major pests and diseases should be selected for cultivation
- Special nutritional requirement for specific varieties/hybrids should be ascertained and the nutrients management should be scheduled accordingly

Propagation

- Rose can be propagated by cutting / budding
- Take cutting / scions from a healthy, vigorous and disease-free mother plant
- Rose plants are propagated by budding or top-grafting on rootstocks like *Rosa indica*, *R. multiflora*, and *R. canina*. 'Nishkant' variety of root stock are without any prickles and easy to bud with high bud uptake.
- Budding in polybags is ideal for easy transportation of material
- Budded plants that are 3 months old are used for planting
- For bare rooted plants, budding has to be taken up in soil and can be shifted 6 months after budding

Planting

- Land should be prepared with thorough ploughing, harrowing and levelling
- Nourish the soil with plenty of organic matter
- Do not apply fresh manure for plant nutrition. Ensure that compost is well decomposed

before use

- Get initial soil sample analysed by a nearby laboratory and plan any addition of plant nutrients accordingly
- Planting can be taken up in rows with spacing of 1 m × 1 m. Depending on the spacing, pits or trenches of 1-2 feet depth is dug to fit roots in the proper position unbent.
- Water the plants immediately after planting.
- Care must be taken to ensure that the bud union must be 2-3 cm above soil

Aftercare

- After planting, shade need to be provided to plants till the plants gets established
- Building up of plant by proper training is important
- Disbudding has to be done during the initial period of 4-6 months after planting
- Removal of emerging rootstock buds in its initial growth is very essential as rootstocks are vigorous and try to outgrow the budded cultivar
- Regular weeding has to be done

Manures and fertilizers

- Regular analysis of soil, water and leaf will be good guide to supply optimum nutrients
- Well decomposed organic manure @ 8 tonnes / acre is to be added and mixed well in the soil before planting
- Nutrient application of 240:80:280 kg NPK/acre/year is recommended
- Fertilizers can be applied in equal split doses in monthly intervals
- Soil application of micronutrient (FeSO₄ and ZnSO₄) @ 2 g/ plant or sq.m twice or thrice in a year based on soil test report or foliar spraying of 0.1% (FeSO₄ and ZnSO₄) if visible symptoms are seen

Irrigation

- Irrigate the plants according to the specific water requirements of the varieties
- Use water from a clean source. Do not use water that may be contaminated by chemicals or waste materials
- The water requirement is 4-6 liter/m²/day through drip irrigation depending on the plant growth and weather conditions

Harvesting

- Stage of harvest varies with the variety and distance to the market
- Harvesting is done during cool hours of the day, either in the early morning or in evening hours
- Use clean and sharp harvesting tools
- Loose flowers are harvested at the initiation of flower opening
- Depending upon the market demand flowers can be harvested at different stages of petal unfurling
- The average yield of flower is 15 t/acre/year
- Flowers has to be shifted to cool places immediately after harvesting
- Damaged/bruised flowers should be discarded and disposed hygienically
- For local market the loose flowers are transported in bamboo or in gunny bags

Plant Protection

Insect pest management

Thrips

- Spray dimethoate 30 EC @ 2ml/l with pongamia oil 0.5% 2 - 3 times at 15 days interval with onset of new flush will minimize their incidence
- Apply Fipronil 5 SC @ 1.5ml/l or imidacloprid 17.8 SL @ 0.5ml/l or spinosad 45 SC @ 0.25 ml/l in case of severe infestation
- Drench the soil with Chlorpyrifos 20EC @ 5ml/l for killing pupae in soil

Aphid

- Spray Acetamaprid 20 SP (0.25 g/L) or Dimethoate 30 EC (2ml/L) when infestation begin
- Spraying of neem or pongamia oil 2 % also gives effective control
- In case of severe infestation spray Imidacloprid 17.8 SC @ 0.5 ml/l or cartap hydrochloride 50SP@ 1g/l
- Spray of *Lecanicillium lecanii* at 3g/l also effective against aphids

Bud borer

- Collection of mature larvae reduces borer population
- Spraying of indoxacarb 14.5 SC @ 0.75 ml/l or methyl parathion 50EC @ 1ml/l or fenvalerate 20EC @ 0.5ml/l in combination with diflubenzuron 25 WP @ 2g/l at appearance of eggs on tender foliage checks borer damage
- Neem seed kernel extract 4% or neem oil 1% also give good protection to foliage
- Spraying of *Ha-NPV* @ 250 LE per ha causes significant mortality of larvae

Two spotted spider mite

- Cutting and burning of severely infested plant parts
- Proper ventilation, irrigation and clean cultivation keep the pest under control
- Spray dicofol 18.5 EC @ 1ml/l or wettable sulphur 80EC @ 3g/l or profenofos 50EC @ 1ml/l or ethion 50EC @ 1ml/l followed by pongamia or neem oil or jatropa oil at 5ml/l under open cultivation
- Release predatory mite *Amblyseius tetranychivorus* @ 20 mites/plant when *T. urticae* populations are at moderate levels. Spray *Lecanicillium lecanii* formulation at 5g/l during evening.

White fly

- Spray Thiamethaxam 25 WG (0.5 g/l) or spiromesifen 240 SC (1 ml/l) or diafenthiuron 50 WP (0.75 g/l)

Nematode

- At the time of planting, apply 1 kg of FYM / 250 g neem cake / 500 g vermicompost enriched with *Pseudomonas fluorescence* + *Trichoderma harzianum* + *Paecilomyces lilacinus* per ha in the beds
- For standing crop dissolve 2 kg of neem cake enriched with biopesticides (*Pseudomonas fluorescence* + *Trichoderma harzianum* + *Paecilomyces lilacinus*) in 200 lit of water and drench in soil 2 lit/sq.m. This can also be filtered thoroughly and sent through drip once in

30 days.

Disease management

Black spot

- Contact fungicide Chlorothalonil (0.2%), and systemic fungicides like Trifloxystrobin (0.1%) in combination with Tebuconazole (0.1%) is reported to give good control of black spot

Powdery mildew

- Early detection followed by sulphur fumigation is most effective and economical under greenhouse conditions.
- Systemic fungicides such as hexconazol (0.1%) and other chemicals belonging to Benzimidazoles (0.1%) and Traizoles (0.1%) offer good control.

Die-back

- Pruning of the infected stems 5-10 cm below the margin of infection and pasting the pruned ends with Bordeaux mixture or Rose paint (copper carbonate, red lead (Pb_3O_4) and linseed oil at 4:4:5 ratio) or Carbendazim (0.1%) give effective control of the disease.

Downy mildew

- All the infected flowers, stems and fallen leaves should be collected and destroyed
- In nurseries overcrowding of plants should be avoided by providing enough space between them
- Spray Fosetyl-Al (0.2%) or Metalaxyl-MZ (0.1%)

Grey mold or botrytis blight

- Chemicals belonging to Benzimidazoles (0.1%), Dicarboximides (0.1%) and Sterol Biosynthesis Inhibitors (0.1%) are commonly used for controlling the disease

Rust

- Chemicals like Bittertenol (0.2%) and Propiconazole (0.1%) used for controlling powdery mildew are also effective in controlling rust

Mosaic disease

- Clean nursery stock of mother plants
- Usage of seedling root stocks as the seedlings are known to be free from viruses

Crown gall

- Good nursery practices and production of disease-free planting material
- Removal and destruction of all infected plants
- Root damage by *Meloidogyne incognita* increases the incidence of crown gall. Hence, care should be exercised to prevent nematode infestation of root stocks

Rose under protected cultivation

Rose (*Rosa hybrida* L.) is a major commercial cut flower, widely cultivated in different parts of the world. Among all other cut flowers, roses is most popular because of its beauty, variety, fragrance and long lasting blooming season. For cut flower production it can be grown under naturally ventilated, cost effective polyhouses or under fully climate-controlled polyhouses.

Importance and scope of Good Agricultural Practices:

- Rose cultivation under protected conditions is done with usage of a number of plant protection chemical sprays to get quality produce.
- Under protected cultivation, the health of workers applying the hazardous chemicals also has to be taken care of.
- The first step towards producing safe crop begins at the farm level and is the responsibility of the grower for which standard package of practices referred as Good Agriculture Practices has to be followed.

Soil and climate

- Loamy soil rich in organic matter with pH of 5.5-6.5 is ideally suited
- The growing medium may consist of soil, sand and FYM in the ratio of 2:1:1. In place of sand, sawdust can also be used.
- Rose cultivation can be taken up ideally in cooler climate with bright sunlight
- Places with day temperature ranging between 25-30°C and night temperature of 15-18°C are suitable for rose production.
- At the temperature lower than the ideal, interval between flushes become longer. When the temperature increases above 30°C, care has to be taken to provide high humidity and to reduce the evaporation loss

Planting material

- Improved varieties / hybrids released by research organizations or planting material produced by registered nurseries should be used for commercial production
- The planting material should meet the minimum requirement of the standards with regard to uniformity, size, vigour, must be true to type and free of pest and diseases.
- As far as possible use varieties/hybrids which are resistant to major pests and diseases should be selected for cultivation
- Special nutritional requirement for specific varieties/hybrids should be ascertained and the nutrients management should be scheduled accordingly.

Propagation

- Cut roses can be propagated by budding or stenting
- Take cutting or scions from a healthy, vigorous and disease-free mother plant
- Rose plants are propagated by budding or top-grafting on rootstocks like *Rosa indica*, *R. multiflora*, and *R. canina*. 'Nishkant' variety of root stock are without any prickles and easy to bud with high bud uptake
- Budding in polybags is ideal for easy transportation of material
- Budded plants of 3 months old are used for planting
- Procure planting material from reliable sources

Planting

- Ideal time for planting is April – May or August – September
- Planting is taken up in well prepared raised beds of 1.0 m width and 30-40 m length
- Budded portion must be 2.5 cm above the soil surface
- Planting is done at a spacing of 40 × 20 cm and 44,000 plants are required per acre
- For necessary cultural operations, 50 cm path can be accommodated between the beds

Aftercare

- Regular weeding has to be done

Special cultural practice for long stalk flower production

Bending of shoots

- Four weeks after planting, shoots are bent to induce strong basal shoots. Development of a good number of basal shoots is essential to build a strong framework in the plant.

Removal of buds from the rootstock

- It has to be done to prevent the unwanted vegetative growth from the rootstock and to encourage healthy buds from the scion

Disbudding

- Removal of side buds below the central bud should be done regularly

Deshooting

- Removal of the young shoots from the flower stalk

Bud netting

- Flower buds are covered with nets to regulate shape and bud opening

Nutrition

- Fertilizer dose of 50:15:60 g N:P: K + 2 kg FYM / sq.m during first year after planting and 40:10:50 g N:P: K + 2 kg FYM / sq.m from second year after planting
- Either straight fertilizers (Urea, SSP, DAP, Muriate of Potash etc.) or water-soluble fertilizers (19:19:19, Sulphate of Potash etc.) can be applied in equal split doses at fortnightly intervals from third month onwards
- Soil application of micronutrient formulations @ 2 g per plant or sq.m twice or thrice in a year based on soil test report or foliar spraying of 0.1% micronutrient mixture if visible symptoms are seen
- Regular analysis of soil, water and leaf will be good guide to supply optimum nutrients.

Irrigation

- Irrigate the plants according to the specific water requirements of the varieties
- Do not use water that may be contaminated by chemicals or waste materials
- Use water from a clean source
- The water requirement is 4-6 liter/m²/day through drip irrigation depending on the plant growth and weather conditions

Harvesting and post-harvest handling

- Stage of harvest varies with the variety and distance to the market
- Cut rose flowers are harvested at the tight bud stage with all sepals unfurled
- Harvesting is done during cool hours of the day, either in the early morning or in evening hours
- Use clean and sharp harvesting tools
- Immediately after harvesting the cut flower is placed in buckets containing clean water for pre-cooling.
- Damaged/bruised flowers should be discarded and disposed hygienically
- Then the flowers have to be graded, packed in cardboard boxes and transported in refrigerated vans
- Rose flowers are graded based on the colour, appearance, stem length etc. Graded flowers are grouped together in bunches of 10,12, 20 or 24.
- Four bundles of roses containing 80 blooms are packed in a standard size carton (120 x 45 x 25 cm or 100 x 40 x 30 cm).
- The average yield of the cut flower is 200-300 stems/ sq. m/year

Plant Protection

Insect pest management

Thrips

- Spray dimethoate 30 EC @ 2ml/l with pongamia oil 0.5% 2 - 3 times at 15 days interval with onset of new flush will minimize their incidence.
- Apply Fipronil 5 SC @1.5 ml/l or imidacloprid 17.8 SL @ 0.5ml/l or spinosad 45 SC @ 0.25 ml/l in case of severe infestation.
- Drench the soil with Chlorpyrifos 20 EC @ 5ml/l for killing pupae in soil.

White fly

- Spray Thiamethaxam 25 WG (0.5 g/l) or spiromesifen 240 SC (1 ml/l) or diafenthiuron 50 WP (0.75 g/l)

Aphid

- Spray Acetamaprid 20 SP (0.25 g/l) or Dimethoate 30 EC (2ml/l) when infestation begin
- Spraying of neem or pongamia oil 2 % also gives effective control
- In case of severe infestation spray Imidacloprid 17.8 SC @ 0.5 ml/l or cartap hydrochloride 50 SP@1g/l
- Spray of *Lecanicillium lecanii* at 3g/l also effective against aphids

Bud borer

- Collection of mature larvae reduces borer population
- Spraying of indoxacarb 14.5 SC @ 0.75 ml/l or methyl parathion 50 EC @1ml/l or fenvalerate 20 EC @ 0.5 ml/l in combination with diflubenzuron 25 WP @ 2g/l at appearance of eggs on tender foliage checks borer damage
- Neem seed kernel extract 4% or neem oil 1% also give good protection to foliage
- Spraying of *Ha*-NPV @ 250 LE per ha causes significant mortality of larvae

Two spotted spider mite

- Cutting and burning of severely infested plant parts
- Proper ventilation, irrigation and clean cultivation keep the pest under control
- Spray dicofol 18.5 EC @ 1ml/l or wettable sulphur 80 EC @3g/l or profenofos 50 EC @ 1ml/l or ethion 50 EC @ 1ml/l followed by pongamia or neem oil or jatropa oil at 5ml/l under open cultivation
- Under protected cultivation, spray abamectin 1.9 EC @ 0.5 ml/l followed by flufenoxuron 10 DC @1 ml/l or fenazaquine 10 EC @1ml/l or diafenthuron 50 SC @ 0.6 ml/l during export season and chemicals suggested for open cultivation during off-season.
- Release predatory mite *Amblyseius tetranychivorus* @ 20 mites/plant when *T. urticae* populations are at moderate levels. Spray *Lecanicillium lecanii* formulation at 5g/l during evening.

Nematode

- At the time of planting, apply 1 kg of FYM / 250 g neem cake / 500 g vermicompost enriched with *Pseudomonas fluorescence* + *Trichoderma harzianum* + *Paecilomyces lilacinus* per ha in the beds.
- For standing crop dissolve 2 kg of neem cake enriched with biopesticides (*Pseudomonas fluorescence* + *Trichoderma harzianum* + *Paecilomyces lilacinus*) in 200 lit of water and drench in soil @ 2 lit/sq.m. This can also be filtered thoroughly and sent through drip once in 30 days.

Disease management

Powdery mildew

- Early detection followed by sulphur fumigation is most effective and economical under greenhouse conditions.
- Systemic fungicides such as hexconazole (0.1%) and other chemicals belonging to Benzimidazoles (0.1%) and Traizoles (0.1%) offer good control.

Black spot

- Contact fungicide Chlorothalonil (0.2%), and systemic fungicides like Trifloxystrobin (0.1%) in combination with Tebuconazole (0.1%) is reported to give good control of black spot.

Die-back

- Pruning of the infected stems 5-10 cm below the margin of infection and pasting the pruned ends with Bordeaux mixture or Rose paint (copper carbonate, red lead (Pb₃O₄) and linseed oil at 4:4:5 ratio) or Carbendazim (0.1%) give effective control of the disease

Downy mildew

- All the infected flowers, stems and fallen leaves should be collected and destroyed
- Bringing down the humidity in polyhouses effectively checks the further spread of the disease
- In nurseries overcrowding of plants should be avoided by providing enough space between them
- Spray Fosetyl-Al (0.2%) or Metalaxyl-MZ (0.1%)

Grey mold or botrytis blight

- Roses under photo selective plastic showed a lower disease compared to commercially used plastic
- Climatic screens increase night temperature and lower the relative humidity, thereby reducing condensation on the plants
- Since *Botrytis* sporulates readily on wounded and senescent tissues these should be thoroughly removed
- Many chemicals belonging to Benzimidazoles (0.1%), Dicarboximides (0.1%) and Sterol Biosynthesis Inhibitors (0.1%) are commonly used for controlling the disease

Rust

- The cultivar “Manetti” used as a rootstock in greenhouse roses is highly susceptible
- Chemicals like Bittertenol (0.2%) and Propiconazole (0.1) used for controlling powdery mildew are also effective in controlling rust

Rose mosaic disease

- Clean nursery stock of mother plants
- Usage of seedling root stocks as the seedlings are known to be free from viruses
- Using ELISA, the virus can be detected very rapidly compared to the use of long-term biological indices

Crown gall

- Clean nursery practices and production of disease-free planting material
- Removal and destruction of all infected plants
- Root damage by *Meloidogyne incognita* increases the incidence of crown gall. Hence, care should be exercised to prevent nematode infestation of root stocks

Tuberose

Tuberose (*Polianthes tuberosa* L.) belongs to the family Amaryllidaceae and is cultivated commercially for its fragrant flowers which are used as loose flowers, cut flowers and in the perfumery industry. The flowers of tuberose are highly fragrant and contain 0.08 to 0.14 % of concrete and have high demand in international market. Flowers of the single type are commonly used for extraction of essential oil, loose flowers, and for value addition, while that of double varieties are used as cut flowers, for garden display and floral arrangements.

Importance of Good Agricultural Practices:

Tuberose is mainly used commercially as a loose flower, cut flower and for extraction of concrete. Though the produce is not consumed directly, lot of inorganic fertilizers and plant protection chemicals go into the crop production.

- The first step towards producing safe crop begins at the farm level and it is the responsibility of the grower, for which standard package of practices referred as good agriculture practices has to be followed.
- Economical and sustainable production by use of quality inputs in prescribed amounts at critical time will help in achieving sustainable production, for which a set of practices in tuberose, is enlisted below:

Suitable growing conditions

- Tuberose thrives in moderate climate with temperature ranging from 20-30^o C. It performs well in sunny situation.
- Ideal soil is loamy to sandy loam, pH range of 6.5 to 7.5 with good aeration and drainag

Planting material

- Improved varieties /hybrids released by research organizations or planting material produced by registered nurseries should be used for commercial production.
- The planting material should meet the minimum requirement of the standards with regard to uniformity, size, vigour being true to type and being free of pest and diseases.
- As far as possible use varieties/hybrids which are resistant to major pests and diseases.
- Special nutritional requirement for specific varieties/hybrids should be ascertained and the nutrient management should be scheduled accordingly.
- Spindle shaped bulbs of 2.0-2.5 cm diameter are used as propagule to achieve uniform crop stand.

Cultural practices

Land preparation

- Selection of the site, should be followed by soil and water testing to ascertain the suitability for cultivation.
- Well drained loamy to sandy loam soil with adequate aeration and a pH of 6.5 to 7.5 is recommended.
- Land should be ploughed deeply 2 to 3 times and brought to a fine tilth.
- Raised beds of 30 cm height, 0.9 m width and convenient length should be prepared leaving 40 cm passage between two beds. Raised beds ensure better drainage of excess

water, ensure aeration for the roots and can be combined with drip irrigation and fertigation system.

Manures and Manuring

- For upkeep of soil health and to improve the organic matter content, 8 tonnes of well decomposed farm yard manure should be applied in one acre at least 15 days prior to planting.
- The organic compost/ farm yard manure should be free from pathogens, nematodes, weed seeds or any other harmful organisms.
- Two tonnes/acre of well decomposed FYM/vermicompost/ deoiled neem cake has to be enriched by mixing with 1 kg of each of *Pseudomonas fluorescens* + *Trichoderma harzianum* + *Paecilomyces lilacinus* formulation under shade. It has to be covered with mulch and optimum moisture of 25 - 30% has to be maintained for a period of 15 days. This has to be incorporated into the beds before planting for control of nematodes.
- Bio-fertilizers should be used to reduce the requirement of inorganic fertilizers. Farm yard manure should be enriched with bio-fertilizers viz., *Azospirillum/Azotobacter*, Phosphate solubilizing bacteria or Arka microbial consortium @ 1.0 kg each/ tonne of farm yard manure and applied to the main field.

Fertilizer application to soil

- The inorganic fertilizers should be applied based on the soil analysis and recommendations only. This will help in providing optimum amount of nutrients to the crop. Excess application of fertilizers should be avoided as it will lead to soil and water pollution.
- Application of 120:60:100 kg NPK/acre is recommended.
- At the time of planting, 50 kg Urea, 30 kg Di ammonium phosphate and 40 kg Muriate of potash /acre /year is applied as basal dose.
- Three months after planting, 160 kg urea, 100 kg DAP and 130 kg MOP/acre/year can be applied in three equal split doses at three monthly intervals.
- Fertilizers should be placed in such a way that it should be easily accessible to the plant roots.

Planting

- Planting is done on raised beds in double row system with one drip line per bed.
- Bulbs are planted at 2.5 cm depth at a spacing of 60cm x 45cm.
- The recommended seed rate is 400 kg of bulbs/ acre
- Ideal planting time is May to July.
- Arka Microbial Consortium@12.5kg/ha /any certified consortium of bio-fertilizers can be drenched 2 weeks after transplanting to enhance the growth.

Fertigation

- Adopt fertigation for better fertilizer use efficiency and higher yield. For fertigation, weekly application of the recommended dose of fertilizers can be followed.
- As the fertilizer use efficiency is high under fertigation 75% of the recommended fertilizer dose will be adequate to obtain the potential yield thereby resulting in saving of 25% fertilizer input.
- In a fertigation schedule, 25 per cent of the total quantity of nitrogen, phosphorous and potassium can be applied to soil at the time of planting as straight fertilizers (Urea-66 kg, Single Super Phosphate-94 kg, Muriate of Potash -42 kg /acre/year) to save the cost on

water soluble fertilizers. Remaining can be injected as through water soluble fertilizers.

- Fertigation can be commenced from the third week after planting and continued at weekly intervals.
- The weekly fertigation schedule can be as follows:
- 0-20 days after planting: No fertigation
- 21-90 days after planting: 5.8 kg urea, 2.1 kg water soluble Mono Potassium Phosphate (MKP) (0:54:32) and 2.4 kg/acre water soluble Sulphate of Potash (SOP) (0:0:50)
- 91-270 days after planting: 2.3 kg urea, 1.3 kg water soluble Mono Potassium Phosphate (MKP) (0:54:32) and 1.5 kg/acre water soluble Sulphate of Potash (SOP) (0:0:50)
- 271-365 days after planting: 3 kg urea, 1.2 kg water soluble Mono Potassium Phosphate (MKP) (0:54:32) and 1.4 kg/acre water soluble Sulphate of Potash (SOP) (0:0:50)
- For the ratoon crop in the subsequent years the basal application of FYM and fertilizer has to be repeated at the beginning of the rainy season.
- If there is a specific recommendation based on the soil analysis for fertigation, the schedule can be modified as per requirement.

Micronutrients

- Need based foliar spray of $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.2% + Boric acid @ 0.1% may also be practiced for getting better growth and yield in tuberose

Irrigation

- For successful cultivation, optimum moisture should be maintained throughout the growing period. Tuberose requires 1000-1200 mm of water per year. Water can be saved to the extent of 25-30 per cent in drip method of irrigation.
- The frequency of irrigation depends on the climatic and soil conditions.
- Daily irrigation through drip system has to be followed based on the stage of the crop (crop factor) and daily evaporation.

Inter culture

- Earthing up is an important operation to prevent exposure of bulbs

Weeding

- The beds should be kept weed free throughout the crop period.
- Regular need based manual weeding is required during the entire cropping period.

Harvesting and post-harvest handling

- Tuberose starts flowering in about three months after planting.
- For loose flower purpose, fully matured flower buds which are at the horizontal position on flowers stalk have to be harvested during morning hours.
- For use as cut flower, spikes have to be harvested when the first pair of flower buds opens on the spike.
- Harvesting has to be done during the cool hours of the day. All the containers into which the flowers are placed should be cleaned before use.
- Precooling of flowers to remove the field heat is an important operation to lower respiration and prolong the shelf and vase life of flowers.
- Damaged/bruised flowers should be discarded and disposed hygienically.
- For local market the loose flowers are transported in bamboo containers lined with cloth or with wet gunny bags or in gunny bags or polythene bags lined with newspaper. About

- 10-15 kg fresh flowers are packed in each basket
- Cut flowers are bunched into bundles of 25, 50 or 100 spikes and transported in containers holding water.
- For long distance transport, corrugated card board boxes of dimension 95 x 40 x 20 cm are used.

Harvesting, lifting and storage of bulbs

- Harvesting stage of tuberose bulb is important for storage of bulbs and their growth. The bulbs are harvested when the flowering is over and plant ceases to grow. At this stage, the old leaves become dry and bulbs are almost dormant.
- Irrigation should be withheld and soil is allowed to dry before digging out the bulbs.
- After digging, the bulbs are lifted out; the bulblets of 2 to 2.5 cm diameter are separated and used as seed stock for the next season.
- The bulbs are graded based on their size and are placed to dry or cure.
- The bulbs should be treated with fungicide and insecticide to prevent rotting and attack of mealy bugs during storage. After treatment, they should be shade dried before storage in a cool dry place.
- The bulbs must be stored or have their position changed every few days to prevent fungal attack and rotting.

Crop protection

Thrips, root mealy bugs and nematodes are the major pests of tuberose. Major diseases are phoma blight, basal rot or stem rot and flower blight. Integrated approach to pest and disease management ensures better control and in safe crop production.

Insect management

- Grow resistant/tolerant varieties to avoid/ minimize pest incidence.
- Thrips can be controlled by spraying of oxydemeton methyl 25 EC @2 ml/litre or dimethoate 30 EC @2 ml/litre or acephate 75 SP @1 g/litre along with 0.5% pongamia oil at 15 days interval is recommended followed by drenching the soil with chlorpyrifos 20 EC @5 ml/litre.
- Root mealy bugs can be managed by dipping the bulbs in chlorpyrifos 0.05% as a prophylactic measure and drenching of chlorpyrifos 20 EC @5 ml/litre. Soil application of neem cake at the time of planting can effectively control root mealybugs.
- Soil drenching with chlorpyrifos 20EC @ 5 ml/litre or thiamethoxam 25WG @0.5g/litre at monthly intervals is recommended for controlling the root mealybugs in the field.
- Avoid spraying the same chemical repeatedly, as it may result in insecticide resistance by the target pest.

Nematode management

- Use of nematode free planting material and growing antagonistic crops like marigold, mucuna (velvet bean) before planting tuberose
- Treating tuberose bulbs with bio-pesticides like *Pseudomonas fluorescens* or *Trichoderma harzianum* @ 10g/kg.
- 1 tonne of farm yard should be enriched with two kg each of the bio-pesticides, viz., *Trichoderma harzianum*, *Pseudomonas fluorescens* and *Paecilomyces lilacinus* and left under shade for 2 to 3 weeks at 25 – 30% moisture. This has to be mixed thoroughly from top to bottom once in three days and applied in field before planting.

- For the standing crop, biopesticide enriched neem cake can also be mixed in water (1: 10 ratio), thoroughly filtered and applied through the drip or as soil drench.
- Chemical nematicide, carbofuran 3 G @ 1 kg a.i. per ha can be applied at planting and repeated after 45 days.

Disease management

- Removal of affected leaves followed by application of carbendazim @2 g/l of water or Propiconazole @ 1 ml/ litre of water will control Phoma blight.
- Basal rot or stem rot can be managed by treating the collar portion and the soil with benlate, carbendazim, iprodione or copper oxy chloride @ 2 g/litre of water.
- Flower blight can be controlled by spraying carbendazim @ 2 g/litre of water.
- Alternaria leaf spot can be managed by spraying with mancozeb @ 0.2%

Marigold

Marigold (*Tagetes* spp.) is one of the most popular flowering annuals grown for loose flowers and also for landscape gardening and as pot plants. The flowers are suitable for garlands and floral decorations. Carotenoids extracted from marigold flowers are the major source of pigment for poultry feed. Marigold flowers are also in demand by pharmaceutical industries for extraction of 'Lutein'. It is popular as trap crop for management of pests in most of the vegetable crops. It is also used in crop rotation for management of nematode.

Importance and scope of Good Agricultural Practices

The first step towards producing safe crop begins at the farm level and is the responsibility of the grower for which standard package of practices referred to as good agriculture practices has to be followed.

- Since marigold is also used for extraction of dyes and pigments for use in poultry feed, besides use as a traditional flower, safe production assumes importance in this crop.
- Economical and sustainable production and use of quality inputs at critical time is important for which a set of practices is enlisted below for marigold:

Site selection

- Choose land that has access to a clean and reliable source of irrigation water
- Make sure there is sufficient space between marigold fields and other fields where pesticides are used to prevent any sprays from contaminating your crops
- Even though marigold can be grown in various types of soils, loamy soil rich in organic matter with pH of 6.0 to 7.0 is ideal for its cultivation.

Planting material

- Improved varieties / hybrids released by research organizations or planting material produced by registered nurseries should be used for commercial production.
- The planting material should meet the minimum requirement of the standards with regard to uniformity, size, vigour, true to type and free of pest and diseases.
- As far as possible use varieties/hybrids which are resistant to major pests and diseases.
- Special nutritional requirement for specific varieties/hybrids should be ascertained and the nutrients management should be scheduled accordingly.

Seeds / planting material

Majority of the varieties and hybrids can be propagated by seeds. Seed rate for marigold varies from 0.4 to 0.6 kg/acre and takes about 5-7 days for germination. Seeds can be sown in nursery beds in lines in shallow furrows. Raised nursery beds of 15 cm height are prepared by mixing 8-10 kg of well decomposed cow dung manure/m². The width of the seedbed should be around 1.2 m. Seedlings will be ready for planting 20-25 days after sowing.

Some hybrids are only vegetatively propagated by tip cuttings. Tip cuttings with 2-3 nodes of 6-8 cm should be prepared with clean and sharp secateurs. Basal node of the cutting should be inserted into protray cells containing cocopeat for rooting. Cuttings placed at a humidity of 80% roots better. Rooting can be obtained by 20-25 days.

- Use fresh seeds that were harvested during the previous season
- Use seeds that are in good condition and free of pests
- If you are collecting your own seeds label the seed packets with details of the species, the origin and date of harvest or collection
- Do not use seeds or planting material that are in poor condition or if you do not know where they came from and when they were harvested
- Procure seeds or planting material from reliable sources
- In case of rooted cuttings, take cuttings from a healthy, vigorous and disease-free mother plant

Land Preparation

- Land should be prepared with thorough ploughing, harrowing and levelling
- Nourish the soil with plenty of organic matter
- Do not apply fresh manure for plant nutrition. Ensure that compost is well decomposed before use
- Get initial soil sample analysed by a nearby laboratory and plan any addition of plant nutrients accordingly
- Farm yard manure @ 8 tonnes/acre should be applied during land preparation.

Planting

- Ensure correct spacing between plants and rows
- In main field, raised beds of 30 cm height and 0.9 m width are prepared
- Seedlings / rooted cuttings are planted in double row system on the beds

Irrigation and interculture

- Irrigate the plants according to the specific water requirements of the species / varieties – if in doubt, seek guidance from an expert and plan the irrigation schedule accordingly. If possible, test the irrigation water for any contaminants and adopt appropriate measures to prevent contamination
- Do not irrigate the plants too little or too much
- Do not use water that may be contaminated by chemicals or waste materials
- In case of flood irrigation, irrigate the crop once in 4-6 days depending upon soil moisture and weather conditions.
- If drip irrigation is adopted, schedule the irrigation daily and depending on the crop stage and weather, the quantity of water should be regulated.
- Use mulch to maintain moisture in the soil and to inhibit growth of weeds
- Manage weeds before they start competing with the main crop for nutrients and light
- Do not allow weeds to produce seeds – this will increase weed growth the following year
- Do not allow the soil to dry up due to excessive weeding
- Weeding is done manually 3-4 times during the entire crop growth period.
- Pinch the buds and terminal portion of the plants till 4-6 weeks after transplanting to encourage branching and increased number of flower bud formation.

Nutrient management

- The recommended dose of FYM is 8 tonnes / acre with the fertilizer dose of 36:36:30 kg NPK/ acre /year
- Basal dose of urea – 19.8 kg/ac, Single super phosphate (SSP) -168.8 kg/ac, Muriate of Potash (MOP) – 12.5 kg/ac can be applied on the beds. This is followed by fertigation as

follows;

- 0-20 days after planting: No fertigation
- 21-40 days after planting: Urea - 13.87 kg; MAP (12:61:0) - 2.5 kg; SOP (0:0:50) - 7.5 kg/ac/week
- 41-70 days after planting: Urea - 3.5 kg; MAP (12:61:0) - 1.85 kg; SOP (0:0:50) - 5.6 kg/ac/week
- Foliar spray of micro nutrients 1.25 g MgSO₄ + 1 g ZnSO₄ + 0.25 g Borax in 1 liter of water twice during the crop season (1 and 2 months after transplanting) improves plant growth and enhance flower quality

Harvesting and Yield

- Harvesting of flowers should be done during cool hours of the day, either in the morning or evening.
- All the tools used for harvesting and containers into which the flowers are placed should be cleaned before use.
- Flower yield depends upon season and cultural practices adopted.
- Harvesting duration depends on variety; in general, 6-9 t/acre of flowers is expected.
- Flowers has to be shifted to cool place immediately after harvesting
- Damaged/bruised flowers should be discarded and disposed hygienically.
- For local market the loose flowers are transported in bamboo or in gunny bags

Plant Protection

Insect pest management

Thrips

- Spray acephate 75 SP @ 1.5 g/l or dimethoate 30 EC @ 2.0 ml/l with 0.5% pongamia oil.
- Apply fipronil 5 SC @ 1.5 ml/l in case of severe infestation.

Bud borer

- Installation of pheromone traps for monitoring the activity of adults.
- Application of HaNPV @ 250 LE/ha followed by spray with any neem formulations at 1.0 – 2.0 ml/l.
- Spray of quinalphos 25 EC @ 2.0 ml/l at fortnightly interval.
- Spray indoxacarb 14.5 SC @ 1.0 ml/l or thiodicarb 75 WP @ 1.0 g/l, if the incidence is severe.

Red spider mite

- Regular inspection of crop for mite infestation and cutting and burning the infested plant parts to avoid further spread.
- Thorough spray of water on the plant dislodges the mites from their webs followed by spraying dicofol 18.5 EC @ 2.5 ml/l or wettable sulphur 80 WP @ 3.0 g/l.
- Spray propargite 57 EC @ 1.0 ml/l or abamectin 1.9 EC @ 0.5 ml/l or flufenoxuron 10 DC @ 1.0 ml/l or fenazaquin 10 EC @ 1.0 ml/l, if infestation is high.
- Integrated pest management approach using companion crops, trap crops, light-traps, crop rotation etc. has to be followed.

Disease management

Damping off

- Proper drainage should be provided in nursery bed.
- Soil drenching with captan (0.2%) or mancozeb (0.2%) should be followed to manage the disease.
- Three-four years crop rotation should be followed.

Leaf Spots and Blight

- The marigold crop should be sprayed with Mancozeb @ 0.2% or Carbendazim (0.1%) at fortnightly intervals starting from the first appearance of disease symptoms.

Powdery Mildew

- The disease can be controlled by spraying with Karathane @ 0.1% or wettable sulfur (3 g/l) at fortnightly intervals.

Flower bud rot

To control this disease regular spraying of mancozeb @ 0.2% or Difenconazole (0.05%) should be followed.

Chrysanthemum under open cultivation

Chrysanthemum (*Chrysanthemum morifolium* /*Dendranthema grandiflora*) belongs to the family Asteraceae. It is a popular commercial flower crop grown in different parts of the world. The word Chryso means “golden” and anthos means “flower”. It is commonly known as Queen of East/ Autumn Queen/ Guldaudi.

Importance and scope of Good Agricultural Practices:

Chrysanthemum is both a commercial crop and a popular exhibition flower. It is suitable for making of garlands, vases, worship, planting in borders and pot culture (pot mums). In the production process of chrysanthemums, lot of inorganic fertilizers and plant protection chemicals are being utilized.

Standard package of practices referred as good agriculture practices must be followed for chrysanthemum crop production as a first step towards producing safe crop. Along with ensuring the production of safe crop, the welfare and safety of persons working in the chrysanthemum farm should be taken into account by the producer or grower. A set of Good Agricultural Practices that is needed to be followed for safe production of chrysanthemum under open field is enlisted below.

Planting material

- For commercial production of chrysanthemums under open field, use of improved varieties /hybrids released by research organizations or planting material produced by registered nurseries is recommended.
- The chrysanthemum planting material should meet the minimum standards with regard to uniformity, size, vigour being true to type and free from pests and diseases.
- Chrysanthemum varieties/hybrids which are resistant to major pests and diseases should be used for commercial production.
- Ascertain the nutritional requirement for specific chrysanthemum varieties/hybrids and schedule the nutrient management accordingly.
- Vegetative propagation in chrysanthemum is mainly done using suckers or terminal cuttings.
- Suckers arise from the underground stem and these are separated and planted in prepared nursery beds during January for stock plants. Regular pinching is performed in these plants for vigorous and profuse branching. Some of these stock plants are used for preparation of cuttings.
- Vegetative propagation through cuttings is the most common and popular method. Terminal Cuttings of 5-7 cm in length are taken from healthy stock plants in May-June. The cuttings are prepared removing basal leaves and reducing the leaf area of remaining leaves to half. The basal portions (less than half inch) of cuttings are dipped in rooting hormone (1000 ppm solution of IBA for 30 sec) for better rooting. The lower portion of cuttings is treated with copper fungicide to avoid fungal growth.

Cultural practices

Land preparation

- Chrysanthemum with a shallow but fibrous root system is sensitive to water-logging and prone to attack by diseases, such as root rot and wilt due to lack of aeration.
- Well drained sandy loam soils with pH ranging between 6.5 and 7.0 are ideal for

chrysanthemum growing.

- Chrysanthemum requires well prepared soil for proper growth and development.
- The field should be ploughed 2 to 3 times before preparing the beds and levelled well.
- Addition of organic matter improves the soil structure and helps in the proper development of the plant.
- Proper soil sterilization with a fungicide should be done before planting to avoid soil borne diseases.

Manures and manuring

- Chrysanthemum is a heavy feeder and hence they are to be adequately manured.
- For the proper upkeep of soil health and to improve the organic matter, a basal dose of well decomposed farm yard manure should be applied @ 8 tonnes per acre at least 15 days prior to planting.
- Ensure that the organic compost/ farm yard manure used are free from pathogens, nematodes, weed seeds or any other harmful organisms.

Fertilizer application to soil

- Inorganic fertilizers should be applied based on the soil analysis and recommendations only, which will help in providing optimum amount of nutrients to the crop. Avoid the excess application of inorganic fertilizers as it will lead to soil and water pollution.
- Application of 40: 20: 40 kg NPK per acre is recommended.

Planting

- Light and temperature are the two important environmental factors influencing the growth and flowering in chrysanthemum.
- As far as light is concerned, both photoperiod and the intensity have profound effects on the growth and flowering of chrysanthemum. It is a short-day plant normally initiates and flowers during September to December.
- Planting should be done in such a way that flowering coincides with short day conditions. Hence, planting during May-June is recommended.
- The optimum plant population for growing chrysanthemum is 25,500 plants per acre.
- The suckers or rooted cuttings are planted at a spacing of 30 cm x 30 cm on raised beds
- Before planting, the roots of the suckers or slips are dipped in a systemic fungicide to give protection against wilt.

Fertigation

- Adopt fertigation for better fertilizer use efficiency and higher yield in chrysanthemum. For fertigation, follow weekly application of the recommended dose of fertilizers.
- The fertilizer use efficiency is reported to be high under fertigation. Hence 75% of the recommended fertilizer dose will be adequate to obtain the potential yield thereby resulting in considerable saving of 25% fertilizer input.
- In a fertigation schedule, basal dose of 8 tonnes per acre FYM + Urea – 16.8 kg; SSP- 70 Kg and MOP – 12.8 Kg/acre should be applied to soil at the time of planting as straight fertilizers. This will save the cost on water soluble fertilizers. This should be followed by fertigation schedule which can be injected as water soluble fertilizers.
- Fertigation in chrysanthemum can be commenced from the third week after planting and continued at weekly intervals.
- The weekly fertigation schedule can be as follows:
- 0-20 days after planting -No fertigation:

- 21-65 days after planting- Urea: 1.9 Kg, MAP (Mono Ammonium Phosphate): 3.1 Kg, SOP (Sulphate of Potash): 2.5 kg/acre/week
- 66-100 days after planting-Urea: 2.3 Kg, MAP (Mono Ammonium Phosphate): 3.7 Kg, SOP (Sulphate of Potash): 3.0 kg/acre/week
- 101-180 days after planting- Urea: 1.2 Kg, MAP (Mono Ammonium Phosphate): 1.8 Kg, SOP (Sulphate of Potash): 1.5 kg/acre/week
- Application of Arka Microbial Consortium @ 12.5 kg/ha also increases flower yield in chrysanthemum
- Need based foliar spray of micronutrients $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.2% + Boric acid @ 0.1% at fortnightly intervals may also be practiced for getting better growth and yield in chrysanthemum

Irrigation

- For successful cultivation of chrysanthemum under open field, optimum moisture should be maintained throughout the growing period. Water can be saved to the extent of 25-30 per cent if drip method of irrigation is adopted.
- The frequency of irrigation depends on the climatic and soil conditions.
- Chrysanthemums are to be irrigated twice a week in the first two weeks and subsequently at weekly intervals if flood irrigation is practiced.
- Daily irrigation through drip system can be followed based on the stage of the crop and daily evaporation.

Pinching

- Pinching is the removal of terminal growing portion of stem to reduce plant height and promote axillary branches
- Only soft vegetative shoot tips 1.5 to 3 cm long are removed.
- Pinching is most essential for small flowered chrysanthemum.
- First pinching is done when the plants reach a height of 15-20 cm with 3-4 pairs of leaves.
- A second pinching may be necessary if the plants make straggly and lean growth.
- Pinching increases the number of flowering stems in each plant; it can indirectly control flowering date and bloom quality; the number of stems to a plant can easily be controlled.
- Two types of pinching are performed:
 - Soft pinching: By this pinching the top soft tips of the shoot along with 2-3 open leaves are removed.
 - Hard pinching: It means removing a longer portion up to hard shoot.
- In spray chrysanthemum numerous small to medium sized flowers are produced, therefore, two pinchings are required to encourage lateral growth.
- As a general rule rooted cuttings are pinched two weeks after planting or approximately 100 days before full bloom.

De-suckering

- During the vegetative growth phase, chrysanthemum plants grow upwards and suckers continue to develop from base of plants.
- For proper and vigorous growth of plants, suckers are removed from time to time.
- It is practiced to allow single stem to develop up to a certain height.
- Without de-suckering the main plant will lose vigour and becomes weak.

Staking

- Staking or support is necessary to prevent lodging and to keep the plants erect and to maintain proper shape of plants and bloom.
- Stakes are prepared mostly from bamboo sticks.
- Staking of plants is required for vertical support of the plants.

Weeding

- Weeding and hoeing are generally done manually as and when required, normally 8-10 times during the cropping period.

Use of Growth regulators

- Crop growth regulation and flowering can be modified or controlled by the use of growth regulators. Flower quality and yield can be improved by the use of regulators.
- 50 ppm GA₃ can be sprayed at 30, 45 and 60 days after planting to increase the flower yield.

Harvesting and Post-harvest handling

- Chrysanthemum starts flowering in about three to four months after planting.
- Harvesting has to be done during the cool hours of the day. All the containers into which the flowers are placed should be cleaned before use.
- Fully opened flowers are plucked with or without the peduncle.
- Decorative types are harvested when the petals in the centre of the topmost flower is almost fully developed.
- Spray mums are generally harvested at the two thirds to three-fourths open stage;
- Pot-mums are sent to the market with half to fully opened flowers.
- Damaged/bruised chrysanthemum flowers should be discarded and disposed hygienically.
- For local market the loose flowers of chrysanthemum are packed in clean bamboo baskets or in gunny bags.

Crop protection:

Aphids, bud borers, whitefly, leaf miner, thrips and mites are some of the major pests of chrysanthemums. Major diseases are rust, white rust, root rot, bacterial blight, leaf spot and flower blight and powdery mildew. Integrated approach should be ensured for pest and disease management for safe crop production in chrysanthemum.

Insect management

- Grow resistant/tolerant chrysanthemum varieties to avoid/ minimize pest incidence.
- The activity of predatory coccinellid beetles and parasitoids can be encouraged in chrysanthemum field to manage aphids. Aphids can be controlled by spraying of neem oil @ 0.1 % at weekly interval when infestation starts on the plant. In case of severe infestation, spray dimethoate 30 EC @2 ml/litre or acephate 75 SP @1 g/litre.
- To control bud borer, install pheromone traps for monitoring the activity of adults. Application of HaNPV @ 250 LE/ha followed by spraying of any neem formulations @ 2 ml/l is recommended. In case of severe incidence, spray indoxocarb 14.5 EC SC @ 1ml/l or thiodicarb 75 WP @ 1g/l.
- In case of leaf miner infestation, remove and destroy weeds which act as alternate hosts. Cutting and discarding of heavily mined leaves reduce further damage. Spray of 5 % Neem seed powder extract controls leaf miner. In case of severe infestation, spray abamectin 1.9

EC @ 0.5 ml/l or triazophos 40 EC @ 1.5 ml/litre.

Disease management

- Spraying of affected plants with Wettable sulphur @ 3g/l or Propiconazole @ 1 ml/ litre will control Rust.
- White rust can be managed by spraying the chrysanthemum plants with Azoxystrobin @ 1g/l or Chlorothalonil @ 2g/l
- Root rot can be controlled by drenching with copper oxy chloride @ 2g/l or Bordeaux mixture @ 1 %. It can also be managed by spraying and drenching with Ridomil MZ @ 2g/l. Soil application or mixing of *Trichoderma viridae* and *Pseudomonas flourescens* with FYM is also effective.
- Leaf spot and flower blight can be managed by spraying with mancozeb @ 2 g/l at 10-15 days interval
- Powdery mildew can be controlled by spraying with sulphur fungicides @ 2g/l or Tridemorph @ 1g/l at 15-20 days interval. Carbendazim @ 2g/l or Azoxystrobin @ 1g/l also controls the disease.

Chrysanthemum under protected cultivation

Chrysanthemum (*Dendranthema grandiflora*) belongs to the family Asteraceae and is commonly known as Glory of East / Queen of East/ Autumn Queen/ Guldaudi. It is the National Flower of Japan. It is a popular and leading commercial flower crop of many countries. In Dutch cut flower auction, chrysanthemum ranks 2nd after rose. It is next only to rose in value of international cut flower trade in the world market.

Importance and scope of Good Agricultural Practices (GAP)

In chrysanthemum, the erect and tall growing cultivars are suitable as cut flowers. The extra-large-bloomed cultivars are ideal for their exhibition value. In the production process of cut flower chrysanthemums, lot of inorganic fertilizers and plant protection chemicals are being utilized.

Standard package of practices primarily referred as good agriculture practices should be adopted for production of chrysanthemum under protected cultivation as a first step towards ensuring the production of safe crop. A list of Good Agricultural Practices that should be followed for safe production of chrysanthemum under protected cultivation is enlisted below.

Planting material

- For commercial production of chrysanthemums under protected cultivation, use of improved varieties /hybrids released by research organizations or planting material produced by registered nurseries is recommended.
- The planting material should meet the minimum standards with regard to uniformity, size, vigour being true to type and free from pests and diseases.
- Chrysanthemum varieties/hybrids which are resistant to major pests and diseases should be used for production.
- Terminal cuttings and tissue culture plants are commonly used for cut flower production under protected cultivation.
- Terminal Cuttings of 5-7 cm in length are taken from healthy stock of mother plants. The cuttings are prepared removing basal leaves and reducing the leaf area of remaining leaves to half. The basal portions (less than half inch) of cuttings are dipped in rooting hormone (1000 ppm solution of IBA for 30 sec) for better rooting. The lower portion of cuttings is treated with copper fungicide to avoid fungal growth. These cuttings are put in seedling trays or in sand beds in shade conditions.

Cultural practices:

Growing conditions

Cut chrysanthemums are grown under protected structures like naturally ventilated polyhouses with the following environmental conditions.

- For getting good flowering stems under protected cultivation, the optimum temperature should be 16-18°C during the night and 24-28°C during the day.
- High relative humidity should be avoided inside the polyhouse. Humidity levels above 95% produce soft growth, which encourages fungal and bacterial diseases in chrysanthemum.
- It is desirable to maintain a relative humidity of 60-70% during crop growth and flower

bud development.

- CO₂ levels of 600 - 900 ppm is recommended in closed environment

Photoperiod

- In protected cultivation, the chrysanthemum crop is accurately programmed by application of artificial lighting and blacking out treatments
- Long day conditions with 13 hours light and 11 hours darkness should be provided during the vegetative stage (up to 4-5 weeks from planting) and short-day conditions should be imposed with 10 hours light and 14 hours darkness during the flower bud initiation stage
- For commercial flower production under polyhouses, programmed blooming is necessary to ensure year-round availability of flowers.

Land and Bed preparation:

- Well drained sandy loam soil rich in organic matter with good texture and aeration or growing medium which is composed of soil, compost and cocopeat (1: 1: 2) with pH ranging from 5.5 to 6.5 is ideal.
- The beds for growing chrysanthemums are formed with 1 m width, 30 cm height and at convenient length.
- The soil pH must be 5.5 to 6.5 with 1 to 1.5 EC (Electrical Conductivity).
- Soil sterilization should be done by drenching the soil beds with 5% solution of formaldehyde @ 4 liters/sq.m and covering them with polyethylene sheets for 2-3 weeks.

Planting

- The optimum planting density and spacing is mentioned below
- 15x 15 cm (45 plants/m²) for spray chrysanthemums
- 12.5 x 12.5 cm (64 plants/m²) for standard chrysanthemums
- Planting of rooted cuttings are done preferably during evening hours.
- After planting the rooted cuttings, a mist of 4-5 m³ water/ 1,000 m² area is given to wet the root and create 85% relative humidity.
- Misting is done regularly in morning and evening for 4-5 days to maintain sufficient moisture.

Fertigation

- NPK @ 20:20:10 g/m² is applied through fertigation at weekly intervals
- A foliar spray of 0.2 per cent EDTA micronutrient mixture or ZnSO₄ @ 0.25% + FeSO₄ @ 0.2% + Boric acid @ 0.1% at 15 days intervals will improve the growth, physiology, yield and quality of cut chrysanthemums.

Irrigation

- For successful cultivation of chrysanthemum under protected cultivation, optimum moisture should be maintained throughout the growing period. Water can be saved to the extent of 25-30 per cent in drip method of irrigation.
- Drip irrigation with 8-9 litres of water/sq.m/day is considered ideal for protected cultivation
- Frequency of irrigation depends on stage of growth, soil and weather conditions

- Proper drainage system should be maintained for chrysanthemum grown in beds under protected structures

Support structure / Crop support netting

- Bamboos 4 ft in height or iron guards are fitted every 3 ft along the length of the bed.
- A nylon crop supporting net of 12.5 cm x12.5 cm mesh are spread on this support structure before the plant is tall enough to get entangled.
- Use of nylon net ladders provides support against lodging to get straight cut stems under protected cultivation.
- When laid horizontally, the support plastic netting in layers becomes a fairly effective guide to space-keeping in planting.
- Successive layers of support nets can be fixed at the brackets with continuing growth of plants.

Pinching

- In spray chrysanthemum, pinching the soft growth at 3-5 leaf stage is done to produce many lateral stems and only 2-3 healthy stems are retained per plant after thinning out the weaker ones.
- In standard chrysanthemum, only a single stem is retained by disbudding the lateral branches and buds as against the removal of the terminal bud in spray types
- For taking one bloom per plant no pinching is done. Only the main stem is allowed to grow.

Disbudding

- These operations are mostly performed for large flowered and decorative chrysanthemums.
- In standard varieties, all the lateral/ axillary buds are removed and only the largest terminal or apical buds are allowed to retain and develop.
- In spray varieties, only the large apical bud is removed and the lateral /axillary buds are retained and are allowed to develop
- For taking three blooms per plant, three lateral strong shoots are allowed to grow and others are removed.
- Lateral buds and side shoots are removed at their early stage of growth from time to time.
- Removal of undesirable lateral buds and shoots are done.

De-shooting

- De-shooting is practiced to reduce the number of branches for improving the size and form of the flower.
- Retain 4-5 shoots in standard chrysanthemums and 8-12 shoots in spray chrysanthemums

Desuckering

- For proper and vigorous growth of the plant; suckers are removed from time to time.
- Without de-suckering, the main plant will lose vigour and become weak.

Use of growth regulators

- Spray of GA₃ @ 50 ppm at 30, 45 and 60 days after planting can be done to increase the flower stem length.

Weeding

- Weeds should be avoided in the greenhouse since they deplete moisture and nourishment from plants.
- 2-3 hand weedings are required. First weeding should be done one month after planting.
- Weeding and hoeing are done manually as and when required.

Harvesting and Post-harvest handling

- Depending upon varieties plant start yielding flower after 3-4 months of transplanting.
- Correct stages of harvest depend up on the cultivar, marketing and purpose
- Standard chrysanthemums are generally harvested, when outer row of ray florets starts unfurling and cease to elongate for distant market and half opened flowers for local market
- Spray chrysanthemums are harvested, when 50% flowers have shown colour for distant market and when two flowers have opened and others have shown colour for local market
- Cutting of the flower stems should be done at about 10 cm above the soil to avoid cutting wooden tissue and leaves from lower one-third of stems are stripped off
- Harvested flowers are to be kept immediately in a clean bucket containing water and floral preservatives to avoid desiccation.
- The lower one third of stem are placed immediately in water containing a biocide to prevent the growth of microorganisms and to extend the vase life of cut flowers.
- In the packing house, flowers are sorted into different grades as heavy stems 70-80 cm and lighter stems of 60 cm and kept in clean buckets at 2°C in cold storage.

Cold storage

- The stems after grading are given a cut using sharp blade and precooled at 10 ° C minimum of 2 hours before packing
- Mature chrysanthemum can be stored dry for 3-8 weeks period at a temperature of 0-3 ° C.

Packaging of Cut flowers

- After harvest, the stems have to be cut at equal length (90 cm is the standard)
- Early morning on day of shipment /night before, bunches can be packed in boxes.
- Wrap flower bunches in cellophane sleeves.

Packaging of Standard chrysanthemums

- Bunched in 5, 10, 20 or 25 putting a rubber band at base and slide them into a transparent plastic sleeve
- They are placed in sleeves and packed in display boxes / corrugated cardboard boxes measuring 91 x 43 x 15 cm (L x W x H)
- It accommodates about 80-100 cut flowers of chrysanthemum.
- They are placed in boxes according to the grades

Packaging of Spray chrysanthemums

- 10, 15 or 20 stems are placed in sleeves according to the grades
- Six sleeves, three at each end are generally packed in each corrugated cardboard box, measuring 80 x 50 x 23 cm (L x W x H)

Crop protection

Aphids, whitefly, leaf miner, thrips, leaf folder, hairy caterpillars, grubs, red spider mites and nematodes are some of the major pests of chrysanthemums under protected cultivation. Major diseases are wilt, stem and foot rot, rust, white rust, root rot, bacterial blight, grey mold, leaf spot and flower blight and powdery mildew. Viral diseases like chrysanthemum stunt, tomato spotted wilt, tomato aspermy, flower distortion, chrysanthemum mosaic and chrysanthemum rosette also affect chrysanthemum. Integrated approach should be ensured for pest and disease management for safe crop production in chrysanthemum grown under protected cultivation.

Insect management

- Growing of resistant/tolerant chrysanthemum varieties to minimize the pest incidence.
- Aqueous spray application of entomogenous fungus *Verticillium lecanii* (Vertilec) @ 15 g/lit (108 CFU/g) controls Aphids. Aphids can be controlled by spraying of neem oil @ 0.1 % at weekly interval when infestation starts on the plant. In case of severe infestation, spray dimethoate 30 EC @ 2 ml/litre or acephate 75 SP @ 1 g/litre. Neem formulations can be used in rotation with regular insecticides
- In case of leaf miner infestation, remove and destroy weeds which act as alternate hosts. Cutting and discarding of heavily mined leaves reduce further damage and help in containing the spread. Spray 0.05% Monocrotophos or 0.05% Triazophos.
- Blue sticky traps can be used for mass trapping of thrips. Release of nymphs and adults of predatory minute pirate bug, *Orius insidiosus* is effective in control of thrips. Spray dimethoate 30 EC @ 1 ml/litre or fenitrothion 50 EC @ 1.0 ml/litre 2 or 3 times at 15 days interval. Application of spinosad is very effective against thrips.
- Spray of 0.05% Dicofol or 0.05% Vertimac or Pentac at fortnightly interval to control mites
- Spraying of 0.02% Cypermethrin or 0.02% Decamethrin or 0.05% Quinalphos at fortnightly interval is effective to control leaf folder

Disease management

- Use resistant varieties to manage wilt. Before planting, dip the rooted cuttings in a solution of *Pseudomonas fluorescens* @ 2g/litre of water. Dipping of rooted cuttings in Benomyl suspension before planting is also effective. Since wilt disease spreads mostly through cuttings, it is important to use disease free planting material. Disease can further be minimized by following strict sanitation; periodical monitoring; crop rotation and roguing of infected plants. Solarization of soil should be done by using black polythene mulch during summer months.
- Sanitation and clean cultivation prevent rust. Early removal of infected leaves/plants helps to prevent the further spread of the disease. Spraying of affected plants with Wettable sulphur @ 3g/l or Propiconazole @ 1 ml/ litre will control Rust.
- White rust can be managed by spraying the chrysanthemum plants with Azoxystrobin @ 1g/l or Chlorothalonil @ 2g/l
- Root rot can be controlled by soil drenching with copper oxy chloride @ 2g/l or Bordeaux mixture @ 1 %. It can also be managed by spraying and drenching with Ridomil MZ @ 2g/l. Soil application or mixing of *Trichoderma viridae* and *Pseudomonas fluoresce* with FYM is also effective. Provide good drainage conditions to prevent water logging.
- Destruction of disease debris and avoiding excessive irrigation is recommended to manage leaf spot and flower blight. Spraying with Mancozeb @ 2 g/l or Copper

- Oxychloride (0.2%) at 10-15 days interval helps in controlling the disease.
- Powdery mildew can be controlled by spraying with sulphur fungicides @ 2g/l or Tridemorph @ 1g/l at 15-20 days interval. Carbendazim @ 2g/l or Azoxystrobin @ 1g/l also controls the disease. Good ventilation and proper spacing for free circulation of air is recommended.

Aster

Aster (*Callistephus chinensis* (L.) Nees.) belongs to the family Asteraceae and is a flowering annual cultivated commercially for its colourful and showy plants which are used as loose flowers, cut flowers, potted plants and as bedding or border plants for landscaping. Wide range of colours, flower forms and plant growth renders aster a versatile crop for varied uses.

Importance and scope of Good Agricultural Practices (GAP):

Aster is cultivated commercially as a loose flower, cut flower, potted plants and in landscapes. Though the produce is not consumed directly, lot of inorganic fertilizers and plant protection chemicals go into the crop production.

- The first step towards producing safe crop begins at the farm level and is the responsibility of the grower for which standard package of practices referred as good agriculture practices has to be followed.
- Economical and sustainable production by use of quality inputs in prescribed amounts at critical time will help in achieving sustainable production, for which a set of practices is enlisted below as for GAP in aster.

Suitable growing conditions

- Aster performs well in an open sunny location. Temperature range of 20-30°C during day and 15-17°C during night with relative humidity of 50-60% is the most suitable.
- Well drained red loamy soil with pH around 6.0 is the best.
- In places with moderate climatic conditions, it can be grown round the year, however, July-September planting is the most ideal.

Planting material

- Improved varieties /hybrids released by research organizations or planting material produced by registered nurseries should be used for commercial production.
- The seeds should meet the minimum requirement of the standards with regard to uniformity, vigour being true to type and being free of pest and diseases.
- As far as possible use varieties/hybrids which are resistant to major pests and diseases.
- Special nutritional requirement for specific varieties/hybrids should be ascertained and the nutrient management should be scheduled accordingly.
- Aster is propagated through seeds. The seed rate requirement is 300 g/acre.

Cultural practices

Land preparation

- Selection of the site, should be followed by soil and water testing to ascertain the suitability for cultivation.
- Well drained loamy to sandy loam soil with adequate aeration and a pH of 6.0. is ideal.
- Land should be ploughed deeply two to three times and brought to a fine tilth.
- Raised beds of 30 cm height, 1.2 m width and convenient length should be prepared leaving 40 cm passage between two beds. Raised beds ensure better drainage of excess water, ensure aeration for the roots and can be combined with drip irrigation and fertigation system.

Nursery raising

- Seeds are sown in raised beds prepared with fine mixture of red soil, sand and farm yard

manure (1:1:1 v/v).

- Seedlings can also be raised in pro-trays with cocopeat as a substrate.
- The seeds must be sown thinly about 0.5 cm deep in rows across the length at 10-12 cm apart and covered with a mixture of soil and farm yard manure.

Manures and Manuring

- For upkeep of soil health and to improve the organic matter, 8 tonnes of well decomposed farm yard manure should be applied in one acre at least 15 days before taking up planting.
- The organic compost/ farm yard manure should be free from pathogens, nematodes, weed seeds or any other harmful organisms.
- Bio-fertilizers should be used to reduce the requirement of inorganic fertilizers. Farm yard manure should be enriched with bio-fertilizers viz., *Azospirillum/Azotobacter*, Phosphate solubilizing bacteria or Arka microbial consortium @ 1.0 kg each/ tonne of farm yard manure and apply to the main field.

Fertilizer application to soil

- The inorganic fertilizers should be applied based on the soil analysis and recommendations only. This will help in providing optimum amount of nutrients to the crop. Excess application of fertilizers should be avoided as it will lead to soil and water pollution.
- Application of 72:48:24 kg NPK/acre is recommended.
- At the time of planting, full dose of P and K and half dose of N is recommended as basal dose whereas the remaining N is applied as top dressing 40 days after transplanting.
- Fertilizers should be placed in such a way that it should be easily accessible to the plant roots.

Transplanting

- Planting is done on raised beds in four row system with two drip lines per bed.
- Planting is done at a spacing of 30cm x 30cm.
- About one month old seedlings are usually transplanted when they have developed about three to four leaves.
- The transplanting should be done preferably during early morning or evening to avoid bright sunshine.
- Arka Microbial Consortium@12.5kg/ha or any certified consortium of bio-fertilizers can be drenched 2 weeks after transplanting to enhance the growth.

Fertigation

- Adopt fertigation for better fertilizer use efficiency and higher yield. For fertigation, weekly application of the recommended dose of fertilizers can be followed.
- As the fertilizer use efficiency is high under fertigation 75% of the recommended fertilizer dose will be adequate to obtain the potential yield thereby resulting in saving of 25% fertilizer input.
- In a fertigation schedule, 25 per cent of the total quantity of nitrogen, phosphorus and potassium can be applied to soil at the time of planting as straight fertilizers (Urea-40kg, Single Super Phosphate-75kg, Muriate of Potash -10 kg /acre/year) to save the cost on water soluble fertilizers. Remaining can be injected as through water soluble fertilizers.
- Fertigation can be commenced from the third week after planting and continued at weekly intervals.

The weekly fertigation schedule can be as follows:

- 0-20 days after planting: No fertigation
- 20-40 days after planting: Urea- 14.8 kg; MAP (12:61:0)- 3.9 kg; SOP (0:0:50)-2.4 kg/ac/ week
- 40-55 days after planting- Urea- 14.7 kg; MAP (12:61:0)- 11.8 kg; SOP (0:0:50)-7.2 kg/ac/ week
- 55-90 days after planting- Urea- 5.9 kg; MAP (12:61:0)- 4.7 kg; SOP (0:0:50)-2.9 kg/ac/ week
- If there is a specific recommendation based on the soil analysis for fertigation, the schedule can be modified as per requirement.

Irrigation

- For successful cultivation, optimum moisture should be maintained throughout the growing period. Aster requires 400-450 mm of water per cropping season. Water can be saved to the extent of 25-30 per cent in drip method of irrigation.
- The frequency of irrigation depends on the climatic and soil conditions.
- Daily irrigation through drip system has to be followed based on the stage of the crop (crop factor) and daily evaporation.

Pinching

- Pinching of main shoot at one month after transplanting increases number of nodes, branches, flowers per plant and flower yield per unit area.

Inter culture

- Earthing up is an important operation to prevent lodging of erect varieties.

Weeding

- The beds should be kept weed free throughout the crop period.
- Regular hand weeding may be done in early stages of crop growth.

Harvesting and post-harvest handling

- Fully opened individual flowers or flowers along with stalk are harvested for garland making, whereas for cut flower, the whole plant is harvested when 60 per cent flowers are fully opened
- Harvesting has to be done during the cool hours of the day. All the containers into which the flowers are placed should be cleaned before use.
- Precooling of flowers to remove the field heat is an important operation to lower respiration and prolong the shelf and vase life of flowers.
- Damaged/bruised flowers should be discarded and disposed hygienically.
- For local market the loose flowers are transported in bamboo containers lined with cloth or with wet gunny bags or in gunny bags or polythene bags lined with newspaper.
- Cut flowers are bunched and transported in containers holding water.

Crop protection

Aphids, leaf hoppers, leaf miner, thrips and mites are some of the major pests of aster. Major diseases are collar rot, and wilt. Integrated approach to pest and disease management ensures better control and in safe crop production.

Insect management

- Grow resistant/tolerant varieties to avoid/ minimize pest incidence.
- Flower caterpillars can be controlled by spraying fenvalerate 20 EC @ 0.5 ml/l or neem seed kernel extract 5%. If the incidence is severe, spray indoxacarb 14.5SC @ 1 ml/l.
- Stem borer can be managed by collecting and destroying infested shoots. Spray profenophos 50 EC @ 1 ml/l or ethofenprox 10 EC @ 1ml/l. If the incidence is severe, apply carbofuran 3G granules @ 1 kg.a.i./ha (33 kg/ha).
- Spraying acephate 75 SP @ 1.5 g/l or dimethoate 30 EC @ 2 ml/l or spraying Neem or Pongamia oil 1% at early incidence is recommended for controlling the aphids.
- To control Leaf miner, spray triazophos 40 EC @ 1.5 ml/L for management. Repeated sprays are to be avoided.
- Mites can be managed by spraying dicofol 18.5 EC @ 2.5 ml/l or fenazaquin 10 EC @ 1 ml/l or profenofos 50 EC @ 1 ml/l.

Aster yellow management

- Since disease is transmitted by leaf hoppers, prophylactic spray with systemic insecticides in rotation has to be taken up.
- Destruction of diseased plant immediately after the appearance of the symptoms helps in minimizing the spread of the disease.
- Keep the field weed free and maintain proper distance from other crops that can act as host is important for management of this problem.

Disease management

- Collar and root rot can be controlled by drenching the soil with captan (2 g/l), mancozeb (2 g/l) and metalaxyl (1 g/l).
- For management of wilt, Benlate (0.1%) or carbendazim (0.1%) can be used.

Gerbera under protected cultivation

Gerbera (*Gerbera jamesonii* Bolus ex. Hook F) belongs to the family Asteraceae and is commonly known as Transvaal daisy, Barberton daisy or African daisy. It is an important cut flower, potted plant and is also ideal for beds and borders in gardens. The flowers are available in wide range of colours including yellow, orange, cream white, pink, red and various other intermediate shades. Based on the flower heads, they are grouped into single, double and semi-double. Major gerbera producing states in India are Karnataka, Maharashtra, Uttarakhand, Assam, Meghalaya, Tamil Nadu, Telangana, Himachal Pradesh, Manipur, Mizoram, Nagaland and Arunachal Pradesh.

Importance and scope of Good Agricultural Practices:

Safe production of crops is being emphasized worldwide. Many of the flower crops are used for aesthetic purpose and only a few are directly consumed or used as food additives.

- Gerbera is mainly used commercially as a cut flower and as potted plants. Though the produce is not consumed directly, lot of inorganic fertilizers and plant protection chemicals go into the production of this crop, to achieve the prescribed quality standards.
- The first step towards producing safe crop begins at the farm level and is the responsibility of the grower for which standard package of practices referred as good agriculture practices has to be followed.
- Cultivation of gerbera in polyhouse in closed environments increases the risk of workers being exposed to harmful chemicals. Meeting concerns on the welfare and safety of persons working or living in the farm is the sole responsibility of the producer/ grower.
- Economical and sustainable production and use of quality inputs at critical crop phases to make production sustainable also is a major aspect of GAP. A set of practices is enlisted below for GAP in Gerbera.

Suitable growing conditions:

- Gerbera requires sufficient sunlight for growth and flower production. However, too much of sunlight can reduce the flower quality and hence partial shade has to be provided using shade nets.
- The optimum day and night temperature is 27°C and 14°C respectively. For flower initiation, the optimum temperature is 23- 25°C.

Planting material

- Improved varieties /hybrids released by research organizations or planting material produced by registered companies of India should be used for commercial production.
- The planting material should meet the minimum requirement of the standards with regard to uniformity, size, vigour being true to type and being free of pest and diseases.
- As far as possible use varieties/hybrids which are resistant to major pests and diseases.
- Special nutritional requirement for specific varieties/hybrids should be ascertained and the nutrients management should be scheduled accordingly.
- Propagation through tissue culture is the most common method and is a large scale and commercial method of multiplication of gerbera. Suckers can also be used by division of clumps though it is not a common practice in many of the commercial units for cut flower production.

Cultural practices

Land preparation

- Selection of the site, should be followed by soil and water testing and if needed further reclamation has to be done.
- Well drained deep loamy soil with adequate aeration and a pH of 5.5 to 6.5 will ensure effective nutrient uptake by the plants.
- The EC of soil should be 0.5-2.0 dS/cm².
- Land should be ploughed deep 2 to 3 times and brought to a fine tilth.
- The growing media comprising of a mixture of soil, sand, cocopeat and well decomposed farm yard manure (15 t/ha) has to be fumigated with 2% formaldehyde (100 ml formalin in 5 liters of water per sq.m. area).
- Thoroughly drain the fumigants from the media before planting.
- Raised beds of 30-45 cm height, 0.6 m width and convenient length should be prepared leaving 40 cm passage between two beds. Raised beds ensure better drainage of excess water, ensure aeration for the roots and can be combined with drip irrigation and fertigation system.

Manures and Manuring

- For upkeep of soil health and to improve the organic matter, 20 tonnes of well decomposed farm yard manure should be applied in one hectare at least 15 days prior to planting.
- The organic compost/ farm yard manure should be free from pathogens, nematodes, weed seeds or any other harmful organisms.
- Five tonnes/ ha of well decomposed FYM/vermicompost/ deoiled neem cake has to be enriched by mixing with 2 kg of each of *Pseudomonas fluorescens* + *Trichoderma harzianum* + *Paecilomyces lilacinus* formulation under shade. It has to be covered with mulch and optimum moisture of 25 - 30% has to be maintained for a period of 15 days. This has to be incorporated into the beds before planting for control of nematodes.
- Bio-fertilizers should be used to reduce the requirement of inorganic fertilizers. Farm yard manure should be enriched with bio-fertilizers viz., *Azospirillum/Azotobacter*, Phosphate solubilizing bacteria or Arka microbial consortium @ 1.0 kg each/ ton of farm yard manure and apply to the main field.

Fertilizer application to soil

- The inorganic fertilizers should be applied based on the soil analysis and recommendations only. This will help in providing optimum amount of nutrients to the crop. Excess application of fertilizers should be avoided as it will lead to soil and water pollution.
- Application of 10:15:20 g NPK/m²/month during first three months of planting and 15:10:30 g NPK/m²/month from fourth month when flowering starts.
- Fertilizer application in two splits at 15 days interval is desirable for good growth and increased flower production.
- Fertilizers should be placed in such a way that it should be easily accessible to the plant roots.

Planting

- Gerbera planting is normally done in two seasons viz., January to March and June to August.
- Tissue cultured plug plants (4-5 leaves) should be planted in such a way that their crown

is slightly above the soil. Care has to be taken to avoid covering of the crown by the growing media.

- Planting is done at a spacing of 30cm x 30cm. After planting, relative humidity inside the greenhouse should be kept 70-80% or shade net should be remaining closed for 4-6 weeks to avoid desiccation of plants.
- As a precautionary measure drench Copper oxy chloride (COC) @ 2.0g/l immediately after planting.
- Arka Microbial Consortium@12.5kg/ha /any certified consortium of bio-fertilizers can be drenched 2 weeks after transplanting to enhance the growth.

Fertigation

- Adopt fertigation for better fertilizer use efficiency and higher yield. For fertigation, weekly application of the recommended dose of fertilizers can be followed.
- As the fertilizer use efficiency is high under fertigation 75% of the recommended fertilizer dose will be adequate to obtain the potential yield thereby resulting in saving of 25% fertilizer input.
- In a fertigation schedule, 25 per cent of the total quantity of nitrogen, phosphorous and potassium can be applied to soil at the time of planting as straight fertilizers (Urea-30g, Single Super Phosphate-40 g, Muriate of Potash -35 g/m²) to save the cost on water soluble fertilizers. Calcium nitrate@ 15g/m² is also applied as basal dose. Remaining can be injected as through water soluble fertilizers.
- Fertigation can be commenced from the third week after planting and continued at weekly intervals.

The fertigation schedule can be as follows:

- Vegetative phase (up to 3MAP)- 0-20 days- no fertigation; 21-90 days- Urea-5g, Mono ammonium phosphate-1.0g, Sulphate of potash-4.0 g/m²per fertigation/ week
- Flowering phase (4MAP onwards)- Urea-2.5g, Mono ammonium phosphate-1.5g, Sulphate of potash-7.0 g/m² per fertigation/week
- If there is a specific recommendation based on the soil analysis for fertigation, the schedule can be modified as per requirement.

Micronutrients

- Foliar spray of micronutrients such as boron, calcium, magnesium and copper @ 0.15% at monthly intervals is found to give quality blooms.

Irrigation

- For successful cultivation, optimum moisture should be maintained throughout the growing period. Gerbera requires 800-900 mm of water per year. Water can be saved to the extent of 25-30 percent in drip method of irrigation.
- The frequency of irrigation depends on the climatic and soil conditions.
- Daily irrigation through drip system has to be followed based on the stage of the crop (crop factor) and daily evaporation. Replenish water by substituting 80% of the evaporation loss.
- Farmers should be encouraged to adopt water harvesting and conserving techniques for better utilization and efficiency for the important natural resources.
- Quality of water used for irrigation is equally important and water quality should be tested periodically. The irrigation water should be free from excess carbonates, bicarbonates and chlorides.

Inter culture

- Leaf pruning has to be done at regular intervals. Retain only 14-15 green leaves/plant at a given time.
- This helps in improving air circulation and minimizing the incidence of foliar diseases. It also eases the cultural operations like spraying.

Weeding

- The beds should be kept weed free throughout the crop period.
- Resort to manual weeding. In general, 3-5 manual weeding will be required for the entire cropping period.

Harvesting and post-harvest handling:

- Gerbera starts flowering in about three months after planting.
- Harvesting of flowers should be done when outer two rows of disc florets have fully developed or when outer row of disc florets is perpendicular to the stalk.
- The cut flower should be pulled rather than cut, because cutting leaves a stem stub on growing plant that encourages the development of diseases.
- Engage trained workers to ensure clean harvesting without any damage to the flowers
- Harvesting has to be done during the cool hours of the day. All the containers into which the flowers are placed should be cleaned before use and hold clean water.
- Precooling of flowers to remove the field heat is an important operation to lower respiration and prolong vase life of flowers.
- Grading of the flowers have to be done based on stalk length, flower diameter and quality of flowers discarding diseased, damaged and abnormal flowers.
- Damaged/bruised flowers should be discarded and disposed hygienically.
- The individual flowers are sleeved using polyfilm cups to prevent petal damage during handling and transport.
- For local market, 10 flowers are bunched and transported in containers holding water. For distant markets, up to 50 sleeved flowers are transported in telescopic cardboard boxes of dimension 100 x 10x 30 cm.
- Gerbera can withstand dry storage at 2-5⁰C for two days and wet storage at 4-7⁰C for four days.
- Maintenance of proper cold chain post-harvest to arrival at the consumer end prolongs the vase life and retains the flower quality.

Crop protection

Aphids, whitefly, leaf miner, thrips and mites are some of the major pests of gerbera. Nematode infestation also is widely found in gerbera polyhouses. Major diseases are crown and root rot, flower bud rot and powdery mildew. Integrated approach to pest and disease management ensures better control and in safe crop production.

Insect management

- Grow resistant/tolerant varieties to avoid/ minimize pest incidence.
- Aphids and white fly can be controlled by spraying Imidacloprid @ 2 ml/l or Dimethoate 30 EC @ 2 ml/l
- Spray insecticides like Imidacloprid (0.005%), or Fipronil (0.01%) at fortnightly intervals after planting to manage sucking pests.
- Apply neem cake @ 250 kg/ha to the soil to reduce leaf miner incidence. Spray Abamectin

- 1.9 EC @ 0.4 ml/l to control leaf miner.
- If mite incidence is noticed, spray Neem soap 1 % or neem oil 1% mixed with synthetic acaricide like dicofol 18.5 EC @ 1.5 ml/l or wettable sulphur 80 WP (3.0 g/l). Spray lower surface of the leaves where mites are generally found. Abamectin 1.9 EC @ 0.4 ml/l is also effective against mites.
 - Yellow sticky trap and blue sticky traps can be installed to monitor and attract sucking pests. This will also prevent transmission of virus to plants as these sucking pests act as vectors.
 - Need based spray of spinosad 45 SC @ 0.3ml/l, indoxacarb 14.5 SC @ 0.75 ml/l or flubendiamide 20 WG @ 0.2 g/l is effective for borers.

Nematode management

- Use of nematode free planting material and growing antagonistic crops like marigold, mucuna (velvet bean) before planting gerbera
- Maintaining the polyhouse free from weeds and alternate hosts
- Application of carbofuran 3G @ 1 kg a.i./ha (33 kg/ha) before planting
- Apply 5 tonnes of FYM or 500 kg of neem cake / pongamia cake or one tonne of vermicompost/ha enriched with *Pseudomonas fluorescens* + *Trichoderma harzianum* + *Paecilomyces lilacinus* during the land preparation or on the beds 5 – 10 days before planting.
- Mix 20 kg of bio-pesticide enriched neem cake / pongamia cake in 200 litres of water, the supernatant can be used for drenching @ 2 lit/ sq. m. or filter it thoroughly and send along the drip, once in an interval of 30 days.
- Alternatively, Arka Plant Growth Enhancer and Yield Promoter can be given through drip/drenching/spraying @ 5ml/ lit. at regular interval of 30 days.

Disease management

- Drench the plants with captaf (0.2%) or carbendazim (0.1%) after planting to prevent root rot.
- Foliar application of copper oxy chloride (0.2%) for the control of crown rot and flower bud rot.
- Foliar application of Wettable Sulphur @ 2g/l or Azoxystrobin @ 1g/l for the management of powdery mildew.

Gladiolus

Gladiolus (*Gladiolus hortensis* L.), belongs to the family *Iridaceae*. It is one of the most popular ornamental bulbous plants having a pivotal place as cut flower both in the domestic as well as the international market. From the commercial point of view, it is a very important flower crop due to its majestic flower spikes having florets of varying shapes, sizes, colours and excellent keeping quality.

Importance and scope of Good Agricultural Practices (GAP)

Gladiolus is relatively easy to grow flower crop and is ideal for bedding and exhibition. The flowers are used in flower arrangement, in bouquets and for indoor decorations. Demand of its cut flower for bouquet and other floral arrangement is increasing day by day due to its long vase-life and economic value. The concept of Good Agricultural Practices (GAP) has assumed importance in recent years in the context of the concerns on environmental sustainability of agriculture. In the production practices of gladiolus, lot of inorganic fertilizers and plant protection chemicals are being utilized. Appropriate adoption of Good Agricultural Practices and use of quality inputs at optimum time enables economical and sustainable gladiolus crop production. A set of Good Agricultural Practices that is needed to be followed for gladiolus crop production is enlisted below.

Planting material

- For commercial production of gladiolus, improved varieties or hybrids released by research organizations and state agricultural universities or planting material produced by registered ornamental nurseries should be used.
- Gladiolus corms should meet the minimum requirement of the standards with regard to size, uniformity, vigour and should be free of pest and diseases.
- Efforts should be made to use gladiolus varieties/hybrids which are resistant to major pests and diseases.
- The nutritional requirement for varieties should be ascertained and schedule the nutrient management accordingly.
- Gladiolus can be commercially propagated by corms of 4-5 cm diameter.
- Conical shaped corms / high crowned corms are preferred over flat ones as propagule to achieve uniform crop stand.

Cultural practices

Land preparation

- The site selected for gladiolus planting should be sunny protected from stormy winds, by wind breaks or hedge.
- They will not perform well if planted in shaded and poorly drained places. Poor drainage will result in rotting of corms.
- Site selection should be followed by soil and water testing to ensure the suitability for cultivation.
- Well drained fertile loamy to sandy loam soil with adequate aeration and pH of 6.5-7 is highly preferred for gladiolus cultivation.
- The soil must be ploughed to a depth of at least 30 cm.
- Raised beds with dimensions of 30cm height, 90 cm width and convenient length should be prepared leaving 40-50 cm path width between two beds.
- Raised beds ensure adequate drainage of excess water, ensures proper aeration for the roots and can be combined with drip irrigation and fertigation system.

Manures and Manuring

- For the proper upkeep of soil health and to improve the soil organic matter, 20 tonnes of well decomposed farm yard manure should be applied in one hectare at least 15 days prior to planting.
- It should be ensured that organic compost/ farm yard manure used should be free from weed seeds, pathogens, nematodes, or any other harmful microbes.
- Well decomposed FYM/Vermicompost/ Neem cake has to be enriched by mixing with 1 kg of each of biocontrol agents like *Pseudomonas fluorescens* + *Trichoderma harzianum* + *Paecilomyces lilacinus* formulation under shade. It has to be covered with mulch and an optimum moisture of 25 - 30% should be maintained for a period of 15 days. Intermittent mixing should be done to ensure proper and uniform distribution of moisture. After 15 days, it has to be incorporated into the beds before planting for control of nematodes.
- Well decomposed FYM should be enriched with bio-fertilizers viz., *Azospirillum/Azotobacter*, Phosphate solubilizing bacteria or Arka microbial consortium @ 1.0 kg each/ tonne of farm yard manure and apply to the main field. This will reduce the requirement of inorganic fertilizers.

Fertilizer application to soil

- Excess and non-judicious application of inorganic fertilizers should be avoided as it will lead to soil and water pollution.
- Inorganic fertilizers should be applied based on the analysis of the soil and recommendations only. This will help in providing optimum amount of nutrients to the crop.
- Application of 120 kg N, 150 kg P₂O₅ and 150 kg K₂O per hectare is recommended
- At planting time, 60 kg N and entire dose of P₂O₅ and K₂O is applied as basal dose.
- The remaining N is given in two split doses, 30 and 60 days after planting. i.e. first dose at 4-6 leaf stage and second at earthing up stage i.e. 6-8 weeks after planting.
- Fertilizers should be applied in such a way that it should be easily accessible to the plant roots.

Planting

- Planting of gladiolus corms is done on raised beds in double row system with one drip line per bed.
- To encourage sprouting of corms, the brown dry scales or the tunics are removed.
- The corms should be disinfected properly before planting to reduce the chances of disease infestation.
- Gladiolus corms which are healthy, disease free with diameter of 4 to 5 cm should be selected and planted at a spacing of 30 x 20 cm and depth of 5 to 10 cm.
- Shallow planting of corms is essential. Deep planting will result in poor production of cormels and also cause decaying of corms.
- Planting is done during September - October and the corms are planted up to November-December.
- Arka Microbial Consortium @ 12.5kg/ha /any certified consortium of bio-fertilizers can be drenched 2 weeks after planting to enhance the growth.

Irrigation

- Judicious use of water is possibly the most important single factor in the production of the best gladiolus spikes.
- Optimum moisture should be maintained throughout the growing period for successful gladiolus crop production
- Soil should have sufficient moisture at the time of planting so that no irrigation is required till sprouting.
- Frequency of irrigation depends on the prevailing climatic conditions and type of soil.
- A gladiolus crop must not be allowed to suffer from water stress especially when spikes are emerging.
- During warm weather conditions, irrigation to the crop can be done twice a week, and once in a week during winter.
- Over watering should be avoided.
- After harvesting of the flower spikes, watering should be reduced.
- Irrigation should be withheld at least 4-6 days before lifting of corms. This would help in easy and effective lifting of corms and cormels.

Inter culture

- When the shoots are about 20 cm tall, they are covered by heaping the soil up to a height of 10 to 15 cm.
- Earthing up is essential after 6-8 weeks of planting corms, or before the emergence of spike. This enables the plants to grow erect despite high winds and rains and suppresses weed growth.
- Earthing up the soil is a must in case of light soils. These plants need staking for its satisfactory growth and if not staked may fall or break due to wind.
- In cases where the spikes grow longer or stems are not strong enough to bear the lodging by wind, they are supported with about 1.5 meters strong stakes.

Weeding

- The beds should be kept free from weeds throughout the crop period.
- Regular need based manual weeding is required for the entire cropping period.

Harvesting and post-harvest handling

- After planting the corms, gladioli blooms in two to three months, depending upon the species and variety.
- The flower spike should be cut as close to the base as possible with a sharp knife or a scissors after the first floret on the spike has opened. The other florets on the same spike will open when placed in water.
- While harvesting or cutting of the spike, care should be taken that at least four to six basal leaves should be retained on the plant to ensure proper development of corms and cormels.
- For the local market, flower spikes are cut when 1-2 lower most florets on the spike have opened and for the distant market, when the colour has fully developed in mature unopened buds.
- Immediately after cutting, the spike should be immersed (up to 15 cm from base) in a clean bucket containing water
- Harvesting of spikes should be done during the cool hours of the day.
- Precooling of flower spikes to remove the field heat may be followed to lower respiration and prolong the vase life.
- Damaged/bruised flower spikes should be discarded.

- Cut flower spikes are bunched and transported in clean containers holding water.

Harvesting and Storage of Corms

Lifting of Corms and Cormels

- Once the spikes are cut out, the leaves begin to turn yellow.
- Plenty of moisture, followed by a dry period, before lifting ensure the formation of large corms.
- Gradually the water supply is reduced till the leaves get dried naturally.
- After 3 - 4 weeks corms and cormels are lifted from the ground.
- Corms are matured when 25% cormels have become brown which generally take 30 to 45 days from flowering when the leaves also start yellowing.
- Corms and cormels should be dug out with the help of a spade.
- Soil should be dug deep in order to take out all the cormels.
- The corms are checked for any disease infection and the affected corms are discarded.

Curing of corms

- Curing is one of the essential post-harvest operations for successful storage of corms.
- After lifting and removing the adhering soil, the corms and cormels of each cultivar are kept in trays in a shady but well-ventilated place for about a fortnight.
- For curing, the layers of corms should not exceed three, which may be cured for five weeks at 21°C.

Cleaning, Grading and Storage of corms

- After the corms are fully cured, these are cleaned, and diseased ones discarded.
- Treat the corms with carbendazim (2g/l) or captan (2g/l) and dried under shade which protects them from diseases during storage.
- The corms and cormels are graded in different grade-sizes and cold stored at 4 to 6°C

Crop protection

Aphids, thrips, bud borer, cut worms, loopers, grubs, beetles and bulb mites are the common insect pests of gladiolus. Nematode infestation also is widely found in gladiolus. Gladioli are infected by several fungal, bacterial and viral diseases. Gladiolus is highly susceptible to fungal diseases like wilt, corm rot, leaf and flower blight, leaf spot, dry rot or neck rot, storage rot etc. Integrated approach to pest and disease management ensures better control and in safe crop production.

Insect management

- Grow resistant/tolerant varieties to avoid/ minimize pest incidence.
- Thrips can be controlled by drenching the soil with chlorpyrifos (0.1 %) and spraying of dimethoate 30 EC @ 2 ml/litre or acephate 75 SP @ 1g/litre or imidacloprid 17.8 SL @ 0.5 ml/litre at 2 weeks interval
- Bud borers can be managed by application of HaNPV @ 250 LE/ha followed by spray with neem formulation @ 2ml/l. Spray quinalphos 25 EC @ 2ml/l at fortnightly interval
- Cut worms can be managed by application of SINV @ 250 LE/ha followed by spray with neem formulation @ 2 ml/l. Spray quinalphos 25 EC @ 2ml/l or cypermethrin 10 EC @ 1 ml/l at fortnightly interval
- Spraying of neem or pongamia oil 0.1 % controls mites. If the mite incidence is severe,

spray abamectin 1.9 EC @ 0.5 ml/l

- Avoid spraying of the same insecticide repeatedly, as it may result in insecticide resistance by the target pest.

Nematode management

- Use nematode free planting material and grow antagonistic crops like marigold, mucuna etc. before planting gladiolus corms
- Treat gladiolus corms with bio-pesticides like *Pseudomonas fluorescens* or *Trichoderma harzianum* or *Paecilomyces lilacinus* @ 10g/kg.
- 1 tonne of well decomposed FYM should be enriched with 2kg each of the biocontrol agents like *Trichoderma harzianum*, *Pseudomonas fluorescens* and *Paecilomyces lilacinus* and left under shade for 2 to 3 weeks at 25 – 30% moisture. This has to be thoroughly mixed once in three days and applied in field prior to planting.
- For the standing crop, biopesticide enriched neem cake can be mixed in water (1: 10 ratio), thoroughly filtered and applied through the drip or as soil drench.
- Chemical nematicide, carbofuran 3 G @ 1 kg a.i. per ha can be applied at planting and repeated after 45 days.

Disease management

- In order to control Fusarium wilt, it is advisable to destroy the infected corms from the field and to spray systemic fungicide like Bavistin (2g/l) on the soil as well as on the plants in the affected field. Treat the corms and cormels with Carbendazim (2g/l) and captan (2g/l) for 20 minutes before planting and after harvesting.
- Corm rot can be managed by hot water treatment with fungicide Carbendazim ((2g/l) and captan (2g/l)
- Leaf and flower blight can be controlled by spraying mancozeb @ 2 g/litre of water at weekly or 10 days intervals.

Crossandra

Crossandra [*Crossandra infundibuliformis* L. (Nees).] commonly known as 'Fire Cracker' plant is a herbaceous perennial, evergreen semi-shrub growing to a height of up to 4 feet. It is an important commercial loose flower crop having great demand in the form of garlands, venis and gajras for hair adornment, religious and decorative purpose. Though not fragrant, crossandra flowers are very popular because of their attractive bright colour, light weight and good keeping quality.

Soil and Climate

- Well drained sandy loam and red soils with pH of 6 - 7.5 are ideal.
- Soil has to be tested for nematodes before planting.
- It requires a temperature of 30°- 35°C for growth.
- If planted in shaded conditions, yield will be reduced
- It is susceptible to low temperature and frost.

Propagation

Local crossandra is multiplied through seeds. However, the triploid varieties are propagated through terminal cuttings.

Nursery raising

- Use fresh seeds that were harvested during the previous season
- Use seeds that are in good condition and free of pests
- In case of rooted cuttings, take cuttings from a healthy, vigorous and disease-free mother plant
- Raised nursery beds of around 15 cm height should be prepared
- Fresh seeds are sown during July-October in raised beds at 15 cm apart in lines
- Watering should be done immediately after sowing and also daily.
- The seedlings will be ready for transplanting in 60 days.
- The required seed rate is 5 kg/ha for optimum plant population.
- In triploid varieties, the terminal cuttings of length 10 cm, preferably with two buds has to be taken.
- The distal end will be dipped in 1000 ppm IBA for 30 seconds and planted in media consisting of 1:1 ratio of sand and cocopeat inside growth chamber with 90% humidity.
- The cuttings will be ready by 30 days.

Field preparation and planting

- Ensure correct spacing between plants and rows
- If you plan to plant other crops as an 'intercrop' then select compatible species which do not compete with main crop for inputs
- If you are collecting your own seeds, label the seed packets with details of the species, the origin and date of harvest or collection
- Do not use seeds or planting material that are in poor condition or if you do not know where they came from and when they were harvested
- Do not use seeds or planting material if you do not know exactly which species and variety they belong to
- Procure seeds or planting material from reliable sources
- The land has to be ploughed three or four times.
- FYM @ 25 t/ha is incorporated and mixed well in the soil.

- Ridges are formed 60 cm apart.
- Two plants in a bed are recommended with 60 cm in between plants and lines.

Manuring and fertilizer application

- Mix 2 kg each of *Azospirillum* and *Phosphobacteria* with 100 kg of FYM / ha and apply to the soil at the time of planting.
- A fertilizer dose of 33.3: 60: 60 kg/ha N: P₂O₅: K₂O is applied as basal dose.
- The crop is top dressed twice with 33.3 kg N per ha each time, the first at 3 months after transplanting and the second 8-9 months after transplanting.
- The application of fertilizers is to be necessarily followed by irrigation.
- On 30 days after planting, apply neem cake 250 kg and N 40 kg/ha. Again on 90 days after planting, apply N P K 40:20:60 kg/ha and repeat this dose at quarterly intervals for a time period of two years.

Inter-cultivation

- Manage weeds before they start competing with the main crop for nutrients and light
- Do not allow weeds to produce seeds – this will increase weed growth the following year
- Do not allow the soil to dry up due to excessive weeding
- Weeding, application of fertilizer and earthing-up can be combined together for easy maintenance of the crop.
- Periodic removal of the dry spikes has to be done to enhance the yield

Irrigation

- Irrigation is done once or twice in a week depending upon the soil moisture and weather conditions
- If drip irrigation is adopted, irrigation can be given daily. This system conserves water besides reducing weed growth.
- Use mulch to maintain moisture in the soil and to inhibit growth of weeds

Harvesting

- Crossandra flowers within two to three months after planting and continues to bear flowers throughout the year with a lean production season during rainy months.
- Fully opened flowers are to be picked early in the morning by pulling the corolla out of the calyx.
- All the tools used for harvesting and containers into which the flowers are placed should be cleaned before use
- Harvesting of flowers is to be done on alternate days.
- The yield of flowers is about 5-10 t/ha.
- The crop duration is 3 years including ratoon crop.

Plant Protection

Insect-pest management

Scale insects

- Removal and burning of heavily infested leaves will check pest build up.
- Clean cultivation and use of insect proof nets helps in prevention of whitefly incidence.
- Spray 1.0 % neem oil or pongamia oil at weekly interval.
- Spray of *Beauveria bassiana* or *Lecanicillium lecanii* formulations @ 2.0 ml/l during evening hours.

- Spray with acephate 75 SP @ 1.5 g/l at fortnightly interval alternating with pongamia oil @ 10 ml/l.

Whitefly

- Removal and burning of heavily infested leaves will check pest build up.
- Clean cultivation and use of insect proof nets helps in prevention of whitefly incidence.
- Install yellow sticky traps to monitor the activity of the adult fly.
- Spray with acephate 75 SP @ 1.5 g/l at fortnightly interval alternating with pongamia oil @ 10 ml/l.
- Spray of *Beauveria bassiana* or *Lecanicillium lecanii* formulations @ 2.0 ml/l during evening hours.
- If the activity of adults is more, spray with dichlorvos 76 EC @ 1.0 ml/l followed by lambda cyhalothrin 5 EC @ 1.0 ml/l or deltamethrin 2.8 EC @ 1.0 ml/l at 5 - 7 days interval.

Disease management

Foot and root rot

- Planting of disease-free seedlings
- Growing the seedlings in raised beds drenched with Captan
- Avoiding water stagnation by providing good drainage and earthing up
- Application of neem cake to control nematode infestation @ 50-100 g / plant depending on the age of the plant
- Prophylactic application of Captan as soil drench at the time of planting in the main field
- Application of Fosetyl-Al as soil drench two or three times at monthly interval during monsoon season when the disease takes a heavy toll.

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