

3. Recent Advances in Commercial Flower Production and Its Scope

Narendra Kumar

Assistant Professor, Faculty of Agriculture,
A.K. College Shikohabad, Firozabad,
Dr. Bhimrao Ambedkar University Agra, U.P., India.

V. M. Prasad

Ex-Professor and Former Head, Department of Horticulture,
Sam Higginbottom University of Agriculture Technology and Sciences,
Prayagraj, U.P, India.

Madhur Kumar

Assistant Professor, Department of Horticulture,
J.S. University, Shikohabad,
Firozabzd, U.P., India.

Abstract:

This comprehensive guide provides in-depth information on all aspects of commercial flowers production. This book satisfies the demand for a quality reference cum edited book among students. The authors have done an exceptional job of compiling all the necessary information related to commercial flowers production technology. They have presented it clearly and concisely, making it easy to understand and apply. Every effort has been taken to assure the accuracy of the data gathered from a variety of sources, including people, organizations, institutions, and publications. We expect that this book will be a helpful resource for educators, professionals, and learners seeking employment in ICAR institutions, State Agriculture University, State Public Services.

Keywords:

Commercial Flower, Improved Varieties, Improved Technology, Flower Colour, Fragrance and Innovation.

3.1 Important:

Floriculture is one of the most important branches of ornamental horticulture. It is the fastest growing sector in Indian horticulture with annual export of 20703.46 MT of 507.31 crores in 2017- 18 (APEDA) About 98 thousand ha was under cultivation in 2001- 02 with a

Sustainable Development

production of 556 thousand tons of loose flowers and 804 million number of cut flowers, which has been increased to 1,659 thousand loose flowers and 484 thousand tones cut flowers covering an area of 248.51 thousand ha. during 2015-16 (India stat). Cut greens refer to ornamental foliage and branches with or without decorative fruits, seed pods etc. to be used as fillers. Softening floral arrangements, provide contrast in floral arrangements. Complement the beauty of flowers. Fills voids or gap in floral designs used in bouquet making and flower arrangements to the extent of 20 to 25 percent. In Global Status Europe is leading exporter in the world. Netherland is important trade hub for cut flowers and foliage. In foliage in Europe share about 60% (CBI market informations Database 2013). The major cut foliage exporters in the world market are the Netherlands, USA, Costa Rice, Italy, Israel, Guatemala, Mexico, Germany, Canada, etc., The major importers are Norway, Germany, Denmark, USA, France, UK, Holland, Italy, Austria, and Japan (AIPH 2012).

In Indian status in terms of area of production, China and India have large total area is under flower cultivation More than 50% of the floriculture units are based in Karnataka, Andhra Pradesh, and Tamil Nadu. India is leading supplier of dry flower, dry and fresh foliage to Europe India's total export of floriculture was Rs. 507.31 crores/78.73 USD Millions in 2017-18. The floral export from India comprises of dry flowers (71%), fresh cut flowers (18%), live plants (9%), fresh bulbs (1%).

Floriculture comprises of various components which include fresh flowers (Cut and loose); Cut Greens, Fillers & Foliage; Potted Flowering Plants, Dry Flowers, Production of bulbs and tubers; Hybrid seed production; Nursery production; Perfumery; Plant rental services; Flower arrangements and floral craft (Garlands & venis, wedding garlands, bridal crown, strings, etc); Specialty flowers/Wild ornamental plants; Landscape Designing; Flower baskets, pots and containers etc. Traditional (Loose) flowers constitute major share of domestic market, they occupy major area as well as production whereas modern (cut) flowers are grown in limited area mostly for export market. The export surplus again is marketed in domestic sector. Flowers are grown in India since time immemorial.

3.2 Scopes in India:

Although floriculture is flourishing in India, but it has not made any remarkable in the domestic and intenational markets due to various constraints. The country's share in the world's total trade of fresh flowers is about 0.40 per cent to 0.50 per cent only as compared to Netherlands as much as 65, Columbia 12, Italy 6, Israel 4 and Kenya 1 %, and other countries share is about 20 per cent. The floriculture area in India is only 0.76 per cent. The investments in this field and per capita consumption of flowers are also considerably very low when compared to developed countries like Japan, USA and Western Europe. Floriculture in India is being viewed as a high growth Industry. Agricultural and Processed Food Products Export Development Authority (APEDA web port)-2016 shows that the Government of India has considered floriculture as a sunrise industry and accorded it 100%

export promotion status. As far as Indian floriculture is concerned, it can strengthen floriculture industry by improving the awareness, weak infrastructural support, quality planting material, post-harvest facilities, exploitation by brokers, sophisticated markets, database, and information on income generation and employment generation from different floriculture and export constraints. It is also viewed that a majority of the flower growers belong to small and marginal farmers' category, facing many constraints. The total area under flower crops in 2012-13 was 232.70 thousand hectares. Total area under floriculture in India is second largest in the world and only next to China.

3.3 Varietal innovations:

Use of molecular breeding for novelty:

Important ornamental character such as flower color, fragrance, and flower shape are clarified through isolation and analysis of related genes. Modification technology for these characters by genetic transformation is also developed. Basic breeding technologies that lead to improved breeding efficiency.

Novelty in flower form:

Different strategies are being applied like hybridization, mutation, polyploidy, genetic engineering to bred the cultivars with new flower forms. Single, semi-double, and double types of flowers are genetically controlled either by a single gene or multiple genes similarly, by induced mutagenesis, the mutant can be easily with modified visible characters such as flower shapes, size, or leaf form and growth habit.

Novelty in flower color:

Color determined by four classes of pigments viz., Flavonoides, carotenoids, betalains and chlorophylls. Creation of novel flower colors employing genetic manipulation techniques. Transgenic carnation and roses accumulating delphinidin as a result of avonoid 3'5' hydroxylase gene expression and having novel blue hued flowers which have been commercialized. Among various transgenic floricultural crops only roses and carnation have been commercialized. This indicates developed so far only colour by genetic engineering is still very challenging due to technical and economic difficulties.

Novelty in floral fragrance:

Flowers of many plant species emit floral scent to attract pollinators. Such scent are mixture aliphatic molecules (terpenoid, phenyl propanoid, benzenoid) (Pichersky and Dudareva, 2007). Chemical composition is varying according to species (Kundson et al., 1993).

Sustainable Development

Several physiological and ecological studies have examined the floral functions of floral scent compounds in plant biology (Vainstein, 2002). Numerous cytological studies have been performed to determine scent glands and scent production and emission process (Bergougnoux et al., 2007).

Recent innovations (Glow in the dark) Orchid:

The world's first genetically modified bioluminescent is of Orchid. Successfully developed by Prof. Chia from the National Institute of Education (NIT). To create bioluminescent orchid, Tissue is transformed from the Dendrobium genus using firefly luciferase gene. Using a method called "particle bombardment" The bioluminescent orchids will produce constant light. Light emits from roots, stem, leaves, and petals. Light intensity ranging from 5,000 to 30,000 photos per second. Bougainvillea – the source of grapheme

Well known ornamentals. Have ability to resist pollutant in the air. Group of scientists of Pune found that high quality grapheme from these flowers by drying followed by chemical treatment. 30gm/kg flower of bougainvillea. This discovery may make the batteries cheaper and long- lasting in near future.

3.4 Recent Advances in Flower Production:

3.4.1 Tuberose:

Tuberose (*Polianthes tuberosa*) is an important commercial ornamental bulbous crops owing to its highly fragrant flowers, round the year flowering and very hardy nature suiting to wide soil and climatic conditions. It is native to Mexico from where it spread to different parts of the world during the 16th century. Tuberose derives its generic name from Greek words (Polios = white / shining and Anthos = semi perennial bulbous plant). It belongs to the family, Agavaceae which has about 12 species. It is commercially cultivated for cut & loose flower trade as well as for extraction of its highly valued essential oils (0.08 – 0.135%) which are exported from India to countries such as U.S., Germany, UK, Italy, the Netherlands, Japan, UAE and Saudi Arabia.

Improved Varieties:

Arka Prajwal, Phule Rajani, Arka Nirantara, Arka Shringar, Bidhan Snigdha, Bidhan Ujjwal and Bidhan Joti among Single type; and Arka Vaibhav, Phule Rajat and Suvasini among double type are significantly better over local varieties in terms of both quality and yield. Most of these were found to be performing better in all the tuberose growing areas of the country. Many of these varieties (single type) produce about 14-15 tonnes/ha of loose flowers per year and about 20-25 tonnes/ ha of bulbs and bulblets may be harvested at the end of 3rd year.

Sahyadri Vaman (PR -9), a dwarf tuberose, a first of its kind is developed at ICAR – DFR, Pune. This is a selection among the open pollinated population of the variety ‘Phule Rajani’. The florets are light pink at bud stage, turn greenish white at anthesis. This variety is suitable for pot-culture, vertical panels, and also in beds.

There are number of success stories if using Arka Prajwal for higher yields thereby higher net returns. These include farmers from Dharmapuri district of Tamil Nadu; and Nadia district of West Bengal.

In a survey conducted by the Pune Centre of AICRP on Floriculture, it was found that the average yield of Phule Rajani in farmers field was 7.47 MT as against 4.65 MT of Pune Local Single tuberose fetching a gross return of Rs.7.09 lakhs per ha in comparison to Local Single (2.63 lakhs/ha) and also recorded a higher BCR of 3.61 over 1.44.

Improved technologies These include use of mulching (50-100 u) before planting, use of pre-emergence weedicides (pendimethalin@1.25 – 1.50 litre per hectare); and use of drip irrigation system – one drip line for every two rows of the crop planted on raised or flat beds.

Loose flowers are packed and transported in gunny/polythene bags (lined with newspaper), bamboo baskets, plastic crates to the market (covered with muslin cloth or with wet gunny bags). ICAR – DFR, Pune has designed and developed foldable and reusable Polypropylene (PP) boxes for packaging of loose flowers. Freshness of tuberose florets was significantly influenced by box size and percentage of ventilation. The flower stored in all the boxes except boxes without ventilation maintained maximum ($\geq 85\%$) freshness till 4 days however wilting was observed from 5 day. Loose flowers packed in PP boxes of size 60 cm x 40 cm x 20 cm with 6% ventilation had less physiological loss in weight and maintained higher freshness up to 5th day of storage.

Tinting of tuberose cut flowers with food colours such as Lemon yellow, Kesar yellow or orange red at 8% for 2 hours; rose pink (4%) for one hour; was found promising to produce attractive colours to double coloured tuberose spikes.

Essential oil from tuberose is one of the costliest oils in the global trade (ranks in top three). The rate of recovery from the loose flowers of Prajwal variety was found to be 0.17%. Considering a average loose flower yield of 15 t/ha per year, an extraction plant through steam distillation with a capacity of 1500 kg per annum (or 5 kg/day) requires a minimum of 60 ha of tuberose. The minimum cost of plant machinery & operational costs would be in the range of 40-50 lakhs. Tuberose crop is susceptible to both foliar and root-knot nematodes.

Sustainable Development

Use of bio-control agents (*Trichoderma viride* or *T. harzianum*; *Pacilomyces* species), chemicals like carbofuran or carbosulfan as well as new molecules which are available in the form of Velum Prime (from Bayer Co.) or Nimitz (from Adama Co.) are effective in nematode management in tuberose.

3.4.2 Marigold:

Marigold is cultivated in most parts of India and has the largest area among flower crops. It is one of the easiest annual flowers to cultivate, having wide adaptability. They produce marketable flower in a short period of time. This can be grown in a wide variety of soil but well drained, fertile sandy loam soil, pH 7.0–7.5 is preferable. It requires mild climate for healthy growth and flowering. Temperature of 15-27°C is generally preferred. Marigold can be raised three times a year- rainy, winter and summer seasons and is commercially propagated by seeds. Healthy seedlings should be transplanted at 3 to 4 leaf stage.

In addition to commercial production for loose flower purpose, it has several other uses. The essential oil from *Tagetes erecta* flowers has been used in high class perfumery and also acts as antihemorrhagic, anti-inflammatory, antiseptic, antispasmodic, astringent, diaphoretic and emmenagogue.

The oil is very valuable in aromatherapy for its powerful skin healing effects and also possesses fly repellent properties. Marigold varieties have pesticidal value as they destroy ground pests particularly nematodes. The genus is also recognized as a potential source of very interesting biologically active products viz. carotenoids that are currently being used as food colorants, nutritional supplements and poultry feed additives and in ophthalmology for the treatment of age-related ocular diseases viz. cataract and dry age-related macular degeneration (ARMD).

Improved Varieties:

Pusa Narangi Gaiinda (orange-colored flowers) and Pusa Basanthi Gaiinda (sulphur yellow-colored flowers), two important high yielding varieties from IARI, New Delhi developed in the year 1995 have revolutionized marigold production in the country. Since then, there is a long gap of around 20 years for the development of more improved varieties in African marigold.

Arka Bangara - 2, Arka Agni and Arka Bangara from IIHR, Bengaluru were developed and released during 2014-15. These are also high yielding with better flower quality. Bidhan Basanthi (BM-1), Bidhan Gold (BM-2) and Bidhan Marigold -3 (BM-3) are improved varieties from BCKV, Kalyani developed during 2018-19. Improved varieties in French marigold include Pusa Arpita (IARI 2009), Pusa Deep (IARI 2018), Arka Honey and Arka Pari (IIHR 2018-19).

Improved Technologies:

There is a significant change in the method of propagation of marigold. Most of the recent varieties are propagated through vegetative means (terminal rooted cuttings). Now-a-days, the culture of raising the seedlings in pro-trays by commercial nurseries is more prevalent and the flower growers are also comfortable with this as it eliminates the process of preparation of raised beds, sowing, irrigation and all other practices required in raising the seedlings at their place.

Pre-emergence application of weedicides (pendimethalin@1.25 – 1.50 litre per hectare); and use of drip irrigation system – one drip line for every two rows of the crop planted on raised or flat beds were found to be enhancing the crop growth and flowering significantly. Drip system enables application of fertilizers through fertigation which improves fertilizer use efficiency. Drip system has multiple benefits, enhancement of water use efficiency, reduction in cost of cultivation, production of quality flowers and in minimizing the weed growth.

Flower yield is mainly dependent on number of flowers bearing branches which can be manipulated by arresting the vertical growth of plants and encouraging side shoots by means of apical bud pinching. Pinching is a practice of removing the apical portion of the shoots at the early stage to get a greater number of axillaries which in turn produces more flowers. Thus, in general to promote growth and for profuse flowering, pinching of main shoot 35-40 days after transplanting is essential and second pinching 25-30 days after first pinching could be practiced to increase the number of flowers and reduced size of flower. Alternatively, pinching of all flower buds till 4-5 weeks (for African types) or 3-4 weeks (French types) after transplanting can be recommended in general.

Marigold loose flowers have very short post-harvest life of 5-6 days and often the quality gets deteriorated due to fungal infection. Adequate dehydration, avoiding harvest during early mornings when there's dew deposit on flowers and proper packaging helps in extending the postharvest life and quality of marigold loose flowers. The research conducted under AICRP on Floriculture during 2015-16 to 2017-18 revealed that packaging of marigold strings in thermocol or bamboo baskets box with paper lining and placing of ice packs was found to be the best container for storage of marigold flower strings up to three days with regard to the post-harvest quality parameters such as physiological loss in weight (8.97%) and weight of flower (316.14g), fresh flower (92.54 %) and overall acceptability. Value addition in marigold African marigold (*Tagetes erecta*) petals are commercially valuable as a natural source of lutein (yellow-orange) pigments and are primarily being used by the poultry industries as feed additives to color egg yolks orange and poultry skin yellow. The orange egg yolks are generally considered as healthy by the consumers in comparison to the colorless. Lutein is the primary xanthophyll pigment that produces the orange color in marigold flowers, roughly comprising of 90% of the total pigments from the petals.

Sustainable Development

Lutein and zeaxanthin are the only dietary carotenoids present in the macular region of the retina and in the lens of the eye and some epidemiologic studies have shown that the risks of ARMD and cataract are inversely correlated with dietary intake and the concentration of xanthophylls in the serum and macula.

In Tamil Nadu, M/s. AVT Natural Products Ltd is taking up contract farming of marigold in Tengumarahada village, Nilgiris District in an area of 250 acres by delivering quality inputs like seeds, fertilizers, plant protection chemicals, sprayers, etc., at right time and offering technical guidance in raising the crop and also buy-back of all the produce (marigold loose flowers) for the extraction of xanthophylls. Due to the support from the company, farmers harvesting high flower yield and quality of the crop. The marigold growers of Tengumarahada are happy and satisfied since M/s. AVT Natural Products Ltd., is constantly increasing the buy-back price of the flowers. The salient findings of the AICRP on Floriculture and ICAR sponsored NAIP (National Agriculture Innovation Projects) project on “Value chain on flowers for domestic and export markets” in collaboration with M/s. AVT Natural Products Ltd., have helped to achieve a remarkable increase in the yield levels of marigold from (25.12 t/ha to 35.74 t/ha), which in turn has resulted in xanthophyll content increase also from (1.44 g to 1.92 g/kg of flowers). This has prompted the company to pay the growers a price of Rs.6.50/kg of flowers at present (against Rs.2.75/kg during 2008). Thus, the livelihood of farmers improved considerably. The company extracts the xanthophylls through Vacuum/flash dryers and converts them in to oleoresins pellets. These oleoresins can be stored for long before they can be used for various applications or for extracting the lutein which has immense medicinal value.

3.4.3 Jasmine:

Jasmine is the India's traditional fragrant flower since pre-historic times having high cultural and heritage value. In India, jasmine is most widely grown in the southern part of the country like Tamil Nadu, Karnataka, Andhra Pradesh, Telangana and Kerala and also to some extent in other states. Jasmine flowers are exported to the neighboring countries like Sri Lanka, Singapore, Malaysia and of late to the gulf countries and to USA. Flowers and buds are used for making garlands, veni, adorning the hair and for religious offering. They are also used for the production of essential oils used in perfumery and making of cosmetics. Three important species of *Jasminum* include, *J. auriculatum* (Mullai), *J. grandiflorum* (pitchi malli) and *J. sambac* (gundu malli) are widely in cultivation. These can be grown in well drained red and sandy loam soils under tropical conditions and planting can be done from June to November. Spacing, nutritional requirements and pruning differs species to species.

Improved Varieties Due to various technical reasons and lack of funding not much breeding work has been taken up in the country except at TNAU, Coimbatore and IIHR, Bengaluru. Some of the improved varieties from these institutions include Co-1, Co-2 and Parimullai

(*J. auriculatum*); Co-1 Pitchi and Co-2 Pitchi (*J. grandiflorum*); Arka Aradhana, Arka Surabhi and Arka Arpan (*J. sambac*). Some of the local cultivars include Single Mogra, Double Mogra, Iruvatchi, Virupakshi, Sujimalli, Madanabanam, Ramabanam, Ramanathapuram Gundumalli and Madurai Malli. The latter has got GI status also. Arka Surabhi, an improved variety from IIHR is highly suitable for essential oil extraction. It has a yield potential of about 10 t/ha of loose flowers with 0.35% of essential oil recovery. It has low juvenile period and also suitable for close planting (HDP). JN-1 (*Jasminum nitidum* Accession No.1 from TNAU) was found to be suitable for off season & year-round flowering with attractive pink coloured flower buds and longest shelf life (40 hrs) when compared with *J. grandiflorum*.

Improved Technologies:

Flowering in Jasmine is highly seasonal ranging from March to October with peak during April to July. Flower production during the off-season will be an added source of income to the farmers as the price of Jasmine flowers during winter is very high. Winter flowering can be induced without any additional inputs and costs involved and with no adverse effect on regular flowering. Advancing the pruning to August – September followed by spraying of urea & micronutrients (FeSO₄ and ZnSO₄) at 0.5% three days after pruning.

KVK, Pechiparai, Kanyakumari, TN was successful in inducing off season production in jasmine by means of defoliation (by goat grazing) during last week of May and once in 3 months thereafter. This is followed by spraying of urea & micronutrients (FeSO₄ and ZnSO₄) at 0.5% three days after pruning (DAP) + spraying of planofix (NAA) @ 20 ppm 7 DAP + soil application of 10 kg FYM, 50g each Azospirillum & Phosphobacteria along with application of 60:120:120g NPK per plant in 4 spilt doses immediately after each defoliation. For the control of bud-worm, monocrotophos (0.1%) at bud initiation and development stage was sprayed. This resulted in a significant economic gain in terms of yield increase (38.2-46.94%), average price realization of Rs.250/- per kg with enhanced net profit (around Rs.2,07,000 to 2,46,500). BCR of 4.41 per rupee investment & Technology adoption to the extent of 33% was registered.

Post-harvest handling of jasmine loose flowers for export is standardized in the NAIP sponsored project (Value chain on flowers for domestic and export markets) sanctioned to TNAU, Coimbatore. Export packaging technology to Dubai market (takes 24-30 hours) includes harvesting of fresh flowers early in the morning, preparation of strings (garlands), treatment of flower strings with boric acid (4%) and packaging in ventilated corrugated fibre boxes. Whereas for export to USA (takes 36-40 hours), the flower strings after treatment with boric acid are packed small boxes which are in turn packed in thermocol boxes lined with aluminium foil. Ice gel packs are placed on every layer of flower string boxes in the thermocol boxes.

3.4.4 Aster:

Aster (*Callistephus chinensis* (L.) Nees), a popular loose flower crop in central and south India (Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal and Maharashtra) belongs to the family, Asteraceae. It is an annual flower crop producing flowers which are solitary, single, semi-double and double. Prominent flower colours are blue/violet, pink and white. Traditionally asters are grown for loose flowers, to some extent cut flower, landscaping/gardening, floral decorations and for making garlands. Flowers last long and are used in vases and floral decorations. It is also a good bedding plant. It is also found to be a good substitute for chrysanthemum.

Improved Varieties:

Limited numbers of varieties are available in aster. These include Poornima, Shasank, Violet Cushion, Kamini, Arka Archana and Arka Aadya from IIHR, Bengaluru; Phule Series (Phule Ganesh Pink; Phule Ganesh White, Phule Ganesh Violet and Phule Ganesh Purple) from MPKV, Pune. All these are significantly better than local types in respect of yield and quality. Average performance of improved aster varieties at Pune during 2015-16 to 2017-18.

The benefits of using the improved variety, Phule Ganesh Pink in farmers field was studied by AICRP on Floriculture – Pune Centre. It was found that the yield (6.96 t/ha over 4.5 t/ha) and net returns (236448 over 71615) owing to better quality were significantly higher in Phule Ganesh Pink in comparison to local variety. A BCR of 2.85 was recorded with Phule Ganesh Pink compared to local variety (1.56).

Improved Technologies:

Asters are propagated by seeds. In general, germination takes place in about 7 days. Seed germination is an issue sometimes hence care should be taken to provide optimum environment (a temperature of 21oC + 4oC). Low poly-tunnels may be used in those areas where the night temperatures go low. Seed loses viability faster hence as far as possible fresh seed should be used for sowing. Asters can be cultivated round the year with a spacing of 30 cm x 20-30 cm. In aster also, pinching is recommended one month after transplanting in order to encourage number of flowers bearing auxiliary shoots. About 90:60:60 kg/ha of NPK is recommended (half of the nitrogen should be top-dressed 40 DAT).

3.4.5 Chrysanthemum:

Chrysanthemum (*Dendranthema grandiflora* Tzvelev) is an important commercial flower crop in India. It is grown for various purposes ranging from production of loose and cut flowers, pot- mums, landscaping/gardening (exhibitions, bedding, borders), etc.

It has several medicinal and insecticidal properties also. It belongs to family 'Asteraceae' and is popularly known as 'Queen of East'. It is often described as the "Autumn Queen" as it blooms in November-December. There is hardly any other garden flower which has such diversity in terms of range of flower colours, shapes and height. It is a typical short-day plant and flowers only the short-day requirement is met. Photoinsensitive varieties, however, are developed both in public and private sector. In addition to this annual chrysanthemum (*Chrysanthemum coronarium*) is also extensively grown for loose flower purpose.

Improved Varieties:

Chrysanthemum is highly vulnerable to mutations (natural or induced). Exploiting this, the breeding programmes in the country have resulted in number of improved varieties which are suitable to different purposes. Important varieties (colour-wise) suitable for loose flower production are as follows.

White: Mother Teresa, Birbal Sahni, Baggi, Poornima, White Anemone and Solan Shirngar
Yellow: Co-1, Autumn Joy, Vasantika, Basanti and Yellow Gold Red: Red Gold and Indira
Bluish Purple: Neelima,

Photo-insensitive: Ajay, Pusa Anmol, Pusa Centenary, Discovery and Vijaykiran

Improved varieties developed recently at BCKV, Kalyani (Bidhan Rajat, Bidhan Lalima, Bidhan Madhuri, Bidhan Jayanthi and Basantika) were also found to be promising for loose flower production. However, most of the chrysanthemum growers still use local cultivars like Aishwarya, Raja, Kolkata, etc indicating ample scope for variety replacement. Numbers of varieties from private sector are also available in the markets which are high yielding and also some of them are photo-insensitive enabling off-season (multiple flushes) production.

In case of annual chrysanthemum, only local varieties (Chandni, Bijli, etc) are being used. There are no improved varieties developed yet in this. But there is an urgent need to develop high yielding varieties as there is good demand in the market across several locations of the country. Improved Technologies Regulation of flowering is an important issue as many of the varieties are photo-sensitive and produces flowering in a particular season. Technologies for manipulation of photoperiod (providing long-days artificially for promoting the vegetative growth as well to extend the flowering season Or providing short days for advancing the flowering) has been standardized at YSPUHF, Solan and IARI, New Delhi in India. Also, varieties were developed at NBRI, Lucknow for planting and getting flower production round the year. These are not necessarily for loose flower production only.

Pinching is one of the most important operations in chrysanthemum, refers to the removal of the growing tips of the plant to induce the growth of vegetative laterals.

Sustainable Development

It reduces the plant height, promotes axillary branching, delays flowering and helps in breaking rosetting. First pinching when the plants reach a height of 15-20 cm with 3-4 pairs of leaves and the second pinching may be necessary if the plants make straggly and lean growth. Pinching also helps in regulation of flowering (especially in delaying it).

3.4.6 Crossandra:

Crossandra (*Crossandra infundibuliformis* L.) is one of the important loose flower crop commercially grown in southern part of India. It is mainly used for making garlands and veni. Flowers are very popular because of its attractive bright colour, light weight and good keeping quality.

These are used for making garland either alone or in combination with jasmine flowers which provides colour contrast and desired fragrance. It is an evergreen shrub. It flowers two to three months after planting and continues to bears flowers throughout the year with a drop in production during the rainy season.

Improved varieties from IIHR, Bengaluru include Arka Chenna (produces medium sized orange colour flowers, 20% bigger than the local, about 40 kgs/week from 1000 plants (4 times higher than the local) with a shelf life - 3.4 days and stalk strength (0.82 kg/cm²) which is 20% more than the local); Arka Ambara (Big size flowers with orange red colour and having yield potential of 5.9 t/acre/year); Arka Kanaka (Big size & yellowsih orange colour with yield potential of 5.0 t/acre/year); Arka Shravya (flower colour is in orange – red group, suitable as a cut flower as well and tolerant to Phytophthora wilt); and Arka Shreeya (Bigger flowers are bigger in size with orange colour and are tolerant to Phytophthora wilt).

3.4.7 Rose:

Rose is one of the most beautiful creations of nature and is universally acclaimed as queen of flowers. It has enormous diversity and has multiple uses ranging from cut flowers, loose flowers for worship, garlands, bouquets, several value-added products like rose water, essential oil, gulkhand, pankhuri, preserves; landscaping/gardening, etc. In India, it is grown in almost all states for one or other purpose.

For loose flower production, Damask rose or Edward rose which are highly scented are widely used. Some of the improved varieties for loose flower production include Gruss-an-Teplitz, Rose Sherbet, Arka Parimala, Arka Savi, Kakinada Red (in Andhra Pradesh and Tamil Nadu). Some of the cut flower varieties grown in open field like Gladiator, Super Star, Rakthagandha, Pusa Bahadur, Arjun are also used for loose flowers.

Some more potential loose flower crops include nerium, barleria, lotus (Indian/Asian/ Sacred lotus – *Nelumbo nucifera*, flowers generally pink in colour, both single type - 15-30 petals and double type - 30-1000 petals); globe amaranth (produces flowers in red, violet, white; popular in making garlands often used for mix colours and also used for bedding & edging); TMC (*Taberna montanacoronarium*, single and double types; dwarf types suitable for pot-culture; flowers yearround and also used for hedging, bonsai making, etc); champaca (*Michelia champaca* produces fragrant flowers which are highly short-lived); and hibiscus (lot of diversity in terms of flower colour, numbers of petals – single/double and multiple uses). These minor loose flower crops are very important and development of high yielding varieties with quality flowers would boost the local market and help in enhancement of net returns of many flower growers.

Considering the above the research needs in loose flower crops include development of high yielding varieties, incorporation of fragrance in aster and some of crossandra varieties, imparting colour to jasmine, tuberose, aster, marigold, extending the shelf life, standardization of value addition protocols (extraction of essential oils, nutraceutical and pharmaceuticals, natural pigments & dyes, pyrethrums, etc), flower drying, improved package of practices, etc. Also, this sector requires financial support (bank loans, subsidies), proper marketing facilities, and dissemination of information through training and media support on improved varieties.

3.5 Reference:

1. Debener, T. 1999. Genetic analysis of horticulturally important morphological and physiological characters in diploid roses. *Gartenbauwissenschaft*, 64(1), 4-19.
2. Fascella, G. and Zizzo, G.V. 2007. Preliminary Results of Aeroponic Cultivation of *Anthuriumandreanum* for Cut Flower Production. Istituto Sperimentale per la Floricoltura – Sezione di Palermo S.S. 113 Km 245.500 - 90011 Bagheria
3. P. Naveen Kumar, D V S Raju, Tarak Nath Saha, Ganesh B Kadam, Prasahnt Kavar, Rahul Yadav and Sithin Mathew. *Advances in cultivation of Loose flower Crops*. ICAR – Directorat of Floricultural Research, Pune, Maharashtra.
4. V.B. Chavan*, S.P. Khedkar, B.R. Salvi, Y.R. Parulekar and N.V. Dalvi 2019. Novel Innovations in Floriculture Industry. *Int.J.Curr.Microbiol.App.Sci* (2019) 8(6), 1855-1863.