

Recent Advances in R & D of Floriculture & Landscaping

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Floriculture has emerged an important agribusiness sector contributes widely to the Indian economy through opportunities in terms of employment, income generation, earning foreign exchanges and empowerment, thus raising the socio economic status in both rural and urban areas. Floriculture is increasing regarded as a viable diversification from the traditional field crops because of higher returns per unit area. Commercial floriculture and landscape gardening are complex and dynamics, which represents an important part of the world economies for growing and trading of floriculture products.

Landscape gardening is becoming important in mitigation and adaptation to climate change. Landscape gardens like indoor, outdoor gardening, vertical gardening, terrace gardening and commercial park management are high in demand and generate employment to un-employed youths. Enormous genetic diversity, varied agro climatic conditions, versatile human resources offer India a unique scope for diversification in new avenues which were not explored to a greater extent. With the opening up of international market in the WTO regime there is a free movement of floriculture products worldwide.

Presently with collaborative effort of the government, scientists and entrepreneurs, technological development and dissemination and proper exploration the country's varied agro climatic situation, floriculture has enterprise. Today floriculture production is being practiced in large climate controlled greenhouses, as well as, small fragmented farm holdings throughout the country.

The production base has doubled during the last ten years and production of cut and loose flowers have been growing at 7% to 10% every year. All this is happening as a result of the technology and enabling environment. Although the potential of floriculture for entrepreneurship development and employment generation is realized and discussed in isolation, there is an urgent need to bring all the stake holders on a single platform to deliberate and develop a roadmap for the future growth of floriculture industry in the country.

The area under production of flowers has increased to 1.85 lac hectare concentrated mostly in Tamilnadu, Andhra Pradesh, Maharashtra, West Bengal, Utrakhand and Himachal Pradesh. At the same there has been a tremendous growth in Landscape sector in the country due to boom in the real estate. The major demand has been realized for potted plants, turf grasses, roof to gardens, seeds and sapling. Indian market has been expended many fold and lot of job opportunities has arised.

The Indian Agricultural Research Institute is a pioneer in scientific research on Floricultural crops spearheaded by luminaries like Dr. B.P. Pal early sixty. Ever since its inception as a separate identity in the year 1983, the Division of Floriculture and Landscaping at IARI, New Delhi heralded an articulated and comprehensive research programmes on crop improvement using conventional and biotech tools, production in open and protected environments, technology dissemination for the benefit of farming fraternity.

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FLORICULTURE

Production Technology

Rose

The IARI has the distinction of evolving the largest number of rose varieties in the country possessing desirable traits. Around 100 varieties comprising of Hybrid teas, Floribundas, Grandifloras, Miniatures and Climbers were released. Varieties with unique colours and hues top the long list of hybrids / Varieties. A chocolate brown coloured rose hybrid Mohini attracted the attention of rose breeders across the globe. Induced mutants viz., Abhisarika, Striped Christian Dior, Pusa Christina and Madhosh: natural mutants Chitra, Pusa Abhishake, Climbing Sadabahar, Climbing Dr.Homi Bhabha, Delhi Pink Pearl and Nav Sadabahar exhibit unique spectrum of patterns and are well received by the garden enthusiasts.

Hybrids like Raktagandha, Arjun, Raktima, Pusa Gaurav, Pusa Pitambar, Mother Theresa, Priya and Dr.B.P.Pal evolved through rigorous breeding programmes possess desirable traits comparable to exotic cut flower varieties suitable for greenhouse cultivation. Rose varieties namely Bhim, Chambe di kali, Ganga, Jawahar, Mridula, Mrinalini, Nehru Centenary, Nurjehan, Priyadarshini, Raja Surender Singh of Nalagarh, Banjaran, Jantar Mantar etc., evolved at IARI became very popular among commercial growers and garden ammatuers for their eternal beauty and higher yield.

For higher yields, the best planting time recommended for North Indian plains is October-November. A new root stock namely *Rosa indica* var *odorata* was identified and recommended for northern plains for mass budding of elite cultivars.

To ensure longer post-harvest life, harvesting the flower buds showing the colour having two outer petals unfurled from the tip was found to be appropriate. Pre harvest sprays of potassium sulphate 200 ppm, gibberellic acid (GA_3) 100 ppm in November and January improved the quality and vase life. Vase life was also found to be increased by pulsing with silver thio-sulphate (1 mM) for 15 min along with 0.3% sucrose for 16-24 hours gave the best vase life and quality flowers.

Technology for producing export quality roses possessing increased stem length and attractive flowers from green house grown roses developed to augment the needs of domestic floriculture industry.

Earlier it was believed that Dieback disease is caused by *Diploida rosarum* but investigations indicated that this disease is also caused by *Betroliploida theobromal* and *Colletotrichum gloesporides*. Fortnightly spray of Bavistin (0.2%) immediately after pruning effectively controls this disease. IARI bred varieties Arunima, Arjun, were found to be tolerant to die back disease.

Powdery mildew was effectively managed by spraying Bavistin (0.1%), Karathane (0.1%), Sulfex (0.2%) or Wettable Sulphur (0.05%). IARI evolved varieties Arunima, Arjun, Himangini, Kamta, Priyadarshini, Raktagandha and Sadabahar were found to be tolerant to powdery mildew. Spraying Captan (0.2%), Dithane M-45 (0.2%) effectively controls Black spot disease. The AICRP on Floriculture has made the following significant contribution in roses.

1. Rose cv. Pusa Gaurav, Pusa Centnary, Pusa Ajay & Arunima (developed by IARI, New Delhi) was found to be suitable for cut flower production.
2. For loose flower production rose cvs. 'Neelambari' and 'Arunima' were found promising whereas 'Banjaran' proved to be the best for garden display under Bhubaneswar agroclimatic conditions.
3. The exotic varieties of rose namely 'Skyline', 'Nobelesse', Holly wood, Ravel, Tajmahal, Firsr Red and 'Golden Gate' performed better under green house.
4. Bending during Oct. found promising in Roses followed by application of FYM @ 10 kg and subsequent application of 400:200:200 ppm NPK/plant/week for commercial cultivation of cut rose.
5. Application of 300-400 ppm nitrogen, 200 ppm each of phosphorus and potash per week to the plants of rose cv. 'Montezuma' growing under protected conditions was found to be

- best with regard to number of flowers per plant (56) as well as size of flowers.
6. Application of 400:200 ppm NPK in rose cv. 'First Red' growing under polyhouse recorded maximum plant height, number of flowers per plant (40.55) and stem length (80-50 cm).
 7. Pulsing the cut flowers of rose with aluminium sulphate (300 ppm) + sucrose (3%) followed by the treatment with a holding solution consisting of aluminium sulphate (300 ppm) and sucrose (1.5%) increased the postharvest life.
 8. For the control of powdery mildew disease of rose, spraying the plants with Difencanazole (0.05%), Hexaconazole (0.05%), Penconazole (0.05%) or Tridemorph (0.05%) significantly controlled the disease.
 9. Three applications of monocrotophos and phosphomidon effectively controlled the aphid population and Dicofol (0.3%) for mites.
 10. There has been a tendency of fungal attack or grey mould in case humidity is higher. Kavach (0.2 %) against *Botrytis* grey mould of rose is very promising.
4. The plants of chrysanthemum cv. 'CO-1' subjected to the exposure of day light for 10 hours (14 hours shade treatment) and an extended period for 2 hours were found to be best in respect of vegetative growth and flower yield under Coimbatore conditions.
 5. Covering the plants of chrysanthemum with black polythene for 14 hours daily at night till 60-70 % buds show their colour induced early flowering in cvs 'Birbal Sahani' and 'Jubilee' by 21 days; 'Flirt' by 16 days; 'Sunil', 'Jayanti' and 'Vijay' by 14 days as compared to their natural blooming under Lucknow like agro-climatic conditions of Uttar Pradesh.
 6. Among the different fungicides tested against the leaf spot disease of chrysanthemum, Cuman (0.02%) and Dithane M 45 (0.02%) economically controlled the disease under Ludhiana conditions.
 7. Photo and thermal regulation help the growers to get year round production of ct flowers in chrysanthemum by using protected structures.

Chrysanthemum

1. Newly developed varieties of chrysanthemum viz., 'Arka Ravi' (at Hesaraghatta, Solan, Udaipur and UAS Bangalore), 'Punjab Gold' (at Hesaraghatta and Pune), Mother Teresa' (at Hesaraghatta), 'CO.2' and Indira (at Coimbatore), 'Yellow Gold' (at Solan), 'Ratlam Selection' and 'Basanti Local' (at Hyderabad), 'Sonali Tara', 'Sunil' 'Baggi' and 'IIHR Hybrid-11 were found to be very promising.
2. Pusa Centenary (IARI), Purnima, Yellow Star, White Star and Tata Century varieties are found better in chrysanthemum for quality and early flower production in Himachal Pradesh followed in NCR.
3. Under Ludhiana conditions, the flowers can be produced in chrysanthemum cv. 'Punjab Anuradha' during May by maintaining the plants under natural short day conditions from December to February and artificial short days from March.

Gladiolus

This is a majestic bulbous ornamental crop grown for its cut flowers possessing a wide array of colours. IARI has the unique distinction of having the largest collection of genotypes in the country. Some twenty hybrids/improved strains have been developed through conventional breeding tools. The hybrids are unique for their colour, enhanced post harvest life and higher corm/cormel production compared to the local varieties.

For higher yields, multi coloured varieties need to be planted from September to November, however the best time of planting is 2nd week of October under North Indian conditions. To enhance sprouting applying GA₃ at 1000 ppm as foliar spray or dipping the corms was found to be highly beneficial. Planting on 1 m width ridge bed with four rows gave better production of flowers and cormels. Corms of 3.5 to 4.6 cm diameter or half cut corms of the same size helped to maximize corm and cormel production.

Dipping of corms in 200 ppm Indole acetic acid (IAA) before planting also increased cormel

production and enhance the sprouting. Dipping corms in ethyl chlorohydrin (3%) or benzyl amino purine (BAP, 200 ppm) followed by 100 ppm GA₃ solution or dipping garlic paste or treatment in 1000 ppm of thio-urea breaks the dormancy of freshly harvested corms. Spray of 0.2% Stomp after planting the corms effectively controls weeds in gladiolus.

Spray with 0.2% Bavistin or Captan was found to be effective for controlling fungal diseases especially fusarium wilt and botrytis blight which are the major devastating diseases that harbour on gladiolus.

Early flowering with better quality and more number of corms per plant can be achieved when grown in polyhouses when compared to open field condition. Technology for off season production under partial shade has been perfected. This technology is found to be quite useful to take second crop from the corms obtained from hilly regions.

Carnation

Planting on 15 to 20 cm high ridge bed with 1m width having 6 rows at a distance of 15 cm across was found to be the most ideal for higher yield per square meter. Pinching of carnation twice, (once after 30 days) and (another after 50 days) of planting enhanced the flower yields.

1. Pinching of carnation cv. 'Impala' growing under protected conditions with pinch and a half method and foliar feeding of nitrogen (150 ppm) at fortnight interval enhanced plant height, flower size, stem length, number of flowers per plant and vase life under Solan like conditions of Himachal Pradesh.
2. Carnation cvs Impala 'Super Star', 'Veleta' and 'Fantasia' supplied with 4 hours extended lighting resulted in maximum flowering stem length and induced early flowering under polyhouse at Solan condition.

Tuberose

1. In tuberose, Prajwal and Vaibhav had been recorded outstanding.
2. In tuberose, 200:200:200 kg NPK/ha were recommended for commercial cultivation.

3. In tuberose, citric acid (300 ppm) + sucrose (2%) at pH 3.6 had been the best pulsing treatments.
4. For the control of *Sclerotium* wilt disease of tuberose, treatment of *Trichoderma viride* @ 20g/m² followed by carbendazim (0.01%) + Captan (0.02%) were found to be effective at Pune. The applications of carbendazim (0.01%) + Captan (0.02%) and Basamid G (40g/m²) significantly reduced the disease incidence under Kahikuchi conditions.
5. Leaf blight disease of tuberose could be controlled effectively by spraying the plants with Iprodione (0.025%) followed by Difencanazole (0.05%) under Pune conditions.
6. Bulb treatment with monocrotophos 36 EC proved to be the best treatment in controlling the nematode population in tuberose at Kalyani.

Gerbera

1. Gerbera cultivars grown under low cost polyhouse performed better than those grown under shadenet and open field conditions at Yercaud, Kalyani and Srinagar.
2. In gerbera 20g P₂O₅ + 10g N/m² are recommended for commercial cultivation.
3. AgNO₃ (SO₄)₃ @ 25 ppm was found to be the best for increasing vase life of cut gerbera varieties 'Thalasa' and 'Lyonella' as reported by IIHR, Bangalore.
4. In gerbera, Al₂(SO₄)₃ (300 ppm) + sucrose (2%) had been the best pulsing treatments.
5. The leaf spot/blight disease of gerbera could be controlled by treating the plants with Benomyl (0.01%) followed by Kavach (0.02%) and difencanazole (0.05%) at Pune, whereas Benomyl (0.02%) was found to be more effective at Ludhiana. Spraying the gerbera plants with copper oxychloride (0.03%) followed by Mancozeb (0.02%) was found superior than other fungicides in reducing the leaf spot/blight disease in gerbera under Kahikuchi conditions.
6. For the control of foot rot/root rot disease of gerbera, the treatment of plants with Benomyl

(0.01 %) + Captan (0.02%) followed by Benomyl (0.01%) and *Trichoderma viride* (20 g/m²) was found to be very effective under Pune agro-climatic conditions.

7. Foliar application of Difencanozole (0.05%) and Panchanozole (0.05%) controlled the disease effectively under Pune conditions.

Marigold

Two improved open-pollinated varieties namely; Pusa Narangi Gaiinda (deep orange), Pusa Basanti (sulphur yellow), Gaiinda, Pusa Arpita, and Pusa Bahar have been developed and released for commercial cultivation. These improved varieties are very popular among the farmers and are widely grown in North India.

Hollyhock

Four F1 hybrids namely, Pusa Apricot Supreme, Pusa Pastel Pink, Pusa Pink Beauty and Pusa Yellow Beauty were developed for the first time in the country. The flowers of these hybrids are double with tufted centre and form a column on the 2.0 to 2.5 m tall main stem. In addition to these hybrids, seven open pollinated varieties namely Dulhan (red), Deepika (light yellow), Gouri (pink), Pusa hollyhock Gulabi (pink), Pusa hollyhock Krishna (maroon), Pusa hollyhock Lalima (red), and Pusa hollyhock Shweta (white) were released. These varieties produce double flowers and the plant height ranges between 1.0 and 1.5 m.

Coreopsis

One spontaneous mutant was named and released as Pusa Tata for garden display purpose. The floral head of this variety has twisted ray florets forming a star brilliantly coloured carmine and yellow on basal and terminal portions respectively. This was developed at IARI and seed is being grown and maintained to grow as seasonal flower during winter in landscape.

Bougainvillea

The Division of Floriculture and Landscaping, IARI is an **International Registration Authority of Bougainvillea (ICRA) recognized by IHS**. Around

375 cultivars of bougainvillea were described and a checklist was published. Among many varieties developed at IARI, a unique cultivar Vishakha (Pink) with variegated leaves became very popular for garden display purpose among the garden lovers, Stanza, Spring Festival, B.P. Pal and R. R. Pal are the major outstanding varieties evolved from IARI, New Delhi.

Comprehensive technology to standardise pruning schedules indicated that Cultivars Sanderiana, Cypheri, Dr. H.B. Singh, hardly require any pruning. The cultivars, Tomato, Bois de Rose, Kayata require partial pruning and the cultivars Shubra, Dr. R.R. Pal, Thimma, Krumbiegal require drastic pruning. An isozyme profile of the cultivars has been documented to characterize the gene pool available in the country so as to identify the genetic relatedness among the cultivars/species. As bougainvillea is a difficult to root crop, bottom heat technique was developed for quick and high frequency rooting in winter season.

Lilium

It is known as lily, herbaceous flowering plants normally growing from bulbs, comprising of genus of about 110 species in the lily family Liliaceae. It is native from the northern temperate regions. It is grown commercially as high value flower. It is easily grown in temperature of 12 to 13°C until stem roots have developed. During the cultivation stage the optimum daily temperature requirement is between 15 to 22°C Temperature below 15°C can result in bud drop and yellowing of the foliage in oriental hybrids. Relative Humidity inside the greenhouse should be 80 to 85 %. It is important to avoid large fluctuation in humidity levels which will cause stress and leaf scorch in susceptible varieties. Light affect the growth of lilium and their development. Insufficient light results in poor growth and bud drop. Asiatic hybrids are more susceptible to bud drop as compared to oriental.

- i) **Shading Net:** To achieve these temperatures shading net is a must. Not only to reduce temperatures; but also to avoid leaf scorching on the plant, one should not compromise on installing proper shading net. The percentage

of shading depends on the light conditions at the site and time of the year. Ideal is a movable shading net, one that opens or closes depending on the light conditions (summer/monsoon). A cheaper option is to go for a 50% agro white shade net, which should be fixed on top of the polyfilm. During the monsoon the same can be removed depending on the light conditions at that time.

- ii) **Growing Media:** The soil; used for cultivation of lilies, has good structure particularly the top layers and is also kept well drained during the entire growing period. Maintaining the correct pH of the soil plays a major role in the root development and uptake of nutrients. It is advisable to maintain a pH of 6 to 7 for the Asiatic and *longiflorum* hybrid groups and a pH of 5.5 to 6.5 for the oriental hybrids. The Chlorine in the soil should not exceed 1.5 mmol/lit.

Biotechnological Approaches

Harnessing biotechnology tools IARI has evolved high frequency reproducible protocols for rapid propagation of rose, carnation, gerbera, liliium and many other ornamental plants. The IARI, SAUs and many other institutes focuses on crop improvement through biotech approaches to evolve novel varieties with desirable traits.

The institute has a strong programme to develop indigenous low cost technology for production of cut flowers (rose, chrysanthemum, gerbera and asiatic lilies) in polyhouses. Varieties evolved at IARI were assessed for their suitability for growing under protected environment. IARI hybrids viz., Raktima, Raktagandha and Arjun were found to be promising for growing under protected environment. Technology has been perfected for advancing the blooming period by 15 to 30 days in Asiatic lilies, a high value crop by growing them in shade net house and polyhouse. A technology capsule for efficient use of polyhouse space almost throughout the year is developed by scheduling the chrysanthemum propagation (during May - Sept) and growing Asiatic lilies (during Oct - February).

Value Addition

Value addition in the form of extraction of pigments, essential oils, pharma-ceutical and nutraceutical compounds has emerged as one of the frontline avenues in floriculture. Keeping abreast of the developments, IARI has embarked on isolation and characterization pigments in an important flower crop: Marigold. The rich gene pool collected world over, promising hybrids / varieties evolved at IARI have been evaluated for carotenoid pigment and leutin content to identify potential varieties for extraction. The attractive orange colour imparted by carotenoids isolated from marigold is widely used as food colourant as well as poultry feed to enhance the colour intensity of egg yolk and also the chicken flesh. Apart from that the carotenoids possess pharmaceutical value as they help in protection of eyes from long term damage by light which can lead to progressive condition known as age related macular degradation (AMD). Besides this the pigments are being increasingly use in cosmetics. Efforts are under way to develop a technology package for isolation, purification of these compounds on commercial scale for the benefit of farmers. Dry flower technologies and use of forest products and dry flowers has become popular now days to use in decoration when there is shortage of fresh cut flowers in the market.

Transfer of Technology

The success of any technology lies solely on its efficient translation in to reality. Keeping this paramount importance in view IARI popularizes its varieties by creating an efficient propagation base to perpetuate in large numbers for supply to farmers and garden enthusiasts. Technology has been perfected for large scale multiplication of elite cultivars of chrysanthemum through soft wood cuttings in mist houses during off season (May-Sept). Repeated cuttings are harvested for rapid bulking in short span of time.

IARI, initiated development of Model Floriculture Villages to showcase the technologies evolved by IARI at Kushak and Hiranki villages of Alipur block of Delhi state and Dadri village in Utter Pradesh, Gurgaon & Faridabad in Haryana, Indore

and Bhopal in MP, Jammu Region and in many other part of the country. A complete production capsule provided to a group of progressive farmers for large scale cultivation of marigold hybrids i.e. Pusa Narangi Gaiinda, Pusa Arpita and Pusa Basanti Gaiinda become popular among the farmers in surrounding villages and helped not only in rapid expansion of acreage under marigold but also improved the socio economic status of flower growers.

LANDSCAPING

Interior and exterior landscaping has become the order of the day. Gardening has been popular in India from ancient times. Few of the very old gardens admired till today are Shalimar gardens of Kashmir and Mehtab Baugh of Taj Mahal, Brindavan gardens for mughal style and there are many gardens of Udaipur and Jaipur of Rajasthan have the influence of British gardens. With changing economy and rapid growth of urbanization India has witnessed remarkable changes in landscaping. Over the past few years Landscaping has achieved the status industry. The recent construction boom, green spaces or lung spaces, green belts, new townships, have added the new dimensions to the landscape gardening in India.

In the changing scenario of Climate change and limited availability of land for gardening new themes/ trends and ideas are emerging in the sphere

of landscaping. Landscape professionals have started integrating the appearance of landscaping and architecture along with life process of plants. Apart from the aesthetic value of plants other potential benefits of plants have been realized. One hectare of healthy turf grass can sequester 1 ton of carbon emissions annually. A single mature tree can absorb carbon dioxide at the rate of 48lbs/year and release enough oxygen back in to the atmosphere to support two human beings. Interior landscaping in offices increases the productivity of the employees.

The concept of Green Buildings envision a new approach to save water, energy and material resources in the construction and maintenance of the buildings and can reduce or eliminate the adverse impact of buildings on the environment and occupants. The major focus should be on

- Pollution tolerant trees and shrubs
- Vertical Gardening
- Tree canopy and surgery management
- CAD in modern era
- Trained HRD
- Soiless potted plants
- Hybrid saplings
- Roads and Hi-ways landscape
- Arboriculture