



# Annual Report 2018-19



**ICAR-Directorate of Floricultural Research**  
College of Agriculture Campus, Shivajinagar  
Pune-411005, Maharashtra, India



**Tuberose Research Plots at ICAR-DFR Farm**

# Annual Report 2018-19



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# Preface

Greetings from ICAR-DFR, Pune

I have great pleasure in presenting salient accomplishments by Team DFR during 2018-19. In crop improvement promising lines of gladiolus, chrysanthemum and tuberose were evaluated for their unique characters. Molecular fingerprints are developed in case of tuberose and gladiolus using different markers. Variety specific markers are identified which would be helpful in future breeding programmes. As a prelude to understand the complete biochemical profile of rose essential oils, six fragrant varieties were analyzed and the major constituents were identified. Nutraceutical pigment profile in rose and chrysanthemum was done to decipher the quantum of pigments present in different varieties. 11 different carotenoids were observed and quantified such as  $\beta$  carotene,  $\alpha$ -carotene, Lycopene, Antheraxanthin, Astaxanthin, Auroxanthin, Canthaxanthin, Violaxanthin, Mutatochrome, Neoxanthin, Zeaxanthin in chrysanthemum florets. Similarly antioxidant properties of the isolated pigments were also established.



**K. V. Prasad, Director**

In crop production, efforts are made to find alternatives to soil based media by incorporating the Industrial and agricultural waste. Combination of fly ash from thermal power plant + press mud from sugarcane industry in combination with cocopeat and vermicompost was found promising for chrysanthemum production in pots.

In plant protection, characterization of 16srRNA was done to identify the phytoplasma causing phyllody in *Chrysanthemum coronarium* known as annual chrysanthemum. An amplicon of 951 bp was obtained. BLAST search showed 100% similarity to *Stevia rebundiana* phytoplasma reported from Uttar Pradesh. The Species allocated as *Candidatus Phytoplasma asteris*; belongs to 16SrI-B based on RFLP pattern of the 100 % similar sequence. On farm diagnostics for viruses/phytoplasma is evolving rapidly in other parts of the world. Serological lateral flow based assay technique for detection of *Plantago asiatica* mosaic of liliium is developed in association with USDA under Norman Borlaug International Fellowship for Agriculture and Technology programme.

In order to minimise the drudgery involved in various operations in floricultural crops, ICAR-DFR has embarked on development of tools and gadgets tailor made for flower crops. One such tool, flower plucker was demonstrated in adopted village, Kasur. Grafting machine, a prototype for grafting of roses and other woody ornamentals has been developed and is being evaluated.

ICAR DFR has organised specialized training programmes on floriculture specifically for the tribal farmers of Nalanda district of Gujarat, one of the aspirational districts in the country. During the period ICAR-DFR had organised the XXVII Group Meeting of the AICRP on Floriculture at Coimbatore successfully.

ICAR-DFR organized and participated in a number of outreach programmes that include World Soil Day, Chrysanthemum Field Day, Certified Farm Advisor programme, Vigilance awareness week, Agricultural Education Day, Kisan Aadhar Sammelan, North Zone Regional farmers Fair, Swachtha Hi Seva Campaign, Hindi Pakhwada etc.

ICAR-DFR is indebted to Hon'ble Secretary (DARE) and DG, ICAR Dr. T. Mohapatra for his constant encouragement and support extended from time to time. The support and cooperation received from the Secretary, ICAR and FA (DARE) are gratefully acknowledged. ICAR-DFR is grateful to all of them for approving the Master Plan of the ICAR-DFR during March 2019.

ICAR-DFR places on record its gratitude to Dr. A. K. Singh, DDG (HS) for constant support, encouragement and overall leadership in shaping ICAR-DFR.

Constant guidance and encouragement from Dr. T. Janakiram, ADG (HS) has been a boon for ICAR-DFR. We place our sincere acknowledgments for his untiring efforts to help ICAR-DFR to reestablish itself at Pune.

Help rendered from time to time by Dr. B. K. Pandey, Dr. Manish Das, Dr. Ranvir Singh and Dr. Vikramaditya Pandey from SMD is sincerely acknowledged. Support and help received from other members from SMD like Mr. Sanjay Kant, Mr. P. K. Srivastava, Mr. Rajneesh Rajput, is duly acknowledged.

The editorial team comprising of Dr. D.V.S. Raju, Dr. Tarak Nath Saha, Dr. Prashant G. Kavar, Dr. Safeena S. A. and Ms. Poornima Gaikwad deserve special appreciation for their involvement and commitment in bringing out this publication.

Support and timely help from all the scientific, administrative and finance staff is fittingly acknowledged.

Pune



(K.V.Prasad)

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# Executive Summary

The highlights of major accomplishments during 2018-19 are summarised here under in different themes.

## Crop Improvement

Gladiolus hybrids *viz.*, DFR-G-Hy-31 (Hunting Song x Ocilla), DFR-G-Hy-87 (Yellow Stone x Blues) and DFR-G-Hy-46 (Limonocello x Verona) were found promising for flowering traits. They were found to be good multipliers producing more corms and cormels and are having potential for commercialization.

Single and double varieties of tuberose were evaluated. Among single types, the cultivars, Prajwal, Bidhan Snigdha and GKTC-4 consistently performed better followed by STR-505 and Mexican Single. Among doubles, Hyderabad Double and Suvasini exhibited consistent performance.

The tuberose selections from open pollinated populations, PR-1, PR-2, PR-3, PR-9, PR-11 and PR-14 have consistently exhibited dwarf nature, hence would be promising for pot culture. In addition, lines AN-3 and AN-4 were also found to be dwarf in nature.

Bulbs of six varieties (4 single namely Prajwal, Phule Rajani, Hyderabad Single and Mexican Single & 2 double type namely Vaibhav and Hyderabad Double) were exposed to gamma rays of different doses (10, 15, 20, 25 and 30 Gy.) and planted for evaluation. Mortality per cent was found to increase with increase in dosage of the gamma ray irradiation (from 10 to 30 Gy). Mortality increased suddenly from 15 Gy to 20 Gy indicating that dosage upto 15 Gy were optimum.

Unique fingerprints of 10 gladiolus and 13 tuberose varieties were developed through SRAP marker system.

## Crop Production

Performance of marigold (cv. Orange Dwarf) was significantly superior with respect to plant height (60.79 cm), number of secondary branches (10.94), number of buds/plant (40), number of flowers/plant (38.48), flower yield/plant (302.9 g), flower diameter (5.9 cm), shoot weight (136 g) and root weight (30.1 g) in the medium comprising of pressmud, vermicompost and cocopeat in 45:15:40 proportion as compared to other treatments.

Chrysanthemum (cv. Basanti) grown in potting medium containing fly ash, pressmud, cocopeat and vermicompost at 12.5: 37.5: 25: 25 proportion exhibited significant difference with respect to growth and flowering attributes when compared to all other treatments.

A pot experiment was conducted to test the suitability of agricultural by-products *viz.*, groundnut shell, rice husk ash, bagasse, soybean husk compost and mushroom spent compost as potting media components for growth and development of marigold cv. Orange Dwarf. Analysis of data revealed that growth and flowering attributes of marigold were significantly superior in growing medium containing groundnut shell, cocopeat and perlite in the ratio 1:1:1 (T<sub>1</sub>) as compared to other treatments.

## Crop Protection

Characterization of 16srRNA was done to identify the phytoplasma causing phyllody in *Chrysanthemum coronarium* known as annual chrysanthemum. An amplicon of 951 bp was obtained. BLAST search showed 100% similarity to *Stevia rebundiana* phytoplasma reported from Uttar Pradesh. The Species allocated as *Candidatus Phytoplasma asteris*; belongs to 16SrI-B based on RFLP pattern of the 100 % similar sequence.

The query 16S rDNA sequence from florist chrysanthemum phyllody shares 98.9% similarity with that of the '*Candidatus Phytoplasma australasiae*' reference strain (GenBank accession: Y10097). The phytoplasma under study is a '*Candidatus Phytoplasma australasiae*'-related strain.

Leaf samples showing yellows and wilting in gladiolus and dieback of the stem in rose were collected. Assoictaed fungi were isolated on potato dextrose agar media. Spores of *Fusarium sp.* was observed to be associated with Yellows of gladiolus. *Acromonium sp.* has been found associated with die back of Rose.

## Postharvest Management and Value Addition

Different carotenoids of 22 chrysanthemum varieties were extracted. It was observed that different carotenoids are in different flower samples due to different colour, nature and variety of flowers. In all 11 different carotenoids were observed and quantified such as  $\beta$  carotene,  $\alpha$ -carotene, Lycopene, Antheraxanthin, Astaxanthin, Auroxanthin, Canthaxanthin, Violaxanthin, Mutatochrome, Neoxanthin, Zeaxanthin in chrysanthemum flower petals.

Total flavonoid content of seventeen rose varieties was determined. Among 17 rose varieties, Charisma has highest total flavonoid content (557mg/g CE) while variety Dr. S. S. Bhatnagar has lowest total flavonoid content (12.17 mg/g CE)

Different carotenoids of seventeen rose varieties were extracted. Out of seventeen varieties, Pusa Bahadur has shown higher quantities of different carotenoids viz.,  $\beta$  carotene (70.13ug/g), Lycopene (56.51ug/g), Astaxanthin (74.60ug/g), Violaxanthin(52.78ug/g), Mutatochrome(65.99ug/g), Neoxanthin (54.39ug/g) while Bonne Nuit has lower quantities of different carotenoids viz.  $\alpha$ -Carotene (15.03ug/g), Antheraxanthin (23.7ug/g), Canthaxanthin (18.91ug/g), Mutatochrome (24.11ug/g), Neoxanthin (20.91ug/g).

Different dyes were used in the experiment to induced attractive colours in the cut spikes of gypsophila without affecting their vase life. The study revealed that value added spikes of gypsophila can provide a great variety of colours for aesthetic beautification. Tinting the spikes of gypsophila with these dyes can enhance the value of these flowers and helps the gypsophila growers in earning more from their produce.

The loose flower plucker had higher plucking rate than hand plucking, minimum damage to flowers and plant during harvesting of flowers, no injury to fingers (thumb and index finger). It was also observed that the flower quality during both the methods of plucking was good. The rate of flower plucking in DFR flower plucker was slightly higher than hand plucking in loose flowers of China aster.

# Introduction

The technologies evolved by various R&D establishments, proactive policies of the government and active participation of entrepreneurs and farmers paved the way for a significant improvement in area and production of flower crops in the country. About 342000 ha of area is under floriculture producing 1760000 MT of loose flowers and 769000 MT of cut flowers annually (2017-18 advanced estimates). In order to sustain the growth the floriculture sector must constantly innovate to produce novel products.

In this endeavor ICAR-DFR, constantly strives its best to introduce new research areas and development programmes for the benefit of the stakeholders. Some of the new initiatives taken during year under report are highlighted hereunder.

- Pigment profile in chrysanthemum and rose has been developed and the antioxidant properties are established to use them as potential nutraceuticals.
- Variety specific markers are identified in case of tuberose and gladiolus.
- Dip stick based, farmer friendly on farm diagnostic tools are being developed to help in identification of major threats in ornamental crops.
- Interactions with the nursery industry indicate that the industry is facing acute shortage of garden soil and is keen to find alternate media to replace the use of soil. Similarly management of agriculture waste and industrial waste has become a major challenge in view of the frequent burning of farm waste resulting in unprecedented pollution in Northern India. A step in the right direction is taken at ICAR-DFR to investigate the suitability of agro and industrial waste as a viable alternative potting medium.
- Pteridophytes including ferns played an important role in the evolution of plant kingdom. Ferns have versatile applications in landscaping, used extensively as cut foliage and pot plants. A number of ferns collected are being evaluated for their suitability to various applications during the year.
- In order to bring the much needed colour in the vertical landscapes a range of ornamental coleus are being evaluated besides their suitability to various landscape applications.
- In his quest to bring the nature close to his living, man domesticated and grown the plants in the surrounding areas as well as indoors. “A greener world is a better world” is the buzz word across the world in view of alarming levels of pollution coupled with climate change. A step in the right direction has been taken at ICAR-DFR to initiate a project on screening a number of indoor foliage ornamental plants based on their morphological traits and pollution tolerance index. The project envisages the importance and role of foliage plants in vertical farming systems to improve the air quality index.

ICAR-DFR organised a series of outreach programmes to disseminate the technologies developed at the institute and AICRP centres. Notable among a number of events organised is the Certified Farm Advisor programme in collaboration with MANAGE, Hyderabad. The program is launched by MANAGE to transform Agricultural Extension Personnel into Specialists in a particular Crop / Enterprise. The program consists of three Modules. Module-I is on the basic aspects of latest technologies in Crop / Livestock, through online on CFA MOOCs for about 3 months which is conducted by MANAGE. In Module-II candidate can opt for any particular crop or enterprise to become expert in that subject. The Module II is conducted at relevant ICAR institution/SAUs or any reputed institute to undergo training for a period of 15 days. During the training, the candidate will have an in-depth training to learn the latest technologies relevant to selected crop/



enterprise. After completing rigorous training, the candidate will be allotted Mentor Scientist/s from the concerned Research Institute for a period of one year for technical guidance to face the field level challenges. On completion, the candidate's Knowledge will be assessed based on the identified parameters and declare as "Certified Farm Advisor" by MANAGE and technical partner Institute. ICAR DFR is glad to organise the first programme for 20 participants from across the country to impart theoretical and practical orientation on floriculture. The trainees are now undergoing the module III in their respective fields with the help of mentors from ICAR-DFR.

### Vision

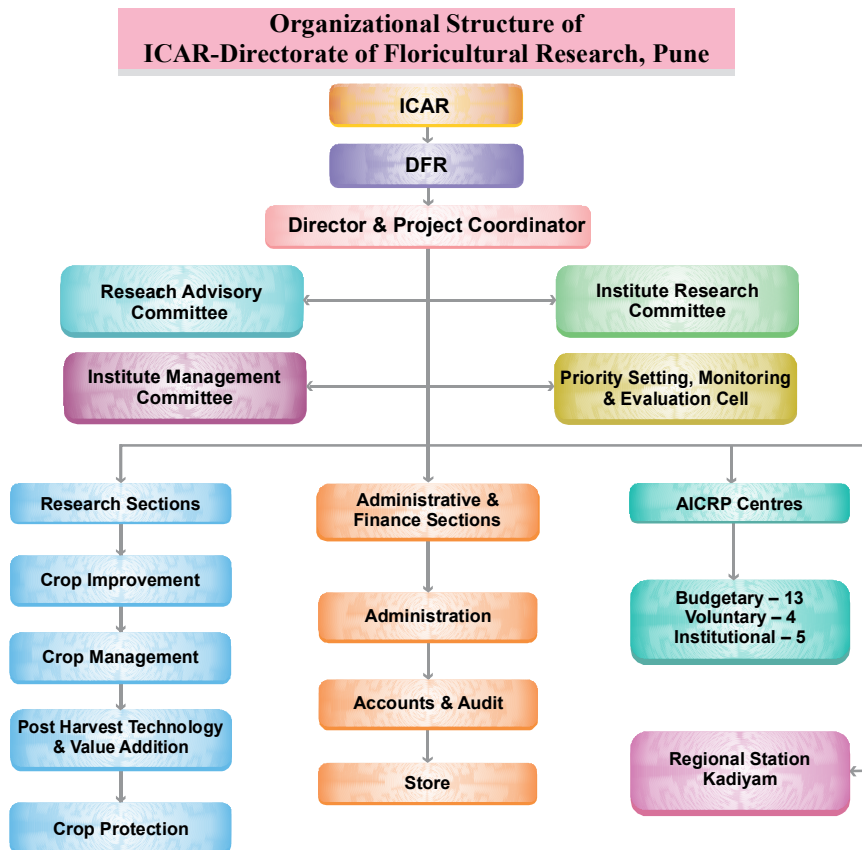
Harnessing the research and development activities in flower crops and landscape gardening for promotion of domestic and export markets.

### Mission

To carry out research, impart education, conduct out-reach programmes in floriculture and landscaping with national and international partners for enhancing the production, productivity, profitability besides alleviating the rural poverty.

### Mission

- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of ornamental crops.
- Repository of genetic resources and scientific information on ornamental crops.
- Transfer of technology, capacity building and impact assessment of technologies.



# Research Achievements

## 1. Crop Improvement

### 1.1 Project 01 (ICAR Project Code: IXX 14257) : Improvement of Gladiolus for Commercial Traits

#### 1.1.1 Germplasm Collection

The existing collection of gladiolus germplasm was enriched by collection of varieties *viz.*, Solan Shringar, Pusa Sindhuri, Arka Aayush, Arka Amar, Arka Darshan, Arka Poonam, Arka Sapna, UHFS Gla HB-11-10 and Punjab Glad-2 developed by ICAR institutes. About 74 gladiolus varieties were evaluated during 2018-19 for their performance under Pune conditions. Data on morphological traits were recorded. The germplasm which was evaluated and maintained under Pune conditions is presented in Table 1.1.

#### 1.1.2 Evaluation of Germplasm

A total of 74 genotypes were evaluated for the morphological traits under Pune conditions (Table 1.1). The maximum plant height was observed in varieties *viz.*, Panibica Beauty (155.0 cm), Red Majesty (138.9 cm), Hunting Song (134.00 cm), Pusa Suhagin (130.4 cm), White Prosperity (129.8), Candyman (123.07 cm) Arka Manorama (120.8 cm) and Sancerre (120.6 cm). Significantly higher number of florets per spike was observed in the varieties *viz.*, Phule Ganesh (20.5), Priscilla (18.9), Lemoncello (18.4), Panibica Beauty (18.2), Snow Princess (18.0), Punjab Glance (18.0) and Smoky Lady (18.0). The florets colour, number of florets and spike length are the most preferred economic traits in market. The maximum spike length was observed in varieties *viz.*, Panibica Beauty (147.4 cm), Red Majesty (123.7 cm), Hunting Song (117.4 cm), White Prosperity (115.9), Pusa Suhagin (112.5 cm), Sancerre (106.3 cm), Wedding Creamby (104.3 cm), Summer Sunshine (103.3 cm), Arka Amar (102.1 cm) and Shahnoda (102.2 cm). Rachis length is a highly desired trait in market which reflects the arrangement of florets on spike. The varieties like Shahnoda (75.3 cm), Panibica Beauty (71.1 cm), Phule Ganesh (68.0 cm) and Pusa Suhagin (64.1cm) have longer rachis length. The earliest floret showing colour was observed in varieties Gulal (39), Red Ginger (55), Dhanvantari (56), Novalux(56), Punjab Glad-2 (56), Snow Princess (57), Priscilla(58), Pusa Shubham(58), Chandni (60), Shahanoda (60), Souvik Biscuits (60) and Summer Sunshine (60) whereas longer days were required for florets showing colour were Friendship (77), Solan Shringar (78), Pusa Sindhuri (79), Suryakiran (79), C.P.G (81), Arka Tilak (94), Sylvia (101). These varieties were also observed to be good multipliers and can be grown successfully in Pune. Based on the evaluation it is inferred that cultivars *viz.*, Hunting Song, Lemoncello, Panibica Beauty, Priscilla, Shoba and Snow Princess were found promising for commercial cultivation.



**Table 1.1: Evaluation of Gladiolus Germplasm under Pune Conditions**

S. No.	Variety	Days required for sprouting	Plant Height (cm)	Days required for spike emergence	Days required for first floret showing colour	Spike Length (cm)	No. of florets per spike	Rachis Length (cm)	Leaf Length (cm)	Leaf Width (cm)	No. of Leaves	Internodal length (cm)	Floret Diameter (cm)
1.	Aly Anaque	12	119.6	54	63	106.4	16.5	57.9	39.9	3.3	8.0	7.2	8.6
2.	Arka Aayush	16	101.9	62	76	81.7	15.3	40.6	43.7	4.3	8.9	5.7	8.5
3.	Arka Amar	9	115.8	61	71	102.1	15.3	48.1	51.0	4.1	9.3	4.8	11.1
4.	Arka Darshan	16	87.5	55	67	70.8	13.3	41.8	39.7	3.8	9.3	5.0	10.1
5.	Arka Gold	16	112.2	61	74	92.1	13.5	47.0	50.1	5.1	9.1	7.0	8.3
6.	Arka Kesar	16	84.4	54	63	68.0	12.7	35.4	44.8	3.2	8.9	6.6	10.2
7.	Arka Kum Kum	15	99.2	62	75	81.6	15.6	43.5	40.1	4.4	8.4	7.2	9.0
8.	Arka Manoroma	9	120.8	56	71	80.9	12.4	40.6	41.8	3.6	8.7	4.6	10.4
9.	Arka Naveen	10	96.2	61	70	75.9	13.4	55.4	44.9	4.4	8.0	3.9	4.5
10.	Arka Poonam	16	118.7	60	72	103.2	12.5	47.2	43.6	4.8	8.5	6.2	8.5
11.	Arka Sapna	22	98.1	62	75	83.3	16.0	54.8	49.3	4.2	7.8	4.6	10.2
12.	Arka Tilak	36	103.9	78	94	122.9	14.7	50.3	47.6	4.4	8.7	7.5	9.4
13.	Aarti	19	101.3	56	67	90.7	13.3	53.2	48.8	3.5	8.4	6.0	10.1
14.	Bindiya	21	103.1	62	74	87.1	15.3	49.9	40.6	3.6	8.9	5.3	10.8
15.	C.P.G	23	98.6	70	81	88.4	14.7	46.6	34.3	3.6	8.7	7.0	9.2
16.	Candyman	12	123.7	61	69	80.9	13.6	49.5	53.2	4.6	8.7	5.2	8.2
17.	Chandni	9	100.6	53	60	99.4	12.0	41.6	49.8	3.3	9.8	8.3	9.3
18.	Cheops	16	89.4	56	67	84.9	11.8	35.0	48.4	3.1	9.1	3.3	10.1
19.	Dhanvantari	9	106.9	48	56	80.7	11.5	43.0	53.4	3.2	8.4	4.4	9.4
20.	Eurovision	16	77.4	58	67	91.4	12.4	33.5	43.1	3.4	8.7	5.4	10.2
21.	Flavo Souvenir	10	82.6	53	62	61.7	13.1	34.7	42.4	3.3	10.1	5.4	8.5
22.	Friendship	20	103.1	66	77	65.8	12.9	41.3	51.7	3.9	8.4	6.0	12.8
23.	G.S. 2	13	104.4	53	64	88.0	11.3	43.1	38.8	3.9	8.0	5.1	9.5
24.	Gulal	17	75.4	30	39	88.2	13.8	34.4	40.7	3.3	8.4	5.4	11.9
25.	Gunjan	14	84.4	59	68	60.8	12.0	31.3	37.2	4.5	9.3	4.1	10.2
26.	Hunting Song	21	134.0	57	67	71.8	18.0	61.3	53.1	3.6	8.7	7.9	11.3
27.	HYAC No.7	11	103.9	58	66	117.4	12.4	34.1	48.7	4.4	8.0	5.0	10.1
28.	IIHR-10	15	98.6	60	75	88.2	13.8	43.8	52.3	3.5	9.5	4.1	8.2
29.	IIHR-11	15	114.6	52	61	78.1	14.2	46.5	48.5	4.0	8.9	7.8	11.6
30.	IIHR-12	14	102.8	52	63	102.1	16.5	50.6	35.8	4.2	9.1	4.4	7.8
31.	Jester	16	92.5	59	71	83.8	12.0	40.2	47.5	3.5	8.0	5.6	9.1
32.	Jester Gold	15	88.6	60	69	76.4	13.8	41.9	48.9	4.5	8.4	6.9	10.4
33.	Lemoncello	15	101.4	56	74	70.0	18.4	50.2	50.0	3.8	8.9	5.5	8.3
34.	Magma	20	86.7	61	75	87.4	14.9	41.0	43.3	4.2	8.4	5.6	8.5

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S. No.	Variety	Days required for sprouting	Plant Height (cm)	Days required for spike emergence	Days required for first floret showing colour	Spike Length (cm)	No. of florets per spike	Rachis Length (cm)	Leaf Length (cm)	Leaf Width (cm)	No. of Leaves	Internodal length (cm)	Floret Diameter (cm)
35.	Melody Open	11	115.7	51	63	71.1	14.4	47.4	47.6	4.9	8.9	7.3	9.0
36.	Novalux	20	115.9	47	56	100.0	16.7	53.6	47.6	4.6	8.4	13.0	8.0
37.	Punjab Dawn	9	98.8	54	62	101.8	14.7	43.0	60.0	2.7	9.3	11.0	7.2
38.	P.S. Hybrid	9	75.6	55	62	81.7	13.5	39.2	49.3	3.6	8.7	5.6	10.2
39.	Panibica Beauty	9	155.0	51	64	57.1	18.2	71.1	52.6	4.3	9.3	5.4	10.0
40.	Phule Ganesh	9	110.7	63	69	147.4	20.5	68.0	51.3	4.1	9.2	10.2	9.3
41.	Phule Neelrekha	11	112.7	56	72	95.4	14.2	51.6	52.0	3.3	8.0	6.6	11.1
42.	Pink Lady	11	81.3	63	76	98.8	12.0	32.7	38.9	3.3	8.2	5.5	10.2
43.	Priscilla	9	114.2	49	58	62.9	18.9	61.2	51.7	4.1	10.2	2.9	10.5
44.	Psittacinus Hybrid	9	72.9	56	76	102.5	13.5	40.2	38.8	2.7	8.9	6.4	10.2
45.	Punjab Glad-2	20	95.8	49	56	54.4	15.3	45.6	47.9	2.6	8.2	7.3	10.3
46.	Punjab Glance	11	106.5	53	61	80.2	18.0	51.4	47.3	4.2	9.1	7.4	11.7
47.	Punjab Lemon Delight	22	75.0	60	70	92.7	11.1	32.8	32.4	2.6	7.6	6.0	11.1
48.	Punjab Pink Elegance	20	92.6	61	76	60.6	15.1	41.5	49.0	3.0	10.2	7.1	8.4
49.	Pusa Kiran	21	100.2	62	75	78.1	14.0	39.5	38.7	3.5	8.4	5.0	10.2
50.	Pusa Sindhuri	20	102.1	67	79	76.3	16.0	40.6	48.3	3.5	8.9	5.1	8.5
51.	Pusa Suhagin	12	130.4	68	76	85.8	13.5	64.1	43.2	4.5	8.0	5.7	10.2
52.	Red Ginger	11	104.9	43	55	112.5	13.3	52.5	43.3	3.4	8.9	5.3	6.4
53.	Red Majesty	9	138.9	54	65	86.8	16.6	59.4	55.4	4.0	12.0	8.6	8.5
54.	Smoky Lady	14	106.5	56	67	123.7	18.0	52.0	46.8	3.9	9.3	6.2	10.2
55.	Sancerre	15	120.6	55	63	91.8	16.4	57.0	41.7	4.6	9.6	5.5	10.3
56.	Shahanoda	9	117.0	51	60	106.3	15.8	75.3	57.8	4.1	9.1	8.6	12.2
57.	Shobha	15	140.3	54	63	102.2	20.9	61.1	49.8	4.2	8.9	8.2	10.3
58.	Pusa Shubham	11	106.7	50	58	96.2	15.1	55.7	51.4	4.4	8.0	5.9	11.3
59.	Snow Princess	9	109.4	50	57	95.6	18.0	60.8	51.0	3.4	10.0	11.3	10.5
60.	Solan Shringar	15	89.3	68	78	66.1	14.5	40.4	41.2	2.8	8.0	5.3	10.5
61.	Souvik Biscuits	10	111.0	53	60	97.3	12.4	58.3	45.9	3.4	8.4	7.3	10.2
62.	Suchitra	17	89.3	58	66	73.5	14.2	41.0	40.6	3.2	9.1	7.2	10.4
63.	Summer Sunshine	9	107.5	49	60	103.3	13.3	51.1	58.5	4.2	9.1	5.1	9.0
64.	Suryakiran	11	104.7	60	79	88.8	17.3	60.1	40.7	3.6	8.4	5.5	10.9
65.	Swarnima	17	90.9	59	68	76.6	10.4	42.4	39.6	4.2	8.7	5.2	12.2



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S. No.	Variety	Days required for sprouting	Plant Height (cm)	Days required for spike emergence	Days required for first floret showing colour	Spike Length (cm)	No. of florets per spike	Rachis Length (cm)	Leaf Length (cm)	Leaf Width (cm)	No. of Leaves	Internodal length (cm)	Flower Diameter (cm)
66.	Sweta	13	96.4	56	68	81.4	15.1	42.1	47.1	4.2	8.5	6.3	7.5
67.	Sylvia	30	97.2	92	101	81.2	16.0	51.7	36.0	3.1	8.0	6.0	5.2
68.	Tambri	21	99.3	62	75	84.3	14.2	49.7	53.9	4.2	8.7	7.1	10.8
69.	UHFS Gla HB-11-10	15	112.9	59	66	98.0	14.0	51.8	34.1	4.4	9.1	6.1	11.4
70.	Urmi	12	107.2	56	75	90.6	14.2	49.8	47.2	3.2	8.7	7.4	11.0
71.	Vicky Lin	12	85.8	56	66	69.3	14.9	31.3	42.8	4.0	8.9	5.4	9.1
72.	Wedding Creamby	11	118.7	53	63	115.9	16.0	50.4	50.5	4.1	9.3	6.3	10.3
73.	White Prosperity	9	129.8	55	62	104.3	16.4	51.5	52.2	3.9	8.7	5.5	10.0
74.	Yellow Stone	22	93.5	63	74	77.1	17.9	49.5	52.6	3.2	9.6	6.0	9.4
	CV	-	4.70	-	-	3.78	5.32	3.85	4.89	5.55	8.10	4.38	2.29
	CD (p<0.05)	-	10.24	-	-	5.35	1.26	3.86	4.75	0.45	1.50	0.58	0.36

### 1.1.3 Hybridization

The hybrid seeds of previous season (2017-18) were sown at Pune and they germinated successfully. Small cormels were harvested and kept in cold storage. The parents were selected for hybridization and crosses were made among selected parents in all possible combinations. The hybrid seeds were harvested and stored. Total 25 crosses were attempted on 10 plants in each cross. Some of the crosses attempted are given in the table 1.2.

**Table 1.2: Hybridization of Selected Parents**

S. No.	Female parent	Male parent	S. No.	Female parent	Male parent
1.	Arka Aayush	Chandni	14.	Punjab Dawn	Panibica Beauty
2.	Chandni	Arka Amar	15.	Punjab Dawn	Chandni
3.	Chandni	Red Majesty	16.	Punjab Dawn	Snow Princess
4.	Melody Open	Punjab Glance	17.	Punjab Dawn	Chandni
5.	Melody Open	Purple Flora	18.	Punjab Dawn	Darshan
6.	Panibica Beauty	Phule Ganesh	19.	Punjab Glance	Purple Flora
7.	Panibica Beauty	Arka Amar	20.	Red Ginger	Chandni
8.	Phule Ganesh	Phule Neelrekha	21.	Red Majesty	Chandni
9.	Phule Ganesh	Urmi	22.	Snow Princess	Red Majesty

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S. No.	Female parent	Male parent	S. No.	Female parent	Male parent
10.	Phule Neelrekha	White Prosperity	23.	Suchitra	Red Ginger
11.	Phule Neelrekha	Sunshine Yellow	24.	Wedding Creamby	S. Leady
12.	Phule Neelrekha	Chandni	25.	Yellow Stone	Snow Princess
13.	Phule Neelrekha	Smoky Lady			

### 1.1.4 Evaluation of Hybrids

The corms of gladiolus hybrids were treated with dormancy breaking growth regulators and chemicals to advance the breeding cycle. The freshly harvested corms were treated with Potassium Nitrate (KNO<sub>3</sub>) @ 1.0%. It was found that the dormancy breaking growth regulators and chemicals were highly effective in breaking the dormancy. The earliest corm sprouting was observed in hybrid DFR-G-Hy-87 (26 days) followed by DFR-G-Hy-46 (34 days) and DFR-Glad-1 (36 days). Morphological characters were slightly influenced by use of dormancy breaking chemicals. These hybrids were tested at Pune after treating with dormancy breaking chemicals and data on morphological traits were collected and presented in table no 1.3.

Hybrid, Hunting Song x Ocilla produced more number of florets per spike (14.2) having pale yellow (18C as per R.H.S colour chart). Reddish spots at the base of inner tepals on background of pale yellow coloured florets make it more attractive. The hybrid starts producing longer spikes (80.2 cm) after 85 days with more number of florets per spike (14.2). In addition, it is a very good multiplier producing 2.0 corms and about 15-20 cormels which makes it more suitable for commercialization.

Hybrid, Yellow Stone x Blues produces bright reddish orange coloured florets (31A RHS colour chart) with 18.6 florets per spike and longer spike length (80.0 cm). The florets were arranged on compact and robust spikes which takes 72.0 days for spike initiation. The florets were bigger in size with pink coloured macule make it more attractive. In addition to that it was also good multiplier making it suitable for cut flower production.

Hybrid, Limoncello x Verona produces creamish yellow (18 C as per R.H.S colour chart) florets with light yellow coloured inner tepals makes it more attractive. This is early hybrid and started spike initiation 83.0 days with robust and compact spikes. Florets are arranged in two rows with semi-upright position having long spike (75.5 cm) and more number of florets per spike (16.2). In addition, it is a very good multiplier on an average producing 2.0 corms and 20-25 cormels per corm which makes it more suitable for commercialization. The morphological data of evaluation of gladiolus hybrids is presented table 1.3.

**Table 1.3: Morphological Data of Promising Hybrids of Gladiolus at ICAR-DFR, Pune**

Sr. No.	Characters	Hybrids		
		DFR-87 (Yellow Stone x Blues)	DFR-46 (Limoncello x Verona)	DFR-G-Hy-31 (Hunting Song x Ocilla)
1.	Days required for sprouting	26.0	35.0	36.0
2.	Plant height (cm)	97.9	93.9	98.1

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Sr. No.	Characters	Hybrids		
		DFR-87 (Yellow Stone x Blues)	DFR-46 (Limoncello x Verona)	DFR-G-Hy-31 (Hunting Song x Ocilla)
3.	Spike length (cm)	80.0	75.5	80.2
4.	Rachis length(cm)	52.6	44.3	45.1
5.	Leaf length (cm)	45.9	43.4	52.8
6.	Leaf width (cm)	3.8	4.3	4.4
7.	No. of leaves (cm)	7.7	7.7	7.9
8.	Internodal distance (cm)	5.5	4.7	4.9
9.	Flower diameter (cm)	10.8	8.9	10.5
10.	No. of florets per spike	18.6	16.2	14.2
11.	Days required for spike initiation	72.0	83.0	85.0
12.	First floret showing colour (days)	82.0	92.0	93.0



DFR-G-Hy-31

#### DFR-G-Hy-31 (Hunting Song x Ocilla)

- This hybrid is a selection from Hunting Song x Ocilla produces more number of florets per spike (14.2) having pale yellow colour (18C as per R.H.S colour chart).
- Reddish spots at the base of inner tepals on background of pale yellow coloured florets make it more attractive.
- The hybrid starts producing longer spikes (80.2 cm) after 85 days with 4-5 florets remains open at a time.
- In addition, it is a very good multiplier producing 2.0 corms and about 15-20 cormels which makes it more suitable for commercialization



DFR-G-Hy-87

#### DFR-G-Hy-87 (Yellow Stone x Blues)

- It is a selection from cross between Yellow Stone x Blues.
- The florets base colour is reddish yellow (31A as per R.H.S colour chart).
- An early season variety (83 days) with robust and compact spikes.
- The variety produces medium spikes (80 cm), having more number of florets per spike (18.6).
- In addition, it is a very good multiplier which makes it more suitable for commercialization.



DFR-G-Hy-46

### DFR-G-Hy-46 (Limoncello x Verona)

- This hybrid is a selection from Limoncello x Verona.
- The florets base colour is creamish yellow (18C as per R.H.S colour chart).
- Inner tepals are light yellow coloured and yellowish white tepals make it more attractive.
- An early season variety (82 days) with robust and compact spikes.
- Two rows of florets arranged in semi-upright position having long spike (75.5 cm) and more number of florets per spike (16.2).
- In addition, it is a very good multiplier on an average producing 2.0 corms and 20-25 cormels per corm which makes it more suitable for commercialization.

## 1.2 Project 02 (ICAR Project Code: IXX 14261) : Breeding of Tuberose for Quality and Yield

### 1.2.1. Evaluation of Tuberose Germplasm

Tuberose germplasm consisting of single (10 nos.) and double type (3 nos.) planted at Hadapsar Research farm were evaluated during 2018-19. Data indicated that among single types, the cultivars, Prajwal, Bidhan Snigdha and GKTC-4 consistently (during 2017-18 & 2018-19) performed better followed by STR-505 and Mexican single (Table 1.4). Among doubles, Hyderabad Double and Suvasini were found to be better during 2017-18 & 2018-19 (Table 1.5).

### 1.2.2. Evaluation of Open Pollinated (OP) Population of Tuberose

The bulbs of the promising mutants from Arka Nirantara, Phule Rajani, Mexican Single and Sikkim Selection were multiplied and planted during August 2018 for evaluation at Hadapsar farm (Table 1.6). Evaluation of open pollinated population of Arka Nirantara (37 nos.) indicated that the lines, AN-3 (Greenish tinge buds) and AN-4 (Pinkish tinge buds) have consistently (during 2017-18 & 2018-19, Table 1.7 & 1.8) exhibited dwarf nature, hence were found promising for pot culture (Fig.1). In the current year, lines AN-29 & AN-17 were also found to be dwarf in nature.

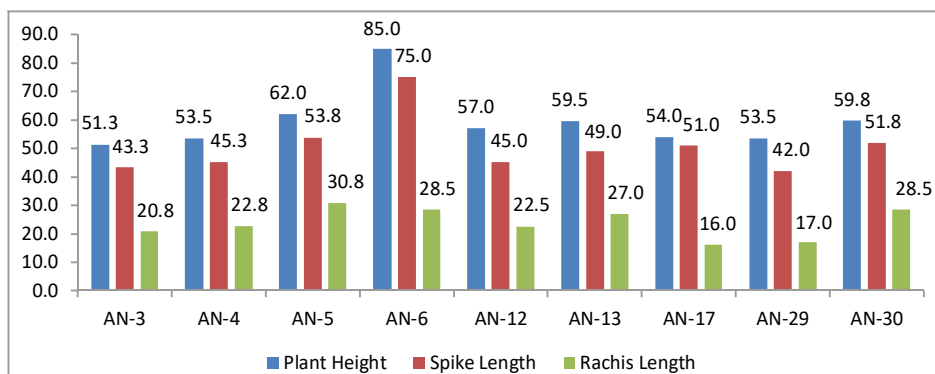


Fig.1. Evaluation of OP Population of Tuberose Variety Arka Nirantara During 2018-19

Data indicated that the line AN-3 has minimum plant height (51.3 cm) followed by AN-4 & AN-29 (53.5 cm each) and AN-17 (54.0 cm). Spike length was minimum in AN-29 (42 cm) followed by AN-3 (43.3 cm). Rachis length was minimum in AN-17 (16.0 cm) followed by AN-29 (17 cm) and AN-3 (20.8 cm). The lines AN-30 and AN-12 recorded maximum floret length (6 cm) whereas size (diameter) was maximum in AN-30 (4.4 cm) followed by AN-3 and AN-12 (3 cm each).



**Table 1.4: Evaluation of Tuberose Germplasm at Pune During 2018-19**

S. No	Variety/ genotype	Plant Height (cm)	Spike Length (cm)	Rachis Length (cm)	Leaf Length (cm)	Leaf Width (cm)	Number of florets per spike	Floret Diameter (cm)	Floret Length (cm)	Plant Spread (cm)	Wt of 10 opened florets (g)	Wt of 10 unopened florets (g)	Number of Leaves	Last flower time	Average number of cut spike per plant	Loose flower yield (kg per plant)
1	Prajwal	120.8	111.4	47.2	62.8	3.4	45	5	7	109.2	22.6	9	17	108.2	5.4	0.55
2	Shringar	93.8	86	48.2	61	2.7	39.4	4.3	6.2	96.6	16	7.6	13.8	86.8	5.6	0.35
3	Phule Rajani	90.6	80.4	43.6	53.6	2.8	38.6	5	6.9	98.4	16.6	6.2	13.4	84.6	4.8	0.31
4	Bidhan Snigdha	103.4	93.2	49.4	51.4	3.8	37.2	5.2	7.3	93.2	20.4	8.8	16.2	100	3.8	0.29
5	Bidhan Ujjwal	73	66.6	29.4	55.8	2.8	33.6	4.4	6.8	86	13.2	7.4	11.6	66.4	2.6	0.12
6	GKTC-4	92.4	82.4	39	50.2	3.4	39.2	4.8	6.8	86.2	17.2	8.4	11	73.8	5.4	0.36
7	Hyderabad Single	88.6	79.4	35	56.4	2.1	39.6	4.6	6	98.6	15.6	7.8	14.2	---	2.4	0.15
8	STR-505	96.6	87.6	40.2	53	2.3	38.8	4.1	6.5	95.6	17.6	11.4	14.4	61.4	3.6	0.25
9	Mexican Single	121.2	111.6	54.4	57	1.3	38.2	3.3	5	92.2	14.2	8.8	13.4	---	---	0.00
10	Arka Nirantara	87.8	77	33.4	50.4	2	31.4	3.3	6	81.6	13.8	8.2	14	---	6.2	0.27
11	Suvasini	93.2	84	41	53.2	3	35.2	4.9	7.3	93.8	39.6	14	15.8	93.6	2.4	-
12	Kolkata Double	92.4	83.6	41.8	51.2	2.8	32.4	5	6.4	88.8	35.2	13.8	14.6	94.2	2.6	-
13	Hyderabad Double	96.2	86.8	45	48	1.6	33	4.9	6.2	81.2	17.6	9.2	14.6	---	2.6	-
	CV (%)	13.51	14.47	16.51	7.98	27.92	10.22	13.90	9.75	8.39	41.06	25.61	11.75	18.28	-	-
	StdDev	12.99	12.58	6.95	4.32	0.73	3.79	0.63	0.63	7.76	8.2	2.38	1.66	15.62	-	-

Table 1.5: Comparative Performance of Tuberose Germplasm at Pune During 2017-18 &amp; 2018-19

S. No.	Variety/ genotype	Plant Height (cm)			Spike Length (cm)			Rachis Length (cm)			Number of florets per spike			Average number of cut spikes / year		
		2017-18	2018-19	Ave	2017-18	2018-19	Ave	2017-18	2018-19	Ave	2017-18	2018-19	Ave	2017-18	2018-19	Ave
1	Prajwal	105	120.8	112.9	83.6	111.4	97.5	45.2	47.2	68.8	45	45	45.0	4.8	5.4	5.1
2	Shringar	83.4	93.8	88.6	69.2	86	77.6	36.8	48.2	60.9	39	39.4	58.7	4.6	5.6	5.1
3	Phule Rajani	78.8	90.6	84.7	67.6	80.4	74.0	37	43.6	58.8	27.2	38.6	46.5	4.2	4.8	4.5
4	Bidhan Smigdha	95.4	103.4	99.4	82	93.2	87.6	47.4	49.4	72.1	35.8	37.2	54.4	3.5	3.8	3.65
5	Bidhan Ujjwal	60.6	73	66.8	47.2	66.6	56.9	26.6	29.4	41.3	25.6	33.6	42.4	2.8	2.6	2.7
6	GKTC-4	67.6	92.4	80.0	58.4	82.4	70.4	32	39	51.5	34.4	39.2	54.0	4.6	5.4	5.0
7	Hyderabad Single	80.4	88.6	84.5	70.4	79.4	74.9	34.4	35	51.9	30.6	39.6	50.4	2.2	2.4	2.3
8	STR-505	86.2	96.6	91.4	75.4	87.6	81.5	40.2	40.2	40.2	32.8	38.8	52.2	2.8	3.6	3.2
9	Mexican Single	121.2	121.2	121.2	111.2	111.6	111.4	54.8	54.4	82.0	34	38.2	53.1	2.2	2.6	2.4
10	Arka Nirantara	87.8	87.8	87.8	77	77	77.0	33.4	33.4	33.4	33	31.4	48.7	4.6	6.2	5.4
11	Suvasini	86.2	93.2	89.7	75.8	84	79.9	33.8	41	54.3	28.4	35.2	46.0	2.2	2.4	2.3
12	Kolkata Double	89.6	92.4	91.0	78.6	83.6	81.1	42.2	41.8	63.1	25.6	32.4	41.8	2.6	2.6	2.6
13	Hyderabad Double	96.2	96.2	96.2	85.7	86.8	86.2	41	45	63.5	30.2	33	46.7	2.8	2.6	2.7
	Std Dev	15.41	12.99	-	15.06	12.58	-	7.45	6.95	-	5.51	3.79	-	1.04	1.44	-
	CV (%)	17.6	13.51	-	19.93	14.47	-	19.17	16.51	-	16.99	10.22	-	30.78	37.39	-
	T test			4.36**			4.64**			3.19**			4.30**			3.33**

**Table 1.6. Performance of OP Population of Tuberose During 2018-19.**

S. No.	Variety	Plant Height (cm)	Spike Length (cm)	Rachis Length (cm)	Flowers Open	Flowers New	Flowers Diameter (cm)	Flowers Length (cm)	Leaf Length (cm)	Leaf Width (cm)	No. of Leaves	Plant Spread (cm)
1	AN-3	51.3	43.3	20.8	12.5	13.5	3.0	5.0	40.3	2.5	9.0	51.0
2	AN-4	53.5	45.3	22.8	10.5	10.3	2.5	4.0	34.5	2.1	10.0	40.3
3	AN-5	62.0	53.8	30.8	0.0	0.0	2.5	4.0	27.0	1.6	11.5	52.0
4	AN-6	85.0	75.0	28.5	7.0	23.0	2.0	4.0	53.0	2.3	14.5	89.0
5	AN-12	57.0	45.0	22.5	16.0	17.0	3.0	6.0	48.5	2.5	8.5	60.0
6	AN-13	59.5	49.0	27.0	14.0	10.0	2.3	5.0	31.0	2.0	8.5	51.5
7	AN-17	54.0	51.0	16.0	12.0	7.0	2.5	5.0	30.0	2.0	11.0	40.0
8	AN-29	53.5	42.0	17.0	0.0	30.5	2.8	5.0	40.5	1.8	10.5	82.0
9	AN-30	59.8	51.8	28.5	20.8	22.0	4.4	6.0	28.8	1.8	14.0	68.8
10	PR-1	41.67	34.67	22.67	-	31.00	-	5.00	26.00	1.50	12.67	56.00
11	PR-2	48.0	36.0	21.0	-	-	-	6.0	21.0	1.5	10.0	54.0
12	PR-3	48.7	40.3	24.7	9.7	8.7	4.0	4.7	20.0	2.0	12.7	40.0
13	PR-4	55.0	45.3	18.0	9.7	13.3	4.0	5.0	28.7	1.7	11.7	79.7
14	PR-9	54.3	44.0	31.0	20.3	26.0	4.2	5.0	30.7	2.0	9.7	49.7
15	PR-10	63.0	54.0	26.0	-	-	-	-	40.0	2.0	9.0	60.0
16	PR-11	54.3	45.7	31.0	9.3	22.0	2.0	4.0	29.0	2.0	13.0	48.7
17	PR-12	84.0	73.3	32.0	7.0	31.3	2.2	5.0	41.0	1.7	14.7	75.0
18	PR-13	68.3	58.3	31.3	13.0	10.0	4.0	5.0	35.3	1.8	10.3	73.0
19	PR-15	58.3	49.8	30.5	5.0	21.3	4.5	5.0	30.0	1.5	-	52.0
20	MS-2	51.7	42.3	22.3	8.7	13.3	4.0	6.0	40.3	2.5	12.7	81.0
21	MS-3	70.7	60.7	24.7	6.0	22.0	3.0	5.0	34.0	2.0	11.7	62.0
22	SS-51	62.0	52.5	16.0	3.0	17.5	3.3	4.4	31.8	1.0	8.3	63.0
23	SS-26	72.3	62.0	16.7	8.3	14.7	4.0	6.0	44.7	2.0	14.7	84.3
	CV(%)	18	20.59	22.22	-	-	48.7	25.74	24.23	18.90	28.9	24.38
	StdDev	10.71	10.34	5.43	-	-	1.359	1.23	8.28	0.36	3.13	14.98

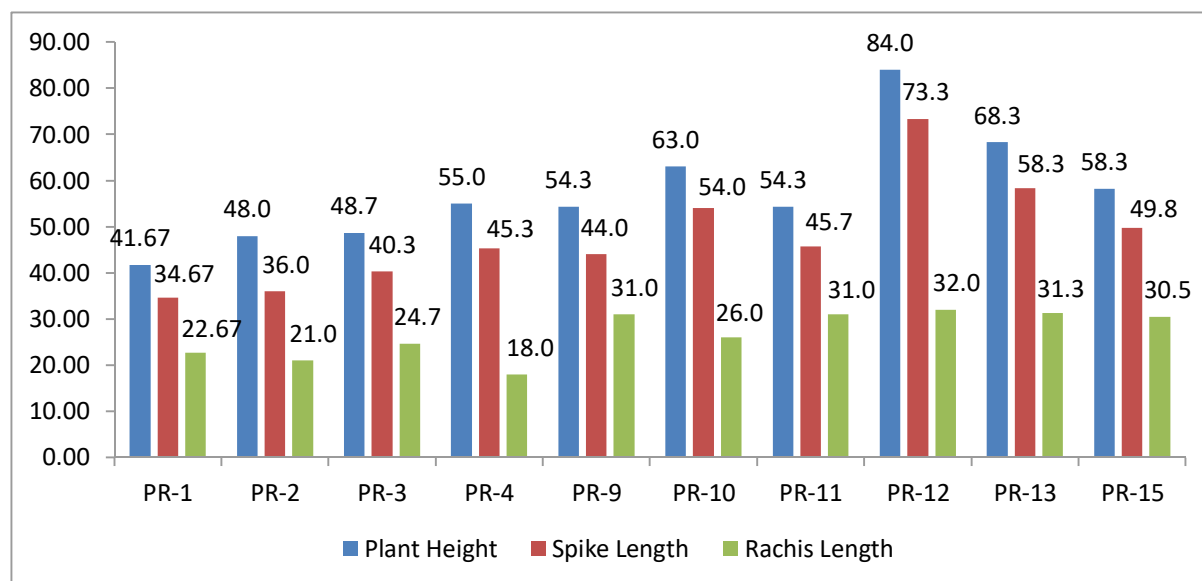
Table 1.7. Comparative Performance of OP Population of Tuberose During 2017-18 &amp; 2018-19.

S. No	Variety	Plant Height (cm)			Spike Length (cm)			Rachis Length (cm)			Number of Leaves			Plant Spread (cm)		
		2017-18	2018-19	Avg.	2017-18	2018-19	Avg.	2017-18	2018-19	Avg.	2017-18	2018-19	Avg.	2017-18	2018-19	Avg.
1	AN-3	46.8	51.3	49.0	41.8	43.3	42.5	18.2	20.8	19.5	10.2	9.0	9.6	72.0	51.0	61.5
2	AN-4	47.4	53.5	50.5	42.8	45.3	44.0	22.2	22.8	22.5	11.0	10.0	10.5	70.4	40.3	55.3
5	AN-12	NA	57.0	57.0	NA	45.0	45.0	NA	22.5	22.5	NA	8.5	8.5	NA	60.0	60.0
7	AN-17	NA	54.0	54.0	NA	51.0	51.0	NA	16.0	16.0	NA	11.0	11.0	NA	40.0	40.0
8	AN-29	NA	53.5	53.5	NA	42.0	42.0	NA	17.0	17.0	NA	10.5	10.5	NA	82.0	82.0
9	AN-30	54.4	59.8	57.1	46.2	51.8	49.0	24.2	28.5	26.4	11.2	14.0	12.6	80.2	68.8	74.5
10	PR-1	46.5	41.67	44.1	41.00	34.67	37.8	25.50	22.67	24.1	8.00	12.67	10.3	63.00	56.00	59.5
11	PR-2	NA	48.0	48.0	NA	36.0	36.0	NA	21.0	21.0	NA	10.0	10.0	NA	54.0	54.0
12	PR-3	43.5	48.7	46.1	38.5	40.3	39.4	23.0	24.7	23.8	7.5	12.7	10.1	36.5	40.0	38.3
13	PR-4	52.3	55.0	53.7	46.6	45.3	46.0	28.3	18.0	23.2	8.6	11.7	10.1	75.6	79.7	77.6
14	PR-9	39.6	54.3	47.0	32.2	44.0	38.1	22.2	31.0	26.6	10.8	9.7	10.2	54.4	49.7	52.0
16	PR-11	46.3	54.3	50.3	40.0	45.7	42.8	26.6	31.0	28.8	8.6	13.0	10.8	60.3	48.7	54.5
18	PR-13	63.6	68.3	66.0	57.3	58.3	57.8	28.6	31.3	30.0	5.3	10.3	7.8	65.3	73.0	69.2
20	MS-2	NA	51.7	51.7	NA	42.3	42.3	NA	22.3	22.3	NA	12.7	12.7	NA	81.0	81.0
21	MS-3	NA	70.7	70.7	NA	60.7	60.7	NA	24.7	24.7	NA	11.7	11.7	NA	62.0	62.0
22	SS-51	NA	62.0	62.0	NA	52.5	52.5	NA	16.0	16.0	NA	8.3	8.3	NA	63.0	63.0
23	SS-26	48.5	72.3	60.4	39.5	62.0	50.8	19.5	16.7	18.1	8.5	14.7	11.6	68.5	84.3	76.4

**Table 1.8. Comparative Performance of OP Population of Tuberose During 2017-18 & 2018-19.**

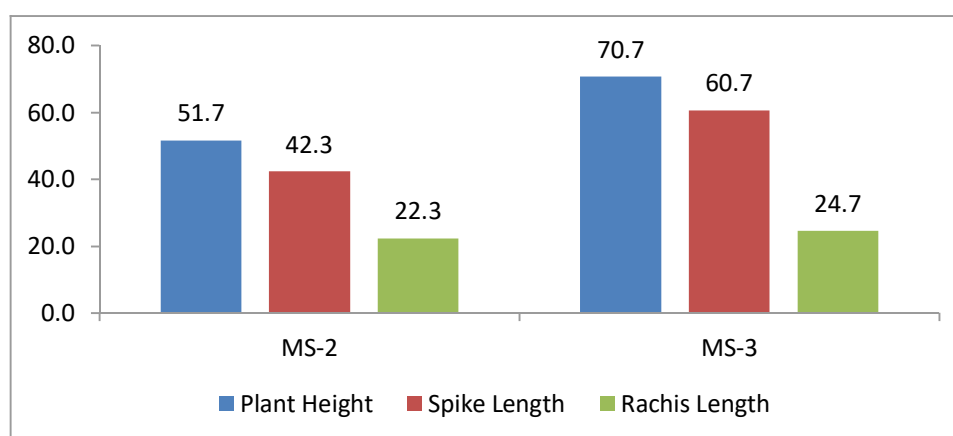
S. No	Variety	Florets Open			Florets New			Florets Diameter (cm)			Florets Length (cm)		
		2017-18	2018-19	Avg.	2017-18	2018-19	Avg.	2017-18	2018-19	Avg.	2017-18	2018-19	Avg.
1	AN-3	12.2	12.5	12.4	25.8	13.5	19.7	2.4	3.0	2.7	3.8	5.0	4.4
2	AN-4	13.6	10.5	12.1	17.8	10.3	14.0	3.2	2.5	2.9	4.6	4.0	4.3
5	AN-12	NA	16.0	16.0	NA	17.0	17.0	NA	3.0	3.0	NA	6.0	6.0
7	AN-17	NA	12.0	12.0	NA	7.0	7.0	NA	2.5	2.5	NA	5.0	5.0
8	AN-29	NA	0.0	0.0	NA	30.5	30.5	NA	2.8	2.8	NA	5.0	5.0
9	AN-30	20.4	20.8	20.6	32.8	22.0	27.4	4.6	4.4	4.5	4.6	6.0	5.3
10	PR-1	19.50	NA	19.5	NA	31.00	31.0	4.00	NA	4.0	5.00	5.00	5.0
11	PR-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.0	6.0
12	PR-3	13.5	9.7	11.6	30.0	8.7	19.3	4.0	4.0	4.0	3.0	4.7	3.8
13	PR-4	20.0	9.7	14.8	11.3	13.3	12.3	3.0	4.0	3.5	4.0	5.0	4.5
14	PR-9	25.6	20.3	23.0	13.6	26.0	19.8	3.6	4.2	3.9	4.0	5.0	4.5
16	PR-11	17.0	9.3	13.2	23.6	22.0	22.8	3.6	2.0	2.8	4.3	4.0	4.2
18	PR-13	12.6	13.0	12.8	16.6	10.0	13.3	4.0	4.0	4.0	5.0	5.0	5.0
20	MS-2	NA	8.7	8.7	NA	13.3	13.3	NA	4.0	4.0	NA	6.0	6.0
21	MS-3	NA	6.0	6.0	NA	22.0	22.0	NA	3.0	3.0	NA	5.0	5.0
22	SS-51	NA	3.0	3.0	NA	17.5	17.5	NA	3.3	3.3	NA	4.4	4.4
23	SS-26	20.0	8.3	14.2	29.0	14.7	21.8	3.0	4.0	3.5	6.0	6.0	6.0





**Fig.2. Evaluation of OP Population of Tuberose Variety Phule Rajani During 2018-19**

The promising lines from the cultivar Phule Rajani (16 nos.) namely PR-1, PR-2, PR-3, PR-4, PR-9 and PR-11 were found to be promising in respect of dwarfness. Data indicated that the line PR-1 recorded minimum plant height (41.67 cm) followed by PR-11 (45.7 cm), PR-2 (48 cm) and PR-3 (48.7 cm) (Fig.2). Spike length exhibited a similar trend and was minimum in PR-1 (34.67 cm) followed by PR-2 (36 cm) and PR-3 (40.3 cm). Rachis length was minimum in PR-4 (18 cm) followed by PR-2 (21 cm) and PR-1 (22.67 cm).



**Fig. 3. Evaluation of OP Population of Tuberose Variety Mexican Single During 2018-19**

MS-2 and MS-3 were the two promising OP lines from Mexican Single. MS-2 exhibited dwarf character with minimum plant height (51.7 cm) compared to MS-3 (70.7 cm). The spike and rachis length also followed a similar trend, it was minimum in MS-2 (42.3 and 22.3) in comparison to MS-3 (60.7 and 24.7). (Fig.3)

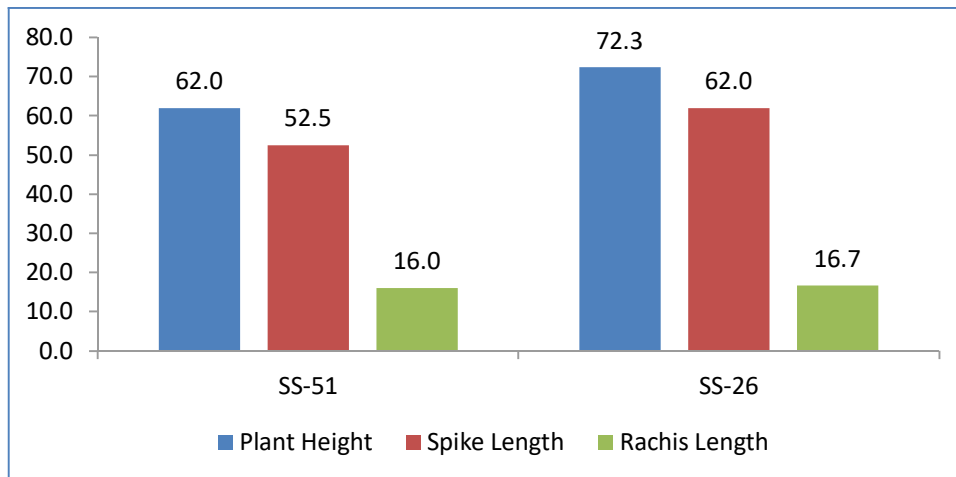


Fig. 4. Evaluation of OP Population of Tuberose Variety Sikkim Selection During 2018-19

SS-26 which has recorded minimum plant height (48.5 cm) during 2017-18 has shown a plant height of 72.3 cm this year and the spike and rachis length were also higher than last year. Another OP line SS-51 was found better than SS-26 in the current year. (Fig. 4)

Overall, the OP lines, AN-3, AN-4, AN-29 and AN-17 from Arka Nirantara; PR-1, PR-11, PR-2 and PR-3 from Phule Rajani; MS-2 from Mexican Selection; and SS-51 from Sikkim Selection were found promising in respect of dwarfness.

### 1.2.3. Evaluation of Irradiated Tuberose Material

Bulbs of six varieties (4 single namely Prajwal, Phule Rajani, Hyderabad Single and Mexican Single & 2 double types namely Vaibhav and Hyderabad Double) were exposed to gamma rays (for half a minute at BARC, Mumbai) of different doses (10, 15, 20, 25 and 30 Gy.) during February, 2018 and planted in Hadapsar farm for evaluation. Mortality per cent was found to increase with increase in dosage of the gamma ray irradiation (from 10 to 30 Gy). It has increased suddenly from 15 Gy to 20 Gy indicating that dosage upto 15 Gy was optimum (Fig.5 and Fig.6). Among different varieties, Prajwal recorded highest survival and field establishment (Fig. 7). This could be attributed to bigger size of the Prajwal bulbs compared to other varieties.

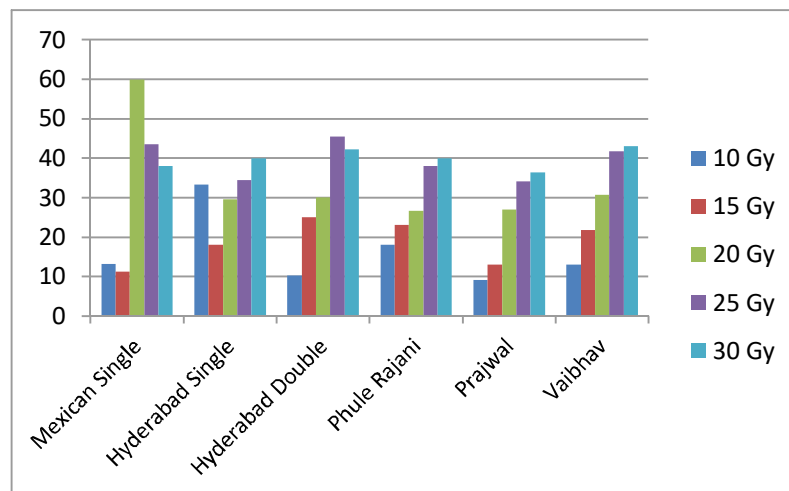


Fig. 5. Per Cent Mortality Among Different Varieties of Tuberose as Influenced by the Dosage of Gamma Ray Irradiation.

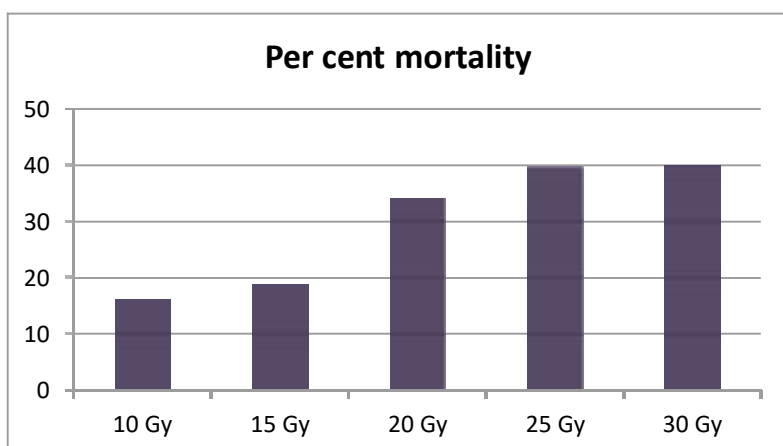


Fig. 6. Effect of Gamma Ray Irradiation Dosage on the Mortality of Tuberose Bulbs (Average of Six Varieties).

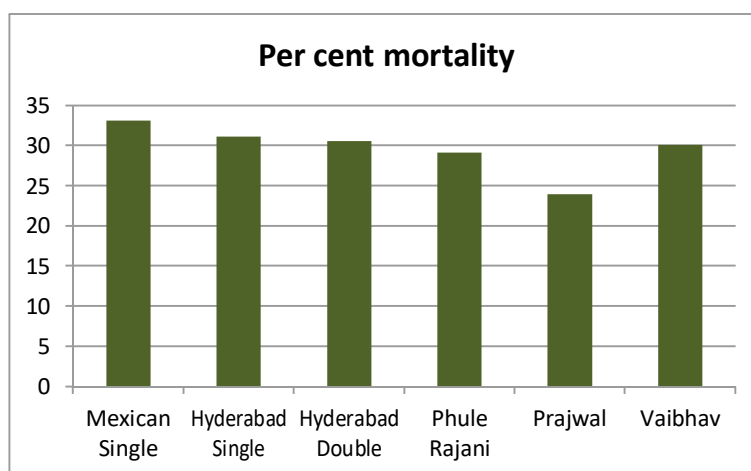


Fig. 7. Varietal Response to Gamma Ray Irradiation in Terms of Mortality Percentage

#### 1.2.4. Studies on the Sprouting Behavior of Tuberose Bulbs During Off-season

Tuberose is a tropical ornamental bulbous flowering plant cultivated for production of loose (single type) and cut flowers (double types). In India, commercial cultivation of tuberose is confined to warm humid areas with average temperature ranging from 20° to 30°C. They are generally planted in March to May when the temperature is optimum for growth. The bulbs can also be planted during July-August. Winter months (November to February) are avoided for planting as the crop/bulb is sensitive to low temperature. An experiment was conducted to evaluate the germination of tuberose varieties (Prajwal and Phule Rajani) during November to January in different planting systems (with mulch, polythene & dry straw and without mulch under Pune conditions during 2018-19).

Per cent sprouting is more than 75% in all the plantings except in the variety Prajwal planted in open (without mulch) (Table 1.9). It decreased as the time of planting was delayed (from November to December). Planting environment has significant effect on per cent sprouting; straw mulch has recorded highest sprouting percentage (97.2% and 86.5% in Phule Rajani and Prajwal, respectively), followed by polythene mulch (93.38% and 79.85%). Number of days to sprouting differed significantly. From November (first & second planting) to December (first planting), the number of days for sprouting increased. Planting in soil (without mulch) recorded highest number of days to sprouting (89.75 and 90.75 days in Prajwal and Phule Rajani, respectively) and minimum was observed in straw mulching (54.5 & 55.5 days, respectively)(Table 1.10). Data recording on flowering parameters is in progress.



Sprouting percentage was high in the variety Phule Rajani as compared to Prajwal but there is no difference among the number of days for sprouting. The use of mulching (straw or polythene) helps in germination during winter season by maintaining the required soil temperature. Planting of tuberose in winter season can help in combating the irrigation related problems during summer season (April-May), as optimum and judicious irrigation is required for crop establishment, growth and yield.

**Table 1.9: Germination Percentage of Tuberose as Influenced by Season of Planting**

Variety	DOP	01/11/18	19/11/18	01/12/18	21/12/18	Average (planting dates)	Average (variety)
Prajwal	Open	91.70	95.80	75.00	23.70	71.55	79.30
	Mulching (Polythene)	97.20	97.20	77.80	47.20	79.85	
	Mulching (Grass)	100.00	100.00	89.00	57.00	86.5	
Phule Rajani	Open	91.70	76.40	73.60	84.70	81.6	90.73
	Mulching						
(Polythene)		95.80	83.30	94.40	93.38		
	Mulching (Grass)	100.00	97.20	94.40	97.20	97.2	
		96.77	93.73	82.18	67.37		
	Variety	Environ	VxE				
CD (p<0.05)	NS	NS	22.61*				

**Table 1.10: Influence of Planting Season on the Number of Days for Sprouting in Tuberose**

Variety	DOP	01/11/18	19/11/18	01/12/18	21/12/18	Average (planting dates)	Average (variety)	Average (Environ)
Prajwal	Open	46	75	109	129	89.75	69.58	90.25
	Mulching (Polythene)	32	52	85	89	64.50		64.63
	Mulching (Grass)	32	48	63	75	54.50		55.0
Phule Rajani	Open	46	96	129	92	90.75	70.33	
	Mulching (Polythene)	32	75	81	71	64.75		
	Mulching (Grass)	38	52	79	53	55.50		
		37.67	66.33	91.00	84.83			
	Variety	Environ	VxE					
CD (p<0.05)	NS	14.69	20.77					

### 1.2.5. Development of Micropropagation Protocol of Tuberose

Standardization of micro-propagation protocol is initiated from tuberose flower petals. Local Single variety of tuberose was inoculated on MS media having composition of 6 BAP, 0.5 NAA, 0.7 2,4D and 0.5 TDZ. Callus initiation was observed after 25 days. Further different media combinations are being tested and once the suitable media combinations are finalized, will be utilized for rapid multiplication of promising tuberose mutants developed by gamma ray irradiation.



Micropropagation of Tuberose cv. Local Single

## 1.3 Project 03 (ICAR Project Code: IXX14254): Improvement of Chrysanthemum for Commercial Traits.

### 1.3.1. Diversity in Chrysanthemum Germplasm with Respect to Maturity (Days to Flowering) and Pigmentation.

About 156 Chrysanthemum varieties were evaluated during 2018-19 under Pune conditions. Based on maturity (number of days taken from planting to flowering) as well as on flower colour, all the varieties were classified into different groups (Table 1.11). Statistical analysis revealed that all the cultivars exhibited significant differences for the traits studied.

### 1.3.2. Grouping of Varieties Based on Maturity (Days to Flowering)

Based on days to flowering, varieties were grouped into five categories *viz.* very early (61 to 80 days), early (81 to 100 days), mid (101 to 120 days), late (121 to 140 days) and very late (141 to 160 days).

Among all the varieties (Table 1.12), 17 varieties attained maturity very early, 61 varieties were early, 62 varieties flowered in mid, 14 varieties were late while two varieties attained maturity very late. Thus, mid maturity was the largest group comprising of 62 varieties followed by early maturity with 61 varieties. Only limited number of varieties constituted the very early, late and very late groups. Within each maturity group, the varieties were further divided into groups (11 nos.) based on their flower colour (Fig.8). Mid maturity group has varieties in wide range of colours (belonging to 10 colour groups).

Varieties differed significantly with respect to days to flowering. Maximum days to flowering was observed in the variety Maghi White (159 days) followed by Basantika (147 days) while Bran Spring and Classic varieties reached maturity within 66 days (Table 1.11).

### 1.3.3. Grouping of Varieties Based on Pigmentation

The flower colour (pigmentation) was recorded as per the RHS colour chart and all the varieties were broadly grouped into various colour groups (12 nos.) such as greyed orange, greyed purple, orange, orange red, purple violet, purple, red, red purple, violet, white, yellow and yellow orange (Table 1.14).

**Table 1.11. Evaluation of Chrysanthemum Varieties with Respect to Maturity Period (Days to Flowering) and Flower Colour.**

Sr. No.	Variety	Colour Group	RHS colour code	Maturity Period
1	Agnishikha	Red Group	46A	117
2	Akitha	Greyed Orange Group	167A	126
3	Anmol	Yellow Group	7A	120
4	Aparajita	Yellow Group	9A	109
5	Basanti	Yellow Group	9A	104
6	Basantika	Yellow Group	9A	147
7	Beauty	Orange Red Group	N34A	86
8	Bidhan Poonam	Yellow Orange Group	20A	74
9	Bidhan Rupanjali	Red Group	42B	115
10	Bidhan Sabita	Orange Red Group	N34A	115
11	Bidhan Shova	White Group	NN155B	83
12	Bidhan Agnidev	Purple Group	75A	119
13	Bidhan Agnisikha	Red Purple Group	69A	119
14	Bidhan Gold	Yellow Group	13A	108
15	Bidhan Jayanti	Yellow Group	12A	125
16	Bidhan Lalima	Yellow Group	13A	90
17	Bidhan Madhuri	Purple Group	77C	114
18	Bidhan Mallica	Yellow Group	6A	72
19	Bidhan Mum	Yellow Group	9A	82
20	Bidhan Neeta	White Group	155A	115
21	BidhanPurna	Yellow Group	5A	102
22	Bidhan Rajat	White Group	NN155B	83
23	Bidhan Swapna	White Group	NN155D	104
24	BidhanTarun	Red Purple Group	69C	119
25	Big Violet	Red Purple Group	72A	120
26	Bran Spring	Purple Group	75B	66
27	Bravo	Greyed Purple Group	185A	125
28	Chandni	Orange Red Group	N34A	105
29	Chandrika	Yellow Group	3A	100
30	Charlie	Red Group	53A	80

Sr. No.	Variety	Colour Group	RHS colour code	Maturity Period
31	Cherabo	Greyed Orange Group	171A	115
32	Cinderella	Red Purple Group	65C	105
33	Classic	Red Purple Group	70B	66
34	Coimbatore Semi-Double	Yellow Orange Group	14A	84
35	Corcon Small	Yellow Group	12A	93
36	Crystal Fall	White Group	NN155C	88
37	Dabam	White Group	NN155A	84
38	Dainty White	Yellow Group	4D	88
39	Dark Eyes	Red Purple Group	69B	86
40	Deep Red	Red Group	53A	105
41	Devi	Yellow Group	2A	88
42	DFR Select White	Yellow Group	4D	93
43	Dignity	Yellow Group	6A	100
44	Discovery	White Group	155B	114
45	Draguma	White Group	155A	85
46	Fireball	Red Group	53A	114
47	Flash	Yellow Group	5B	100
48	Flirt	Orange Red Group	N34A	112
49	Gaity	Red Purple Group	61A	93
50	Garden Beauty	Red Group	46A	84
51	Gauri	White Group	NN155C	118
52	Gitanjali	Yellow Group	5B	90
53	Gunjan	Red Group	53A	107
54	Heritage	Yellow Group	7A	72
55	Himani 3	Puple Violet Group	N80C	115
56	Honey Comb	Yellow Group	6A	88
57	Houston	Red Purple Group	64A	86
58	HYDC Local Yellow	Yellow Group	6B	83
59	HYDC-12	Red Purple Group	N74B	138
60	HYDC-16	Red Group	53A	124
61	HYDC-2	Red Purple Group	62C	105
62	HYDC-25	Yellow Group	9A	90



Sr. No.	Variety	Colour Group	RHS colour code	Maturity Period
63	HYDC-28	Red Purple Group	72B	90
64	HYDC-29	Purple Group	N78D	92
65	HYDC-35	Yellow Group	6A	105
66	HYDC-40	White Group	NN155B	85
67	HYDC-41	White Group	NN155A	105
68	HYDC-42	Red Purple Group	N57D	88
69	HYDC-55	White Group	155A	86
70	HYDC-56	White Group	NN155A	98
71	HYDC-9	Red Purple Group	N57D	92
72	IAH Red	Orange Red Group	N34A	115
73	Indira	Red Group	53A	93
74	Jaya	Red Group	53A	79
75	Jessica	Red Purple Group	71A	103
76	Jessica-1	Red Purple Group	69C	104
77	Jessica-2	Purple Group	77C	105
78	Karnal Pink	Red Purple Group	65C	80
79	Kiran	Yellow Group	6A	118
80	Kirti Gold	Yellow Group	6A	113
81	Kundan	Yellow Group	7A	136
82	Lal Pari	Orange Red Group	N34	88
83	Lalima	Red Group	46A	115
84	Liliput	Yellow Group	6A	96
85	Little Darling	Red Purple Group	70B	74
86	Little Pink	Red Purple Group	N74D	138
87	Magenta	Red Purple Group	70A	133
88	Maghi White	White Group	155A	159
89	Mahatma Gandhi	Purple Group	75C	95
90	Marigold	White Group	NN155C	91
91	Mauve Sarah	Red Purple Group	N74D	121
92	Mayor	Yellow Group	3A	102
93	Melody	Orange Red Group	34C	115
94	Mini Jassi	Yellow Group	9A	86



Sr. No.	Variety	Colour Group	RHS colour code	Maturity Period
95	Mother Teresa	White Group	155B	114
96	Mountaineer	Yellow Group	9A	98
97	Naughty White	White Group	N155B	79
98	Naughty Yellow	Yellow Group	5A	80
99	Navy Pride	Red Purple Group	64A	99
100	NBRI Little Orange	Yellow Group	6A	105
101	NC Pink	Purple Group	75B	115
102	Neelam	Red Purple Group	69A	74
103	PAU-107	Purple Group	77C	105
104	PAU-35	Violet Group	84B	120
105	PAU-38	Red Purple Group	62D	103
106	PAU-55	Purple Group	77B	120
107	PAU-58	White Group	NN155B	120
108	PAU-66-2	Red Purple Group	71A	122
109	PAU-D-11	Red Group	55A	109
110	Pink Cloud	Red Purple Group	64A	104
111	Pink Sensation	Purple Group	75A	93
112	Pink Star	Red Purple Group	70A	86
113	Pinky	Red Purple Group	N74C	72
114	Preet Shringar	Yellow Orange Group	14B	105
115	Preverto	Red Purple Group	70B	98
116	Punch White	White Group	155B	88
117	Purple Quill	Red Purple Group	70A	134
118	Pusa Aditya	Yellow Group	9A	93
119	Pusa Chitraksha	Red Purple Group	71A	106
120	Pusa Guldasta	White Group	NN155A	106
121	Pusa Shwet	Yellow Orange Group	17A	104
122	Ragini	Yellow Group	13A	84
123	Ravi	Yellow Group	9A	80
124	Ravikiran	Greyed Orange Group	176A	74
125	Red Bouquet	Greyed Orange Group	164A	132



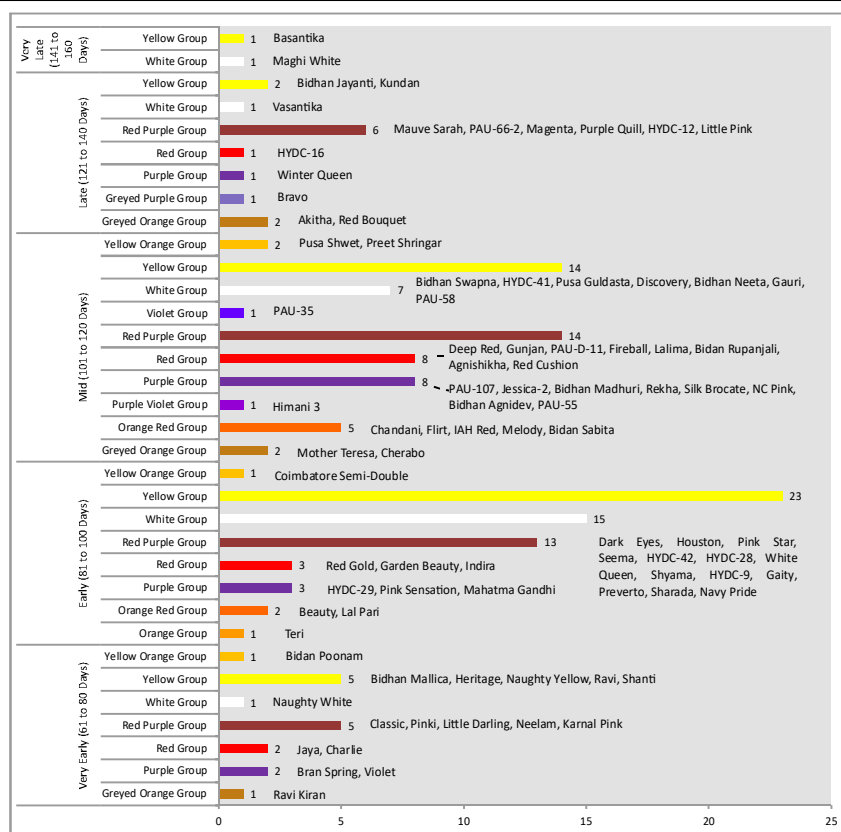
Sr. No.	Variety	Colour Group	RHS colour code	Maturity Period
126	Red Cushion	Red Group	53A	118
127	Red Gold	Red Group	53A	83
128	Rekha	Purple Group	75A	114
129	River City	Yellow Group	13A	116
130	Royal Princess	White Group	155B	92
131	Royal White	Yellow Group	2D	103
132	Sadwin Yellow	Yellow Group	9A	83
133	Salmon	Red Purple Group	62C	117
134	Scent White	White Group	NN155B	82
135	Seema	Red Purple Group	70C	87
136	Sensation	Red Purple Group	70B	114
137	Shanti	Yellow Group	6A	80
138	Sharada	Red Purple Group	62B	99
139	Shyama	Red Purple Group	72A	90
140	Shyamal Double	Red Purple Group	72B	114
141	Silk Brocade	Purple Group	75A	114
142	Splash	Yellow Group	7A	83
143	Sulphur	Yellow Group	6A	115
144	Sunny	White Group	NN155C	83
145	Teri	Orange Group	28A	83
146	Vanity Pink	Red Purple Group	N66D	114
147	Vasantika	White Group	155A	123
148	Vijay	Yellow Group	5A	98
149	Violet	Purple Group	77B	80
150	W.A. Reid	White Group	NN155A	99
151	White Prolific	White Group	155B	87
152	White Queen	Red Purple Group	N74A	90
153	Winter Queen	Purple Group	76D	134
154	Yellow	Yellow Group	7A	88
155	Yellow Gold	Yellow Group	6A	113
156	Yellow Reflex	Yellow Group	12A	83
	CD (p<0.05)	-	-	10.71
	CD (p<0.01)	-	-	14.07

Significant variation was observed within the cultivars with regards to flower colour (Table 1.13) Yellow colour with 45 varieties was the largest group followed by red purple group with 38 varieties. Greyed purple, orange, purple violet and violet were the smallest colour groups with only one variety each.

Significant variation was observed with regards to maturity period within the same colour group. In the largest colour group (yellow), 5 cultivars exhibited very early flowering (61 to 80 days), 23 attained early maturity (81 to 100 days), 14 cultivars flowered in mid (101 to 120 days), two cultivars exhibited late flowering (121 to 140 days) and only one cultivar exhibited very late maturity (141 to 160 days). Similar variation was also recorded in other colour groups (Fig. 9)

**Fig. 8. Classification of Chrysanthemum Varieties Based on Maturity and Flower Colour.**

(B) Early (61 nos.)	Yellow Group (23 nos.)	Bidhan Mum, Yellow Reflex, Splash, HYDC Local Yellow, Sadwin Yellow, Ragini, Mini Jassi, Honey Comb, Devi, Daity White, Yellow, Gitanjali, HYDC-25, Bidhan Lalima, Pusa Aditya, Corcon Small, DFR Select White, Liliput, Mountaineer, Vijay, Flash, Dignity, Chandrika
	White Group (15 nos.)	Scent White, Bidhan Rajat, Sunny, Bidan Shova, Dabam, HYDC-40, Draguma, HYDC-55, White Prolific, Crystal Fall, Punch White, Marigold, Royal Princess, HYDC-56 and W.A. Reid
(C) Mid (62 nos.)	Red Purple Group (14 nos.)	Jessica, PAU-38, Jessica-1, Pink Cloud, Cinderella, HYDC-2, Pusa Chitraksha, Sensation, Shyamal Double, Vanity Pink, Salmon, Bidhan Agnisikha, Bidhan Tarun, Big Violet
	Yellow Group (14 nos.)	Bidhan Purna, Mayor, Royal White, Basanti, HYDC-35, NBRI Little Orange, Bidhan Gold, Aparajita, Kirti Gold, Yellow Gold, Sulphur, River City, Kiran, Anmol

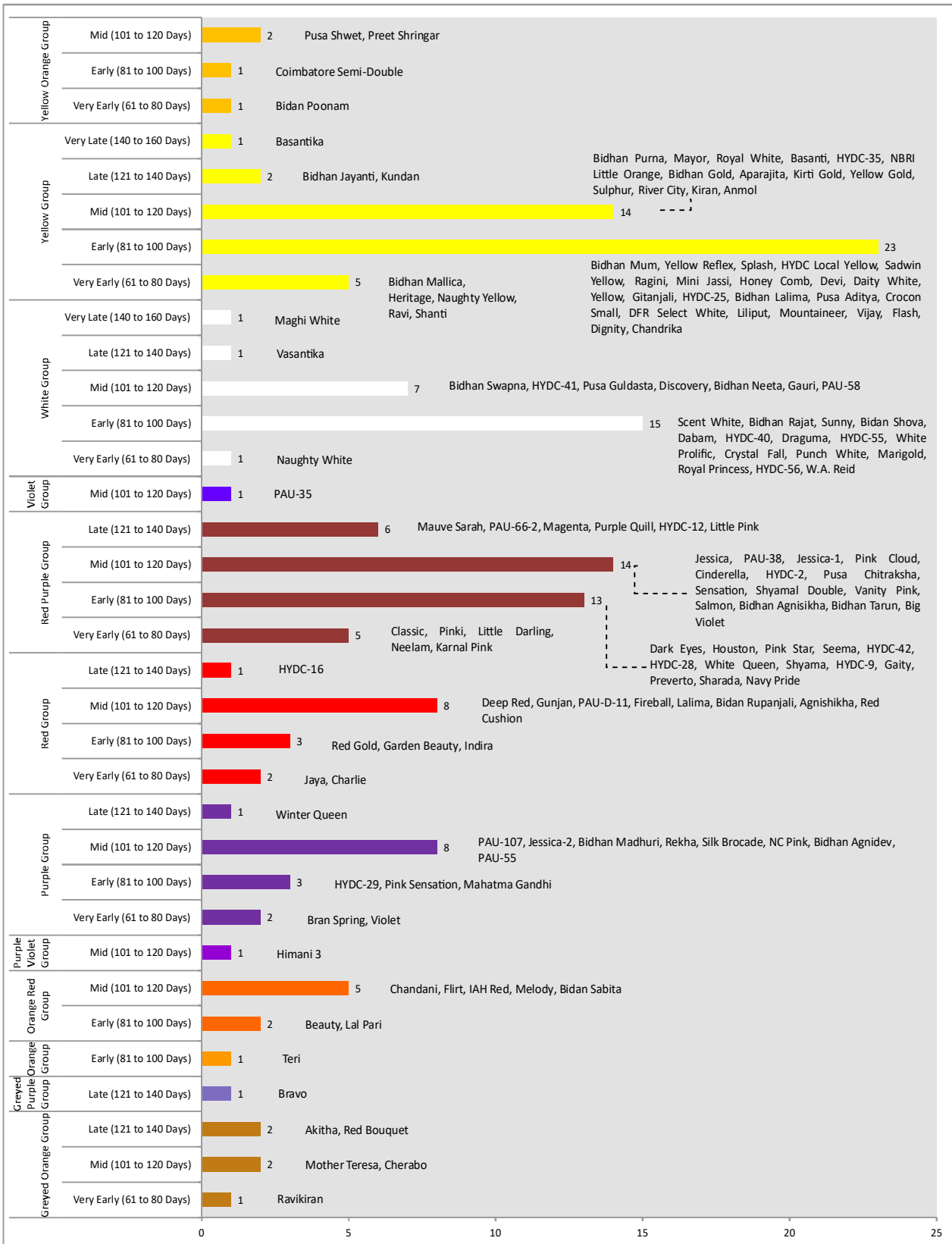




**Table 1.12. Grouping of Chrysanthemum Varieties Based on Days to Flowering**

S. No.	Maturity Group	No of varieties	Names of varieties
1	Very early (60-80 days)	17	Charlie, Karnal Pink, Naughty Yellow, Ravi, Shanti, Violet, Jaya, Naughty White, Bidhan Poonam, Little Darling, Neelam, Ravikiran, Bidhan Mallica, Heritage, Pinky, Bran Spring and Classic
2	Early (81-100 days)	61	Chandrika, Dignity, Flash, Navy Pride, Sharada, W.A. Reid, HYDC-56, Mountaineer, Preverto, Vijay, Liliput, Mahatma Gandhi, Corcon Small, DFR Select White, Gaity, Indira, Pink Sensation, Pusa Aditya, HYDC-29, HYDC-9, Royal Princess, Marigold, Bidhan Lalima, Gitanjali, HYDC-25, HYDC-28, Shyama, White Queen, Crystal Fall, Daity White, Devi, Honey Comb, HYDC-42, Lal Pari, Punch White, Yellow, Seema, White Prolific, Beauty, Dark Eyes, Houston, HYDC-55, Mini Jassi, Pink Star, Draguma, HYDC-40, Coimbatore, Semi-Double, Dabam, Garden Beauty, Ragini, Bidhan Shova, Bidhan Rajat, HYDC Local Yellow, Red Gold, Sadwin Yellow, Splash, Sunny, Teri, Yellow Reflex, Bidhan Mum and Scent White.
3	Mid (101-120 days)	62	Anmol, Big Violet, PAU-35, PAU-55, PAU-58, Bidhan Agnidev, Bidhan Agnisikha, Bidhan Tarun, Gauri, Kiran, Red Cushion, Agnishikha, Salmon, River City, Bidan Rupanjali, Bidhan Sabita, Bidhan Neeta, Cherabo, Himani 3, IAH Red, Lalima, Melody, NC Pink, Sulphur, Bidhan Madhuri, Discovery, Fireball, Mother Teresa, Rekha, Sensation, Shyamal Double, Silk Brocade, Vanity Pink, Kirti Gold, Yellow Gold, Flirt, Aparajita, PAU-D-11, Bidhan Gold, Gunjan, Pusa Chitraksha, Pusa Guldasta, Chandni, Cinderella, Deep Red, HYDC-2, HYDC-35, HYDC-41, Jessica-2, NBRI Little Orange, PAU-107, Preet Shringar, Basanti, Bidhan Swapna, Jessica-1, Pink Cloud, Pusa Shwet, Jessica, PAU-38, Royal White, Bidhan Purna and Mayor
4	Late (121-140 days)	14	HYDC-12, Little Pink, Kundan, Purple Quill, Winter Queen, Magenta, Red Bouquet, Akitha, Bidhan Jayanti, Bravo, HYDC-16, Vasantika, PAU-66-2 and Mauve Sarah
5	Very Late (141-160 days)	2	Maghi White and Basantika

**Fig 9. Classification of Chrysanthemum Varieties Based on Flower Colour.**





**Table 1.13. Grouping of Chrysanthemum Varieties Based on Flower Colour**

S. No.	Colour Group	Nos.	Varieties
1	Greyed orange	4	Ravikiran, Cherabo, Akitha and Red Bouquet
2	Greyed purple	1	Bravo
3	Orange red	7	Beauty, Lal Pari, Chandni, Flirt, IAH Red, Melody and Bidhan Sabita
4	Orange	1	Teri
5	Purple violet	1	Himani 3
6	Purple	14	Bran Spring, UN-12, Violet, HYDC-29, Pink Sensation, UN-18, PAU-107, Jessica-2, Bidhan Madhuri, Rekha, NC Pink, Bidhan Agnidev, PAU-55 and Winter Queen
7	Red	14	Jaya, Charlie, Red Gold, Garden Beauty, Indira, Deep Red, Gunjan, PAU-D-11, Fireball, Lalima, Bidan Rupanjali, Agnishikha, Red Cushion and HYDC-16
8	Red purple	38	Classic, Pinky, Little Darling, Neelam, Karnal Pink, Dark Eyes, Houston, Pink Star, Seema, HYDC-42, HYDC-28, White Queen, Shyama, HYDC-9, Gaity, Preverto, Sharada, Navy Pride, Jessica, PAU-38, Jessica-1, Pink Cloud, Cinderella, HYDC-2, Pusa Chitraksha, Sensation, Shyamal Double, Vanity Pink, Salmon, Bidhan Agnisikha, Bidhan Tarun, Big Violet Mauve Sarah, PAU-66-2, Magenta, Purple Quill, HYDC-12 and Little Pink
9	Violet	1	PAU-35
10	White	25	Naughty White, Scent White, Bidhan Rajat, Sunny, Bidhan Shova, Dabam, HYDC-40, Draguma, HYDC-55, White Prolific, Crystal Fall, Punch White, Marigold, Royal Princess, HYDC-56, W.A. Reid, Bidhan Swapna, HYDC-41, Pusa Guldasta, Discovery, Bidhan Neeta, Gauri, PAU-58, Vasantika and Maghi White
11	Yellow	45	Bidhan Mallica, Heritage, Naughty Yellow, Ravi, Shanti, Bidhan Mum, Yellow Reflex, Splash, HYDC Local Yellow, Sadwin Yellow, Ragini, Mini Jassi, Honey Comb, Devi, Daity White, Yellow, Gitanjali, HYDC-25, Bidhan Lalima, Pusa Aditya, Corcon Small, DFR Select White, Liliput, Mountaineer, Vijay, Flash, Dignity, Chandrika, Bidhan Purna, Mayor, Royal White, Basanti, HYDC-35, NBRI Little Orange, Bidhan Gold, Aparajita, Kirti Gold, Yellow Gold, Sulphur, River City, Kiran, Anmol, Bidhan Jayanti, Kundan and Basantika
12	Yellow orange	4	Bidan Poonam, Coimbatore Semi-Double, Pusa Shwet and Preet Shringar

In another experiment, about 49 varieties (Table 1.14) were evaluated for flowering duration (commencement of flowering to end of flowering/start of withering). Significant variation was observed with regards to flowering duration. The variety Bidhan Rajat exhibited longest flowering duration (65 days) followed by HYDC-40 (64 days). Flowering duration was found to be shortest in the varieties HYDC-12 and Marigold (12 days each) followed by Dark Eyes (16 days).

**Table 1.14. Evaluation of Chrysanthemum Varieties for Flowering Duration.**

S. No	Variety	Flowering duration (commencement of flowering to end of flowering) (days)	S. No.	Variety	Flowering duration (commencement of flowering to end of flowering) (days)
1	Basanti	43	26	HYDC-56	55
2	Bidhan Rupanjali	31	27	HYDC-9	47
3	Bidhan Sabita	31	28	Jaya	60
4	Bidhan Shova	63	29	Jessica	40
5	Bidhan Mum	53	30	Karnal Pink	56
6	Bidhan Rajat	65	31	Lal Pari	57
7	Chandrika	44	32	Liliput	39
8	Cinderella	40	33	Marigold	12
9	Dainty White	45	34	Naughty Yellow	24
10	Dark Eyes	16	35	PAU-107	46
11	Devi	45	36	PAU-38	44
12	Dignity	44	37	PAU-D-11	40
13	Draguma	48	38	Punch White	45
14	Flash	44	39	Pusa Aditya	31
15	Honey Comb	57	40	Pusa Chitraksha	42
16	HYDC Local Yellow	54	41	Pusa Guldasta	33
17	HYDC-12	12	42	Pusa Shwet	35
18	HYDC-2	42	43	Royal White	39
19	HYDC-25	59	44	Scent White	54
20	HYDC-28	47	45	Seema	46
21	HYDC-29	59	46	Vijay	47
22	HYDC-40	64	47	Violet	56
23	HYDC-41	43	48	White Prolific	17
24	HYDC-42	33	49	Yellow	45
25	HYDC-55	52			

#### 4.1.2. Development of Micropropagation Protocol for Chrysanthemum

Standardization of micro-propagation protocol was initiated from chrysanthemum florets as explant. In total five chrysanthemum varieties *viz.*, cultivars Scent White, Mother Teresa, Bidhan Savita, Lalima and Supa- 1 were used for development of micro-propagation protocol. For varieties Scent White and Mother Teresa florets with MS media composition 2BAP and 0.1 NAA were used in inoculation medium and callus initiation was observed after 60 days (Fig. 10). While florets explant were used for variety Bidhan Savita, Lalima and Supa-1 with media composition 10 Kinetin and 0.5 NAA and initial callusing was observed at 60 days (Fig. 11). Further different media combinations are being tested and once the suitable media combination, will be utilized for rapid multiplication of promising chrysanthemum mutants developed by gamma irradiation.

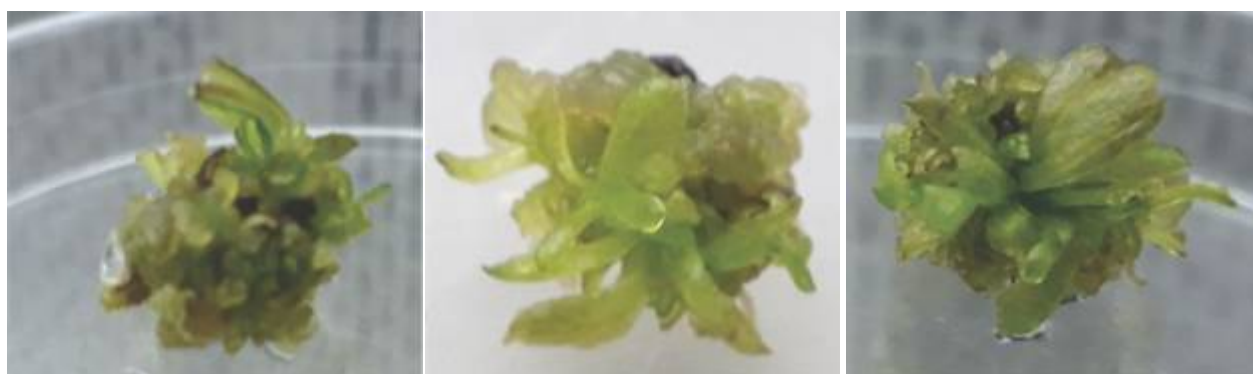


Fig. 10 : Morphogenic Callus induction from Chrysanthemum cv. Scent White in MS+2BA+0.1NAA

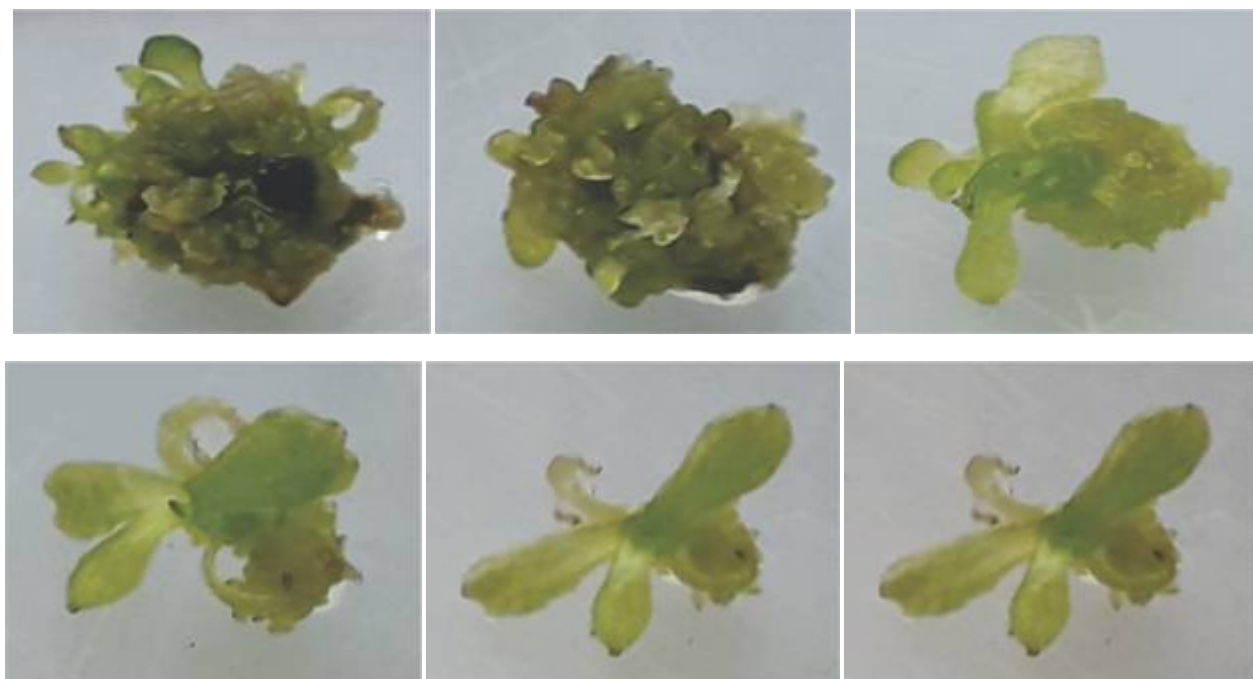


Fig. 10 : Morphogenic Callus induction from Chrysanthemum cv. Bidhan Savita in MS+ 10 Kinetin+0.5 NAA



## 1.4 Project 04 (ICAR Code No: IXX 14255): Improvement of Rose for Commercial Traits

### 1.4.1. Germplasm Collection

The following 51 varieties were collected from Kharagpur, West Bengal *viz.*, Fragrant Mauve, Intrigue, Bordo, Gold Stick, Uzma Alam, Julia Child, Peace, Out of Africa, Ace of Hearts, Bora Bora, Ferry Porsche, Ingrid Bergman, Madam Delbard, Papa Mielland, Belissima, Golden Medallion, Helmut Schmidt, Sun Goddess, Carmousine, Hot Pewter, Montezuma, Superstar, Shocking Blue, Tipu's Flame, Princess de Monaco, Grand Opera, Pinata, George Burns, Magic Lantern, Sheer Elegance, Flame, Preference, April in Paris, Scented Night, Love and Peace, Branden Gate, Charles Mallerin, Skyline, Fragrant Beauty, Bronze Star, Janice Kellogg, Tribute, California Dream, Freedom, Sunfire, Ronald Reagan, Almondeen, Cabaret, Charleston, Beautiful Bhopal and Kupfer Konigin. They will be evaluated for different traits and will be used in crossing programme.

Among the varieties in existing germplasm, the following varieties were having traits that can be useful for breeding fragrant varieties. The varieties were Oklahoma, Bonne Nuit, Raktima, Rose Sherbet, Karen Blixen, French perfume, Blue Moon, Fragrant Plum, Christian Dior, Mister Lincoln, Blue Perfume, Black Delight, Nurjehan, Fragrant Gold, Summer Fragrance, Double Delight, Brandy, Black Lady and Sentimental.

Varieties *viz.*, Raktagandha, Pusa Arun, Pusa Shatabdi, Scarlet Knight, Pusa Bahadur, Queen Elizabeth, Montezuma, Radhanath, American Heritage, Mainau, Perle, Montreal, Friendship, Christian Dior, First prize, Bugatti, Inge Horstmann, Double Delight, Dorris Tysterman, Paradise, Folklore, Gladiator, Granada and Sophia have promising cut flower traits and can be used to breed cut flower varieties, if they set seed.

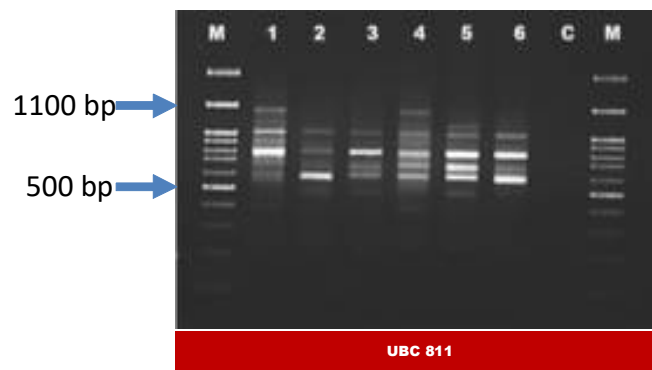
Varieties *viz.*, Rose Sherbet, Delhi Princess, Happiness, Crimson Glory, Kashmir Velvet, Echo and Summer Snow have loose flower traits.

### 1.4.2. Crossing Programme

During this year, varieties *viz.*, Christian Dior, Montreal, Sophia, Karl Herbst, Friendship, Paradise, Pusa Bahadur, Pusa Shatabdi, Raja Surendra Singh of Nalagarh, Folklore, Inge Hortsman, Double Delight, American Heritage were used in crossing to breed varieties for cut flower production. The varieties *viz.*, Lalima, Jantar Mantar, Honest Red, Surkhab, Pusa Arun, Dr. S. S. Bhatnagar, Azure Sea, Pusa Gaurav, Delhi Princess, President Pranab, Harmonie, Ametista were used in crossing to breed varieties for loose flower production. The varieties *viz.*, Bonne Nuit, Fragrant Plum, Oklahoma, Mister Lincoln, Black Lady, Double Delight, Blue Moon, Rose Sherbet were used to breed varieties for gardens with fragrance. The hips will be collected in the following season.

### 1.4.3. Development of Unique Fingerprints Using ISSR Markers

Leaf samples of six fragrant rose varieties were collected from ICAR-DFR Hadapsar farm and stored at -20°C. Protocol for total genomic DNA isolation from leaf material of rose was standardized. Total genomic DNA from six accessions of rose were isolated, purified and quantified. For developing SRAP and ISSR profiles and PCR reactions were standardized for ISSR fingerprinting. ISSR profiles for six rose accessions were developed, scoring for polymorphic bands is being carried out. Variety specific unique polymorphic bands are being identified and further sequence information will be utilized to develop robust specific markers (Fig. 12).



— Marker, 1-Midas Touch, 2-Raktima, 3-Brandy, 4-Black Lady, 5-Double Delight, 6-Oklahoma, C-Control

Fig. 12. ISSR Profiling of Rose Accessions by ISSR 811 Primer

## 1.5 Project 05 : Developing Unique DNA Fingerprints of Flower Crops

### 1.5.1. Developing Unique Fingerprints of Tuberose Accessions Using SRAP Marker System

Thirteen tuberose accessions were subjected to SRAP (Sequence Related Amplified Polymorphism) fingerprinting. In total 50 combinations of SRAP primers were utilized, out of 20 primer combinations developed scorable profiles and were repeated three times for reproducibility. 20 SRAP primers produced 83 scorable bands of which 69 were polymorphic while 14 were monomorphic.

After scoring all reproducible bands the profile cluster analysis was performed using NTSys Program. 13 tuberose cultivars in the present study were divided into two major clusters. Cluster I included Arka Nirantara, Local Double, GKTC-4, Hyderabad Single, Prajwal, Arka Sugandhi and Suhasini and Cluster II included Mexican Single, Local Single, Phule Rajani, Bidhan Ujwal, Arka Vaibhav and Single Selection.

In cluster one Hyderabad single and Prajwal were found to be closely related with about 91% similarity. Arka Sugandha shared about 82% similarity with Prajwal and 78% similarity with Hyderabad single. Arka Nirantara and local double formed subgroup under cluster 1 with 73% similarity. In cluster II, Mexican single and local single were in same sub-group with about 85% similarity. Similarly Bidhan Ujwal and Arka Vaibhav were found to be closely related with about 84% similarity. Phule Rajani was offset to subgroup with Bidhan Ujwal and Arka Vaibhav with 80% and 77% similarity respectively (Fig. 13). SRAP primer combinations has yielded tuberose nine variety specific bands which further needs to be validated and developed in to variety specific markers for varietal distinctness (Fig. 14 & 15; Table 1.15).

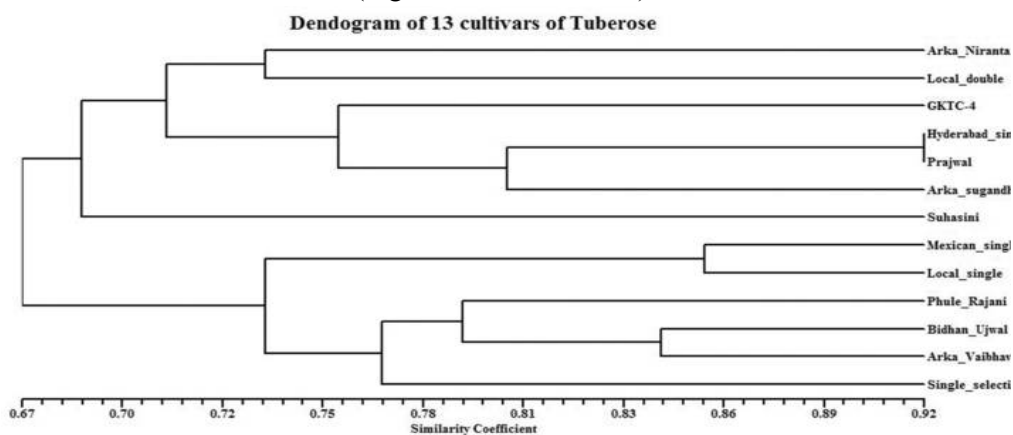
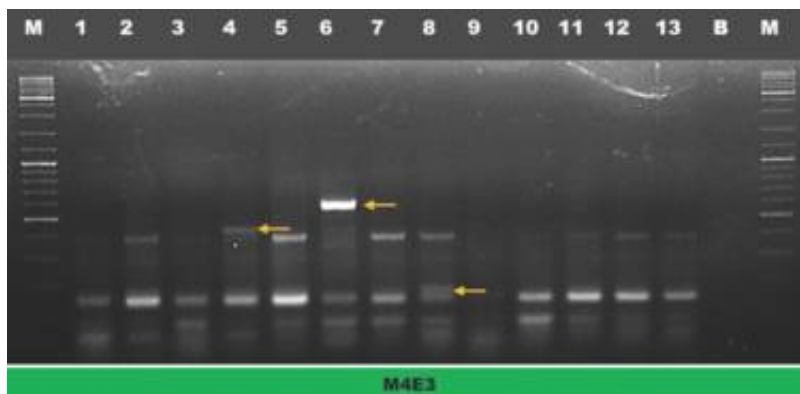


Fig. 13 : Cluster analysis of 10 tuberose varieties by NJ tree

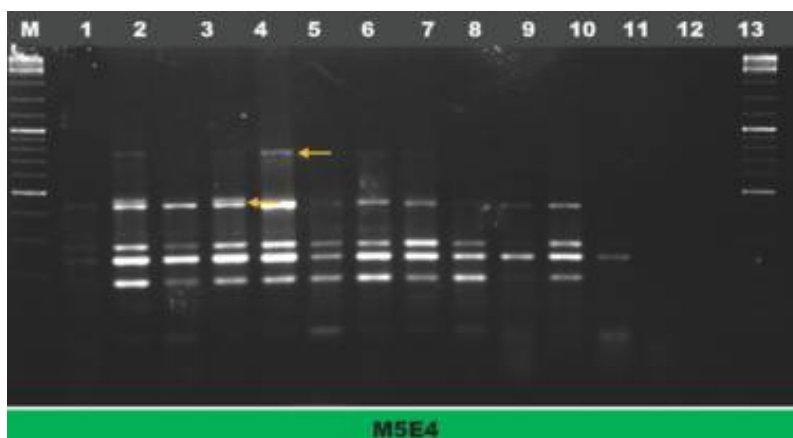
### Tuberose Variety-specific Unique Polymorphic Bands Identified:



M Marker 1 Arka Nirantara, 2 Mexican Single, 3. Phule Rajani, 4. Local Single, 5. Bidhan Ujwal, 6. Suhasini, 7. Arka Vaibhav, 8 Single Selection, 9. GKTC-4, 10 Local Double, 11 Hyderabad Single, 12 Prajwal, 13 Arka Sugandha, B Blank

**Fig. 14 : SRAP Profile of 10 Tuberose Varieties using M4E3 Primer Combination**

M Marker 1 Arka Nirantara, 2 Mexican Single, 3. Phule Rajani, 4. Local Single, 5. Bidhan Ujwal, 6. Suhasini, 7. Arka Vaibhav, 8 Single Selection, 9. GKTC-4, 10 Local Double, 11 Hyderabad Single, 12 Prajwal, 13 Arka Sugandha, B Blank



**Fig. 15. SRAP Profile of 10 Tuberose Varieties using M5E4 Primer Combination**

**Table 1.15: Tuberose Variety-specific Unique Bands Identified**

Sr. No.	Tuberose Variety	SRAP primer combination	Band size
1.	Suhasini	M4e3	600 bp
2.	Local single	M4e3	450 bp
3.	Single Selection	M4e3	100 bp
4.	Suhasini	m3e7	100 bp
5.	Suhasini	m3e7	1000bp
6.	Arka Vaibhav	m1e3	200 bp
7.	Hyderabad Single	m5e7	300 bp
8.	Suhasini	m5e7	600 bp
9.	Suhasini	M4e7	350 bp

### 1.5.2. Developing Unique Fingerprints of Gladiolus Accessions Using SRAP Marker System

Ten gladiolus accessions were subjected to SRAP (Sequence Related Amplified Polymorphism) fingerprinting. In total 80 combinations of SRAP primers were utilized. Out of 25 combinations developed scorable profiles and were repeated three times for reproducibility. In total 25 SRAP primer combinations produced 234 scorable bands of which 176 were polymorphic while 58 were monomorphic.

After scoring all reproducible markers the profile cluster analysis was performed using NTSys Program. Out of ten gladiolus cultivars, cultivars Purple-Flora, Melody Open, Novalux, Punjab Dawn and Yellow Stone formed a single cluster. While Novalux and Punjab Dawn were found closely related with 96% similarity. While Purple Flora was found closely related to Novalux and Punjab dawn with 88% similarity. Smoky Lady, Pusa Srijan and Amsterdam formed separate cluster having a sub-cluster with 76% similarity. Lady Oscar shared 73% similarity with Pusa Srijan and Amsterdam. While Dhanvantari was distinct from all other cultivars with similarity of 57 to 71 % (Fig 16). Nineteen SRAP primer combinations yielded gladiolus variety specific bands which further needs to be validated and developed in to variety specific markers for varietal distinctness (Fig. 17 & 18; Table 1.16).

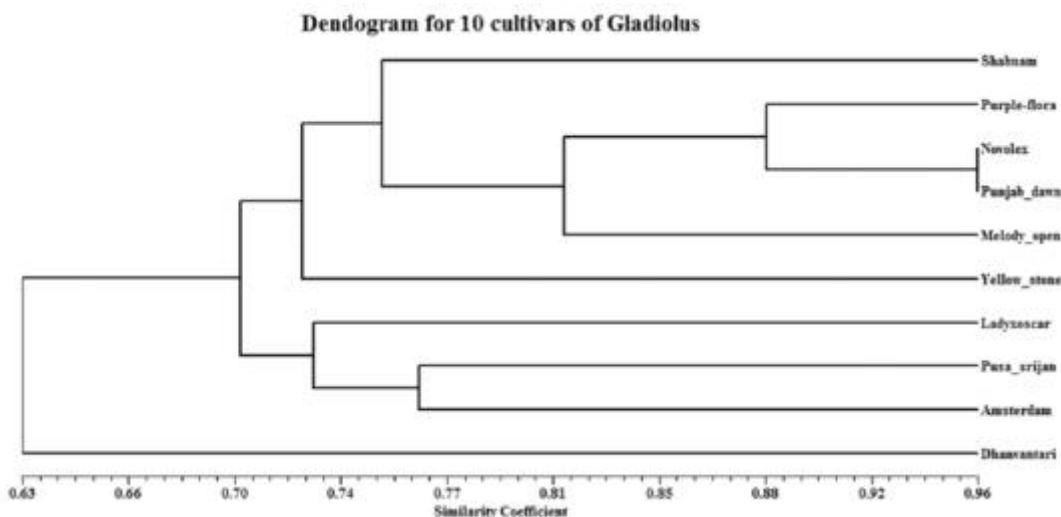
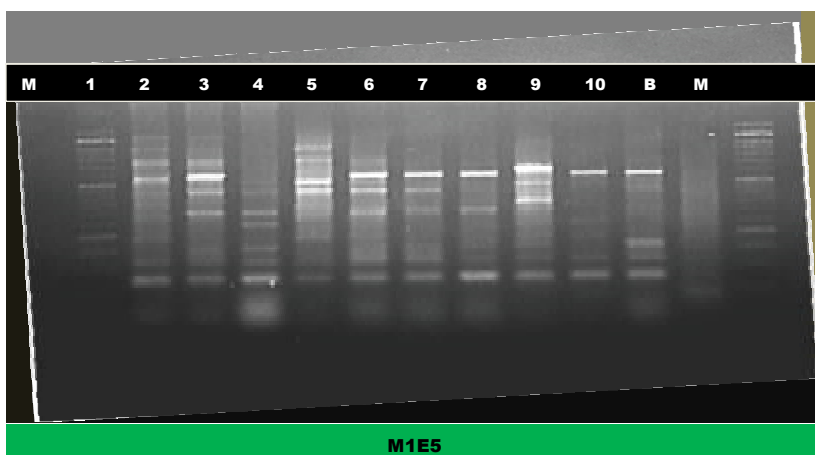


Fig. 16. Cluster analysis of 10 gladiolus varieties by NJ tree



M Marker, 1 Shabnam, 2. Purple-flora, 3. Smoky Lady, 4. Melody Open, 5. Novalux, 6. Punjab Dawn, 7. Yellow Stone, 8. Dhanvantari, 9. Pusa Srijan, 10. Amsterdam, B Blank

Fig. 17. SRAP Profile of 10 Gladiolus Varieties using M1E5 Primer Combination

M Marker, 1 Shubham, 2. Purple Flora, 3. S. Lady, 4. Melody Open, 5. Novalux, 6. Punjab Dawn, 7 Yellow Stone, 8. Dhanvantari, 9 Pusa Srijan, 10 Amsterdam, B Blank.

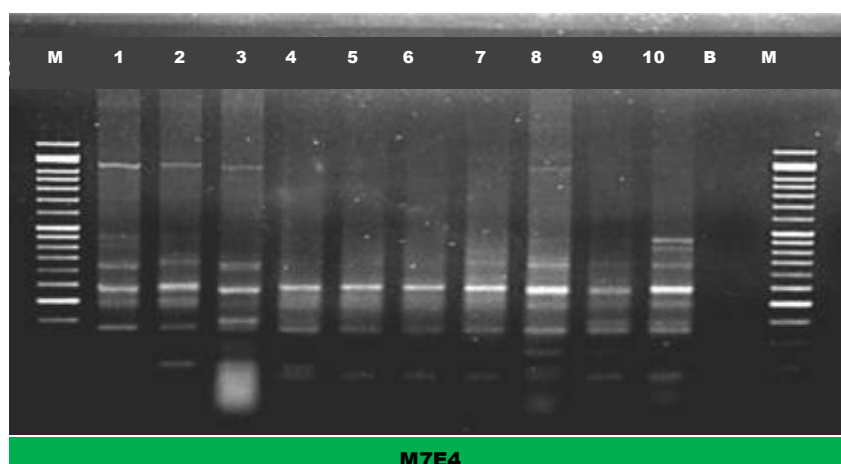


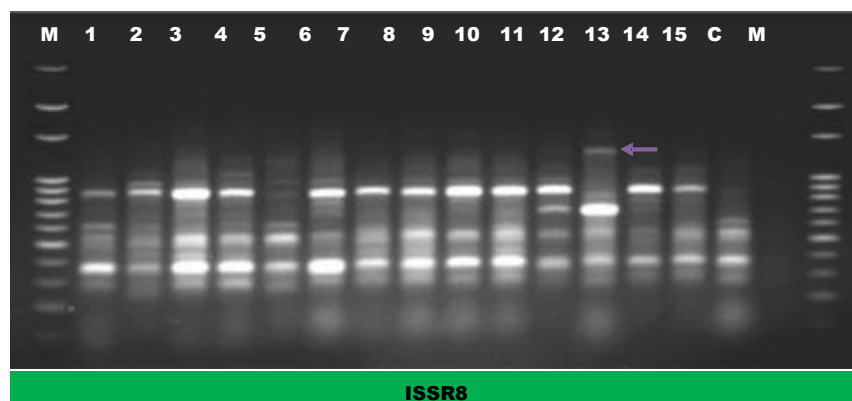
Fig. 18: SRAP profile of 10 Gladiolus Varieties using M7E4 Primer Combination

Table 1.16: Gladiolus Variety Specific Bands Identified by SRAP Primers

Sr. No.	Varieties of Gladiolus	SRAP Primer combination	Band Size
1.	Dhanvantari	m2e6, m5e7, m5e12, m1e5, m6e5&m7e5	600 bp, 250 bp, 175 bp, 350 bp, 600bp & 250 bp
2.	Purple Flora	m2e4	900 bp
3.	Novalux	m2e7	650 bp
4.	Smoky Lady	m3e6, m5e7, m5e6, m1e5, m7e4	300bp, 650 bp, 375 bp, 300 bp, 275 bp
5.	Amsterdam	m5e6, m7e4	450 bp, 450 bp
6.	Shubham	m1e7	475 bp
7.	Yellow stone	m1e7, m5e4, m6e5	400 bp, 375 bp, 550 bp
8.	Melody Open	m6e5	500bp,

### 1.5.3. Developing Unique Fingerprints of Gladiolus Accessions Using ISSR Markers

Fifteen gladiolus accessions were subjected to ISSR (Inter Simple Sequence Repeats) fingerprinting.



M Marker, 1 Shubham, 2- Falvo-amico, 3-Purple Flora, 4-Mohini, 5- Chandani, 6. S. Lady, 7- Solicit, 8.-Melody Open, 9- Novalux, 10- Punjab Dawn, 11- Yellow Stone, 12-. Dhanvantari, 13- Pusa Srijan, 14- Flora Savinlo 15- Amsterdam, B Blank.

Fig 19 : ISSR Profiling of Gladiolus Accessions by ISSR 8 Primer



In total 50 ISSR primers were utilized, out of 10 combinations developed scorable profiles that were repeated three times for reproducibility. In total 10 ISSR primer combinations produced 87 scorable bands of which 76 were polymorphic while 11 were monomorphic. Three variety specific ISSR bands were identified after validation may be used for varietal distinctness (Fig. 19 & Table 1.17).

**Table 1.17: Gladiolus Variety Specific Bands Identified by ISSR Primers**

Sr. No.	Varieties of Gladiolus	ISSR Primer	Band Size
1.	Dhanvantari	ISSR 8 & ISSR 25	1100 bp & 700bp
2.	Mohini	ISSR 11	1100 bp

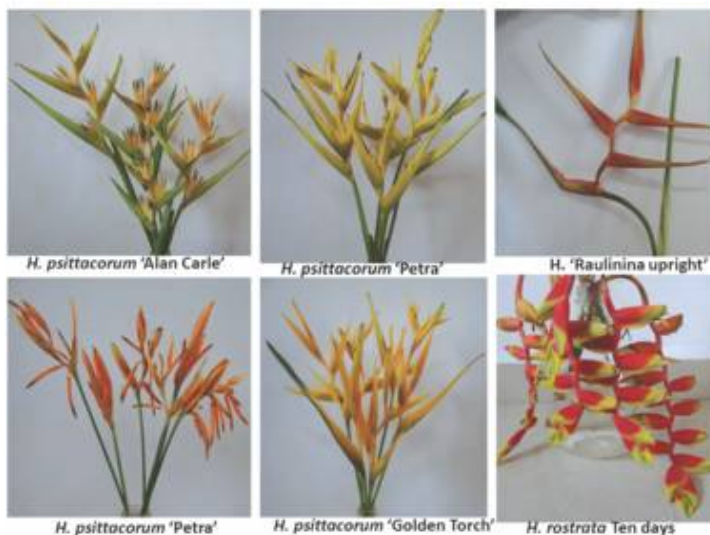
## 1.6 Project 06 (ICAR Code No: IXX 14262): Utilization of Specialty flowers, Cut foliages, fillers and Aromatic flower Crops to address various landscape uses

### 1.6.1 Performance of Heliconia Cultivars for Flower Yield and Quality Under Agro-climatic Conditions of Maharashtra

Heliconia is considered as a popular specialty flower with varied fantastic forms and rich colour. The cut flower market has made heliconia a key player in global as well as domestic markets. Under this study, heliconia germplasm was raised by collecting planting materials from various sources. A group of 40 genotypes of heliconia were evaluated for their performance and acclimatization under agro – climatic conditions of Maharashtra for consistent performance in growth and yield. The experiment was conducted in randomized block design with three replications under open field conditions. The collected accessions of heliconia were planted at a spacing of 1.5m x 1.5m. Six plants from each accession were taken for recording observations. The growth and flowering characters were recorded and analysed statistically. The growth and flowering characteristics recorded in different types of heliconia collected from different sources are furnished in Table 1.18 and Table 1.19. The results recorded indicate that, based on the height of the plant, heliconias can be classified into three categories viz., tall types, medium types and dwarf type. Among the evaluated heliconia accessions, *H. 'Kathy'*, *H. psittacorum 'Petra'*, *H. psittacorum 'Lady Di'*, *H. bihai*, *H. psittacorum 'Golden Torch'*, *H. 'Golden Torch Sunshine'*, *H. 'Strawberries and Cream'*, *H. 'Golden Torch Adrian'*, H-23, *H. 'Prince of Darkness'*, *H. bihai 'Yellow'*, *H. 'Pedro Ortiz'*, *H. caribaea*, *H. psittacorum 'Kenya red'*, *H. 'St. Vincents Red'* and *H. 'Red Christmas'* are dwarf types. *H. 'Raulinina upright'*, *H. rostrata*, *H. 'Temptress'*, *H. 'Jacquini'* and *H. 'She'* are tall types. *H. bihai Schaefer*, *H. psittacorum 'Sassy'*, *H. metallica*, H-20, *H. 'Tropics'*, *H. 'Yellow Parrot'*, *H. psittacorum 'Alan Carle'*, *H. rostrata 'Parrot's beak'*, *H. rostrata 'Tendays'*, H-25, *H. wagneriana*, *H. 'Guyana'*, *H. Red*, *H. 'Irish'*, *H. bihai 'Lobster Claw'*, *H. 'Firebird'* and *H. latispatha* are medium types. The results revealed that cv. *H. 'Raulinina upright'* recorded the highest plant height (188.20 cm). The highest number of leaves was recorded in *H. bihai* (6.67), maximum leaf length of 105.25 cm in *H. 'Jacquini'* and the maximum leaf breadth (27.15 cm) in *H. 'Jacquini'*. Maximum sucker production was recorded in *H. 'Tropics'* (46.20), *H. psittacorum 'Alan Carle'* (38.11) and *H. 'Yellow Parrot'* (33.33). Maximum stalk length was observed in *H. 'She'* (28.45 cm). The length of the flower spike ranged from 34.88 cm to 151.00 cm. The highest spike length (151.00 cm) was observed in the genotype *H. 'Raulinina upright'*. The lowest spike length (34.88 cm) was observed in the genotype *H. bihai*. The highest number of bracts / florets per spike was recorded in *H. 'Raulinina upright'* (9.50). *H. metallica* recorded the highest number of flowers/bract (9.10). Size of floret/bract was recorded highest (6.95 cm) in *H. psittacorum 'Petra'*. The highest bract length (15.90 cm) and bract width (2.65 cm) was observed in the genotype- *H. metallica* and *H. 'Golden Torch Adrian'* respectively. The lowest bract length (7.65 cm) and bract width (1.55 cm) was observed in the genotype *H. psittacorum 'Petra'* and *H. 'Yellow Parrot'* respectively. The study is under progress for identifying and recommending the most appropriate cultivars of heliconia for commercial cultivation under agroclimatic conditions of Maharashtra.



Field View of Heliconia Germplasm



Evaluation of Different Species of Heliconia



Evaluation of Different Species of Heliconia



Harvested Stalks of Different Heliconia Species

**Table 1.18 : Evaluation of Different Species/ Types of Heliconia Under Agro-climatic Conditions of Maharashtra**

Treatments	Plant height (cm)	No. of suckers/plant	No. of leaves/sucker	No. of leaves/plant/clump	Leaf length (cm)	Leaf width (cm)	Leaf length without stalk (cm)	Petiole length (cm)
T1- <i>H. 'Kathy'</i>	51.43	8.17	3.83	28.17	25.97	7.43	22.62	3.88
T2- <i>H. psittacorum 'Petra'</i>	52.33	13.16	4.83	56.00	27.28	6.52	23.48	3.80
T3- <i>H. psittacorum 'Lady Di'</i>	62.28	13.83	3.83	32.83	29.37	7.68	24.45	4.92
T4- <i>H. bihai Schaefer</i>	86.48	13.17	4.50	38.67	29.56	8.80	26.50	3.37
T5- <i>H. bihai</i>	49.17	6.00	6.67	19.33	23.70	7.73	23.63	3.33
T6- <i>H. psittacorum 'Golden Torch'</i>	79.75	15.67	5.33	59.00	44.55	11.40	37.05	7.70
T7- <i>H. 'Golden Torch Sunshine'</i>	74.90	9.50	4.00	28.50	45.10	11.15	36.55	7.55
T8- <i>H. psittacorum 'Sassy'</i>	101.60	25.50	3.50	85.50	61.13	17.18	45.42	14.05
T9- <i>H. 'Strawberries and Cream'</i>	67.12	12.83	4.50	39.17	28.47	7.88	24.55	3.92
T10- <i>H. metallica</i>	129.58	21.16	4.17	76.67	79.52	19.48	62.95	16.58
T11- <i>H-20</i>	95.97	13.50	4.00	46.33	61.75	14.57	50.82	10.95
T12 - <i>H. 'Golden Torch Adrian'</i>	49.40	3.50	3.50	10.00	31.95	10.30	25.85	6.05
T13- <i>H. 'Tropics'</i>	128.94	46.20	4.40	167.00	79.02	12.54	53.48	24.90
T14- <i>H. 'Yellow Parrot'</i>	94.97	33.33	3.67	92.33	53.13	12.87	43.27	9.87
T15- <i>H. psittacorum 'Alan Carle'</i>	128.89	38.11	4.56	138.56	79.38	15.00	58.87	20.39
T16- <i>H. chocoiana</i>	145.72	23.57	4.10	75.27	91.99	18.54	72.05	20.03
T17- <i>H. stricta</i>	75.83	21.00	4.11	62.94	46.38	12.53	38.27	8.94
T18- <i>H. 'Raulinina upright'</i>	188.20	22.50	4.50	100.50	101.20	24.90	72.85	27.35
T19- <i>H. rostrata 'Parrot's beak'</i>	128.42	12.00	4.33	44.17	75.12	16.07	55.48	17.45
T20- <i>H-23</i>	55.85	10.00	4.50	39.50	34.45	8.95	27.80	6.60
T21- <i>H. 'Prince of Darkness'</i>	51.90	5.50	3.50	19.00	30.80	10.90	28.20	2.70

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Treatments	Plant height (cm)	No. of suckers/plant	No. of leaves/sucker	No. of leaves/plant/clump	Leaf length (cm)	Leaf width (cm)	Leaf length without stalk (cm)	Petiole length (cm)
T22- <i>H. rostrata</i>	150.55	16.00	3.50	50.50	90.50	20.75	63.90	16.60
T23- <i>H. rostrata</i> 'Tendays'	128.75	16.00	4.50	51.00	65.45	18.05	55.95	9.50
T24- <i>H-25</i>	92.18	23.33	4.17	80.50	56.98	11.52	43.30	13.02
T25- <i>H. wagneriana</i>	94.33	20.50	4.17	68.67	54.87	14.42	45.33	9.53
T26- <i>H. 'Guyana'</i>	101.62	21.83	4.33	70.33	64.38	13.77	52.18	14.03
T27- <i>H. bihai</i> 'Yellow'	77.23	7.00	3.33	23.67	50.17	13.50	41.53	6.60
T28- <i>H. Red</i>	119.40	5.50	3.50	15.50	76.30	18.25	57.95	13.35
T29- <i>H. 'Pedro Ortiz'</i>	41.47	4.67	3.67	15.00	30.47	15.97	27.23	3.80
T30- <i>H. 'Irish'</i>	128.28	20.20	3.80	61.20	85.56	20.08	67.50	12.06
T31- <i>H. 'Tempress'</i>	158.40	11.00	3.67	33.67	94.10	21.93	71.67	19.10
T32- <i>H. bihai</i> 'Lobster Claw'	103.05	24.00	3.50	58.00	60.45	14.35	48.35	12.10
T33- <i>H. caribaea</i>	34.65	1.50	4.00	4.25	21.95	10.30	20.52	5.68
T34- <i>H. 'Jacquini'</i>	160.90	23.00	4.50	68.50	105.25	27.15	84.25	18.50
T35- <i>H. psittacorum</i> 'Kenya red'	63.45	14.50	2.50	23.50	39.75	12.50	33.15	6.10
T36- <i>H. 'St. Vincents Red'</i>	28.20	2.50	3.50	5.50	19.15	6.05	17.15	2.50
T37- <i>H. 'Red Christmas'</i>	64.40	14.00	4.00	31.50	35.75	11.45	29.85	5.40
T38- <i>H. 'Firebird'</i>	85.80	17.50	3.50	42.50	53.85	17.60	45.70	8.65
T39- <i>H. 'She'</i>	164.55	13.50	4.50	49.00	103.75	25.05	77.70	28.45
T40- <i>H. latispatha</i>	134.95	7.50	4.50	28.50	75.45	25.05	64.40	11.05
Sem+	7.30	2.69	0.34	10.25	4.91	1.12	3.05	1.91
CD (p<0.05)	21.90	8.07	1.01	30.75	14.74	3.37	9.14	5.72

**Table 1.19 : Flower quality characteristics of Heliconia cultivars under agro-climatic conditions of Maharashtra**

Treatments	Spike length (cm)	No. of bracts/floret/spike	No. of flowers/bract	Size of flowers/bract (cm)	Inter nodal length between florets/bract (cm)	Width of bract (cm)	Length of bract (cm)
T1- <i>H. 'Kathy'</i>	62.90	2.50	4.00	6.10	3.50	2.05	9.30
T2- <i>H. psittacorum 'Petra'</i>	41.58	2.25	3.25	6.95	3.05	1.75	7.65
T3- <i>H. psittacorum 'Lady Di'</i>	54.25	3.00	6.17	5.78	2.83	1.73	9.27
T4- <i>H. bihai Schaefer</i>	78.27	3.83	4.83	6.63	2.63	2.50	10.95
T 5- <i>H. bihai</i>	34.88	2.75	2.75	6.60	3.10	2.45	8.25
T6- <i>H. psittacorum 'Golden Torch'</i>	54.40	3.50	3.83	5.02	2.82	1.87	8.50
T7- <i>H. 'Golden Torch Sunshine'</i>	39.05	2.50	3.50	5.45	2.65	1.75	8.70
T8- <i>H. psittacorum 'Sassy'</i>	68.25	3.25	5.50	6.83	3.33	2.38	10.28
T9- <i>H. 'Strawberries and Cream'</i>	54.98	3.00	5.25	6.55	2.75	1.98	9.83
T10- <i>H. metallica</i>	54.00	4.90	9.10	5.45	2.80	1.95	15.90
T11- <i>H-20</i>	60.75	3.90	6.50	4.95	2.75	1.95	12.15
T12 - <i>H. 'Golden Torch Adrian'</i>	53.83	4.00	5.00	5.55	3.45	2.65	12.15
T13- <i>H. 'Tropics'</i>	80.93	3.72	4.44	5.18	2.93	1.97	10.76
T14- <i>H. 'Yellow Parrot'</i>	63.93	3.00	3.50	5.05	2.95	1.55	11.30
T15- <i>H. psittacorum 'Alan Carle'</i>	69.60	3.00	4.00	5.10	2.95	2.15	11.85
T16- <i>H. choconiana</i>	69.54	4.67	6.17	5.34	2.90	2.15	10.88
T17- <i>H.stricta</i>	60.62	3.75	4.67	5.30	2.93	1.93	11.59
T18- <i>H. 'Raulinina upright'</i>	151.00	9.50	4.50	5.00	2.65	2.50	14.80
CD (p<0.05)	4.27	0.23	0.50	0.21	0.12	0.10	0.59
	12.81	0.68	1.51	0.63	0.37	0.31	1.78

### 1.6.2 Utilization of Different Ornamental Plant Species in the Vertical Landscape System for Improvement of Air Quality

Vertical landscaping is a distinctive method of gardening by expanding the possibility of growing ornamental plants in a vertical space wherever space is a constraint. The experiment initiated envisages on identifying appropriate ornamental species for developing green walls. Objectives of the study are to evaluate different ornamental plant species for their performance in the vertical landscape system and to estimate the Air Pollution Tolerance Index of different ornamental plant species used in vertical landscape system. The experiment was laid out in Randomized Block Design with 18 treatments and 3 replications. Eighteen different species of ornamental plants viz., T<sub>1</sub>: *Syngonium podophyllum* 'Berry Allusion' (Berry Allusion Nephthytis), T<sub>2</sub>: *Alternanthera* Green, T<sub>3</sub>: *Syngonium podophyllum* 'Strawberry Cream' (Strawberry Cream Arrowhead Vine), T<sub>4</sub>: *Pleomele reflexa*, T<sub>5</sub>: *Syngonium podophyllum* 'Bold Allusion' (Bold Allusion Nephthytis), T<sub>6</sub>: *Rhoeo discolor* (Moses in the cradle) Sitara Gold, T<sub>7</sub>: *Syngonium podophyllum* 'Maria Allusion' (Maria Allusion Nephthytis), T<sub>8</sub>: *Peperomia obtusifolia variegata*, T<sub>9</sub>: *Syngonium podophyllum* 'Pink Allusion' (Pink Allusion Nephthytis), T<sub>10</sub>: *Syngonium podophyllum* 'Cream Allusion' (Cream Allusion Nephthytis), T<sub>11</sub>: *Syngonium podophyllum* 'White Butterfly' (White Butterfly Arrowhead Vine), T<sub>12</sub>: *Alternanthera* White, T<sub>13</sub>: *Philodendron scandens green*, T<sub>14</sub>: *Epipremnum aureum* (Golden money plant / Golden Pothos), T<sub>15</sub>: *Tradescantia spathacea variegata*, T<sub>16</sub>: *Alternanthera* Red, T<sub>17</sub>: *Philodendron* Imperial Green and T<sub>18</sub>: *Chlorophytum comosum* green were tested under the study. Morphological and growth parameters biochemical parameters viz., relative water content, total chlorophyll content, leaf extract pH, ascorbic acid content and air quality parameters viz., Air Pollution Tolerance Index (APTI) were monitored during the experimental period. Data was recorded on various morphological parameters at bimonthly intervals and analyzed statistically. Statistically significant variations in vegetative attributes were recorded. The desired characteristics for plants grown in vertical garden wall system should be dense, compact, well-formed, evergreen and slow growing in nature with healthy root system.

In the present study, out of the eighteen species evaluated for their vegetative characteristics (Table 1.20), least plant height of 21.24 cm was observed in *Peperomia obtusifolia variegata* followed by *Rhoeo discolor* (23.93 cm), *Tradescantia spathacea variegata* (25.95 cm), *Syngonium podophyllum* 'Cream Allusion' (26.2 cm) and *Syngonium podophyllum* 'Strawberry Cream' (26.39 cm). The maximum plant height was recorded in *Epipremnum aureum* (139 cm) followed by *Philodendron scandens* Imperial Green (116.7 cm). Since they were trailing and tall growing with fast growth, these species are not suitable for vertical landscaping. Longest (28.10 cm) and broadest (7.88 cm) leaves were observed in *Syngonium podophyllum* 'White Butterfly' (White Butterfly Arrowhead Vine) whereas, shortest (3.61 cm) and narrowest (1.39 cm) leaves were observed in *Alternanthera* Green. The covering percentage was observed maximum in *Syngonium podophyllum* 'Bold Allusion' which recorded the highest leaf area of 247.50 cm<sup>2</sup> followed by *Syngonium podophyllum* 'White Butterfly' (223.50 cm<sup>2</sup>) It is evident from the results that *Syngonium podophyllum* 'White Butterfly', 'Maria Allusion', 'Berry allusion' and 'Bold Allusion' were promising in respect of growth and quality for vertical landscape system.

For the estimation of APTI which is one of the best indices to depict the tolerance and sensitivity of plant species to air pollution, total chlorophyll, ascorbic acid, pH and relative water content were taken into account. The tolerance of plants to any of the pollutant may be linked with synthesis or degradation of chlorophyll and those having high chlorophyll content under field conditions were generally tolerant to air pollutants (Table 1.21). Highest total chlorophyll content was observed in *Syngonium podophyllum* 'Maria Allusion' (1.86 mg/g) and 'Pink Allusion' (1.83 mg/g) whereas lowest was observed in *Peperomia obtusifolia variegata* (0.08 mg/g). Leaf extract pH on the higher side could provide tolerance in plants against pollutants. A higher level of leaf-extract pH was observed in *Syngonium podophyllum* 'Cream Allusion' (7.74) and 'Maria Allusion' (7.71) whereas least was observed in *Philodendron scandens* (5.37). High water content within a

plant body helps to maintain its physiological balance under stress conditions such as exposure to air pollution. Maximum relative water content was observed in species like *Peperomia obtusifolia variegata* (92.63 %), *Syngonium podophyllum* 'Maria Allusion' (89.28%) and 'Berry Allusion' (88.43 %). The ascorbic acid content of the leaf samples was also estimated. The studies conducted indicate that *Syngonium podophyllum* is ideal in view of the vegetative characters and APTI indicator. The study shows that inclusion of ornamental plants having pollution mitigating ability in the landscape plan will serve the dual purpose of making the environment green and pollution free in the long run.



**Performance of Different Ornamentals in Vertical Landscape System**



**Performance of Different Ornamentals in Vertical Landscape System**



*Philodendron scandens green*



*Epipremnum aureum*  
(Golden Pothos)



*Philodendron Imperial Green*



*Alternanthera Red*



*Tradescantia spathaceae variegata*



*Chlorophytum comosum*

**Performance of Different Ornamentals in Vertical Landscape System**



**Comparative Evaluation of Different Ornamentals in Vertical Landscape System**

**Table 1.20 : Growth Attributes of Different Ornamental Plant Species in the Vertical Landscape System One Year After Planting**

Treatments	Plant height (cm)	Number of leaves	Leaf length (cm)	Stalk length of the leaf (cm)	Leaf width (cm)	Leaf area (cm <sup>2</sup> )
T- 1 : <i>Syngonium podophyllum</i> 'Berry Allusion' (Berry Allusion Nephthytis)	31.16	10.83	24.02	15.34	7.78	186.72
T - 2 : <i>Alternanthera</i> Green	32.00	89.22	3.61	1.94	1.39	4.02
T - 3 : <i>Syngonium podophyllum</i> 'Strawberry Cream' (Strawberry Cream Arrowhead Vine)	26.39	12.22	21.29	13.67	7.16	154.09
T - 4 : <i>Pleomele reflexa</i>	14.57	12.67	12.17	0.89	2.41	23.23
T- 5 : <i>Syngonium podophyllum</i> 'Bold Allusion' (Bold Allusion Nephthytis)	36.64	16.11	27.36	18.16	9.01	247.51
T- 6 : <i>Rhoeo discolor</i> (Sitara Gold)	23.93	41.89	15.31	1.52	2.79	39.78
T - 7 : <i>Syngonium podophyllum</i> 'Maria Allusion' (Maria Allusion Nephthytis)	32.58	16.00	25.34	17.03	7.98	199.18
T- 8 : <i>Peperomia obtusifolia</i> variegata	21.24	11.56	11.39	2.63	6.10	68.94
T- 9 : <i>Syngonium podophyllum</i> 'Pink Allusion' (Pink Allusion Nephthytis)	51.23	22.33	16.73	9.24	3.94	66.35
T- 10 : <i>Syngonium podophyllum</i> 'Cream Allusion' (Cream Allusion Nephthytis)	26.20	27.22	20.27	12.08	5.18	95.56
T- 11 : <i>Syngonium podophyllum</i> 'White Butterfly' (White Butterfly Arrowhead Vine)	34.21	21.11	28.10	18.27	7.88	223.51
T- 12 : <i>Alternanthera</i> White	33.35	82.00	5.39	2.05	1.84	6.86
T- 13 : <i>Philodendron scandens</i> green	116.73	27.89	15.57	5.72	6.27	97.79
T- 14 : <i>Epipremnum aureum</i> (Golden money plant / Golden Pothos)	139.04	23.83	15.78	6.61	7.32	109.27
T- 15 : <i>Tradescantia spathaceae</i> variegata	25.95	21.33	14.94	0.80	2.50	35.91
T- 16 : <i>Alternanthera</i> Red	25.74	89.83	4.33	1.89	1.52	3.82
T - 17 : <i>Philodendron</i> Imperial Green	74.77	15.44	24.37	11.34	6.52	159.37
T - 18 : <i>Chlorophytum comosum</i> green	42.86	36.78	28.67	0.63	2.61	69.39
Sem+	6.79	7.33	1.26	0.97	0.36	12.15
CD (p<0.05)	20.36	21.99	3.77	2.91	1.09	36.44

Table 1.21 : Physiological Traits of Different Ornamental Plant Species in the Vertical Landscape System

Treatments	Chl a (mg/g)	Chl b (mg/g)	Total Chl (mg/g)	Fresh Weight (g)	Turgid Weight (g)	Dry Weight (g)	RWC (%)	pH
T- 1 : <i>Syngonium podophyllum</i> 'Berry Allusion' (Berry Allusion Nephthytis)	0.15	0.11	0.25	2.27	2.46	0.64	88.43	7.24
T - 2 : <i>Alternanthera</i> Green	0.18	1.69	1.86	0.60	0.70	0.20	79.44	6.20
T - 3 : <i>Syngonium podophyllum</i> 'Strawberry Cream' (Strawberry Cream Arrowhead Vine)	0.12	1.71	1.83	1.00	1.13	0.19	85.71	6.87
T - 4 : <i>Pleomele reflexa</i>	0.11	0.11	0.22	0.50	0.70	0.08	66.23	7.13
T- 5 : <i>Syngonium podophyllum</i> 'Bold Allusion' (Bold Allusion Nephthytis)	0.18	1.24	1.43	1.47	1.83	0.38	77.33	6.81
T- 6 : <i>Rhoeo discolor</i> (Moses in the cradle) Sitara Gold	0.03	0.02	0.05	3.40	3.73	0.87	88.85	6.60
T - 7 : <i>Syngonium podophyllum</i> 'Maria Allusion' (Maria Allusion Nephthytis)	0.17	1.69	1.86	1.13	1.23	0.29	89.28	7.71
T- 8 : <i>Peperomia obtusifolia</i> variegata	0.04	0.03	0.08	4.03	4.27	1.08	92.63	6.09
T-9 : <i>Syngonium podophyllum</i> 'Pink Allusion' (Pink Allusion Nephthytis)	0.17	1.69	1.86	0.37	0.57	0.13	52.82	6.81
T- 10 : <i>Syngonium podophyllum</i> 'Cream Allusion' (Cream Allusion Nephthytis)	0.24	0.51	0.75	0.50	0.60	0.08	80.52	7.74
T- 11 : <i>Syngonium podophyllum</i> 'White Butterfly' (White Butterfly Arrowhead Vine)	0.20	0.31	0.52	0.77	0.93	0.10	80.74	6.85
T- 12 : <i>Alternanthera</i> White	0.08	0.08	0.16	0.63	0.73	0.27	78.31	6.94
T- 13 : <i>Philodendron scandens</i> green	0.18	0.26	0.44	1.47	1.70	0.53	80.24	5.37
T- 14 : <i>Epipremnum aureum</i> (Golden money plant (Golden Pothos)	0.11	0.08	0.19	1.43	1.70	0.39	80.53	6.61
T- 15 : <i>Tradescantia spathaceae</i> variegata	0.18	0.24	0.42	3.90	4.20	2.09	86.93	6.53
T-16 : <i>Alternanthera</i> Red	0.16	1.69	1.85	0.83	1.10	0.20	69.43	7.35
T - 17 : <i>Philodendron Imperial</i> Green	0.28	0.13	0.41	1.57	1.77	0.59	83.71	6.71
T - 18 : <i>Chlorophytum comosum</i> green	0.21	0.35	0.56	1.73	1.90	0.96	81.21	6.89
Sem+	0.02	0.10	0.11	0.19	0.21	0.14	5.75	0.08
CD (p<0.05)	0.05	0.32	0.31	0.57	0.63	0.42	17.26	0.24



### 1.6.3 Effects of Plant Growth Regulators on the Growth and Flowering of *Spathiphyllum wallisii*

*Spathiphyllum wallisii* is a popular indoor pot plant grown for its lush dark green foliage and showy white flowers. It is commonly known as Peace Lily, White Sails, or Spathe flower and is reported to be capable of removing toxins from the air.

The present experiment was initiated to study the effects of exogenous application of plant growth regulators in improving the growth and flowering of *Spathiphyllum wallisii*. The main objective of the present experiment is to study the effects of different plant growth regulators viz., Benzyl adenine (BA), Gibberellic acid (GA<sub>3</sub>) and 1-Naphthaleneacetic acid (NAA) on the growth and flowering of *Spathiphyllum wallisii*. The experiment was been laid out in Completely Randomized Design with 10 treatments and 3 replications. The treatment applications constitute Benzyl adenine [100, 150 and 200mg l<sup>-1</sup>], Gibberellic acid [100, 150 and 200 mg l<sup>-1</sup>], 1-Naphthaleneacetic acid [100, 150 and 200mg l<sup>-1</sup>] and Control. The study was aimed to find out the optimum concentration of PGR's to be applied for improving the growth rate and flowering of *Spathiphyllum wallisii* through exogenous application. The different growth and yield attributes as influenced by treatment with different concentrations of growth regulators on growth and flowering of *Spathiphyllum wallisii* recorded during the experimental period are presented in the Table 1.22. Results of this study showed that various concentrations of plant growth regulators exhibited significant differences on the growth and flowering of *Spathiphyllum wallisii*. Plant height increased significantly with the application of Gibberellic acid @ 200 mg. L<sup>-1</sup> over all the other treatments and it was least with the untreated control. Among the treatments, plant height was maximum (23.13 cm) in Gibberellic acid @ 200 mg. l<sup>-1</sup>. Control treatment recorded minimum plant height (16.42 cm). The plants treated with Gibberellic acid @ 200 mg. l<sup>-1</sup> recorded maximum number of leaves (28.13), while minimum number of leaves (11.47) was noticed in control. Similar trend was noticed for leaf length and leaf width. Significantly highest (25.44cm) stalk length of the inflorescence was noticed when Benzyl adenine: 200 mg. l<sup>-1</sup> was applied. Maximum length (11.38cm) and width (5.00 cm) of the spathe was recorded when Benzyl adenine: 200 mg. l<sup>-1</sup> was sprayed.

**Table 1.22 : Growth attributes of *Spathiphyllum* as Influenced by Different Growth Regulator Treatments Nine Months after Planting**

Treatments	Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf width (cm)	Total leaf length (cm)	Stalk length of inflorescence (cm)	Length of spathe (cm)	Width of spathe (cm)
BA : 100 mg/l	22.52	17.20	12.40	4.51	21.75	23.37	9.28	4.47
BA : 150 mg/l	23.63	18.50	13.40	4.81	21.87	24.29	10.66	4.74
BA: 200 mg/l	23.83	18.80	13.50	4.86	22.51	25.44	11.38	5.00
GA <sub>3</sub> : 100 mg/l	26.60	27.40	14.60	5.89	24.39	18.56	8.46	3.89
GA <sub>3</sub> : 150 mg/l	29.53	27.53	14.70	6.00	24.99	20.47	8.82	4.00
GA <sub>3</sub> : 200 mg/l	41.37	28.13	17.10	7.75	31.25	22.59	9.27	4.38
1-NAA : 100 mg/l	25.08	19.33	13.80	5.05	22.81	12.05	6.98	3.07
1-NAA : 150 mg/l	25.61	22.93	14.10	5.25	23.71	16.43	7.34	3.58
1-NAA : 200 mg/l	25.87	24.00	14.60	5.79	23.88	17.31	8.13	3.77
Control	16.42	11.47	9.69	3.37	13.85	8.50	6.79	2.03
SEM	2.52	3.27	1.42	0.66	2.28	2.65	0.77	0.49
CD (p<0.05)	7.56	9.81	4.25	1.97	6.85	7.96	2.30	1.49



#### 1.6.4 Effect of Mode of Application of Micronutrients on Growth, Cladophyll Production and Vase Life of Sprengeri Fern (*Asparagus densiflorus* 'Sprengeri')

Cut greens are an important component of floricultural industry, largely used as fillers in bouquet making and in flower arrangements. The foliage of sprengeri fern (*Asparagus densiflorus* 'sprengeri') is highly valued in the domestic as well as international florist greenery market owing to its versatile design qualities in terms of form and texture, better post harvest life, low cost and year round availability. Nutrition is one of the most important aspects of cut foliage production. Plants need sufficient mineral nutrients in optimum balance for normal growth and development. The present experiment is intended to determine the effect of mode of application of micro-nutrients on growth, cladophyll production and vase life of sprengeri fern (*Asparagus densiflorus* 'sprengeri'). The experiment is laid out in Randomized Block Design with thirteen treatments and three replications. In the present study, foliar as well as soil application of micronutrients was done. The results reveal that plants treated with foliar application of micronutrients showed significant increase in different growth characteristics (Table 1.23). The plant spread East-West (116.38 cm) and North-South (112.69 cm) was significantly increased with foliar application of micronutrient mixture ( $ZnSO_4 + \text{Boron} + FeSO_4 + MnSO_4$  Foliar application @ 0.5% at 30 and 45 DAP). Regarding production of number of cladophylls per plant, the results revealed significantly higher number (38.67) by foliar application of micronutrient mixture. Foliar application of  $ZnSO_4 + \text{Boron} + FeSO_4 + MnSO_4$  @ 0.5% at 30 and 45 DAP significantly increased the cladophyll length (76.39 cm) and cladophyll width (18.933 cm) than the soil application and without application of micronutrients. The present study recorded significantly higher number of branches per cladophyll (60.44) with foliar application of micronutrient mixture as compared to soil application as well as control, without micronutrients (46.44 and 30.33), respectively. Among the two methods of application of micronutrients, the present investigation clearly demonstrated that foliar application of micronutrients either alone or micronutrient mixture significantly increased the various growth attributes of sprengeri fern (*Asparagus densiflorus* 'sprengeri') as compared to soil application of micronutrients.



Field View of Asparagus

**Table 1.23 : Growth Attributes of Sprengerii Fern (*Asparagus densiflorus 'sprengerii'*) as Influenced by Mode of Application of Micronutrients**

Treatments	Plant spread E-W (cm)	Plant spread N-S (cm)	No: of cladophylls plant	cladophyll length (cm)	cladophyll breadth (cm)	No. of branches per cladophyll	Internodal length of cladophyll (cm)
T1: ZnSO <sub>4</sub> Soil application @ 10kg per hectare	81.93	87.28	27.67	55.11	14.46	42.22	1.31
T2: ZnSO <sub>4</sub> Foliar application @ 0.5% at 30 and 45 DAP	94.29	89.62	34.11	57.56	15.36	42.56	1.42
T3: Boron Soil application @ 10kg per hectare	78.32	82.56	33.78	51.03	12.54	40.00	1.27
T4: Boron Foliar application @ 0.5% at 30 and 45 DAP	78.74	87.17	38.00	57.83	13.98	43.56	1.50
T5: FeSO <sub>4</sub> Soil application @10kg per hectare	85.27	82.50	28.89	54.50	13.22	40.67	1.12
T6: FeSO <sub>4</sub> Foliar application @ 0.5% at 30 and 45 DAP	94.44	95.33	32.89	58.47	13.48	40.78	1.41
T7: MnSO <sub>4</sub> Soil application @ 10kg per hectare	92.42	87.41	32.88	53.88	13.71	38.56	1.37
T8: MnSO <sub>4</sub> Foliar application @ 0.5% at 30 and 45 DAP	97.41	90.09	37.22	61.93	13.88	45.33	1.39
T9: ZnSO <sub>4</sub> + Boron+ FeSO <sub>4</sub> + MnSO <sub>4</sub> Soil application @ 10kg per ha	101.52	107.43	30.00	63.72	15.76	46.44	1.54
T10: ZnSO <sub>4</sub> + Boron+ FeSO <sub>4</sub> + MnSO <sub>4</sub> Foliar application @ 0.5% at 30 and 45 DAP	116.38	112.69	38.67	76.39	18.93	60.44	1.62
T11: Microla Soil application @ 10kg per hectare	80.69	79.17	25.89	51.42	13.62	37.56	1.22
T12: Microla Foliar application @ 0.5% at 30 and 45 DAP	82.91	85.92	34.56	54.58	14.38	41.00	1.40
T13: No Micronutrients	66.50	58.27	23.00	42.13	10.50	30.33	1.03
SEM	7.59	8.50	2.94	4.09	1.06	2.96	0.10
CD (p<0.05)	22.79	25.50	8.82	12.28	3.18	8.87	0.31

### 1.6.5 Evaluation of Different Varieties of Ornamental Coleus for Imparting Colour in Vertical Gardens

The present study is conducted to evaluate the performance of different varieties of ornamental coleus (*Solenostemon scutellarioides* syn. *Plectranthus cutellarioides*) which have large vibrant and multicoloured leaves for their suitability as a colourful alternative for vertical gardens in a shady landscape. The experiment is laid out in Randomized block design with twenty treatments and three replications. The various observations on morphological attributes are being recorded regularly to identify and recommend the most appropriate cultivars of ornamental coleus for vertical gardening in shady landscape for provision of colour. The observations recorded one month after planting is presented in the Table 1.24

**Table 1.24 : Performance of Different Ornamental Coleus Varieties in the Vertical Landscape System**

Treatments	Plant height (cm)	No. of leaves	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Internodal length (cm)
T1- Tilt a Whirl	15.24	16.22	3.72	4.97	2.09	1.80
T2- Juicy Lucy	22.61	20.22	7.18	5.20	1.93	2.91
T3-Pistachio Nightmare	22.43	14.67	8.67	6.22	2.21	3.91
T4-Indian Summer	19.88	23.00	6.31	4.54	2.86	2.34
T5- Miss Monahan	19.84	22.04	8.10	5.37	2.37	2.56
T6- Apple Mint	21.02	20.69	8.44	5.34	2.47	3.17
T7- Eruption	30.18	12.44	8.14	4.52	4.71	6.43
T8- Gay Delight	25.60	12.67	8.07	5.98	2.60	4.16
T9- Freckles	20.08	18.67	6.84	4.99	2.57	2.94
T10-Blackberry Waffles	26.03	12.67	9.69	5.86	2.33	3.11
T11-Kong Scarlet	33.61	15.67	8.84	6.76	3.13	3.87
T12-Eruption White	18.92	10.89	7.76	3.99	1.88	2.33
T13- Green Halo	16.67	13.00	8.03	5.26	1.57	1.56
T14- Dare Devil	30.86	12.44	9.83	5.96	3.86	4.76
T15- Mahagony Giant	33.40	8.22	9.76	6.01	2.84	6.28
T16- Gold Giant	26.38	16.44	8.69	6.82	2.91	3.90
T17- Trailing Queen	14.37	15.11	5.67	3.04	1.78	1.24
T18- Wizard Mosaic	28.74	14.00	9.22	5.93	2.87	4.83
T19-Electric Lime	22.56	6.78	11.09	7.23	2.93	4.44
T20-Grape Expectations	27.69	12.00	9.82	6.96	2.89	4.00
SEM+	1.27	1.94	0.44	0.33	0.27	0.39
CD (p<0.05)	3.79	5.83	1.33	0.98	0.81	1.19



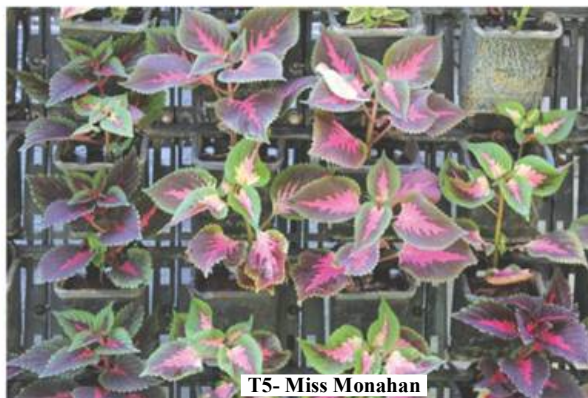
T1- Tilt a Whirl



T11- Kong Scarlet



T4-Indian Summer



T5- Miss Monahan



T6- Apple Mint



T8- Gay Delight



T3- Pistachio Nightmare



T9- Freckles



T7- Eruption

Evaluation of Different Varieties of Ornamental Coleus for Imparting Colour in Vertical Gardens



Evaluation of Different Varieties of Ornamental Coleus for Imparting Colour in Vertical Gardens



### 1.6.6. Study on the Suitability of Cut Foliage Species for Various Purposes in Floristry

Cut foliage species viz., Boston fern (*Nephrolepis exaltata*), Button fern (*Nephrolepis cordifolia* 'Duffii'), Fish tail fern (*Nephrolepis biserrata furcans*), Hard fern (*Blechnum orientale*), Emerald fern (*Asparagus densiflorus* 'Sprengeri'), Ladder brake fern (*Pteris vittata*), Leather leaf fern (*Rumohra adiantiformis*), Peacock fern (*Selaginella willdenowii*), Silverback fern (*Pityrogramma calomelanos*), Soft fern (*Christella dentata*) and Staghorn club moss (*Lycopodiellacernua*) were assessed for their suitability for various purposes in floral industry. Significant variation was noticed among cut foliage species for various morphological and leaf quality traits viz., frond length, frond width, number of fronds per plant, number of leaflets per frond, frond production interval, fresh weight of the frond, stipe length and stipe girth. Based on the morphological traits studied the fern varieties are categorized for various applications. The various cut foliage species studied could be used for various purposes in floristry as listed.

<b>Hanging baskets</b>	<i>Nephrolepis exaltata</i> , <i>Nephrolepis cordifolia</i> 'Duffii', <i>Nephrolepis biserrata furcans</i>
<b>Mass bedding</b>	<i>Nephrolepis exaltata</i> , <i>Selaginella willdenowii</i> , <i>Christella dentata</i> , <i>Selaginella delicatula</i>
<b>Ground cover</b>	<i>Nephrolepis biserrata furcans</i> , 'Myers', <i>Nephrolepis exaltata</i>
<b>Indoor potted plant</b>	<i>Nephrolepis exaltata</i> , <i>Nephrolepis biserrata furcans</i>
<b>Fillers</b>	<i>Nephrolepis exaltata</i> , <i>Nephrolepis biserrata furcans</i> , <i>Nephrolepis cordifolia</i> 'Duffii', 'Sprengeri' compacta
<b>Vertical gardens</b>	<i>Nephrolepis cordifolia</i> 'Duffii'
<b>Containers</b>	<i>Nephrolepis biserrata furcans</i> , <i>Pityrogramma calomelanos</i> , <i>Selaginella delicatula</i>
<b>Foundation or backdrop</b>	<i>Pteris vittata</i>
<b>Vertical accent for floral designs</b>	<i>Nephrolepis cordifolia</i> 'Duffii', <i>Nephrolepis biserrata furcans</i>

a. *Nephrolepis exaltata*b. *Pityrogramma calomelanos*c. *Selaginella willdenowii*d. *Nephrolepis cordifolia* 'Duffii'e. *Rumohra adiantiformis*f. *Pityrogramma calomelanos*g. *Nephrolepis biserratafurcans*h. *Selaginella delicatula*I. *Christella dentata*j. *Adiantum raddianum*k. *Pteris vittata*l. *Selaginella willdenowii*

### Different Fern Species for Various Landscape Applications



## 2. Crop Production

### **Project 2.1(ICAR Code: IXXI3991): Evaluation of Industrial and Agricultural by-products as Potting Media Components for Production of Potted Ornamental Plants**

#### **2.1.1 Evaluation of Suitability of Fly Ash and Pressmud as Potting Media Components for Better Growth and Development of Flowering Ornamental Plants**

Pot experiments were conducted to test the suitability of fly ash and pressmud as potting media components for growth and development of chrysanthemum cv. Basanti and marigold cv. Orange Dwarf during August, 2018-19. The experiments were laid out in Randomized Block Design with 11 treatments and three replications. The treatments were as follows

- T1: Flyash + Vermicompost + Cocopeat (10:30:60)
- T2: Flyash + Vermicompost + Cocopeat (15:35:50)
- T3: Fly ash + Vermicompost + Cocopeat (20:30:50)
- T4: Pressmud + Vermicompost + Cocopeat (25:25:50)
- T5: Pressmud + Vermicompost + Cocopeat (35:20:45)
- T6: Pressmud + Vermicompost + Cocopeat (45:15:40)
- T7: Fly ash+ Pressmud + Cocopeat + Vermicompost (10:25:25:40)
- T8: Fly ash+ Pressmud + Cocopeat + Vermicompost (12.5:37.5:25:25)
- T9: Fly ash + Pressmud + Cocopeat + Vermicompost (15:35:40:10)
- T10: Fly ash + Pressmud + Cocopeat + Vermicompost (20:45:25:10)
- T11: Cocopeat: Vermiculite: Perlite (1:1:1)(control).

Observations on growth and flowering attributes of chrysanthemum and marigold were recorded and analyzed statistically.

Chrysanthemum: Perusal of data revealed that chrysanthemum (cv. Basanti) grown in potting medium containing fly ash, pressmud, cocopeat and vermicompost at 12.5 : 37.5 : 25 : 25 proportion (T8) showed significant difference with respect to growth and flowering attributes when compared to all other treatments.

At bud initiation stage, maximum plant height (21.7 cm), primary branches/plant (4.3), secondary branches/plant (11.5), number of leaves/plant (242.3), number of buds/plant (83.7) were observed in T8 as compared to other treatments (Table 1.25). Whereas in control (cocopeat, vermiculite and perlite at 1:1:1) (T11) least plant height (13.5 cm) with minimum number of primary (2.1) and secondary branches (6.7), number of leaves/plant (121) and number of buds/plant (35.1) were recorded. Similar trend was observed at flowering stage also. Plants grown in T8 were significantly taller (30.42 cm) with maximum number of flowers/plant (80.6), flower diameter (4.19 cm), flower yield/plant (150.3 g), shoot weight (95.7 g) and root weight (17.8 g). Whereas shorter plants (20.72 cm) with least number of flowers/plant (33.5), flower diameter (2.88 cm), flower yield per plant (47.1 g), shoot weight (24.33 g) and root weight (6.37 g) were observed in control.



Table 1.25 : Effect of Different Growing Media on Growth and Development of Chrysanthemum Variety Basanti

Treatments	At bud initiation stage							At flowering stage						
	Plant height (cm)	Plant spread (cm)	No. of primary branches	No. of secondary branches	No. of leaves/plant	No. of buds/plant		Plant height (cm)	Plant spread (cm)	No. of primary branches	No. of secondary branches	No. of leaves/plant	No. of buds/plant	
T1	15.1	18.17	2.6	6.9	138.3	36.0		20.93	34.3	3.30	50.2	25.97	7.33	
T2	19.5	24.70	3.2	8.5	167.0	44.5		26.51	42.4	3.72	79.8	42.23	9.80	
T3	18.2	22.70	3.0	7.6	141.0	40.0		24.22	38.1	3.60	73.5	36.52	9.13	
T4	19.7	28.47	3.3	9.8	177.3	51.4		26.88	48.9	3.95	86.7	69.10	10.87	
T5	21.1	29.47	4.2	11.0	232.0	70.8		29.28	67.7	4.13	125.3	85.55	14.23	
T6	22.0	30.28	4.2	11.3	236.0	75.4		30.53	72.8	4.14	144.5	91.80	16.83	
T7	21.1	28.88	3.7	10.1	220.0	52.9		28.49	50.4	4.03	94.6	60.78	13.15	
T8	21.7	30.78	4.3	11.5	242.3	83.7		30.42	80.6	4.19	150.3	95.70	17.80	
T9	20.5	28.47	3.9	10.6	201.0	55.5		27.32	52.8	3.98	104.5	56.43	13.03	
T10	21.0	29.20	4.1	10.7	224.3	63.7		29.20	61.0	4.09	120.3	77.23	13.97	
T11	13.5	17.00	2.1	6.7	121.0	35.1		20.72	33.5	2.88	47.1	24.33	6.37	
Sem±	0.80	1.04	0.17	0.64	15.98	3.00		0.83	2.89	0.09258	7.79	5.54	2.26	
CD (p<0.05)	2.37	3.10	0.52	1.88	47.15	8.85		2.44	8.51	0.27312	22.99	16.33	6.67	



**T<sub>8</sub>**  
(Fly ash+ Pressmud+Cocopeat+Vermicompost  
12.5:37.5:25:25)



**T<sub>11</sub>**  
(Cocopeat: Vermiculite: Perlite 1:1:1)

#### Growth and Development of Chrysanthemum Variety Basanti as Influenced by Different Growing Media

**Marigold:** Response of marigold (cv. Orange Dwarf) was significantly superior with respect to plant height (60.79 cm), number of secondary branches (10.94), number of buds/plant (40), number of flowers/plant (38.48), flower yield/plant (302.9 g), flower diameter (5.9 cm), shoot weight (136 g) and root weight (30.1 g) in the medium comprising of pressmud, vermicompost and cocopeat in 45:15:40 proportion (T<sub>6</sub>) as compared to other treatments (Table 1.26). Longest field life of flowers (fully opened flower to withering) was also recorded in this particular treatment (4.6 days). Whereas shorter plants (47.19 cm) with minimum number of secondary branches (6.9), number of buds/plant (26), number of flowers/plant (23.33), flower yield/plant (143.1 g), flower diameter (4 cm), shoot weight (66 g) and root weight (17.5 g) were observed in potting medium containing fly ash, vermicompost and cocopeat in the ratio 10:30:60 (T<sub>1</sub>). The lowest field life of flowers was observed in T<sub>11</sub> (4.1 days).



**T<sub>6</sub>**  
(Pressmud+ Vermicompost+ Cocopeat 45:15:40)



**T<sub>1</sub>**  
(Flyash +Vermicompost +Cocopeat 10:30:60)

#### Growth and Development of Marigold Cultivar Orange Dwarf as Influenced by Different Growing Media

Table 1.26: Effect of Different Growing Media on Growth and Development of Marigold Cultivar Orange Dwarf

Treatments	Plant height (cm)	Plant spread (cm)	No. of secondary branches	No. of buds/plant	No. of flowers/plant	Flower yield/plant (g)	Flower diameter (cm)	Field life of flowers (days)	Shoot weight (g)	Root weight (g)
T1	47.19	33.69	6.90	26.0	23.33	143.1	4.0	5.00	66	17.5
T2	57.34	42.47	9.90	36.4	35.01	235.4	4.2	5.17	123	27.6
T3	50.48	30.67	7.06	32.7	30.21	190.9	5.0	6.00	90	18.6
T4	54.73	38.05	9.05	33.2	31.62	210.6	5.1	4.18	107	21.7
T5	57.30	43.57	10.76	38.5	37.43	266.9	5.0	4.33	118	26.0
T6	60.79	47.62	10.94	40.0	38.48	302.9	5.9	4.60	136	30.1
T7	55.99	41.02	10.29	36.0	34.64	232.2	5.6	4.23	113	25.7
T8	55.64	39.10	9.38	33.1	31.00	210.8	5.6	4.50	101	20.2
T9	55.32	39.81	8.95	35.0	33.24	223.3	5.1	4.67	113	24.0
T10	54.43	38.83	9.43	36.8	34.79	235.1	4.7	4.67	110	22.5
T11	50.80	36.64	8.38	32.4	31.52	202.2	4.5	4.10	96	19.2
SEM±	2.39	1.88	1.27	1.66	1.82	24.18	0.35	0.25	7.70	1.82
CD (p<0.05)	7.06	5.55	3.76	4.89	5.37	71.33	1.05	0.74	22.72	5.36



### 2.1.2 Evaluation of Suitability of Agricultural by-products as Potting Media Components for Better Growth and Development of Potted Flowering Ornamental Plants

A pot experiment was conducted in October, 2018 to test the suitability of agricultural by-products *viz.*, groundnut shell, rice husk ash, bagasse, soybean husk compost and mushroom spent compost as potting media components for growth and development of marigold cultivar Orange Dwarf. There were six treatments and four replications in the experiment and experiment was laid out in randomized block design. Observations on growth and flowering attributes were recorded and analyzed statistically.

Analysis of data revealed that growth and flowering attributes of marigold were significantly superior in growing medium containing groundnut shell, cocopeat and perlite in the ratio 1:1:1 ( $T_1$ ) as compared to other treatments. Significantly higher plant height (57.41 cm), number of secondary branches (10.4), number of buds/plant (39), number of flowers/plant (28.7), flower yield/plant (189.8 g), flower diameter (5.83 cm), shoot weight (82.75 g) and root weight (30.38 g) were observed in  $T_1$ . The longest field life of flowers was also observed in this particular treatment (4.73 days). Marigold plants grown in potting medium containing cocopeat, vermiculite and perlite in the ratio 1:1:1 ( $T_6$ ) were significantly shorter with minimum number of secondary branches (5.1), number of buds/plant (13.5), number of flowers/plant (9.6), flower yield/plant (40.87 g), flower diameter (4.13 cm), field life of flowers (4.11 days), shoot weight (19.5 g) and root weight (10 g) (Table 1.27).

Table 1.27 : Effect of Different Growing Media on Growth And Development of Marigold Cultivar Orange Dwarf

Treatments	Plant height (cm)	Plant spread (cm)	No. of secondary branches	No. of buds/plant	No. of flowers/plant	Flower yield/plant (g)	Flower diameter (cm)	Field life of flowers (days)	Shoot weight (g)	Root weight (g)
T <sub>1</sub> : Groundnut shell: Cocopeat: Perlite (1:1:1)	57.41	35.73	10.4	39.0	28.7	189.80	5.83	4.73	82.75	30.38
T <sub>2</sub> : Rice husk ash: Cocopeat: Perlite (1:1:1)	48.16	26.72	6.2	15.0	15.0	74.87	4.90	4.18	46.00	12.00
T <sub>3</sub> : Bagasse: Cocopeat: Perlite (1:1:1)	52.44	31.18	7.8	30.3	22.3	119.41	5.25	4.25	47.25	18.00
T <sub>4</sub> : Soybean husk compost: Cocopeat: Perlite (1:1:1)	55.84	34.09	10.0	36.0	27.5	173.87	5.48	4.60	61.50	22.25
T <sub>5</sub> : Mushroom spent compost: Cocopeat: Perlite (1:1:1)	55.03	33.28	8.5	33.8	24.0	139.59	5.66	4.30	56.75	19.75
T <sub>6</sub> : Cocopeat: Vermiculite: Perlite (1:1:1) (control)	37.65	17.12	5.1	13.5	9.6	40.87	4.13	4.11	19.50	10.00
SEm±	1.92	0.94	0.21	0.7	2.51	22.37	0.40	0.13	3.89	0.8
CD (p<0.05)	5.79	2.86	0.65	2.40	7.56	67.43	1.21	0.38	11.73	2.7

### 2.1.3. Pilot Study on Utilization of Biodegradable Protrays

During one of the visits ICAR-DFR has suggested ICAR-CIRCOT, Mumbai to venture in to developing biodegradable pots/protrays from cotton biomass to reduce the plastic footprint by the nursery industry. Accordingly ICAR-CIRCOT has developed protrays using cotton biomass. The first lot received from ICAR-CIRCOT disintegrated as soon as the trays were irrigated. Second set of trays with better composition were developed and were utilized for the pilot study. *Dracaena* was planted in these protrays in different media having different water holding capacities viz., only soil, cocopeat based media (cocopeat:vermiculite:perlite 1:1:1) and soil based media (soil:sand:FYM 1:1:1). Since the protrays tested earlier crumbled on watering daily, watering the plants at two different frequencies (watering once a day and once in two days) was also tested as another treatment in cocopeat and soil. It was observed from the experiment that even after three months of planting protrays are stable besides supporting the growth of the plants. The scope of the experiment is being expanded with more number of samples from ICAR-CIRCOT.



**Growth of *Dracaena* in Cocopeat and Soil in Biodegradable Protrays with Watering Once a Day**



**Growth of *Dracaena* in Cocopeat and Soil in Biodegradable Protrays with Watering Once in Two Days**



**Growth of *Dracaena* in Only Soil, Cocopeat Based Media and Soil Based Media in Biodegradable Protrays with Daily Watering**

## 3. Crop Protection

### Project 3.1 (ICAR Code: IXXI11705): Investigations on Virus and Phytoplasma Diseases of Commercial Flower Crops

#### 3.1.1 Diagnostics and Characterization of Phytoplasma Infecting Daisy Family Based on 16SrRNA

To characterize the species of Phytoplasma causing phyllody, little leaf, stunting, witches broom, virescence symptoms in flower crop members of Asteraceae family, DNA was isolated from the phloem tissue using CTAB method and subjected to PCR amplification using universal P1 /P7 primers and further nested PCR with R16F2n/R16R2 from 16srRNA. The amplicon of 1.75kb size was subjected to Bi-directional Sanger sequencing.

#### Marigold Phyllody

Marigold cultivated in Maharashtra, exhibited high incidence of phyllody. The incidence was high in vegetatively propagated plants. In order to characterize the phytoplasma, symptomatic plants of two cultivars of marigold Calcutta Type exclusively vegetatively propagated and Tuljapur local which is seed propagated, were collected.



Marigold infected with Phytoplasma showing Virescence and Phyllody.  
 Inset: Healthy flower. Phytoplasma infected Marigold flowers not setting seeds (Left)

Species Assignment : 16S rDNA sequence of Calcutta Type shares 99.7% and Tuljapur local shares 99.6 % similarity with that of the "*Candidatus Phytoplasma asteris*" reference strain (GenBank accession: M30790). Virtual RFLP pattern is identical (similarity coefficient 1.00) to the reference pattern of 16Sr group I, subgroup B (GenBank accession: AP006628).

#### Phyllody in Annual Chrysanthemum

To characterize the phytoplasma causing phyllody in *Chrysanthemum coronarium* known as garland chrysanthemum or annual chrysanthemum locally called as Bijli in and around Maharashtra, the similar procedure of characterization of 16srRNA was done. An amplicon of 951 bp was obtained. BLAST search

showed 100% similarity to *Stevia rebundiana* phytoplasma reported from Uttar Pradesh. The Species allocated as *Candidatus Phytoplasma asteris*; belongs to 16SrI-B based on RFLP pattern of the 100 % similar sequence.



Phylloidy and Virescence in Annual Chrysanthemum

### China aster Phylloidy

The most closely related phytoplasma is "*Candidatus Phytoplasma australasiae*" (GenBank accession: Y10097), whose 16S rDNA sequence shares 97.4257425742574% similarity with the query. Virtual RFLP pattern assigns it to 16Sr group II and a new subgroup. Thus further study by characterizing other genes is required for assigning exact taxonomic position.



Flower malformation, Phylloidy and Virescence symptoms of Phytoplasma infection in China Aster



### Chrysanthemum Phyllody

The query 16S rDNA sequence from chrysanthemum showing phyllody shares 98.9% similarity with that of the "*Candidatus Phytoplasma australasiae*" reference strain (GenBank accession: Y10097). The phytoplasma under study is a "*Candidatus Phytoplasma australasiae*"-related strain.

The virtual RFLP pattern derived from the query 16S rDNA F2nR2 fragment is different from the reference patterns of all previously established 16Sr groups/subgroups. The most similar is the reference pattern of the 16Sr group II, subgroup D (GenBank accession: Y10097), with a similarity coefficient of 0.92, which is less than or equal to 0.97. This strain may represent a new subgroup within the 16Sr group II.



Chrysanthemum Flowers (Preet Shringar) Showing Phyllody and Healthy Flowers

### 3.1.2 Disease Distribution Map-Phytoplasma Diseases of Ornamental and Flower Crops in India

Based on the reports of survey conducted in major flower growing areas in Maharashtra and the incidence report across India available in the public domain; the disease distribution of phytoplasmal infection in flower crops in India has been prepared. The crop-wise distribution of the phytoplasma across the states is listed in Table 1.28.



**Table 1.28 : State-wise List of Distribution of Phytoplasma Diseases on Ornamental and Flower Crops In India**

SN	Place/State	Plant Host	Botanical name	Associated disease symptoms	Phytoplasma species
1.	Gorakhpur/UP	Ice Plant	<i>Carpobrotus edulis</i>	Little leaf and leaf yellow	'Ca. P. phoenicium'
		Rose Periwinkle	<i>Catharanthus roseus</i>	Phyllody	'Ca. P. asteris'
		Golden Dew Drop	<i>Duranta erecta</i>	Yellows	'Ca. P. asteris'
		Hibiscus	<i>Hibiscus rosa-sinensis</i>	Yellow leaf	'Ca. P. asteris'
		White Rose	<i>Rosa alba</i>	Little leaf phyllody, witches' broom, virescence, bud proliferation	'Ca. P. asteris'
		Bermuda grass	<i>Cynodon dactylon</i>	White leaf	'Ca Phytoplasma
2.	Lucknow/UP	Chrysanthemum	<i>Chrysanthemum</i>	Little leaf, Virescence,	'Ca. P. asteris'
		Gladiolus	<i>Gladiolus sp.</i>	Yellowing and malformation of flowers	'Ca. P. asteris'
		Damask Rose	<i>Rosa damascena</i>	Rose witches broom	-
		Moss rose	<i>Portulaca grandiflora,</i>	Portulaca Little Leaf	NA
		Petunia	<i>Petunia sp.</i>	Witches' broom	'Ca. P. asteris'
		Mexican Marigold	<i>Tagetes erecta</i>	Little leaf	'Ca. P. asteris'
		Southern Cone Marigold	<i>Tagetes minuta</i>	Phyllody	'Ca. P. cynodontis'
3.	Shahajahanpur/UP	Madagascar Periwinkle	<i>Catharanthus roseus</i>	Little leaf, Phyllody, Yellows	-
4.	Sitamadhi/BR	Garden Croton	<i>Codiaeum variegatum</i>	Leaf yellow, witches' broom	'Ca. P. asteris'
5.	Himachal Pradesh	Indian Periwinkle	<i>Catharanthus roseus</i>	Little leaf, Phyllody	'Ca. P. asteris'
6.	Mukteshwar/UK	Newzealand Christmas Bell	<i>Alstroemeria psittacina</i>	Little leaf	'Ca. P. asteris'
		Zinnia	<i>Zinnia elegans Jacq.</i>	Phyllody	'Ca. P. asteris'
7.	Pantnagar/UK	Amaranthus	<i>Amaranthus spp.</i>	Phyllody	'Ca. P. aurantifolia'
		Mexican Marigold	<i>Tagetes erecta.</i>	Witches' broom	'Ca. P. aurantifolia'
8.	New Delhi/DL	Yellow Allamanda	<i>Allamanda cathartica</i>	Little leaf	'Ca. P. trifoli'
		Daizy	<i>Brachyscome sp.</i>	Little leaf, witches' broom	'Ca. P. asteris'
		Silver Cock's Comb	<i>Celosia argentea</i>	Flat stem, witches' broom	'Ca. P. asteris'
		Chrysanthemum	<i>Chrysanthemum morifolium</i>	Phyllody	'Ca. P. aurantifolia'
		Four o' clock Flower	<i>Mirabilis jalapa</i>	Little leaf	'Ca. P. aurantifolia'
		Garden Petunia	<i>Petunia hybrida</i>	Flattened stem, witches'	'Ca. P. asteris'
		Phlox	<i>Phlox drummondii Hook.</i>	Witches' broom	'Ca. P. phoenicium'
		Hybrid Tea Rose	<i>Rosa hybrida</i>	Little leaf, Multiple buds	'Ca. P. aurantifolia'
		Chrysnthemum	<i>Chrysanthemum sp.</i>	Little Leaf	'Ca. Phytoplasma'
		Saponaria	<i>Saponaria sp.</i>	Little leaf	'Ca. P. trifoli'
Wild Pansy	<i>Viola tricolor</i>	Witches' broom	'Ca. P. asteris'		
9.	Jaipur/RJ	Jasmine	<i>Jasminum sambac</i>	Witches' broom	'Ca. P. cynodontis'
10.	Karnal/HR	Silver Cock's Comb	<i>Celosia argentea</i>	Fasciation	'Ca. P. australasia'
11.	Punjab	China Pink	<i>Dianthus chinensis</i>	Leaf Yellowing	-
12.	Pune/MH	Hibiscus	<i>Hibiscus rosa-sinensis</i>	Yellow leaf	'Ca. P. trifoli'
		Annual Chrysanthemum	<i>Chrysanthemum sp.</i>	Phyllody, Little leaf	'Ca. P. asteris'
		Gerbera	<i>Gerbera jamesonii</i>	Phyllody	-
		Marigold	<i>Tagetes erecta</i>	Phyllody, Stunting	-
		Periwinkle	<i>Catharanthus roseus</i>	Little leaf, Virescence	-
		China Aster	<i>Callistephus chinensis</i>	Phyllody, Yellows	'Ca. P. australasiae'
		Jasmine	<i>Jasminum sambac</i> <i>Aiton</i>	Phyllody, Little leaf	-
13.	Devanahalli /Bengaluru/ KA	Jasmine	<i>Jasminum sambac</i>	Little leaf	-
14.	Mysuru/KA	China Aster	<i>Callistephus chinensis</i>	Virescence and phyllody	'Ca. P. aurantifolia'
15.	Tamil Nadu	Jasmine	<i>Jasminum sp.</i>	Phyllody	-

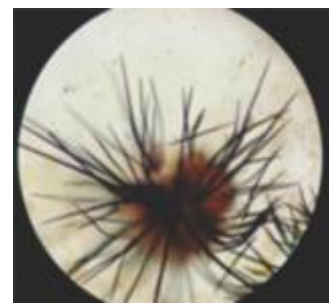
## Project 3.2 (ICAR Code: IXX 14260) : Etiology and Integrated Management of Fungal Diseases of Ornamental Crops

### 3.2.1. Identification of Causal Agent of Leaf Blight in *Aglaonema* and *Amaryllis*

Infected samples showing blight symptoms have been collected and observed under microscope. Causal fungi was isolated on PDA media and growth has been observed. It has been observed that *Colletotrichum* sps. is associated with the blight symptoms.



Blight and Anthracnose of *Aglaonema*



*Colletotrichum* sps.

Infected samples of *Amaryllis* were collected and isolated on PDA media. Microscopic study of the culture indicated the organism associated as *Colletotrichum* sp.



Red blotch of *Amaryllis*



*Colletotrichum* sps.

### 3.2.2. Isolation, Pure Culture and Identification of Causal Organism of Yellows in *Gladiolus* and Dieback in *Rose*

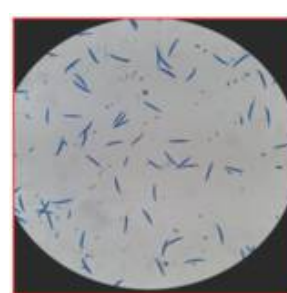
Leaf samples showing yellows and wilting in *Gladiolus* and dieback of the stem in *rose* were collected. Associated fungi was isolated on potato dextrose agar media. *Fusarium* sp. was observed to be associated with Yellows of *Gladiolus*. *Acremonium* sp. was found associated with die back of *rose*.



Corm rot of *Gladiolus*



Pure culture of *Fusarium oxysporum* f. sp. *gladioli*



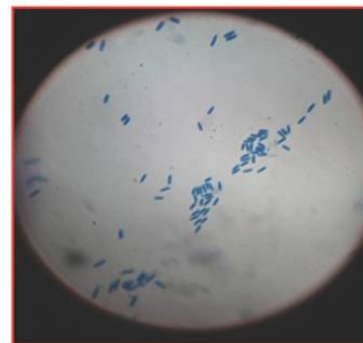
*Fusarium oxysporum* f. sp. *gladioli* spores



Rose Dieback



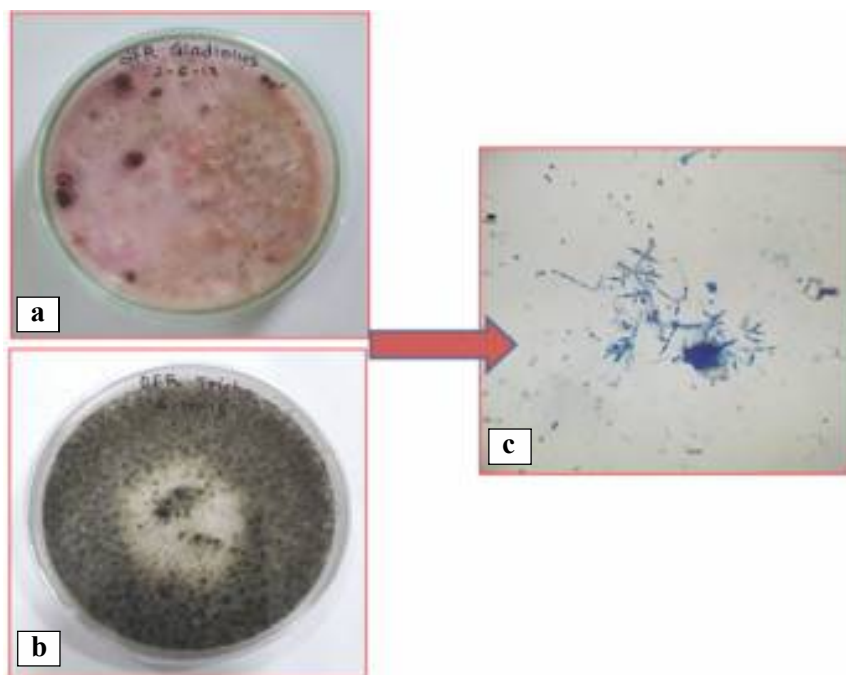
Culture Plate



*Acremonium* spp.

### 3.2.3. Isolation, Identification and Characterization of *Trichoderma asperellum* from DFR-Farm, Vaduj and Kusr Villages

Rhizospheric soil samples were collected from different areas in sterile plastic bags. The soil samples were air dried and isolation was done by the serial dilution technique. A *Trichoderma*-selective agar medium (TSM from High Media) was used for quantitative isolation of *Trichoderma* spp. from soil. Morphologically distinct colonies were picked on the basis of their morphology and purified on PDA. Further morphological and molecular identification of the fungi has been undertaken. The species has been identified as *Trichoderma asperellum* Samuels, Lieckf. & Nirenberg belongs to *Glomerellaceae* family. NFCCI Accession no. of the culture submitted is 4399.



Colony and Spores of *Trichoderma* sp. isolated from ICAR-DFR farm.  
(a & b : Colonies of *Trichoderma* sp.; c: Spores of *Trichoderma* sp.)

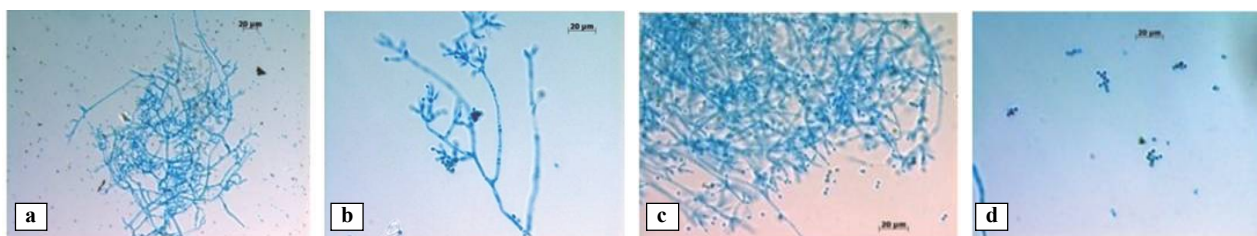
#### Morphological Characters:

Colony on PDA : dull yellowish green, pustulate, exudate watery, periphery buff to dull yellow, highly sporulating towards periphery.

Conidiophores : branched, hyaline, septate, dichotomously branched, 4.30  $\mu$ m wide.

Phialides : Ampulliform to largeniform, terminal phialides 2-4 in number, variable in shape and size, neck small to medium long, hyaline, 11.98-8.46 x 2.42-2.35  $\mu$ m.

Conidia : globose to sub-globose, sub-hyaline to light olivaceous, smooth to minutely roughened, 2.37-4.73 x 2.54 - 3.74  $\mu$ m.



**Fungal Mycelium and Spores of *Trichoderma asperellum***

(a, b, c: Mycelium of *Trichoderma asperellum*; d : Spores of *Trichoderma asperellum*)

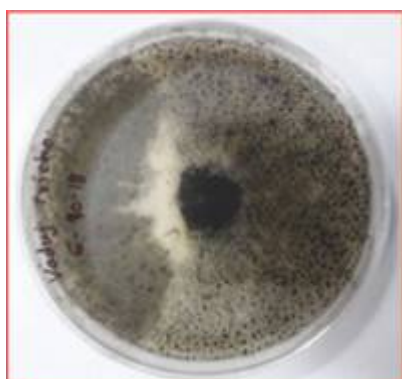
Isolation of *Trichoderma* was also attempted from the soils of Vadaj village and Kusur village. All the isolated cultures were maintained in PDA and further its efficiency have been checked against the pure cultures of *Fusarium* spp. isolated from gerbera and gladiolus crops.



**Pure culture of *Trichoderma* spp (Kusur Village)**



**Microscopic image of *Trichoderma* spp (Kusur Village)**



**Pure culture of *Trichoderma* spp (Vadaj) Village**



**Microscopic image of *Trichoderma* spp (Vadaj) Village**

### 3.2.4. Study of Antagonistic Activity of *Trichoderma* Species against *Fusarium*

Dual cultures of *Trichoderma* and *Fusarium* have been prepared and growth of colonies of both the fungi were observed.



In dual culture plate with *Trichoderma*-DFR, colony diameter of *Fusarium* is 2.4 cm, 2.1cm, 2.4 cm respectively. In control plate, where *Fusarium* was grown alone the colony diameter is 7.2 cm. Total percent Inhibition observed is 68%.



Dual culture of  
*Trichoderma* (DFR) &  
*Fusarium* spp. (Gladiolus)



Dual culture of  
*Trichoderma* (Kusur) &  
*Fusarium* spp. (Gladiolus)



Dual culture of  
*Trichoderma* (Vadaj) &  
*Fusarium* spp. (Gladiolus)

In dual culture plates with *Trichoderma*-Vadaj, colony diameter of *Fusarium* is 1.8 cm, 2.1cm, 2.0 cm respectively. In control plate, where *Fusarium* was grown alone the colony diameter is 7.2 cm, 7.8 cm, 7.6 cm respectively. Total percent Inhibition observed was 75%.

In dual culture plates with *Trichoderma*-Kusur, colony diameter of *Fusarium* is 1.9 cm, 2.1cm, 2.2 cm respectively. In control plate, where *Fusarium* was grown alone the colony diameter is 7.9 cm, 7.8 cm, 7.8 cm respectively. Total percent Inhibition observed was 73%.

## 4. Postharvest Technology and Value Addition

### Project 4.1: Harnessing Natural Pigments from Flower Crops for Making Value Added Products from Grapes

#### 4.1.1. Phytochemical Analysis of Chrysanthemum Florets

##### Determination of Total Tannin Content

Total tannin content of the methanolic crude extract of the 22 flower samples were determined by modified Folin-Denis method. Among 22 samples tested, cv. Mahatma Gandhi has shown the highest tannin content (6mg/g TAE) while lowest levels were present in PAU B-46 (4.13mg/g TAE; Fig. 20).

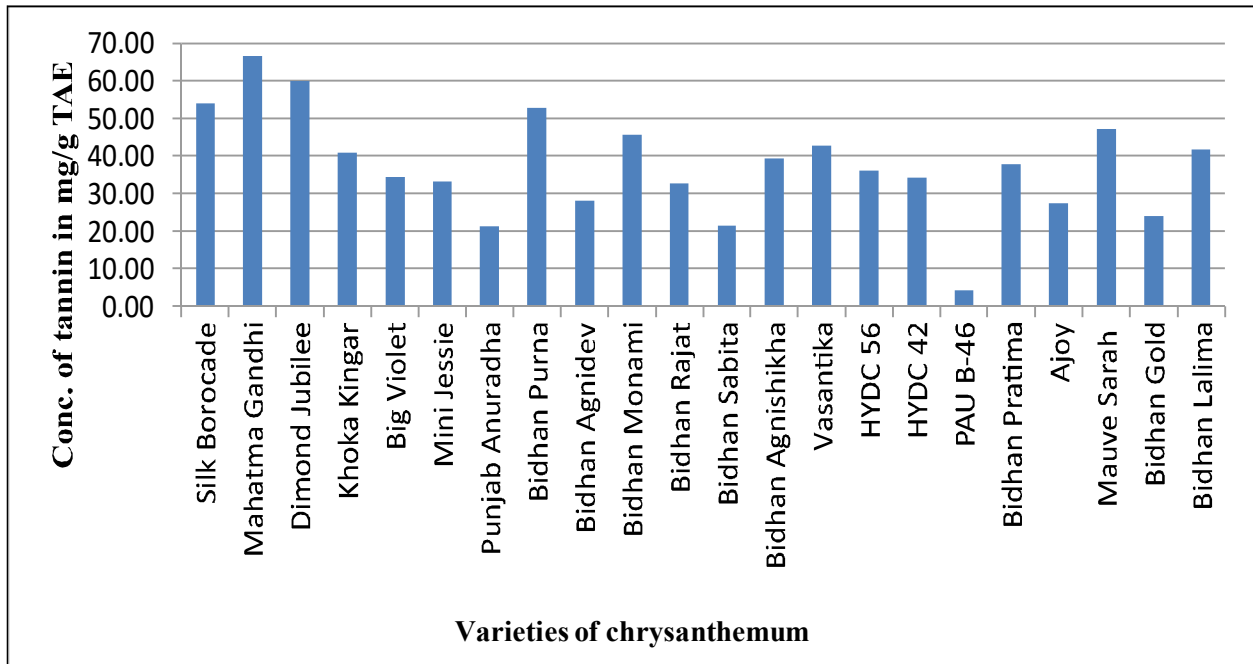


Fig. 20 : Total Tannin Content of Chrysanthemum Varieties

##### Determination of Total Anthocyanin Content

Total anthocyanin content of 22 chrysanthemum varieties was measured using a modified spectrophotometric differential pH method as described by Rapisarda *et al.*, (2000) and Scalzo *et al.* (2008). Out of 22 varieties, Mini Jessie has shown the lowest anthocyanin content (0.3mg/L) while Mauve Sarah has shown the highest anthocyanin content (65.4mg/L; Fig. 21.)

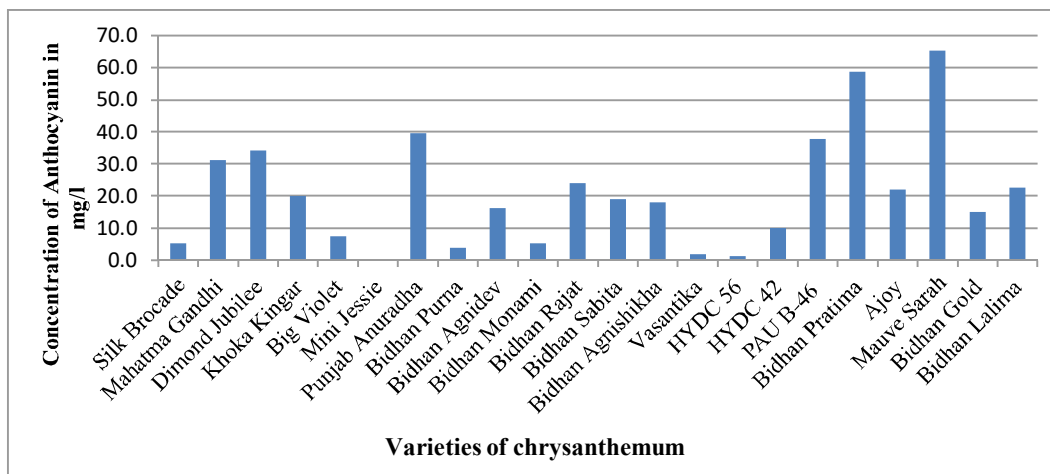


Fig. 21: Total Anthocyanin Content of Chrysanthemum Varieties

### Antioxidant Assays of Chrysanthemum Extracts

In this study, the analysis of the antioxidant activity of extracts from ray florets of chrysanthemum was performed using two methods: DPPH and FRAP. These methods are distinguished by their mechanism of action and would be complementary to study the antioxidant potential of flower petals.

#### DPPH Assay

DPPH is a stable free radical that has been widely used to evaluate the free radical-scavenging activity of natural antioxidants. The antioxidant activity of the flower crude extracts increases with a decrease in the inhibitory concentrations at 50% or IC<sub>50</sub>. The highest radical scavenging activity was observed in the Bidhan Agnishikha crude extract (84.57ppm) followed by the Bidhan Sabita (79.70ppm; Fig. 22).

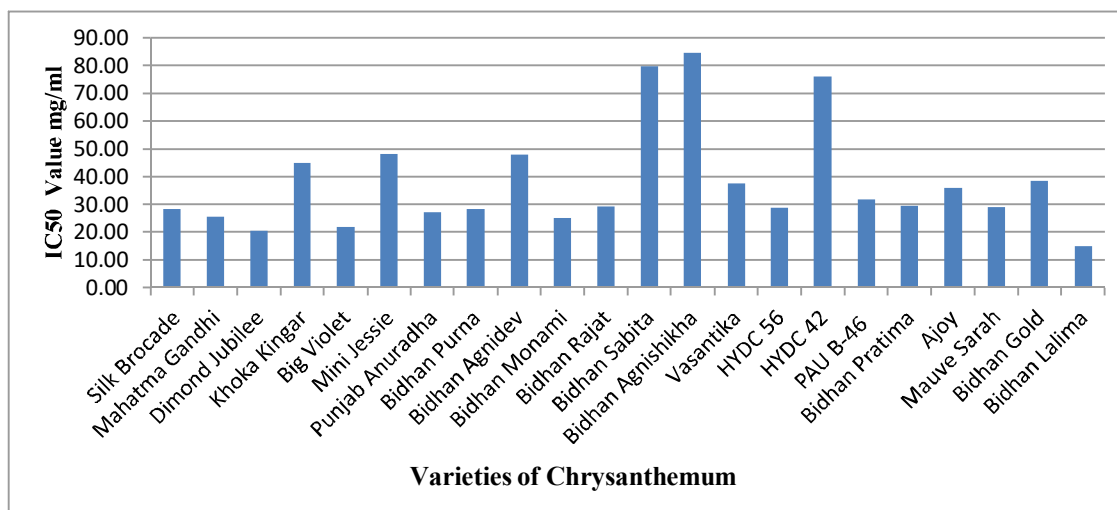


Fig. 22 : Total Antioxidant Activity of Extracts from Chrysanthemum Varieties by DPPH Assays

#### FRAP Assay

The FRAP assay has always been used as a method to estimate the activity of phenolic antioxidants. The antioxidant capacity of samples was estimated by their abilities to reduce Fe<sup>3+</sup>-TPTZ to Fe<sup>2+</sup>-TPTZ. Higher absorbance of the reaction mixture indicates a higher reducing power. Bidhan Pratima recorded higher reducing power (65 mg/gferrous equivalent) while Ajoy exhibited the lowest reducing power (20 mg/gferrous equivalent; Fig. 23).



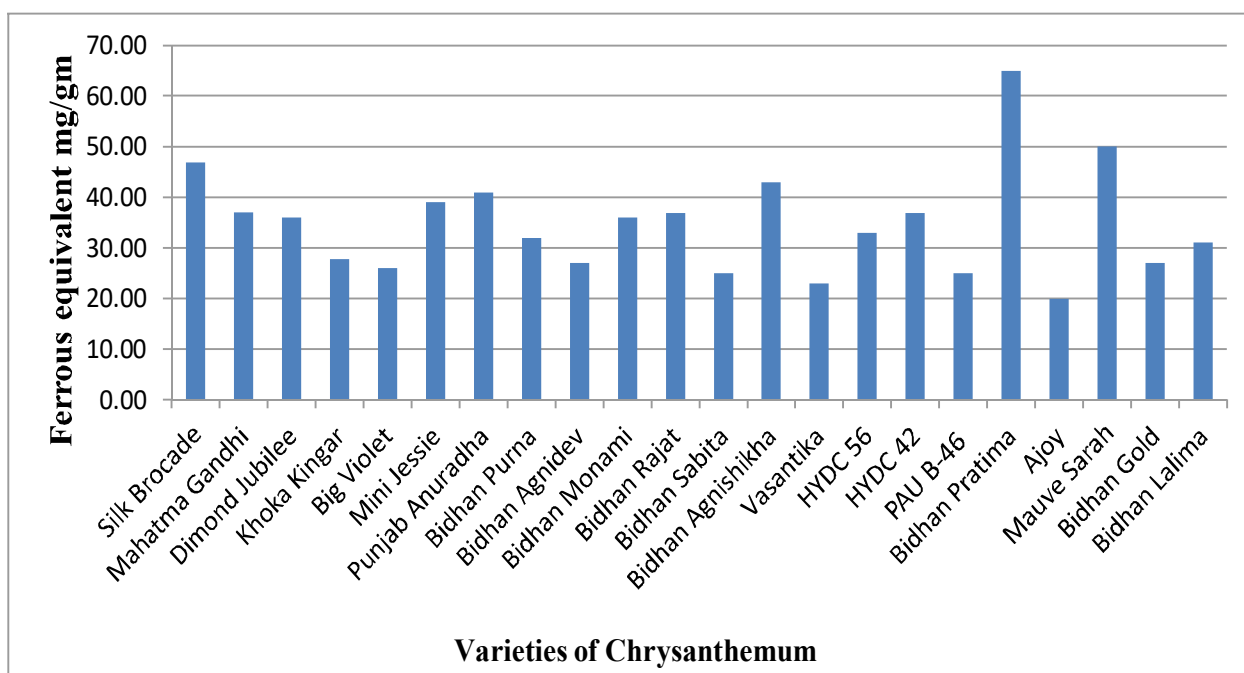


Fig. 23 : FRAP Values of Chrysanthemum Floret Extracts

### Determination of Total Saponins

Total saponins of 22 chrysanthemum varieties were determined by the Mercy Gospel Ajuru *et. al* protocol (2017). Bidhan Sabita variety has shown the highest percentage of saponin content (10%) while Mini Jessie variety has shown the lowest saponin content percentage (3.67%; Fig. 24.).

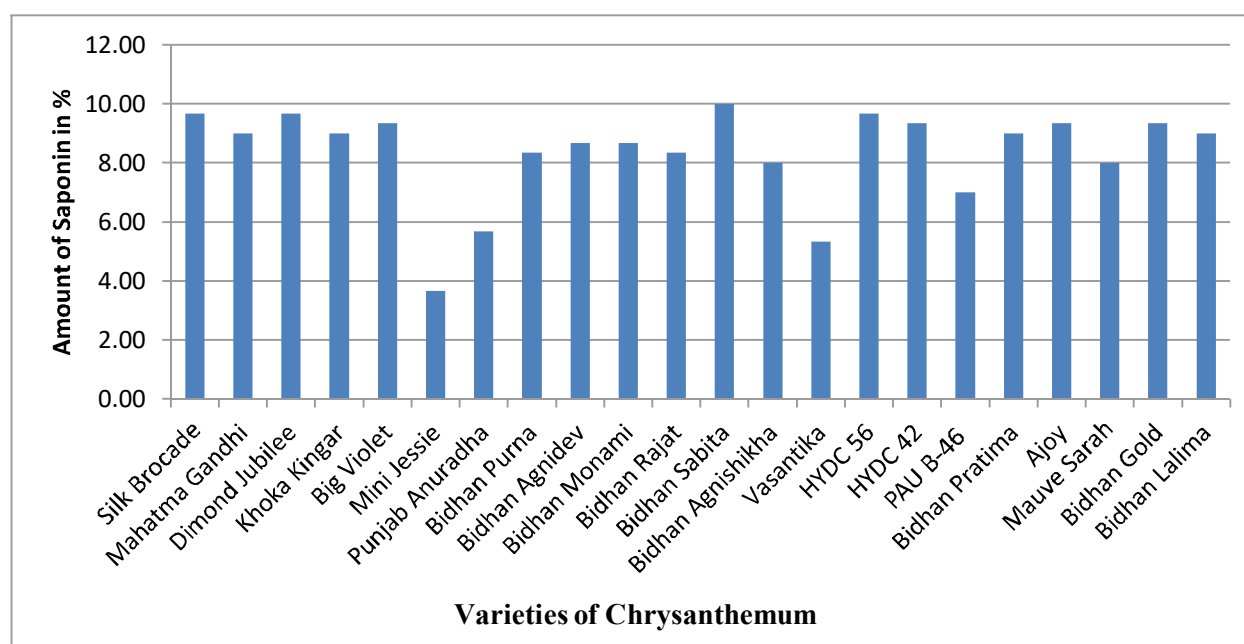


Fig. 24 : Total Saponins Content of Chrysanthemum Varieties.



### Determination of Total Alkaloid Content

Total alkaloid content of 22 varieties of chrysanthemum was determined using method described by Debnath *et al* (2015). Out of 22 varieties, Bidhan Gold had shown the highest alkaloid content (0.68g) followed by Vasantika and Bidhan Sabita (0.67 g and 0.64 g) respectively while Mauve Sarah had the lowest alkaloid content (0.22g; Fig. 25).

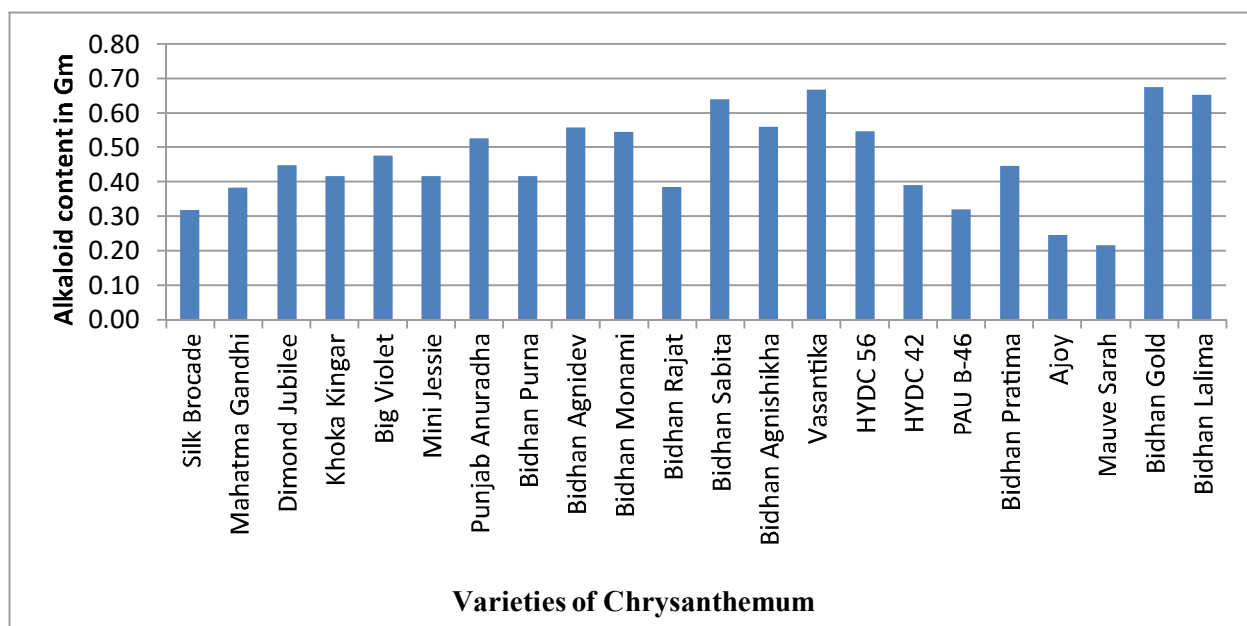


Fig. 25 : Total Alkaloid Content of Chrysanthemum Varieties

### Determination of Different Carotenoids:

Different carotenoids from 22 chrysanthemum varieties were extracted in acetone and quantified using UV-visible spectrophotometer using the protocol of Kamalambigeswari *et al* (2016). It was observed that different carotenoids are in different flower samples due to different colour, nature and variety of flowers. In all 11 different carotenoids were observed and quantified such as  $\beta$  carotene,  $\alpha$ -Carotene, Lycopene, Antheraxanthin, Astaxanthin, Auroxanthin, Canthaxanthin, Violaxanthin, Mutatochrome, Neoxanthin, Zeaxanthin in chrysanthamum florets. Out of 22 varieties Bidhan Agnidev contained the presence of nine different carotenoids with varied concentrations *viz.*  $\beta$ -carotene (72.24ug/g), Lycopene (58.21ug/g), Astaxanthin (98.89ug/g), Auroxanthin (93.17ug/g), Canthaxanthin (78.64ug/g), Violaxanthin (84.38ug/g), Mutatochrome (80.23ug/g), Neoxanthin (79.65ug/g), Zeaxanthin (86.27ug/g) compared to other varieties.

#### 4.1.2. Phytochemical Analysis of Rose Flower Petals

##### Determination of Total Tannin Content

Total Tannin content of 17 rose cultivars was determined using modified Folin- Denis method. Among 17 rose varieties studied in present study, cv. Pusa Gaurav contained the highest tannin content (85.08 mg /g TAE) in the crude methanolic extracts while cv. Pusa Mohit (20.53mg/g TAE) contained least tannin content (Fig. 26).

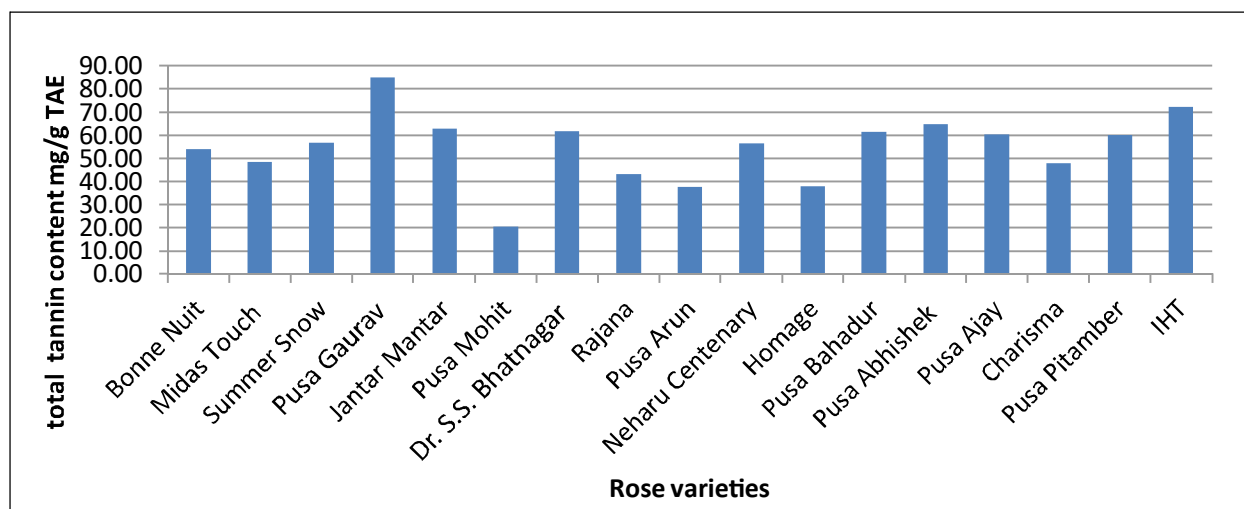


Fig. 26 : Total Tannin Content of Rose Varieties

### DPPH Assays to Study the Antioxidant Activity of Rose Extracts

In this study, the analysis of the antioxidant activity of 17 rose cultivars was studied using DPPH assays. The highest radical scavenging activity of petal crude extract was observed in cv. Pusa Guarav (39.75ppm) followed by cv. Jantar Mantar (38.54 ppm) while comparatively less antioxidant activity was observed in cv. Pusa Mohit (10.80 ppm Fig. 27).

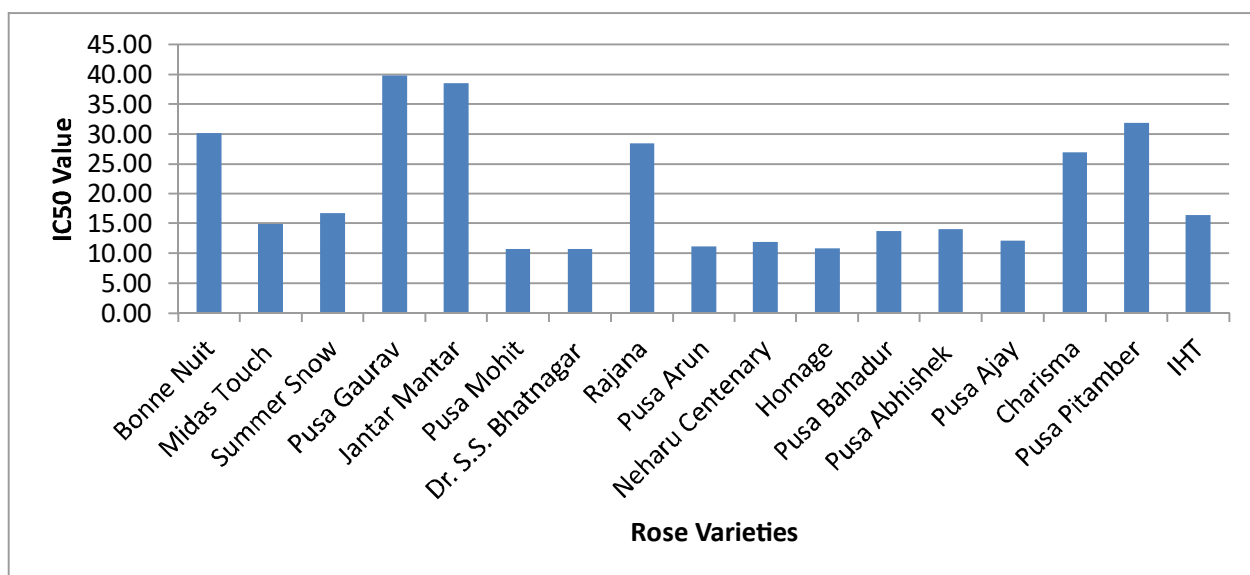


Fig. 27 : Total Antioxidant Activity of Rose Varieties in DPPH assays

### Determination of Total Flavonoid Content

The total flavonoid content in 17 rose varieties was also determined using aluminium chloride spectrophotometric method. Among 17 rose varieties, cv. Charisma contained highest total flavonoid content (557mg/g CE) while cv. Dr. S.S. Bhatnagar contained the lowest total flavonoid content (12.17 mg/gCE; Fig. 28).

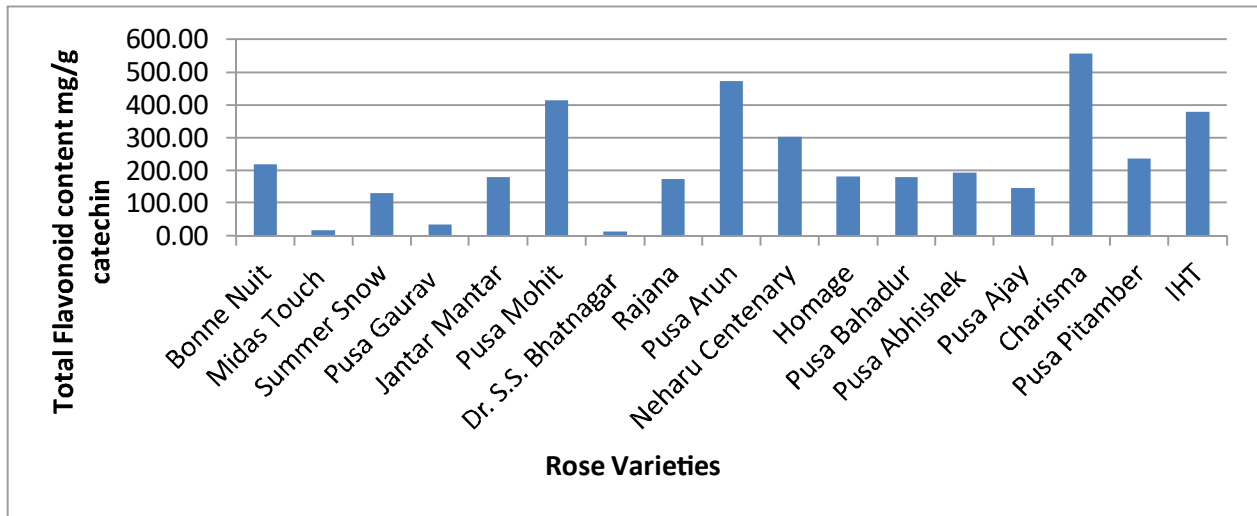


Fig. 28 : Total Flavonoid Content of Rose Varieties

### Determination of Different Carotenoids

Different carotenoids from 17 rose varieties were extracted in acetone and quantified using UV-visible spectrophotometer using the protocol of Kamalambigeswari *et al* (2016). It was observed that depending on the colour of flower, the carotenoid types and content varied significantly. In all 11 different carotenoids were observed and quantified such as  $\beta$  carotene,  $\alpha$ -Carotene, Lycopene, Antheraxanthin, Astaxanthin, Auroxanthin, Canthaxanthin, Violaxanthin, Mutatochrome, Neoxanthin, Zeaxanthin in rose petals. Out of 17 varieties Pusa Bahadur has higher quantities of different carotenoids *viz.*  $\beta$  carotene (70.13ug/g), Lycopene (56.51ug/g), Astaxanthin (74.60ug/g), Violaxanthin (52.78ug/g), Mutatochrome (65.99ug/g), Neoxanthin (54.39ug/g). While Bonne Nuit Shown lower quantities of different carotenoids *viz.*  $\alpha$ -Carotene (15.03ug/g), Antheraxanthin (23.7ug/g), Canthaxanthin (18.91ug/g), Mutatochrome (24.11ug/g), Neoxanthin (20.91ug/g).

## Project 4.2 (ICAR Code: IXXI14263): Standardization of Post Harvest Technology and Value Addition Techniques in Ornamental Crops

### 4.2.1 Studies on Tinting of Baby's Breath (*Gypsophila Elegans*) for Value Addition in Flower Crops

Value addition is a better option or alternative to avoid post-harvest loss or wastage of flowers and to utilize the surplus produce. Post harvest technology and value addition through product diversification are important strategies suggested to enhance income of farmers. The present experiment was conducted to investigate the efficiency of different dyes on *Gypsophila elegans* for dry flower decoration. The flower spikes of gypsophila were immersed in six different edible food dyes T1: Carmoisine (Raspberry red), T2: Sunset yellow + Tartrazine (Kesari), T3: Tartrazine (Lemon Yellow), T4: Carmoisine + Ponceau (Tomato Red), T5: Brilliant blue + Tartrazine (Apple Green), T6: Carmoisine + Sunset yellow (Orange Red) and T7 : Control. The concentration of dyes employed in the treatments was 1%.

The experimental design adopted was CRD with three replications (Table 1.29). Different dye chemicals used in the experiment effectively induced attractive colours in the cut spikes of gypsophila without affecting their vase life. The study reveals that value-added spikes of gypsophila can provide a great variety of colours for aesthetic beautification. Tinting the spikes of gypsophila with dye chemicals can enhance the value of these flowers and helps the gypsophila growers in earning more from their produce. The growers of

gypsophila can adopt tinting technique by using edible dyes in white gypsophila spikes for inducing different colours as value addition. Value addition ensures high premium to the growers coupled with provision of more acceptable quality products for the market.

**Table 1.29 : Effect of Dye Chemicals on Physiological Loss in Weight of Gypsophila Spikes**

Treatments	Fresh Weight(g)	Dry weight (g)	Physiological loss in weight (%)
T <sub>1</sub> : Carmoisine (Raspberry Red)	216.27	60.33	72.13
T <sub>2</sub> : Sunset Yellow + Tartrazine (Kesari)	157.30	44.40	71.78
T <sub>3</sub> : Tartrazine (Lemon Yellow)	147.60	43.63	70.44
T <sub>4</sub> : Carmoisine + Ponceau (Tomato Red)	153.60	48.50	68.43
T <sub>5</sub> : Brilliant blue + Tartrazine (Apple Green)	139.50	44.73	67.94
T <sub>6</sub> : Carmoisine + Sunset yellow (Orange Red)	108.56	30.50	71.91
T <sub>7</sub> : Control	69.30	18.50	73.31
Sem <sub>±</sub>	0.53	0.52	0.26
CD (p<0.05)	1.59	1.56	0.77



T1 : Carmoisine



T2: Sunset yellow + Tartrazine



T3: Tartrazine



T4 : Carmoisine + Ponceau



T5 : Brilliant blue + Tartrazine



T6: Carmoisine + Sunset yellow

**Studies on Tinting of Baby's Breath (*Gypsophila Elegans*) for Value Addition**



## Project 4.3 (ICAR Code: IXX 12322): Standardization of Post Harvest Packaging Technology for Tuberose and Jasmine

### Effect of Packaging Size and Ventilation on Physiological Weight Loss (PLW%), Freshness and Inside Temperature of Loose Tuberose Loose Flowers

Experiment on Effect of packaging size and ventilation on Physiological Weight Loss (PLW%), freshness and inside temperature of tuberose loose flowers was conducted in year 2018-19. Physiological Weight Loss (PLW%), freshness and inside temperature of tuberose loose flowers was significantly influenced by box size and percentage of ventilation. The flowers stored in all the boxes except boxes without ventilation maintained maximum ( $\geq 83\%$ ) freshness till 5<sup>th</sup> day. Flowers stored in A2B3 treatment had maximum freshness followed by A2B2 and A2B3 on 5<sup>th</sup> day. The flowers stored in A2B3 box had less physiological loss in weight (PLW) and maintained higher freshness up to 6<sup>th</sup> day. The inside temperature within tuberose flower boxes at middle and bottom were increased with size but decreased with increased percentage of ventilation. These results were probably due to the modified atmosphere condition of gaseous composition and high relative humidity created by the size and ventilation of the box. In previous year experiment on packaging, same trends were also observed related to physiological weight loss (PLW%), freshness and inside temperature of tuberose loose flowers stored in different sized ventilated packaging boxes.

## Project 4.4: Design and Development of Tools and Gadgets for Floriculture

### 4.4.1. Testing of ICAR-DFR Loose Flower Plucker

The loose flower plucker developed and 3D printed by ICAR-DFR was tested in farmer fields to test the efficacy. In this study the plucker was tested for harvesting loose flowers of aster. In this study, the loose flowers of aster were harvested for 30 min duration per person by ICAR-DFR plucker and hand picking. These two methods of harvesting of loose flowers (30 min hand plucking v/s 30 min plucking with the help of loose flower plucker) were compared. During testing of plucker we recorded the data of total weight of plucked flowers (Grams), plucking rate (g/min), flower quality (Score/5), pain experience (Score/5) and plucking efforts (Score/5). We were given score out of 5. From Table 1.30 and 1.31, it is show that the pain experience and plucking efforts during hand plucking of aster loose flowers were more than plucking with the help of ICAR-DFR Flower Plucker. The loose flower plucker had higher plucking rate than hand plucking, minimum damage to flowers and plant during harvesting of flowers without any injury to fingers (thumb and index finger). It was also observed that the flower quality during both the methods of plucking was good. The rate of flower plucking in ICAR-DFR flower plucker was higher than hand plucking in case of aster loose flowers.

**Table 1.30 :Plucking of Aster Flower for 30 min by ICAR-DFR Flower Plucker**

S. No.	Name (M/F)	Age (Years)	Plucking with ICAR-DFR Plucker (30 min)				
			Plucking Rate (g/min)	Number of flowers	Flower Quality Score (/5)	Pain Experience (/5)	Plucking Effort Score (/5)
1	Sanjay Bamnya (M)	30	72.3	58	5	1	1
2	Sandhya Bamnya (F)	28	75.5	63	5	1	2
3	Ajay Bamnya (M)	35	80.9	71	5	2	1
4	Gauri Ukey (F)	27	81.7	73	5	1	2
5	Sunil Bamnya (M)	26	80.5	72	4	2	1

**Table 1.31 : Plucking of Aster Flower for 30 min by Hand Picking**

S. No.	Name (M/F)	Age (Years)	Plucking with ICAR-DFR Plucker (30 min)				
			Plucking Rate (g/min)	Number of flowers	Flower Quality Score (/5)	Pain Experience (/5)	Plucking Effort Score (/5)
1	Sanjay Bamnya (M)	30	65.1	51	5	4	5
2	Sandhya Bamnya (F)	28	60.4	46	4	5	4
3	Ajay Bamnya (M)	35	63.7	49	5	5	5
4	Gauri Ukey (F)	27	60.8	47	4	4	4
5	Sunil Bamnya (M)	26	61.9	48	5	5	5

#### 4.4.2. Design and Development of Grafting Machine

The rose grafting machine was tested for grafting of rose plants. *Rosa multiflora* and *Rosa indica* species were selected as rootstock for testing of grafting machines. The rootstock was planted in micro bag for easy handling during grafting process. One month old rooted plants of *Rosa multiflora* and *Rosa indica* was selected. The major emphasize was given on the cutting and making compatible joint between rootstock and scion. The rootstock and scion cutting and reunion assembly have different sized springs (four) having different size and tension capacity, omega shaped cutting blades to cut the rootstock and scion and reunion assembly. There are two cutting mechanism in grafting machine. One is to cut rootstock and another is for scion. In the initial testing it was observed that the required notch is made on rootstock but the scion portion need to be refined for sharp cut. The rootstock of different sizes starting from 20 mm to 90 mm were selected for grafting. It was observed that in 20-40 mm diameter of rootstock it was difficult to make the graft due to tender bark and inner wood of rootstock. The diameter of 50-70 mm was found to suitable for making a successful graft. Beyond 70 mm there was problem of hard stem wood that prevents a sharp cut. The observations taken are given in the following Table 1.32.

**Table 1.32 : Testing of Grafting Machine on *Rosa indica* Species**

S. No.	Rootstock diameter (mm)	Species	Success in make compatible graft	Reason
1.	20	<i>Rosa indica</i>	No	Rootstock is tender to make the sharp cut and difficult in making joints
2.	30	<i>Rosa indica</i>	No	
3.	40	<i>Rosa indica</i>	No	
4.	50	<i>Rosa indica</i>	Yes	Easy to make the operation and graft compatibility
5.	60	<i>Rosa indica</i>	Yes	
6.	70	<i>Rosa indica</i>	Yes	
7.	80	<i>Rosa indica</i>	No	Difficult to make the graft due to harder inner wood. Making sharp cut to outer bark is difficult
8.	90	<i>Rosa indica</i>	No	

The efficacy of grafting machine was tested on the rose rootstock (*Rosa indica*). Initially rootstock of different sizes were selected and grafting was attempted. In randomly selected rootstocks only 5 grafts were made per minute whereas, when rootstock of 50-60 mm diameter was selected the efficiency of machine was found to improve and 11-12 grafts were made (Table 1.33). These are preliminary trials and it will be tested further for compatibility of grafts as well as survival in field.

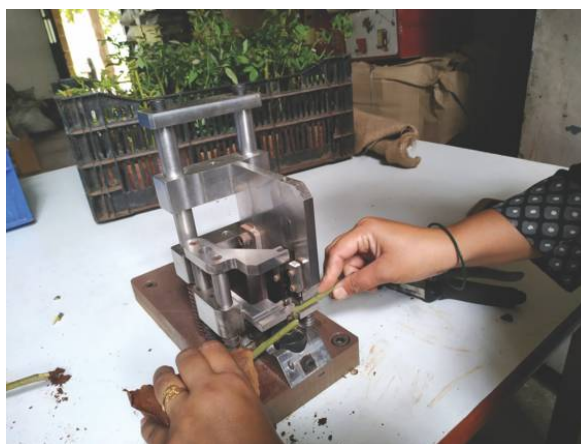


**Table 1.33 : Frequency of Making Rose Grafts Through Grafting Machine**

S. No.	Species	Diameter of rootstock (mm)	Number of grafts per minute
1.	<i>Rosa indica</i>	Random ranging from 20-90 mm	5
2.	<i>Rosa indica</i>	50-60 mm	12



**Rose Grafting Machine**



**Joining of Rootstock and Scion**



**V-notch After Completion of Grafting Process**



**Grafted Plants**



## Post Graduate Education

ICAR-DFR has been recognized as a part of Post-Graduate Education Programme of MPKV Rahuri. Dr. Ganesh B. Kadam and Dr. Tarak Nath Saha were identified as the faculty for Post-Graduate teaching and research guidance in College of Horticulture, Pune. During the year two courses on breeding of ornamental crops and value addition in flowers were taught.

## Outreach Programmes/Exhibitions

### Kisan Aadhar Sammelan-2018

ICAR-DFR Actively Participated in Kisan Aadhar Sammelan-2018 Organized at MPKV, Rahuri during October 15 -18, 2018 at Rahuri.



ICAR-DFR Stall at Krish Aadhar Sammelan, Rahuri



Dr. P. Vishwanatha, VC, MPKV, Rahuri, other Dignitaries and Farmers at ICAR-DFR Stall in Krish Aadhar Sammelan

### KISAN Agri-Expo

ICAR-DFR actively participated and displayed its technologies at KISAN Agri-Expo held at Moshi Pradhikaran, Pune on December 12-16, 2018.



ICAR-DFR Stall at KISAN Agri-Expo at Moshi



### Awareness Workshop on “Plant Parasitic Nematode: A Hidden Threat to Nursery Industry”

ICAR Directorate of Floricultural Research in association with Horticultural Science Division, ICAR organized an awareness workshop on “Plant Parasitic Nematode; A Hidden Threat to Nursery Industry” on December 14, 2018 in the conference hall of ICAR-CTRI, Rajamahendravaram. Around hundred farmers and more than fifty academia and horticulture department employees participated in the workshop. Dr. K. V. Prasad, Director ICAR-DFR welcomed the dignitaries and explained the menace of nematode incidence in nurseries and the need of the awareness workshop. In his address, Dr. A.K. Singh, Chief guest, stressed on the importance of integration of science and technology in farming and other farming interventions for increasing the income of farmers. He impressed upon that it is possible only through the harmony of scientists and farmers and other stakeholders. He appreciated the great effort of Kadiyam nurserymen in bringing out Kadiyam as a brand in international ornamental plant market. He also stressed on the importance of production of quality material meeting the international standards for increasing the market of brand Kadiyam. In his address to the gathering, Dr. T. Janakiram mentioned the constant effort taken by Horticultural Science Division at ICAR and ICAR-DFR to meet the requirement of completing the regional centre of ICAR at Kadiyam. He stressed on clean cultivation for addressing nematode problems in ornamental nursery. Dr. Damodar Reddy, in his address appreciated the efforts made by ICAR-DFR to reach farmers of Kadiyam and he extended his wholehearted help for ICAR-DFR. Dr. S. Rama Mohan, Project Director, Andhra Pradesh Micro irrigation Project addressed the gathering. The nematology experts who have made a mark in their field across the country delivered lectures to farmers about various topics on nematodes from identification to management in both Telugu and English. Among the experts, Dr. R. K. Walia, Former Project Co-ordinator, who got a wide experience of working in nematode problems in nurseries, gave the overall picture of nematode problem in the country, their dissemination and solutions available at present. Dr. Nagesh, Principal Scientist (ICAR-NBAIR), who has got a wide experience in nematodes of horticultural crops, gave an elaborate speech highlighted the Good Agricultural Practices for addressing nematodes in nurseries. Dr. Prasanna Holajjer, Scientist (ICAR-NBPGR Regional Centre, Hyderabad) focussed on nematodes of flower crops gave a picture of diagnosis on nematode infestation in ornamental nursery and importance of quarantine and the possible ways of nematode entry. Dr. M. Venkateshan from ICAR-CTRI explained the life cycle and infestation tactics of plant parasitic nematodes. A scientist-farmer interaction session was organized where experts from ICAR-DFR and Dr. YSRHU, Venkataramannagudam participated and detailed discussions on problem occurring in nurseries were discussed, not only on nematodes but clarifications on the merging problem of Rugosa whitefly were also given by the experts.



Dignitaries releasing the leaflet on “Know About Nematodes” during the awareness workshop on “Plant Parasitic Nematode: A Hidden Threat to Nursery Industry”

### Mera Gaon Mera Gaurav

Under the flagship programme of the Government of India titled "Mera Gaon Mera Gaurav", a scheme to make scientists adopt villages to promote the best farming practices. ICAR-DFR, Pune has adopted two villages as per the guidelines. Various outreach activities were planned and executed in the adopted villages. ICAR-DFR has given major emphasis on promotion of flower crops in the region and providing the scientific and technical support to the farmers. The improved varieties and technologies developed under ICAR/SAU for flower and other horticultural crops are being promoted and farmers are motivated to adopt these technologies for better returns. Tuberose, marigold, chrysanthemum, gladiolus, China aster, annual chrysanthemum, balsam, etc. are the major crops grown by the farmers. ICAR-DFR is making efforts to develop some model village wherein all the technologies can be demonstrated and nearby flower growers shall be benefitted. ICAR-DFR is trying to provide simple solutions to various issues faced by the farmers in cultivation of flower and other horticultural crops.



Participation in Mera Gaon Mera Gaurav Programme

### Training on Chrysanthemum Propagation Techniques

One day on-farm training on chrysanthemum propagation was organised at farmers' field in Village Kamargaon, Tal-Ahmednagar, Dist-Ahmednagar on July 10, 2018. More than 30 chrysanthemum growers, Agriculture Officer, SBI Chas Branch were present for the on-farm training. Dr Tarak Nath Saha and Dr Ganesh B Kadam, Scientists from ICAR-DFR explained about scientific propagation techniques used in chrysanthemum including preparation of cuttings, stages and age of cuttings, different media used for propagation, rooting hormones, plug tray filling, etc. were demonstrated. Farmers have shown keen interest in techniques of propagation and tried hands on media preparation, preparation of cuttings, plug trays filling, treatment of cuttings and preparation of rooting hormone (IBA) solutions.



On Farm Demonstration of Media Preparation and Plug Trays Filling for Raising of Chrysanthemum Cuttings



On Farm Training in Chrysanthemum



### ICAR-DFR Actively Participated in Zonal Sports Meet (West Zone)

ICAR-DFR actively participated in zonal Sports Meet (West Zone) held during October 5-8, 2018 at ICAR-IGFRI, Jhansi. The team DFR comprised of Dr. P. Naveen Kumar (Chief-de-mission), Dr. Prashant Kavar, Dr. Ganesh B Kadam, Sh. R. S. Bhatt and Sh. Sudesh Kumar participated in various sports events.



Team ICAR-DFR at Zonal Sports Meet (West Zone) held during October 5-8, 2018 at ICAR-IGFRI, Jhansi

## Training/Seminar/Symposia/Workshop Organized

### Certified Farm Advisor Programme from November 14-28, 2018

A fifteen days training programme entitled “Certified Farm Advisor (Floriculture) Module II” sponsored by National Institute of Agricultural Extension Management (MANAGE), Hyderabad was organized at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune, from 14-28 November, 2018. The programme was inaugurated by Dr. Lakhan Singh, Director, ICAR-ATARI, Pune. The training was designed for intensive specialized skill oriented training for a period of 15 days for those who have completed Module I from MANAGE. The training programme was lead by Dr. K. V. Prasad, Course Director and Dr. Tarak Nath Saha & Dr. Ganesh B. Kadam as Course Coordinators. A total of twenty participants including five women and fifteen men from various State Departments/ self-employed attended the training programme. An intensive training schedule was followed with a blend of theoretical lectures (39) and hands on- practicals with the help of internal as well as external experts. In addition, there were ten exposure visits to Flower Market; Flora Expo; Soil Museum; Hi-tech Floriculture Units at COA, Pune and Talegaon; Hydroponics Unit, Flower grading Unit, Hi-Tech Nursery Unit at Talegaon; Bonsai Namaste Unit, Somantane; ICAR-NRC Grapes; K.F. Bioplants; ICAR-DFR Research Farm; Jagtap Nursery; KVK,



Participants of Certified Farm Advisor Programme

Baramati; Commercial Mushroom Production Unit and Essar Floritech, Kamshet. Dr. K. E. Lawande, Former Vice-Chancellor, BSKKV, Dapoli was the chief guest during the valedictory function of the training programme and he urged the trainees to pass on the learning experience to the stakeholders for the betterment of the farming community and keep in touch with the Directorate for ready reference.

### Training on Recent Advances in Floriculture

A two days training programme entitled “Recent Advances in Floriculture” was organized at ICAR-Directorate of Floricultural Research from February 07-08, 2019. The training programme was designed for the benefit of Progressive Farmers from Himachal Pradesh under Development Foundation (registered with NGO Darpan, NITI AAYOG, Government of India) and was held in the Training Hall of ICAR-IVRI-TEC Regional Station, Pune. In this training, various aspects related to advances in the cultivation of commercial flower crops including the nutrient management, insect pest and disease management, post-harvest handling, etc. was delivered to the participants and also practical exposure in the production of flower crops were organised.



Lectures and Farm Visits during Training Programme “Recent Advances in Floriculture

### Tribal Sub-Plan (TSP) Training Programme

ICAR-DFR has undertaken various programmes under tribal sub-plan for taking the knowledge and technologies of floriculture to Tribal India.

### TSP Training Programme on 'Vyavsayik Phool Pako' held at NAU, Navsari, Gujarat from December 20-22, 2018

A three-day training programme on Commercial Flower Crops (*Vyavsayik Phool Pako*) was jointly organized during December 20-22, 2018 for farmers of Narmada Aspirational District by ICAR- DFR, Pune; AICRP on Floriculture, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, NAU, Navsari, and KVK, Dediypada at Swami Vivekananda Hall, NAU, Navsari. The inaugural function was presided



Dignitaries and trainees at Training on 'VYAVSAYIK PHOOL PAKO' held at AICRP (F) NAU Navsari from December 20-22, 2018



over by Dr. C. J. Dangria, Honourable Vice Chancellor, NAU, Navsari; Dr. K. V. Prasad, Director, ICAR-Directorate of Floricultural Research, Pune graced the function as Chief Guest and Dr. S. R. Chaudhary, Director of Research and Dean (PGS) was guest of Honour. Dr. B. N. Patel, Principal and Dean, ACHF; Dr. P. K. Shrivastava, Principal, College of Forestry; Dr. D.V.S. Raju, Principal Scientist, ICAR-DFR, Pune and Dr. S. L. Chawla, Associate Professor and PI, AICRP on Floriculture, NAU were present on the occasion. Along with them, scientists from ICAR-DFR (Dr. Tarak Nath Saha and Dr. Ganesh B. Kadam), faculties of ACHF, PG students of the department and farmers were present in the inaugural function. The 3 days training programme was a grand success with 30 farmers of Narmada district of Gujarat as participants, faculties and PG students of floriculture who participated actively during the technical sessions. Lectures and practicals were delivered by the experts about the advances in production technology of flower crops like rose, marigold, tuberose, chrysanthemum, gladiolus, China aster, etc. with water management and plant protection. The tribal farmers were provided with farm inputs, sprayers and planting material to encourage them to intensify floriculture.

### **TSP Training Programme on “Flower Cultivation to Improve Livelihood of Tribal Farmers” held at ICAR-RCNEH Region, Umiam, Meghalaya from February 4-6, 2019**

A three day Tribal Sub-Plan training on “Flower Cultivation to Improve Livelihood of Tribal Farmers” was organized for the benefit of tribal farmers from the aspirational district Ri-Bhoi, Meghalaya during 04-06 February, 2019 at Division of Horticulture, ICAR Research Complex for NEH region, Umiam. The training was jointly organized by ICAR- Directorate of Floricultural Research, Pune and Division of Horticulture, ICAR Research Complex for NEH region, Umiam under the flagship programme Tribal Sub Plan (TSP), Government of India. About 59 farmers from Byrwa, Umran, Umsuing, Palwi, Umroi and Mawlai villages, Dist-RiBhoi, Meghalaya participated. Farmers were exposed to various aspects of flower cultivation like nursery preparation, new varieties of flower crops, crop cultivation practices, crop protection, dry flower making, postharvest management of flower crops. In addition, hands on training was given to farmers at Research Farm, Division of Horticulture, ICAR Research Complex for NEH region, Umiam. A total of 14 lectures were delivered by various experts in the training. During the valedictory programme, the Director, ICAR Research Complex for NEH region, Umiam released a Technical Manual on 'Cultivation of Flower Crops to Improve Livelihood of Farmers' and distributed 50 knapsack sprayers to trainees. The programme was coordinated by Dr. H. Rymbai, Dr. H.D. Talang, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam and Dr. A.K. Jha



**Tribal Participants from Aspirational District RiBhoi, Meghalaya**



**Release of Publication by the Chief Guest Dr. N. Prakash, Director, ICAR-NEH**



**Distribution of Certificates to Participants by the Chief Guest**



Distribution of Farm Inputs to the Tribal Farmers by the Chief Guest



Group Photograph of the Participants

### NEH Training Programme

#### NEH training programme on “*Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam*” held at Horticulture Research Station (AAU), Kahikuchi, Assam

A three day training programme on “*Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam*” was organized for the benefit of small and marginal flower growers from the aspirational districts viz., Baksa, Darrang, Bongaigaon, Nalbari, Kamrup and Jorhat of Assam during February 07-09, 2019 at Horticultural Research Station, AAU, Kahikuchi, Azara, Guwahati. The training was jointly organized by ICAR- Directorate of Floricultural Research, Pune and Horticultural Research Station (AAU), Kahikuchi, Guwahati, under the NEH Programme, Government of India. A total of 34 farmers from different villages of above districts had participated in the training. Farmers were exposed to various aspects of flower cultivation like soil-water-nutrition, nursery preparation, new varieties of flower crops, crop cultivation practices, crop protection, dry flower making, postharvest management of flower crops. In addition, hands on training was given to farmers at Research Farm, AICRP on Floriculture, HRS, Kahikuchi. A total of 13 lectures were delivered by various experts in the training. During the valedictory programme, the Chief Scientist, HRS, AAU, Kahikuchi released a Technical Manual on 'Role of Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam'. Apart from distributing certificate among the participating flower growers, input kits containing different farm materials like small sprayer; secateurs; garden hoe; fungicide, NPK fertilizer, bio-fertilizer; three types of planting materials, publications (a local language book on plant protection, extension bulletins etc) were also handed over. The programme was coordinated by Dr. S. K. Borah, Dr. N. Mazumder, Dr. K. K. Deka, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam and Dr. S. Saikia.



Inaugural Session of the NEH Training Programme



Group photographs of Participants during the NEH Training Programme



### **Skill Training on Floriculture for Technical Staff of ICAR-DFR**

One day training programme on imparting scientific skills in floriculture was successfully organized at ICAR-DFR, Pune on March 20, 2018. The training was designed for imparting necessary working skill in the field of floriculture and protected cultivation to the newly recruited technical staff besides other staff working at the Directorate. A total of ten participants attended the training programme. An intensive training schedule was followed with a blend of theoretical lectures and one exposure visit to the Talegaon Hi-tech floriculture Units. The lectures covered status of floriculture, flower production under open field, cut flower production, Specialty flowers and fragrant ornamentals, Cut greens and fillers, Turf Grass management, Indoor plants, Vertical garden, Basics of Protected Cultivation, Growing Media and Hi-tech flower production. In the exposure visit the participants were taken to the Hi-tech unit located at Talegaon Dabhade. The trainees have practically seen the complete process of grafting/ budding techniques commercially employed for roses, besides planting in the media and maintaining them at mist chamber. The commercial cultivation of roses were also explained in one of the units and the management practices, intercultural operation employed for its successful production were shown to them. The practical aspects related to vertical garden, ornamental foliage, its propagation system, mass multiplication were also covered. The other important aspect like growing of all these in suitable protected structures were also explained. In the unit they were shown the type of coloured shade nets (Black, green, white, Interwoven) used for cultivation of suitable plants. The other aspects of erection of ployhouse and shadenets were also practically demonstrated and besides the precaution to be employed for the same. The participants expressed high level of satisfaction and thanked the Director for organizing an useful training programme.



**Dr. K. V. Prasad, Director, ICAR-DFR Delivering Lecture**



**Guest Lecture on Protected Cultivation**



**Visit to Hi-Tech Floriculture Unit at Talegaon Dabhade**



**Demonstration of Propagation Technique in Rose**



## Meetings of Institute Research Committee / Institute Management Committee

### 5<sup>th</sup> Institute Management Committee (IMC) Meeting

The 5<sup>th</sup> meeting of Institute Management Committee of ICAR-Directorate of Floricultural Research was conducted on September 17, 2018 in the Conference Hall, IVRI TEC Centre, Pune. Dr. K. V. Prasad, Director, ICAR - Directorate of Floricultural Research (Chairman), R. Shirish Jamdade, JD(Hort.) nominee of Director of Horticulture, Commissionerate of Agriculture, Maharashtra State, (member), Dr. T. Janakiram, Assistant Director General (HS-I), ICAR (member), Dr. Shruti Sethi, Principal Scientist, Division of Food Science and Post harvest Technology, IARI, (Member), Dr. K. Kandiannan, Principal Scientist, Horticulture, ICAR-Indian Institute of Spices Research, Kozhikode, (member), Dr. K. K. Upreti, Principal Scientist, Division of Plant Physiology & Biochemistry, ICAR-Indian Institute of Horticultural Research, Mr. A. Narasimha Murthy, F&AO, ICAR-Indian Institute of Millets Research, Hyderabad. Mr. R. S. Bhatt, Assistant Finance and Account Officer, and Dr. P. Naveen Kumar, Administrative Officer (I/C) & Member Secretary were present. Important issues related to the institute were discussed and approved various agenda items related to Institute management.



Members of IMC with  
staff of ICAR-DFR



Members of IMC of ICAR-DFR  
visiting the field at Hadapsar farm



### **Institute Research Council Meeting**

The 2<sup>nd</sup> IRC meeting of ICAR-DFR for the year 2018 was held on December 20, 2018 to review the proposed works going on and do midterm corrections to the ongoing programmes. Dr. K.V. Prasad, Director, ICAR-DFR chaired the sessions and all scientific staffs of the institute presented their research achievements and work done so far and chairman and members deliberated their observations. Dr. T. Janakiram, ADG (Hort. Sci), observed the conduct of IRC as ICAR nominee and gave his valuable inputs for streamlining the research programmes based on his wide experience in Floriculture. He urged the scientists to think out of the box to bring innovations in floriculture. He congratulated the team DFR under Dr. K.V. Prasad for attempting good research with limited resources at ICAR-DFR.



**IRC Meeting of ICAR-DFR, on October 20, 2018**

## Institutional Activities

### PM Live Interaction with Farmers

A live broadcast of the Hon'ble Prime Minister's Interaction with farmers through video-conferencing was arranged at ICAR-NRCG on June 20, 2018. Sixty-one viewers including nearby farmers, scientists, staff members and research fellows watched this programme with interest. Directors and scientists from ICAR-NIASM and ICAR-DFR who had come for the interface meeting at ICAR-NRCG also joined.



Participants during the Broadcasting of Honourable PM Live Interaction with Farmers

### Celebration of International Yoga Day

ICAR – Directorate of Floricultural Research, Pune celebrated International Day of Yoga on June 21, 2018. A “Yoga Workshop” was organized in the premises of ICAR-DFR, College of Agriculture Campus, Shivaji Nagar, Pune in association with ICAR-NRCG, Pune, Agricultural Technology Application Research Institute, Pune and TEC-Indian Veterinary Research Institute, Regional Station, Pune. The International Day of Yoga Celebrations, 2018 was attended by Scientists, Technical staff, Administrative staff and contractual staff from ICAR–Directorate of Floricultural Research, Pune, Agricultural Technology Application Research Institute, Pune and Indian Veterinary Research Institute, Regional Station, Pune. Yoga experts from B.K.S. Iyengar Institute, Pune conducted the “Yoga Workshop” and also demonstrated important Asanas for the benefit of all the participants. The programme commenced with Common Yoga Protocol followed by Mass Yoga Performance. Sh. Swapnil Gadekar, explained the importance of yoga, benefits of different Asanas, how the different Asanas have to be performed and science behind each Asana. All the staff performed various Aasanas, such as Vrikshasana, Tadasana, Chakratadasana, Makarasana, Praanayams, Anulom, Vilom etc. Dr. K. V. Prasad, Director of ICAR–Directorate of Floricultural Research, Pune enlightened the gathering about the unique contribution of India to the mankind in terms of its contribution to Yoga. Dr. P. Naveen Kumar, Principal Scientist (Floriculture and Landscaping), ICAR- DFR, Pune, proposed formal vote of thanks. The necessary arrangements for conduct of the programme was done by team ICAR -DFR, Pune.



Participants during the Yoga Day Celebration



## ICAR-DFR Celebrated 72<sup>nd</sup> Independence Day

ICAR-DFR celebrated 72<sup>nd</sup> Independence Day at its Hadapsar campus on August 15, 2018. Dr. K.V. Prasad, Director, ICAR-DFR hoisted the national flag. In his Independence Day address he stressed on the responsibility of we as ICAR employees for conducting the flagship programmes of the Govt. of India. The entire DFR office building was decorated in tricolor LED light on the eve of Independence Day.

### Hindi Pakhwada Celebrated at ICAR-DFR

ICAR-DFR celebrated “Hindi Pakhwada” from September 14-29, 2018. Different competitions like Essay, Word Dictation, General Knowledge, Poem Recitation and Rangoli Programme were organized in which all the scientific, technical, administrative and contractual staff of ICAR-DFR, ICAR-IVRI-TEC, Pune and students of MPKV, Pune actively participated. During “*Hindi Pakhwada Samapan Samaroh*”, Dr. Lakhan Singh, Director ATARI, Pune was chief guest. Dr. K. V. Prasad, Director, ICAR-DFR delivered welcome address and Dr. Lakhan Singh emphasized the importance of hindi and encouraged the staff to use more and more hindi in official work as hindi is the simplest language. During this function certificates and prizes were given to the winners of different competitions.

### Swachhata Hi Sewa Campaign -2018

'Swachhata Hi Sewa' Campaign was observed at ICAR- DFR, Pune in connection with *Swachhata Pakhwada* (15.09.2018 to 02.10.2018). A pledge taking ceremony was conducted in the office premises of ICAR – DFR, Pune for administering the oath of cleanliness. All the staff members of the institute administered the '*Swachhata Hi Seva Pledge (Sapath)*' whereby the staff resolved to create a clean healthy and new India. An awareness campaign was organized on '*Swachhata hi Sewa*' at Krishi Vigyan Kendra, Narayangaon. For the staff members of ICAR –DFR, Pune an essay writing competition was held on the topic “*Plastic ka unmoolan-uchithya anuchith*”. During the Pakhwada, all the staff participated actively in the *shramadaan* programme by removing the weeds from the institute campus. A *shabdlekhan* competition (Word writing) competition was conducted with the theme “*Paryavaran Pradhooshan aur Swachhata*”. A drive for cleaning and systematic arrangement of chemicals, glass wares, farm inputs and farm implements in Stores section of the Institute was organised. A Rangoli competition was conducted on the theme-'*Swacchata hi Sewa*’ wherein four groups participated including contractual staff members from ICAR-DFR, Pune and Students from College of Agriculture, Pune. An Awareness Rally was organized in collaboration with ICAR- NRC for Grapes depicting the importance of Swachh Bharath Mission (*Ek Kadam Swachhata Ki Aur*) at Shewalwadi Gram Panchayat, Manjri Village, Hadapsar on October 2, 2018.



Celebration of 72<sup>nd</sup> Independence Day by ICAR-DFR



Prize distribution for the winners of competitions during Hindi Pakhwada



Staff of  
ICAR-DFR  
taking  
Swachhata Pledge

### Workshop on “Importance of Segregation of Waste and Disposal”

A workshop on “Importance of Segregation of Waste and Disposal” was organized on September 26, 2018 co-ordinated by Dr. Safeena S.A., nodal officer Swachhata campaign. The workshop was conducted by the Officials from 'Adar Poonawalla Clean City Initiative' in collaboration with Janwani group and 'GOOD 4 NOTHING (g4n)'. Venue of the workshop was Training Hall, TEC-Indian Veterinary Research Institute, Regional Station, Pune. Around 50 participants including DFR staff, ICAR-IVRI Regional station - Pune staff, Teaching Faculty from College of Horticulture Pune and B.Sc. (Hort.) final year Students, College of Horticulture, Pune participated actively in the workshop.



Workshop on “Importance of Segregation of Waste and Disposal” by 'Adar Poonawalla Clean City Initiative'

### ICAR-DFR Celebrated 150<sup>th</sup> Birth Anniversary of Mahatma Gandhi

A grand function was organized on the occasion of 150<sup>th</sup> birth anniversary of Mahatma Gandhi in collaboration with ICAR- NRC for Grapes at ICAR- NRC for Grapes. As part of this, a Workshop on “Generation of Wealth from Waste” was conducted wherein method demonstration were conducted on four different topics. The group from a firm 'GOOD 4 NOTHING (g4n)' (Mr. Mayur Mehta, Mr. Nilay Parikh and team) had demonstrated the making of Paper Bags and Paper Box from old newspapers wherein hands-on demonstration was done involving all the participants. The team also demonstrated how to make pencils from old newspapers which can be started as a rural enterprise. Also Dr. Dharmendra Kumar Phalke (Nodal Officer to State Govt., M.P.K.V., Rahuri and Asst. Professor (Soil Science and Agrl. Chemistry), Agrl. College, Pune) had given a lecture on 'Utilization of Waste by composting'. A method demonstration on different methods of dehydration for preparation of dry flowers and methods for preparation of Potpourri from dried petals of flower crops was given by Dr. (Mrs.) Safeena S.A, Scientist, ICAR- DFR, Pune. Around 150 participants including the staff members from ICAR-DFR, Pune, ICAR-NRC for Grapes, Farmers and Villagers wholeheartedly participated with great enthusiasm.



**Shramadaan by Staff from ICAR-DFR and ICAR-NRCG at Shewalwadi Gram Panchayat**



**Dr. K.V. Prasad, Director, ICAR-DFR addressing the gathering during the Workshop on "GENERATION OF WEALTH FROM WASTE"**

### Swachhata Pakhwada-2018

In accordance with the Council's instructions, 'Swachhata Pakhwada' was observed during December 16-31, 2018. A pledge taking ceremony was conducted in office premises of ICAR – DFR, Pune for administering the oath of cleanliness. Cleanliness and sanitation drive was conducted during which biodegradable and non -biodegradable waste was segregated and proper disposal was done. The students of Arnold School Pune were sensitized regarding the importance of Swachhata at ICAR-DFR, Hadapsar campus, Pune. Awareness was created among the students regarding Agricultural Technologies for conversion of waste to wealth. The students from Clara Global School, Pune from Grade 1 to Grade 6 were also sensitized about the importance of cleanliness and hygienic practices. An essay writing competition was held on the topic "What Can I do to make India Clean and Green?" during the Pakhwada. Post Graduate students from College of Agriculture-Pune Campus, Technical Staff, Administrative staff, SRF's and Contractual staff members of ICAR – DFR, Pune participated in the event. An Awareness programme was organized in the villages adopted under Mera Gaon Mera Gaurav Programme in collaboration with Krishi Vigyan Kendra, Narayangaon, Junnar Taluka for depicting the importance of Swachh Bharath Mission.



**Team ICAR-DFR along with members of KVK Narayangaon, spreading message of Swachhata**



**Sensitization of Students of St. Arnold's School on importance of cleanliness**

### ICAR-DFR Observed Vigilance Awareness Week

As per directive of the Vigilance cell ICAR and Central Vigilance Commission, Vigilance Awareness Week 2018 was observed at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from October 29<sup>th</sup> to November 3, 2018 with the theme “Eradicate Corruption-Build a New India”. The observance of vigilance awareness week began with the staff of ICAR-DFR taking Integrity and Organizational Pledge on 29<sup>th</sup> October. On 30<sup>th</sup> October, the staff of ICAR-DFR visited Zilla Parishad School near Kusur, Junnar taluk, Pune and organized a Sensitization workshop on vigilance awareness campaign for the students. About 60 students participated in this programme. During interaction, the teachers pointed out the importance of introduction of “Vigilance” in the teaching curriculum as many are not well aware of the system. A lecture on “Eradicate corruption-Build a New India” was delivered by Dr. Prashanth Kawar, Principal Scientist, ICAR-DFR. On 31<sup>st</sup> October a quiz competition was organized for the staff of ICAR-DFR on “Vigilance” and all the staff members actively participated in the same.



Director and staff of ICAR-DFR taking Integrity and Organizational Pledge (29<sup>th</sup> October, 2018 at ICAR-DFR Office)



Sensitization Workshop on Vigilance Awareness in Zilla Parishad School near Kusur, Junnar Taluk, Pune District on 30<sup>th</sup> October, 2018

### ICAR-DFR Celebrated World Soil Day

World Soil Day was organized by ICAR-Directorate of Floricultural Research, Pune on December 5, 2018 in collaboration with Krishi Vigyan Kendra, Narayangaon and ICAR- Directorate of Onion and Garlic Research, Rajgurunagar at Krishi Vigyan Kendra, Narayangaon (Pune). The programme was held in the presence of Krishiratna Mr. Anil Meher (Chairman, KVK Narayangaon), Mr. Prakash Pate (President, Gramonnati Mandal Narayangaon), Mr. Ravindra Pargaonkar (Secretary, Gramonnati Mandal Narayangaon), Dr. K.V. Prasad (Director, ICAR-DFR, Pune), Dr. Lakhan Singh (Director, ICAR-ATARI, Pune), and Dr. Vijay Mahajan (Director (I/c) & Principal Scientist, ICAR-DOGR, Rajgurunagar).



Dr. K.V. Prasad (Director, ICAR- DFR, Pune) distributing soil health card to the farmer on the occasion of World Soil Day, 2018

### ICAR-DFR Celebrated its 9<sup>th</sup> Foundation Day

The 9<sup>th</sup> Foundation day of ICAR-DFR was celebrated on December 10, 2018 in the benign presence of the Directors of ICAR sister institutes, Associate Deans of College of Horticulture and Agriculture, AICRP staff, Faculty of ICAR-DFR and students. Welcoming the dignitaries, Dr. K. V. Prasad, Director, ICAR-DFR highlighted the progress made in research, master plan, infrastructure development. Chief Guest of the function Dr. Y. S. Nerkar, former Vice Chancellor, MPKV, complimented the Team DFR for their remarkable progress in research, field infrastructure creation and outreach programmes after DFR was relocated to Pune in 2014. Dr. S. D. Sawant, Director, ICAR-National Research Centre for Grapes, Dr. Major Singh, Director, ICAR-Directorate of Onion and Garlic, Dr. Lakhan Singh, Director, ICAR-Agricultural Technology Application Research Institute, Dr. Jyotsana Sharma, Director, ICAR-National Research Center for Pomegranate, Sholapur, Station Heads of ICAR-IARI Regional Station, Dr. S. K. Sharma and ICAR-Indian Veterinary Research Institute, Dr. S. Bhilgonkar, Associate Deans of College of Agriculture Dr. R. N. Rasal and Horticulture, Dr. S. D. Masalkar, faculty and students, industry representatives Dr. S. Tikoo, Tierra Seed Science Pvt Ltd, Shri. R. N. Shinde, MD, Tirupati Balaji Mushrooms Pvt ltd, participated in the event.



**Dr. Y. S. Nerkar, Chief Guest along with other dignitaries during the foundation day**



**Aerial view of ICAR-DFR farm along with the participants of Foundation day celebrations**



### ICAR-DFR Celebrated Chrysanthemum Day

ICAR-Directorate of Floricultural Research celebrated chrysanthemum day to showcase the technologies specific to chrysanthemum for the benefit of all the stakeholders at its Hadapsar farm on December 11, 2018. The experimental farm has around 140 named varieties of chrysanthemum from National Agricultural Research and Education System, promising selections and mutated populations developed by ICAR-DFR. The celebration was successful with the active participation of academicians, farmers, nurserymen, traders and people associated with various arenas of floriculture. The programme began with lighting of lamp. Dr. K. V. Prasad, Director, ICAR-DFR welcomed all to the occasion. Dr. Lakhan Singh, Director, ICAR-ATARI, Pune was the Chief Guest of the function. In his inaugural address, chief guest appreciated the efforts of team DFR in bringing out colourful and astonishing blooms of chrysanthemums in field. He also stressed the importance of linking KVKs and research institutions like ICAR-DFR for technologies to reach out to the farmers for doubling their income. The representatives from KVK Solapur, KVK Mohol, Solapur, KVK, Jalna, KVK Jalgaon were a part of this programme, who brought team of farmers from their region and actively participated in the field interactions. Chrysanthemum growers from villages Hanga, Kamargaon and Kusr were also present. The farmers evinced keen interest in some of the varieties available with ICAR-DFR for growing on a commercial scale in their fields



**Dr. Lakhan Singh, Director, ICAR - ATARI Addressing during Chrysanthemum Day Celebrations**



**Flower Growers from Different Parts of Maharashtra at Chrysanthemum Field of ICAR-DFR on Chrysanthemum Day**



### Celebration of Kisan Diwas

ICAR-DFR, ICAR-NRC for Grapes and ICAR-ATARI, Pune jointly organized Kisan Diwas on December 23, 2018. During Kisan Diwas, the farmers contributing to Swachh Bharat Mission were invited to share their experience of working on “*Swachh Bharat Mission*” and implementing at village level. Dr. Sandeep Panwar, CEO, Farinsys Agro Pvt. Ltd. and representative of PMFAI (Pesticides Manufacturers and Formulators Association of India) chaired the deliberations. He appraised the farmers on safe use of pesticides and how to use the protective gear. During the event more than 36 farmers, around 50 scientists and staff of ICAR institutes participated. Twelve farmers were felicitated for their outstanding contribution in promoting “*Swachh Bharat Mission*” at grass root level during Kisan Diwas. Safety kits were distributed to the farmers and farm labours.



Kisan Diwas Inaugural Session at ICAR-DFR



Felicitating the farmers on Kisan Diwas; Mrs Swati Shingade felicitated by Dr. Indu Sawant, ICAR-NRCG, Pune

# Institution Building

## Master Plan of ICAR-DFR

The Master Plan of ICAR-DFR was prepared by the Senior Architect and his Team from Nagpur Division of CPWD based on the inputs provided by Team ICAR-DFR. The Master Plan has envisaged the creation of Research, Administrative and Field infrastructure. Director ICAR-DFR Dr.K.V.Prasad made a detailed presentation on the Master Plan before the empowered committee under the Chairmanship of Hon'ble Secretary, DARE and Director General, ICAR Dr.TrilochanMohapatra on 07.03.2019 at 2.30 pm in KrishiBhavan, New Delhi. The meeting was attended by Senior functionaries of ICAR like Shri Sushil Kumar, Secretary, ICAR, Dr.T. Janakiram, ADG (HS I), ICAR, Shri. V.P. Kothiyal, Director (Works), ICAR, New Delhi besides Shri. M.J. Peter, Senior Architect, CPWD Nagpur. Very useful suggestions were made during the deliberations which were incorporated in the Master Plan. The Master Plan was approved in principle on 22 March 2019.

## Foundation Stone Laid for ICAR-Directorate of Floricultural Research, Regional Station

The ICAR-Directorate of Floricultural Research, Pune organised the foundation stone laying ceremony of its Regional Station at Vemagiri Village, Kadiyam mandal, Andhra Pradesh on January 21, 2019 at 10.30 am. The programme was well attended by about 450 people involving people's representatives, farmers, nursery growers, state department officials, and university officials. The Foundation Stone was laid by the Chief Guest Shri M. Murali Mohan, Hon'ble Member of Parliament, Rajamahendravaram constituency. The event was presided over by Shri. Gorantla Butchaiah Chowdhary, MLA. ICAR Officials Dr. T. Janakiram, ADG (HS I), Dr. K. V. Prasad, Director, ICAR-DFR, Pune, Dr. Damodar Reddy, Director, ICAR-CTRI, Dr. R. K. Mathur, Director, IIOPR, Pedavegi, Dr. P. Naveen Kumar, PS, Dr. D. V. S. Raju, PS, ICAR-DFR, People's representatives including Smt. P. Rajani Sesha Shai, Mayor, Rajamahendravaram, Smt. Kunche Shashi Rekha, MPTC, Vemagiri, Shri. Margani Lakshmi Satyanarayana, Smt. Margani Lakshmi MPP, Kadiyam Mandal, Shri. Velugubanti Nani, Vice MPP, Kadiyam, Shri. Pulla Satyanarayana, President Kadiyam Nurserymen Association, Shri. Palla Subramanyam, Ex President, Indian Nurserymen Association, District Administration officials including Shri Sai Kanth Varma, Sub-Collector participated in the event.

While welcoming the gathering Dr. T. Janakiram, ADG (HS I) outlined the genesis of the Regional Station and steps taken by the ICAR to operationise the station. He further highlighted the enormous scope the region holds for commercial floriculture. Speaking on the occasion, the Chief Guest Shri M. Murali Mohan, Member of Parliament reminded the farmers the enormous contributions made by them in making Kadiyam a major nursery hub in the country in spite of limited technology backstopping. With the establishment of the Regional Station of ICAR-DFR he opined that the farmers would get access to advanced technologies to further boost science led nursery development in the region. In his presidential remarks, Shri. G. Butchiah Chowdhary, MLA, Rajamahendravaram Rural called up on the farmers to diversify in to more number of flower crops, adopt value addition to increase their income. Dr. K. V. Prasad, Director, ICAR-DFR, Pune proposed formal vote of thanks. A leaflet highlighting the genesis of the Regional Station was released by the dignitaries during the occasion. The event was widely covered in the press and electronic media.



Foundation stone laid by Honble Member of Parliament Shri. M Murali Mohan



Dignitaries on the Dias



Release of Publication on the Genesis of Regional Station of ICAR-DFR



Glimpses of the Audience

### Hon'ble DDG (Horticultural Science), ICAR Inaugurates ICAR-DFR's Transit Office at ICAR-CTRI, Rajamahendravaram, Andhra Pradesh

ICAR-DFR set up its transit office at ICAR-CTRI, Rajamahendravaram for steering the activities of its Regional station at Vemagiri, Kadiyam on December 14, 2018. Dr. A.K. Singh, Hon'ble DDG Horticultural Science, ICAR inaugurated the transit office in the gracious presence of Dr. T.Janakiram, ADG (HS-I), ICAR, Dr. K.V. Prasad, Director, ICAR-DFR and Dr. Damodar Reddy, Director ICAR-CTRI. Hon'ble DDG and ADG appreciated the gesture of ICAR-CTRI in offering DFR, office space. Dr. K.V. Prasad, Director, ICAR-DFR expressed sincere gratitude to Director and staff of ICAR-CTRI for their full co-operation and support.



Dr. A.K. Singh, Hon'ble DDG (Horticultural Science), ICAR inaugurated the Transit Office in the gracious presence of Dr. T. Janakiram, ADG Hort. Sci, ICAR, Dr. K.V. Prasad, Director, ICAR-DFR and Dr. Damodar Reddy, Director ICAR-CTRI.

**Field infrastructure developed at ICAR-DFR, Keshavnagar (Hadapsar) Resaerch Farm**



**Water Filtration Unit**



**Naturally Ventillated Polyhouse**



**Shadenet House**



**Tractor Shade**



**Multipurpose Threshing Floor**

## Research Projects

S. No.	Projects	PI	Co-PI
<b>Crop Improvement</b>			
1	Project No.01 (Project IXX 14257) Improvement of Gladiolus for Commercial Traits	Dr. Ganesh B. Kadam	Dr. Tarak Nath Saha Dr. P. Naveen Kumar Dr. Nitika Gupta
2	Project No.02 (Project IXX 14261) Breeding of Tuberose for Quality and Yield	Dr. P. Naveen Kumar	Dr. Tarak Nath Saha, Er. Rahul S. Yadav, Dr. Prashant G. Kaware, Dr. Ganesh B. Kadam
3	Project No.03 (Project IXX 14254) Improvement of Chrysanthemum for Commercial Traits	Dr. Tarak Nath Saha	Dr. Ganesh B. Kadam, Dr. P. Naveen Kumar, Dr. Shilpashree K.G., Dr. D. V. S. Raju, Dr. K. V. Prasad
4	Project No.04 (Project IXX 14255) Improvement of Rose for Commercial Traits	Dr. D. V. S. Raju	Dr. Prashant G. Kaware, Dr. Ganesh B. Kadam
<b>Crop Production</b>			
1	Project No.01 (Project IXX 13991) Evaluation of Industrial and Agricultural By-products as Potting Media Components for Production of Potted Ornamental Plants	Dr. Shilpashree K. G.	Dr. Safeena S. A., Dr. Nitika Gupta
2	Project No.02 (Project IXX 14262) Utilization of Specialty Flowers, Cut Foliages, Fillers and Aromatic Flower Crops to Address Various Landscape Uses	Dr. Safeena S. A.	Dr. P. Naveen Kumar Dr. Tarak Nath Saha Dr. Shilpashree K. G.
<b>Crop Protection</b>			
1	Project No.01 (Project IXX 11705) Investigations on Viral and Phytoplasmal Diseases of Major Flowering Crops in India	Dr. Prabha K.	Mr. Girish K. S. and Dr. Nitika Gupta
2	Project No.02 (Project IXX 14260) Etiology and Integrated Management of Fungal Diseases of Ornamental Flower Crops	Dr. Nitika Gupta	Dr. Prabha K. Dr. Tarak Nath Saha Dr. Ganesh B. Kadam
<b>Post Harvest Technology and Value Addition</b>			
1	Project No.01 (Project IXX 12322) Standardization of Post Harvest Packaging Technology for Tuberose and Jasmine.	Er. Rahul S. Yadav	Dr. Tarak Nath Saha Dr. Ganesh B. Kadam
2	Project No.02 (Project IXX 14263) Standardization of Post Harvest Technology and Value addition Techniques In Ornamental Crops.	Dr. Safeena S. A.	Er. Rahul S. Yadav Dr. D. V. S. Raju



### ICAR Inter-Institutional Projects

S. No.	Projects	Collaborative Programme	PI/Co-PI
1	Design and Development of Tools and Gadgets for Floriculture	Collaborative Project with ICAR-CIAE, Bhopal	Er. Rahul S. Yadav, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam
2	Harnessing Natural Pigments from Flower Crops for Making Value added Products from Grape	Collaborative Project with ICAR-NRCG, Pune	Dr. K. V. Prasad, Dr. Prashant G. Kawar, Er. Rahul S. Yadav from ICAR-DFR and Dr. Kaushik Banerjee, Dr. A. K. Sharma and Dr. Ahammed Shabeer T.P.
3	Developing Unique DNA fingerprints of flower crops	Collaborative Project with ICAR-NRCPB, New Delhi, Pune	Dr. Prashant G. Kawar, Dr. Ganesh B. Kadam, Dr. Tarak Nath Saha, Dr. P. Naveen Kumar & Dr. D.V.S. Raju from ICAR-DFR and Dr. Amol Kumar Solankhe from ICAR-NRCPB, New Delhi.



## Visitors

### Study Visit of the Standing Committee on Agriculture

The Standing Committee on Agriculture visited Pune during February 27-28, 2019. The committee comprised of four honorable Member of Parliament namely Shri Ravindra Gaikwad (Chairman), Shri Tapas Mandal, Shri Md. Ali Khan, Shri Kailash Soni and four staff of parliament secretariat viz., Shri Vinod Tripathi, Shri K.C. Pandey, Shri Sumesh Kumar and Shri Nirantar Singh. The committee took a review of the ICAR institutes located in Pune (ICAR-DOGR, ICAR-DFR and ICAR-ATARI) and held a meeting at ICAR-NRCG conference hall. During their visit they were appraised of various technologies developed by the institutes and their commercialization. The committee appreciated the efforts made by the institutes in their respective fields for upliftment of the stakeholders and advised to develop farmer friendly technologies keeping in view the Govt. strategy of doubling the farmer's income by 2022. On 28 Feb., 2019, a workshop was organised on 'Awareness and Training on Intellectual Property Laws and Intellectual Portfolio Management in ICAR Institutes'. Dr S. K. Saxena (ADG –IP& TM) briefed the committee on the IPR activities of ICAR. This was followed by discussion amongst the committee members and Directors of various ICAR institutes in Pune.

### Distinguished Visitors

1. Dr. K. P. Vishwanatha, Vice Chancellor, MPKV, Rahuri visited research farm of ICAR-Directorate of Floricultural Research, located at Hadapsar, Pune and appreciated the collection of massive germplasm of Chrysanthemum, gladiolus, tuberose, rose, speciality flowers, etc. He also lauded the efforts taken by the Directorate in popularizing commercial cultivation of loose flowers and quality planting materials in the region.
2. Dr. M. Ariz Ahammed, Managing Director, National Horticulture Board, Gurgaon visited ICAR-DFR and had a meeting with the Director and Scientists. He showed his keenness for participation of the Directorate for promotion of commercial floriculture.
3. Dr. Man Singh, Professor & Project Director (Acting), Water Technology Center, ICAR-IARI, New Delhi visited the research farm of the Directorate on April 11, 2018. He complimented the Director and staff for the effort in bringing the land at Hadapsar under cultivation and also stressed upon the use of treated sewage water for floriculture.
4. Dr. N. K. Dadlani, Vice-president, Asia-Pacific Seed Association visited the research farm at Hadapsar and offered valuable suggestion for the Directorate.
5. Dr. H. P. Singh, former DDG (HS) visited ICAR-DFR and offered valuable suggestions and guidance on various research programmes and Institutional development.

### Farmers' Visits

A number of farmers from the states of Tamil Nadu, Gujarat, Himachal Pradesh, Karnataka, Maharashtra, Madhya Pradesh and Rajasthan visited the Directorate during various occasions. The information on different varieties and cultural practices were imparted to them.

### Education Tours

A number of students from various Universities and colleges from Karnataka, Rajasthan, Gujarat, Madhya Pradesh, Tamil Nadu visited the Directorate during their education tours/ all India visits. They were appraised about field and lab facilities, research farm and ongoing research activities.



# Publications

## Research Papers

1. Abhay Kumar Gaurav, Namita, D. V. S. Raju, Markandey Singh, Bhupinder Singh, Gopalkrishnan, S., S. V. Amitha Mithra, Sapna Panwar, Mohar Singh and M. R. Dhiman (2018). Genetic characterization of *Rosa* species using morphological markers. *Indian Journal of Agricultural Sciences*, 88 (9): 1396–1402.
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7. Namita, D.V.S. Raju, Markandey Singh, S.S. Sindhu, Surendra Kumar, A.S. Dhama, M.C. Singh and Prativa Anand. 2018. Development of *in vitro* protocol for mass multiplication of open pollinated seedling of rose (*Rosa × hybrida* L.) cv. Rose Sherbet. *Journal of ornamental horticulture*, 21(1&2) : 24-30.
8. Narendra Chaudhary, S. S. Sindhu, Ramesh Kumar, T. N. Saha, D. V. S. Raju, Ajay Arora and R. R. Sharma (2018). Effect of growing media composition on growth, flowering and bulb production of LA hybrid (Red Alert) and Oriental (Avocado) group of liliium under protected condition. *Indian Journal of Agricultural Sciences*, 88 (12): 1843–7.
9. Pramod P Aradwad, J. P. Sinha, Arun Kumar T. V., Rahul S. Yadav and D. V. K. Samuel (2018). Development of solar powered screen cleaner. *Indian Journal of Agricultural Sciences*, 88 (12): 1914–9.
10. Rahul S. Yadav, S. K. Jha, J. P. Sinha, Pramod Aradwad, Nilesh Gaikwad, Arun Kumar, T. V. and D. V. K. Samuel (2018). Cross-flow thin bed drying characteristics of maize (*Zea mays*) using continuous sample weight measurement. *Indian Journal of Agricultural Sciences*, 89 (3): 458–62.
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of gibberellic acid on plant growth and flowering of chrysanthemum cv. Thai Chen Queen under short day planting conditions. *International Journal of Agriculture Sciences*, ISSN: 0975-3710&E-ISSN: 0975-9107, 10 (11): 6274-6278.

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### Technical/ Extension Bulletin/ Manual/ Folder/ Newsletter

1. Shilpashree K.G., Safeena S.A., Tarak Nath Saha, Prabha K., Ganesh B. Kadam, Prasad K. V. (2018). Technical Bulletin No. 23. Quality Water for Quality Flowers: Irrigation Water Quality for Flower Production. Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune.
2. Shilpashree K.G., Safeena S.A., Tarak Nath Saha, Prabha K., Ganesh B. Kadam, Prasad K. V. (2018). Technical Bulletin No. 24, Healthy Soil: Healthy Crop. Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune.
3. Shilpashree, K.G., Safeena S.A., Tarak Nath Saha, Prabha K., Ganesh B. Kadam, Prasad K. V. (2019). Healthy Soil: Green Farm (Swasth Dhara: Kheth Hara). *Technical bulletin No. 24*, ICAR-Directorate of Floricultural Research, Pune, Maharashtra.
4. P. Naveen Kumar, Tarak Nath Saha, Ganesh B. Kadam, D. V. S. Raju and K. V. Prasad (2018). Training Manual on Certified Farm Advisor in Floriculture Module-II. Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune.
5. P. Naveen Kumar, Tarak Nath Saha, Ganesh B. Kadam, D. V. S. Raju and K. V. Prasad (2018). Vivarnika: Hindi Profile DFR, Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune.
6. Prabha, K., P. Naveen Kumar, Tarak Nath Saha, Rahul S. Yadav and Ganesh Kadam (2017). 'Flori News' July-December 2017 Issue No.4 of Directorate of Floricultural Research, College of Agriculture Shivajinagar, Pune.
7. Prabha, K., P. Naveen Kumar, Tarak Nath Saha, Rahul S. Yadav and Ganesh Kadam (2018). 'Flori News' January-June 2018 Issue No.5 of Directorate of Floricultural Research, College of Agriculture Shivajinagar, Pune.
8. Mazumder, N., S. K. Borah, K. K. Deka, T. N Saha, G. B. Kadam and K. V. Prasad (2019). Training manual on "Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam" held at Horticultural Research Station (AAU), Kahikuchi, Guwahati, Assam from February 7-9, 2019 under NEH Plan.
9. Rymbai, H., H. D. Talang, Tarak Nath Saha, Ganesh B. Kadam, A. K. Jha and K. V. Prasad (2019). Training manual on "Flower Cultivation to Improve Livelihood of Tribal Farmers" held at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP).
10. P. Naveen Kumar, Tarak Nath Saha, Ganesh B. Kadam, D. V. S. Raju and K. V. Prasad (2018). *E-Manual* on Certified Farm Advisor in Floriculture Module-II. Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune.

### Technical/Popular Articles

1. D. V. S. Raju, Ganesh B. Kadam and Prashant Kawar (2018). Advances in cultivation of roses under open field conditions. *In: training manual on MANAGE*, Hyderabad sponsored training programme on



- Certified Farm Advisor in Floriculture, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from November 14-18, 2018. pp. 12-14.
2. Ganesh B. Kadam Tarak Nath Saha and Rahul S. Yadav (2019). Dry flowers based entrepreneurship options in tribal area, *In: training manual on “Flower Cultivation to Improve Livelihood of Tribal Farmers”* held at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP) pp.107-120.
  3. Ganesh B. Kadam Tarak Nath Saha and Rahul S. Yadav (2019). Dry flowers based entrepreneurship options in tribal area, *In: Training manual on “Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam”* held at Horticultural Research Station (AAU), Kahikuchi, Guwahati, Asom from February 7-9, 2019 under NEH Plan, pp. 54-67.
  4. Ganesh B. Kadam, Rahul Yadav and Sanjivani Karne (2018). Nursery raising and propagation of ornamental crops. *In: training manual on MANAGE Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture*, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from November 14-18, 2018. pp. 42-47.
  5. Ganesh B. Kadam, T. N. Saha, P. Naveen Kumar and D. V. S. Raju (2018). Cultivation of gladiolus for cut flower production. *In: training manual on MANAGE Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture*, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from November 14-18, 2018. pp. 191-198.
  6. Ganesh B. Kadam, Tarak Nath Saha, P. Naveen Kumar and D. V. S. Raju (2019). Production technology of gladiolus, *In: training manual on “Flower Cultivation to Improve Livelihood of Tribal Farmers”* held at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP) pp.61-70.
  7. Ganesh B. Kadam, Tarak Nath Saha, P. Naveen Kumar and D. V. S. Raju (2019). Production technology of gladiolus, *In: Training manual on “Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam”* held at Horticultural Research Station (AAU), Kahikuchi, Guwahati, Asom from February 7-9, 2019 under NEH Plan, pp.45-53.
  8. Ganesh B. Kadam, Tarak Nath Saha, P. Naveen Kumar and Prashant Kavar (2019). Cultivation of marigold for hilly areas, *In: training manual on “Flower Cultivation to Improve Livelihood of Tribal Farmers”* held at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP) pp.47-51.
  9. Ganesh Kadam, Tarak Nath Saha, Prabha, P Naveen Kumar and Prashant Kavar (2018). Year round cultivation of marigold for loose flower production. *In: training manual on MANAGE Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture*, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from November 14-18, 2018. pp. 23-27.
  10. K. V. Prasad and Safeena S.A. (2018). Vertical farming in Floriculture. *In: Training Manual of Certified Farm Advisor in Floriculture (Module-II)* (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp: 250-256.
  11. Kavar, P.G., Jadav P and Shraddha Wable (2018). Micropropagation in ornamentals crops. *In: training manual on MANAGE Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture*, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from November 14-18, 2018.
  12. P. Naveen Kumar, D.V.S. Raju, Safeena S. A. and Prashant Kavar (2018). Post Harvest Management in Ornamental Crops. *In :Training Manual of Certified Farm Advisor in Floriculture (Module-II)* (14-28

- November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp: 166 – 173.
13. P. Naveen Kumar, Tarak Nath Saha, Ganesh B Kadam and D. V. S. Raju (2018). Prospects of bulbous ornamental crops. *In*: training manual on manage Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from November 14-18, 2018. pp. 231-245.
  14. P. Naveen Kumar, Tarak Nath Saha, Ganesh B. Kadam and Abhishek Verma (2018). Advances in cultivation of tuberose for cut and loose flower production. *In*: training manual on MANAGE Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune from November 14-18, 2018. pp. 56-62.
  15. Safeena, S. A. (2018). Advances in cultivation of jasmine for loose flower production. *In*: Training Manual of Certified Farm Advisor in Floriculture (Module-II) (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp: 73-81.
  16. Safeena, S. A. (2018). Dry flowers – everlasting ornamentals. *In*: Training Manual of Certified Farm Advisor in Floriculture (Module-II) (November 14-28, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp: 147-156.
  17. Safeena, S. A. (2018). Potential of ornamental plants in mitigating indoor air pollution. *In* : Training Manual of Certified Farm Advisor in Floriculture (Module-II) (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp : 63-72.
  18. Safeena, S. A. (2018). Specialty flower crops. *In* : Training Manual of Certified Farm Advisor in Floriculture (Module-II) (November 14-28, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp: 131-140.
  19. Tarak Nath Saha and K. V. Prasad (2018). Essential oils from flower crops. *In*: Training Manual of Certified Farm Advisor in Floriculture (Module-II) (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp. 174-190.
  20. Tarak Nath Saha, Ganesh B. Kadam and K.V.Prasad (2019). Chrysanthemum: a remunerative crop for NEH Region, *In*: Training manual on “Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam” held at Horticultural Research Station (AAU), Kahikuchi, Guwahati, Asom from February 7-9, 2019 under NEH Plan, pp. 11-25.
  21. Tarak Nath Saha, Ganesh B. Kadam and K.V.Prasad (2019). Production Technology of Carnation, *In*: Training manual on “Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Asom” held at Horticultural Research Station (AAU), Kahikuchi, Guwahati, Asom from February 7-9, 2019 under NEH Plan, pp. 1-10.
  22. Tarak Nath Saha, Ganesh B. Kadam, P. Naveen Kumar, D. V. S. Raju, Shilpashree and K.V.Prasad (2019). Chrysanthemum: a remunerative crop for tribal farmers, *In*: training manual on “Flower Cultivation to Improve Livelihood of Tribal Farmers” held at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP) pp.30-46.
  23. Tarak Nath Saha, Ganesh B. Kadam, P. Naveen Kumar, D.V.S. Raju, K. G. Shilpashree and K. V. Prasad (2018). Cultivation of chrysanthemum for loose flower production. *In*: Training Manual of Certified Farm Advisor in Floriculture (Module-II) (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp. 28-41.



24. Tarak Nath Saha, P. Naveen Kumar, Ganesh B. Kadam and K. V. Prasad (2018). Seed production of annual flowers. *In: Training Manual of Certified Farm Advisor in Floriculture (Module-II)* (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE). pp. 82-87.

### Book Chapters

1. Kavar, P.G.,Kardile, H.B., Raja S, Dutt S, Kumar R, Manivel P, Bhardwaj V., Singh B.P., Govindakrishnan P.M. and Chakrabarti S.K. (2018) Developing early maturing and stress resistant potato varieties' part of book entitled "Achieving sustainable cultivation of potatoes Vol.1 (Ed. Prof. Gefu Wang-Pruski)" Burleigh Dodds Science Publishing Limited 82 High Street, Sawston, Cambridge CB223HJ UK.
2. Safeena, S. A. and K. V. Prasad (2018). Vertical Farming: Status, Researchable Issues and Way Forward–Floricultural Crops. *In: Vertical Farming: Status, Researchable Issues and Way Forward.* Janakiram, T.; Kaushik, Nutan; Pandey, Vikramaditya; Singh, Ranvir and Sharma, Abhishek (*eds.*), pp. 180. Published by: Indian Council of Agricultural Research, Krishi Anusandhan Bhawan-II, Pusa, New Delhi – 110012 *and* Amity University Uttar Pradesh, Sector 125, Noida – 201313. Pp. 86-122 along with the Chronology pp. 162-180.

## Presentations in Conferences / Symposia / Seminar / others

1. D. V. S. Raju (2018). Production technology of rose. *In*: TSP Training on Commercial Flower Production held at NAU Navsari, Gujarat from December 12-14, 2018.
2. D. V. S. Raju (2019). Advances in cultivation of tuberose for cut and loose flowers. *In*: Training Programme for Developing Entrepreneurship in Floriculture, KVK, ADT, Baramati, Pune, January 23-25, 2019.
3. Ganesh B. Kadam (2019). Dry flowers and other flower based entrepreneurship options. *In*: Training Programme for Developing Entrepreneurship in Floriculture, KVK, ADT, Baramati, Pune, January 23-25, 2019.
4. Ganesh B. Kadam (2019). Ornamental nursery industry: opportunities and challenges. *In*: Training Programme for Developing Entrepreneurship in Floriculture, KVK, ADT, Baramati, Pune, January 23-25, 2019.
5. Ganesh B Kadam (2019). शेवंतीलगवाडीचे आधुनिक तंत्रद्यान. *In*: पिक परिसंवाद, पिक प्रात्यक्षिक व कृषि प्रदर्शन held at KVK Narayangaon, Pune from January 3-6, 2019.
6. Ganesh B. Kadam (2019). Paper (oral) was presented at National Conference on Ornamental Horticulture to Uplift Rural Economy held at MPUAT, Udaipur. January 11-13, 2019.
7. Ganesh B. Kadam Tarak Nath Saha and Rahul S. Yadav (2019). Dry flowers based entrepreneurship options in tribal area. *In*: TSP training on “Flower Cultivation to Improve Livelihood of Tribal Farmers” held at ICAR NEH Complex Umiam, Meghalaya from February 04-06 2019 under Tribal Sub-Plan (TSP).
8. Ganesh B. Kadam, D. V. S. Raju, Prashant Kwar, Tarak Nath Saha and K V Prasad (2019). Status of flower marketing in India: A case study of Pune flower market. *In*: National Conference on Ornamental Horticulture to Uplift Rural Economy held at MAPUAT, Udaipur. January 11-13, 2019.
9. Ganesh B. Kadam, Tarak Nath Saha, Naveen Kumar and D. V. S. Raju (2019). Production technology of gladiolus. *In*: training manual on “Flower Cultivation to Improve Livelihood of Tribal Farmers” held at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP).
10. Ganesh B. Kadam (2018). Production technology of gladiolus cultivation in tribal area. *In*: TSP Training on Commercial Flower Production held at NAU Navsari, Gujarat from December 12-14, 2018.
11. Ganesh B. Kadam (2019). Crop production with precision farming in fruit vegetables and ornamental plants for domestic and export market. *In*: Refresher Training Programme on Business Opportunities in Horticulture for Established Agripreneurs organized by MANAGE, Hyderabad at Department of Extension, College of Agriculture Pune, from February 25-28, 2019.
12. Kwar, P.G. (2019). Tissue culture industry in ornamental crops. *In*: Training programme for developing Entrepreneurship in floriculture, KVK, ADT, Baramati, Pune January 23-25, 2019.
13. P. Naveen Kumar (2019). Lecture delivered on Advances in cultivation of tuberose for cut and loose



- flowers. *In*: Training Programme for Developing Entrepreneurship in Floriculture, KVK, ADT, Baramati, Pune, January 23-25, 2019.
14. P. Naveen Kumar (2018). Lecture delivered on Advances in cultivation of tuberose for cut and loose flowers. *In*: MANAGE, Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune, November 14-18, 2018.
  15. P. Naveen Kumar (2018). Lecture delivered on Cultivation of Bulbous Ornamentals., *In*: MANAGE, Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune, November 14-18, 2018.
  16. P. Naveen Kumar (2018). Lecture delivered on Post-Harvest Management in Ornamental Crops. *In*: MANAGE, Hyderabad sponsored training programme on Certified Farm Advisor in Floriculture, held at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune, November 14-18, 2018.
  17. Prabha K. (2018). Lead lecture entitled “Point of Care Diagnostics for Plant Viruses: Recent Trends and Future Advances” in “INTERVIROCON 2018”- “Global Viral Epidemics:A Challenging Threat” an international conference of Indian Virological Society at PGIMER, Chandigarh, India from November 10-14, 2018.
  18. Safeena S. A. (2018). Advances in cultivation of jasmine for loose flower production during Certified Farm Advisor Training Programme on Floriculture (Module-II) (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and MANAGE on November 16, 2018.
  19. Safeena S. A. (2018). Dry flowers: an everlasting ornamentals during Certified Farm Advisor Training Programme on Floriculture (Module-II) (November 14-28, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management on November 20, 2018.
  20. Safeena S. A. (2019). Landscaping components with ornamental plants during the Training Programme on Floriculture and Protected Cultivation organized by ICAR-DFR, Pune at the lecture hall of ICAR - IVRI TEC on March 20, 2019.
  21. Safeena S. A. (2018). Potential of ornamental plants in mitigating indoor air pollution during Certified Farm Advisor Training Programme on Floriculture (Module-II) (November 14-28, 2018) jointly organized by ICAR-DFR, Pune and MANAGE on November 16, 2018.
  22. Safeena S. A. (2019). Recent advances in production technology of flower crops *viz.*, gladiolus, marigold, tuberose and Bird of Paradise during the Two days Training programme on “Recent Advances in Floriculture” (February 7-8, 2019) for the benefit of Progressive Farmers from Himachal Pradesh under Development Foundation (registered with NGO Darpan, NITI AAYOG, Government of India) at the lecture hall of ICAR - IVRI TEC on February 7, 2019.
  23. Safeena S. A. (2018). Specialty flowers during Certified Farm Advisor Training Programme on Floriculture (Module-II) (November 14-28, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE) on November 20, 2018.
  24. Safeena S. A. (2019). Vertical Gardening: Emerging Opportunities and Challenges during the Three days Training Program on Developing Entrepreneurship in Floriculture organized by ICAR-Agricultural Technology Application Institution and ICAR-DFR, Pune at Krishi Vigyan Kendra, Agricultural Development Trust, Baramati from January 23-24, 2019.
  25. Safeena S. A. (2018). Lecture cum demonstration on Different methods of dehydration for preparation of dry flowers and methods for preparation of Potpourri from dried petals of flower crops to 150 participants



including the staff members from ICAR-DFR, Pune, ICAR-NRC for Grapes, Farmers and Villagers during Workshop on “Generation of Wealth out of Waste” at ICAR- National Research Centre for Grapes, Pune on October 2, 2018.

26. Safeena S. A., M. Thangam and N. P. Singh (2018). Conservation and Evaluation of different cut foliage species comprising Pteridophytes (Ferns and fern allies) of West Coast Regions of India. *In*: “National Symposium on Coastal Agriculture: Boosting Production Potential under Stressed Environment” from 28<sup>th</sup> September to 01<sup>st</sup> October, 2018 held at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra.
27. Tarak Nath Saha, Ganesh B. Kadam and K. V. Prasad (2019). Spider lily and unexploited multipurpose ornamental crop. *In*: National Conference on Ornamental Horticulture to Uplift Rural Economy held at MPUAT, Udaipur. January 11-13, 2019. (Invited Oral)
28. Tarak Nath Saha (2018). Delivered a lecture during a training programme on chrysanthemum cultivation practices (new varieties, new techniques) and pest management organized at Village Kinhi (Parner), Dist-Ahmednagar by BAIF Institute for sustainable Livelihood and Development on June 25, 2018.
29. Tarak Nath Saha (2018). delivered lectures on Essential oils from flower crops, Cultivation of chrysanthemum for loose flower production and Seed production of annual flowers during the Training Programme of Certified Farm Advisor in Floriculture (Module-II) (14-28 November, 2018) jointly organized by ICAR-DFR, Pune and National Institute of Agricultural Extension Management (MANAGE), Hyderabad
30. Tarak Nath Saha (2019). Delivered lecture on Chrysanthemum: a remunerative crop for tribal farmers during the Training Programme on “Flower Cultivation to Improve Livelihood of Tribal Farmers” held at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP).
31. Tarak Nath Saha (2019). Delivered lectures on Production Technology of Carnation, and chrysanthemum: a remunerative crop for NEH region during the Training Programme on “Role of Commercial Floriculture for Promotion of Livelihood of Small and Marginal Flower Growers of Assam” held at Horticultural Research Station (AAU), Kahikuchi, Guwahati, Assam from February 7-9, 2019 under NEH Plan.
32. Tarak Nath Saha (2018). Delivered a lecture on Chrysanthemum Cultivation during the TSP Training on Commercial Flower Production held at NAU Navsari, Gujarat from December 12-14, 2018.
33. Tarak Nath Saha (2019). Delivered a lecture on Improved Cultivation Practices in Chrysanthemum during the training Programme for Developing Entrepreneurship in Floriculture held at KVK (ADT), Baramati, Pune, during January 23-25, 2019.

### Radio and TV Talks

- Ganesh B. Kadam: TV Talkon “फुल पिकांमधील सुत्र कृषिचे व्यवस्थाप” in Krishi Darshan Program on DD Sahyadri telecasted on August 28, 2018 (6.10-6.30pm).
- Ganesh B. Kadam: TV Talk on “फुलांपासून नैसर्गिक तेलांचे उत्पादन व त्यातील व्यवसायाची संधी” in Krishi Darshan Program on DD Sahyadri Livetelecasted on February 02, 2019 (6.10pm).
- Prashant G. Kavar delivered a talk entitled 'फुल शेतीमध्ये जैवतंत्रज्ञानाची उपयुक्तता व प्रसाराची गरज' in Marathi in the Krishidarshan Program of DD Mumbai aired on February 10, 2018 (6:10pm).
- Prashant G. Kavar delivered a talk on topic entitled 'टिशूकल्चरचा फुल पिकामध्ये वापर व उपयोगिता' in Marathi in the Krishidarshan Program of DD Mumbai aired on February 14, 2019 (6:10pm).



# Training and Capacity Building

## Training Programmes Organized

S. No.	Training Programme	Coordinators
1	On-Farm Training on "Chrysanthemum Propagation Techniques" at Village Kamargaon, Ahmednagar on August 10, 2018.	Dr. Tarak Nath Saha and Dr. Ganesh B. Kadam
2	Workshop on "Importance of Segregation of Waste and Disposal" as part of 'Swachhta Hi Sewa Campaign' at ICAR-DFR, Pune in collaboration with 'Adar Poonawalla Clean City Initiative' on September 26, 2018 at Training Hall, TEC-IVRI, Regional Station, Pune	Dr. Safeena S. A.
3	Certified Farm Advisor Training Programme on Floriculture (Module-II) (November 14-28, 2018) jointly organized by ICAR-DFR, Pune and MANAGE.	Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam and Dr. K. V. Prasad
4	TSP Training on Commercial Flower Production held at NAU Navsari, Gujarat from December 12-14, 2018.	Dr. K. V. Prasad, Dr. D. V. S. Raju, Dr. Tarak Nath Saha and Dr. Ganesh B. Kadam
5	Awareness Workshop on "Plant Parasitic Nematode: A Hidden Threat to Nursery Industry" on December 14, 2018 at ICAR-CTRI	Dr. K. V. Prasad and Dr. P. Naveen Kumar
6	Workshop on "Generation of Wealth out of Waste" at ICAR- NRCG Pune on October 2, 2018 as Nodal Officer, Swachh Bharat Abhiyaan.	Dr. Safeena S. A.
7	Progressive Farmers Training Programme for farmers from Himachal Pradesh Government at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune on January 28, 2019.	Dr. Ganesh B. Kadam and Dr. Tarak Nath Saha
8	TSP Training at ICAR NEH Complex Umiam, Meghalaya from February 04-06, 2019 under Tribal Sub-Plan (TSP).	Dr. Ganesh B. Kadam and Dr. Tarak Nath Saha
9	Organized three days farmers training on Flower Cultivation to Improve Livelihood of Hilly Region" held at HRS, AAU, Kahikuchi, Assam, from February 07-09, 2019 under NEH.	Dr. Tarak Nath Saha and Dr. Ganesh B. Kadam
10	Two days Training programme on "Recent Advances in Floriculture" (7-8 February, 2019) for the benefit of Progressive Farmers from Himachal Pradesh under Development Foundation (registered with NGO Darpan, NITI AAYOG, Govt. of India) at the lecture hall of ICAR - IVRI TEC on February 7, 2019.	Dr. Safeena S. A.
11	Organized one day training-cum interactive session to floriculture farmers of KVK, Solapur at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune on December 12, 2018.	Dr. Ganesh B. Kadam and Dr. Tarak Nath Saha
12	Skill Training Programme on Floriculture for Technical Staff of the directorate at ICAR-Directorate of Floricultural Research, Shivajinagar, Pune on March 20, 2019	Dr. Tarak Nath Saha

### Training Programmes Attended

S. No.	Training Programme	Scientists Attended
1.	Study Visit and Practical Training on DUS Testing of Rose at Bundessortenamt, Hannover, Germany during 9th to 13th July, 2018 under Indo-German Bilateral Cooperation.	Dr. D. V. S. Raju
2.	Climate change and abiotic stress management strategies for doubling farmers income held at ICAR-NIASM, Baramati from September 7-27, 2018	Dr. Shilpashree K. G.
3.	Training of Trainers program at ICAR-ATARI-Kanpur organized by ASCI (Agril. Skill Council of India) during December 17-19, 2018.	Dr. P. Naveen Kumar
4.	ISO 9001:2015 Awareness Training course	Dr. P. Naveen Kumar, Dr. D. V. S. Raju, Dr. Prashant G. Kawar, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam, Dr. Safeena, S. A. Dr. Prabha K., Dr. Shilpashree K.G., Mr. Abhishek Verma, Ms. Preetam Jhadav, Mr. R. S. Bhatt, Mr. Deepak Verma, Mr. Rupesh Kumar Pathak, Mr Mahadev Babu Walke, Mr. Sudesh Kumar
5.	Hands on workshop on mass spectroscopy based proteomics for beginners	Dr. Prashant G. Kawar
6.	Proteomics and its applications in agriculture	Dr. Prashant G. Kawar
7.	Practical aspects of KRISHI Repositories at ICAR-IASRI, New Delhi during March 18-19, 2019	Dr Tarak Nath Saha
8.	Establishment and financial matters for Assistants/ AAOs/ AOs / JAO/ AFAO/FAO/Section Officers of ICAR dealing with the subject	Mr. R. S. Bhatt
9.	Organisation Specific Programme (OSP) at ISTM, New Delhi from 14.05.2018 to 8.06.2018	Mr Mahadev Babu Walke
10.	Skill Training Programme on Floriculture for Technical Staff at ICAR-DFR, Shivajinagar, Pune on March 20, 2019	Mr. Abhishek Verma, Ms. Preetam Jhadav and Ms. Poornima Gaikwad



### Participation in Conferences/Symposia/Seminar/Others

S. No.	Conference/Seminar/Symposia	Participation
1	Agritech Summit-2018 in Pune organised by Navabharat, Group, National Hindi Daily at Dr. Shirname Auditorium Hall, Agrl. College, Pune on April 21, 2018.	Dr. P. Naveen Kumar, Dr. D. V. S. Raju, Dr. Prashant G. Kawar, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam, Dr. Safeena, S. A. Dr. Prabha K., Dr. Shilpashree K.G.
2	Workshop on Saving Lives and Property through Severe Weather Alerting based on Total Lightning Detection organized by U.S. Commercial Service India in Mumbai on May 23, 2018.	Dr. Ganesh B. Kadam
3	Valedictory session and address by Hon'ble Shri Venkaiah Naidu, Vice-President of India during National Consultation on "Making Agriculture Sustainable & Profitable" Swarajya to Surajya Series on June 22, 2018 at Vaikunth Mehta National Institute of Co-operative Management (VAMNICOM).	Dr. K. V. Prasad, Dr. Prashant G. Kawar, Dr. D. V. S. Raju, Dr. Tarak Nath Saha, Dr. Safeena S. A.
4	7th International Conference on Agriculture, Horticulture and Plant Sciences (ICAHPS 2018), June 28-29, 2018 at Shimla, Himachal Pradesh jointly organized by The Society of Tropical Agriculture, New Delhi and ICAR-IARI, Regional Station, Shimla (Himachal Pradesh).	Dr. Safeena S. A.
5	XXVII AGM of AICRP on Floriculture held at TNAU Coimbatore from July 27-29, 2018.	Dr. K. V. Prasad, Dr. P. Naveen Kumar, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam, Dr. Prabha K., Dr. Shilpashree KG.
6	Inaugural programme of Project Green Thumb at Mumbai on August 13, 2018.	Dr. D. V. S. Raju
7	National Symposium on "Coastal Agriculture: Boosting Production Potential under Stressed Environment" from 28th September to 01st October, 2018 held at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra.	Dr. Safeena S. A.
8	National Workshop on Digital Field Book at ICAR-DOGR September 29, 2018.	Dr. P. Naveen Kumar, Dr. D. V. S. Raju and Dr. Prashant G. Kawar, Mr. Abhishek Verma
9	Stall exhibition at Kisan Aadhar Sammelan-2018, held at MPKV Rahuri from October 15-18, 2018.	Dr. Ganesh B. Kadam, Dr. Tarak Nath Saha, Dr. P. Naveen Kumar, Dr. Safeena S. A., Dr. D. V. S. Raju, Dr. Shilpashree KG.
10	National Workshop on "e-crop an IoT solution in Agriculture" - ICAR-CTCRI, September 5-7, 2018.	Dr. Prabha K.

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S. No.	Conference/Seminar/Symposia	Participation
11	Point of Care Diagnostics for Plant Viruses: Recent Trends and Future Advances" in "INTERVIROCON 2018"- "Global Viral Epidemics:A Challenging Threat" an international conference of Indian Virological Society at PGIMER, Chandigarh, India from November 10-14, 2018	Dr. Prabha K.
12	National Workshop on Vertical Farming on October 18, 2018 organized by Horticulture Science Division of Indian Council of Agricultural Research, New Delhi in collaboration with Amity University Uttar Pradesh, at the National Agricultural Science Complex, ICAR, New Delhi.	Dr. K. V. Prasad and Dr. Safeena S. A.
13	KISAN AGRI SHOW (India's Largest Agri Show) at International Exhibition Arena, Moshi, Pune during December 12-16, 2018.	Dr. P. Naveen Kumar, Dr. D. V. S. Raju, Dr. Prashant G. Kawar, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam, Dr. Safeena, S. A. Dr. Prabha K., Dr. Shilpashree K.G.
14	National Conference on Ornamental Horticulture to Uplift Rural Economy held at MPUAT, Udaipur from January 11-13, 2019.	Dr. K. V. Prasad, Dr. Tarak Nath Saha and Dr. Ganesh B. Kadam
15	Stall exhibition on 18th January 2019 during KRUSHAK- Live Demo and Agri Expo-2019 held at KVK, Baramati, Pune during January 17-20, 2019.	Dr. P. Naveen Kumar, Dr. D. V. S. Raju, Dr. Prashant G. Kawar, Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam, Dr. Safeena, S. A. Dr. Prabha K., Dr. Shilpashree K.G.
16	Training Programme for Developing Entrepreneurship in Floriculture, KVK, ADT, Baramati, Pune, January 23-25, 2019.	Dr. P. Naveen Kumar, Dr. D. V. S. Raju, Dr. Ganesh B. Kadam, Dr. Tarak Nath Saha, Dr. Safeena S. A.
17	Farmers training on Flower Cultivation to Improve Livelihood of Hilly Region" held at HRS, AAU, Kahikuchi, Assam, from February 07-09, 2019 under NEH.	Dr. Ganesh B. Kadam and Dr. Tarak Nath Saha
18	Krishi Kumbh 2019 at Motihari during February 9-11, 2019.	Dr. P. Naveen Kumar and Dr. D. V. S. Raju
19	ICAR-BSMA Horticulture Workshop at BCKV, Kalyani during February 21-23, 2019.	Dr. K. V. Prasad and Dr. D. V. S. Raju
20	14 <sup>th</sup> International Flora Expo 2019 organized by Media Today Group on February 22, 2019 at Messe Global, Exhibition and Convention Centre, Laxmi Lawns, Magarpatta, Pune.	Dr. Safeena S. A., Dr Prabha and Dr. Tarak Nath Saha

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S. No.	Conference/Seminar/Symposia	Participation
21	Refresher Training Programme on Business Opportunities in Horticulture for Established Agripreneurs organized by MANAGE, Hyderabad at Department of Extension, College of Agriculture Pune, from February 25-28, 2019.	Dr. Ganesh B. Kadam
22	ICAR-BSMA Meeting at UUHF, Bharsar for revision of horticulture syllabus, January 08-10, 2019	Dr. D. V. S. Raju
23	Stall exhibition at GLOBAL FARMERS -Live Demos, Agri Exhibition and Crop conference at KVK Narayangaon from January 03-06, 2019.	Dr. P. Naveen Kumar, Dr. D. V. S. Raju, Dr. Ganesh B. Kadam, Dr. Tarak Nath Saha, Dr. Safeena S. A., Dr. Shilpashree

## Awards/Recognition

1. Safeena S. A. Conferred with Young Scientist Award – 2018 during the 7<sup>th</sup> International Conference on Agriculture, Horticulture and Plant Sciences (ICAHPS 2018) held on June 28-29, 2018 at the Hotel Landmark, The Mall, Shimla, Himachal Pradesh which was jointly organized by The Society of Tropical Agriculture, New Delhi and ICAR-IARI (Indian Agricultural Research Institute), Regional Station, Shimla (Himachal Pradesh).
2. Dr. Tarak Nath Saha awarded best Oral in the theme-IV: Arboriculture, eco-management and eco-tourism (entitled Spider Lily: An unexploited multipurpose ornamental crop) during the National Conference on Ornamental Horticulture to Uplift Rural Economy held at MPUAT, Udaipur, Rajasthan during January 11-13, 2019.
3. Ganesh B. Kadam awarded best paper (oral) presentation In: National Conference on Ornamental Horticulture to Uplift Rural Economy held at MAPUAT, Udaipur, Rajasthan from January 11-13, 2019.

## AICRP on Floriculture

All India Coordinated Research Project (AICRP) on Floriculture was established during IV Five-Year Plan in the year 1970-71 to carry out nation-wide interdisciplinary research by linking ICAR Institutes with State Agricultural Universities (SAUs). The necessity of the project has been examined from time to time in view of growing importance and potential for floriculture in different regions of the country and the number of Coordinated Centres as well as the research programmes was modified accordingly. At present the Coordinated Project has 22 Centres which includes 13 budgetary, 5 institutional and 4 voluntary Centres.

Sr. No.	Centre	Year of Start	Crops
Budgetary Centres			
1.	Floricultural Research Station (SKLTSHU), Hyderabad, Telangana	1987	Chrysanthemum, crossandra, China Aster, Jasmine, tuberose, rose, dahlia, underexploited ornamentals (heliconia, Bird of Paradise)
2.	Horticultural Research Station (AAU), Kahikuchi, Guwahati, Assam	2001	Orchids, tuberose, gerbera, marigold, underexploited ornamentals (heliconia, Bird of Paradise, lotus), fillers (Fern)
3.	Bidhan Chandra Krishi Viswavidyalaya, Kalyani, District-Nadia, WB	1972	Chrysanthemum, orchids, tuberose, marigold, dahlia, gladiolus, China Aster, gerbera, fillers (Fern)
4.	Birsa Agricultural University, Ranchi, Jharkhand	2001	Rose, marigold
5.	Dr. Y. S. Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh	1975	Rose, gladiolus, carnation, gerbera, chrysanthemum, tulip, daffodil, liliun, alstroemeria, underexploited ornamentals (Bird of Paradise, ginger lily, lotus), fillers (asparagus, dracaena, gypsophila, ferns)
6.	G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand	2001	Rose, gladiolus, chrysanthemum, tuberose, dahlia
7.	Kerala Agricultural University, Vellanikkara, Thrissur, Kerala	1975	Orchids, anthurium, crossandra, jasmine, marigold, underexploited ornamentals (bird of paradise, ginger lily & lotus), fillers (asparagus, dracena, gypsophila & ferns)
8.	National Agricultural Research Project (MPKV), Ganeshkhind, Pune, Maharashtra	1975	Rose, gladiolus, carnation, tuberose, gerbera, marigold, underexploited ornamentals (Bird of Paradise, ginger lily), China Aster
9.	Punjab Agricultural University, Ludhiana, Punjab	1975	Rose, gladiolus, chrysanthemum, marigold, dahlia, gerbera, tuberose, fillers (ferns)



Sr. No.	Centre	Year of Start	Crops
10.	Rajasthan College of Agriculture (MPUAT), Udaipur, Rajasthan	1980	Gladiolus, chrysanthemum, tuberose, rose
11.	Odisha University of Agriculture and Technology, Bhubaneswar, Odisha	2011	Rose, tuberose, gerbera, marigold, underexploited ornamentals (lotus)
12.	Sher-E-Kashmir University of Agricultural Sciences & Technology, Shalimar Campus, Srinagar, Jammu & Kashmir	1987	Gladiolus, tulip, daffodil, liliun, alstroemeria
13.	Horticultural College and Research Institute (TNAU), Coimbatore, Tamil Nadu	1982	Chrysanthemum, anthurium, tuberose, carnation, gerbera, crossandra, China aster, jasmine, marigold, rose
<b>Institutional Centres</b>			
14.	ICAR-Indian Agricultural Research Institute, New Delhi	1971	Rose, gladiolus, chrysanthemum, marigold
15.	ICAR-Indian Agricultural Research Institute, Regional Station, Katrain, Himachal Pradesh	1971	Gladiolus, liliun, dahlia
16.	ICAR-Indian Institute of Horticultural Research, Hessaraghatta, Bengaluru, Karnataka	1971	Rose, gladiolus, carnation, chrysanthemum, tuberose, gerbera, marigold, underexploited ornamentals (heliconia), crossandra, China Aster, jasmine, dahlia
17.	ICAR Research Complex for NEH Region, Umiam, Meghalaya	1971	Orchids, gerbera
18.	ICAR- Central Island Agricultural Research Institute, Port Blair	2016	Anthurium, underexploited ornamentals (heliconia), China aster, crossandra, jasmine
<b>Voluntary Centres</b>			
19.	College of Horticulture and Forestry (CAU), Pasighat, Arunachal Pradesh	2016	Gladiolus, tuberose
20.	Navsari Agricultural University, Navsari, Gujarat	2016	China aster, rose, fillers (asparagus, dracaena, gypsophila, ferns)
21.	Indira Gandhi Krishi Viswavidyalaya, Raipur, Chhatishgarh	2016	Tuberose, marigold
22.	Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar	2010	Tuberose, marigold, gerbera



## XXVII Annual Group Meeting of AICRP on Floriculture

### ICAR-Directorate of Floricultural Research, Pune held at Tamil Nadu Agricultural University, Coimbatore during July 27-29, 2018

The XXVII Annual Group Meeting (AGM) of AICRP on Floriculture was held during August 27-29<sup>th</sup>, 2018 at TNAU, Coimbatore. Review of the research work done during the last year (2017-18) at coordinated centres (22 nos.) and preparation of technical programme for the years 2018-2021 are the major objectives of this AGM. There were nine technical sessions besides inaugural and plenary. In the inaugural session (on July 27, 2018), Dr. T. Janakiram, ADG (HS-II), ICAR was the chief guest, while Dr. K. Ramaraju, Director of Research, TNAU, Coimbatore presided over the function.

#### Release of Publications

Released publications include- (1) Roadmap for Branding Rose Products, a technical publication jointly from ICAR-DFR, Pune and ICAR-Horticultural Science Division, New Delhi; (2) Annual Report 2017-18 of AICRP on Floriculture in the form of a CD; (3) Current issue of ICAR-DFR Newsletter; (4) Proceedings and recommendations of the National Symposium on Recent Advances in Floriculture and Urban Horticulture in Global Perspective (held at BCKV, at Kalyani during January 4-5, 2018); and (5) '*A Guide on Commercial Flowers*', a technical publication from TNAU, Coimbatore.

#### Chief Guest's Remarks

Dr. T. Janakiram, ADG (HS-I), ICAR congratulated different centres for various achievements and he stressed on the need to increase the visibility of the achievements made so as to get due recognition to the floriculture sector. He directed all the centres to document the impact of the technologies disseminated through AICRP. He also emphasized the importance of estimating the value of the technology released in the society. He complimented the teams at MPUAT, Udaipur and ICAR-DFR for documenting the contributions of AICRP-Udaipur centre in taking forward the cultivation of rose species for making the value add products and preparing a road map for the same. He encouraged other centres also to document such success stories. He appreciated the efforts made by TNAU and ICAR-DFR in organizing the programme befittingly.

#### Salient Achievements of AICRP on Floriculture During 2018-19

Dr. K. V. Prasad, Director, ICAR-DFR made a presentation on salient research achievements during 2017-18, few success stories and extension activities undertaken by the Coordinated Centres.

Dr M. Jawaharlal, Dean (Hort), HC&RI, TNAU, Coimbatore highlighted the fact that floriculture is the sector which has the potential for doubling of farmers' income. At the end of the address he thanked ICAR for choosing TNAU for hosting the 27th AICRP group meeting. Dr. K. Ramaraju, Director of Research, TNAU, Coimbatore, in his address he touched up on a number of aspects of floriculture and gave a profile of floriculture cultivation in Tamil Nadu state. He expressed the need for the growth of floriculture sector in India to be at par with other major flower exporting countries.

#### Technical Sessions for Review of the Work and Compilation of Technologies

In the first Technical session, Dr. K. V. Prasad, Director, DFR presented action taken report (ATR) on the recommendations of XXVI AGM of AICRP on Floriculture held at ICAR-IIHR, Bengaluru. Dr. T. Janakiram, Chairman of the session emphasized that the testing of varieties at Centre of Excellence/KVKs shall be promoted and third-party evaluation of technology may be carried out for better acceptance of technology by the stakeholders.

The proposals of identified varieties/advanced lines are to be prepared and submitted by the coordinated centres/breeders to enable their release through CVRC. He said that the council is in the process of developing the guidelines for evaluating the performance of coordinated centres and their impact analysis and requested the Directorate to follow the same. It will help in assessing the strengths and weaknesses of the centres and to motivate the staff.

The Chairman also emphasized to consult the scientists of CRP (Consortia Research Project) on borers for



finalizing the technical programme on plant protection. In various technical sessions spread over three days, the deliberations should be on the listing of technologies in pipeline, measures to improve the performance of centres, preparation of technical programme keeping in view the challenges and priorities in floriculture and also the requirements of the industry.

Keeping in view of the technology adoption of variety Prajwal, the chairman asked TNAU to undertake an impact study of the same in Tamil Nadu. He also requested others to undertake the impact study in other states of the technology/variety developed at AICRP Floriculture. The chairman expressed his concern that none of the floriculture varieties are notified at CVRC level during last five years and urged the project workers to take initiative for their release through SVRC/CVRC.

Dr. M. Jawaharlal, Co-chairman of the session to identify some centres (like IARI New Delhi, IIHR Hessaraghatta, DFR Pune) where one can deposit planting material and other testing centre can collect whenever anyone visiting these places. He also pointed out that if a centre is unable to take any experiment, it should be brought to the notice of Director, DFR immediately. It is sad report it during the time of group meeting.

### Interface with the Industry and Farmers

Dr. M. Jawaharlal, Dean (Hort), HC& RI, TNAU, Coimbatore welcomed the participants of this session and gave prelude about the session. This was followed by a presentation by Ms. Yamini, a Ph. D student of Department of Floriculture and Landscaping, TNAU on “Lotus Research at TNAU”. In her presentation she made an attempt to highlight the research on lotus in China *vis-a-vis* in India. This was followed by presentations from the Floricultural Industry.

- Dr. D. Dhinesh, Technical Executive, KF Bio-Plants, Tamil Nadu spoke about planting material supply in Tamil Nadu and Kerala and the constrains and opportunities in cut flowers.
- Mr. Surendra Mohan, Manager, Hawukal Estate, Kothagiri shared their experiences in Liliun cultivation and Orchid cultivation in non-traditional areas of Tamil Nadu.
- Mr. Balashiva Prasth from M/s. Shiva Floritech, Hosur briefed his experiences on cut rose cultivation in Hosur and he emphasized the importance of managing pest and diseases problems in greenhouse cultivation.
- Mr. Gopal, a progressive farmer from Ooty shared his success story on carnation cultivation.
- Sh. Devi Lal Jat, a progressive farmer from Chittorgarh narrated about desi rose cultivation and value added products from rose. He emphasized the importance of contract farming in rose and need to extend this to other crops also.
- Mr. K. Radhakrishnan, ADH, Ooty explained about carnation planting material supply chain through State Department of Horticulture.



Participants at the XXVII Annual group meeting of AICRP on Floriculture at TNAU, Coimbatore

## Personnel

S. No.	Name	Designation	Particulars
1.	Dr. K. V. Prasad	Director	-
2.	Dr. P. Naveen Kumar	Principal Scientist (Horticulture-Floriculture)	-
3.	Dr. D V S Raju	Principal Scientist (Horticulture-Floriculture)	-
4.	Dr. Prashant G Kawar	Senior Scientist (Genetics and Plant Breeding)	-
5.	Dr. Tarak Nath Saha	Scientist (Horticulture-Floriculture)	-
6.	Dr. A. Safeena	Scientist (Horticulture-Floriculture)	-
7.	Dr. Ganesh B. Kadam	Scientist (Horticulture-Floriculture)	-
8.	Dr. K. Prabha	Scientist (Plant Pathology)	-
9.	Dr .Nitika Gupta	Scientist (Plant Pathology)	-
10.	Dr. Shilpashree K.G.	Scientist (Soil Science)	-
11.	Er. Rahul S. Yadav	Scientist (Agricultural Structure and Process Engineering)	On study leave
12.	Dr. Shephalika Amrapali	Scientist (Economic Botany)	On Study Leave
13.	Dr. K. S. Girish	Scientist (Agricultural Entomology)	On Study Leave
14.	Sh. R.S. Bhatt	Assistant Finance and Accounts Officer	Upto 14.01.2019 (AN)
15.	Sh. Deepak Verma	Assistant	-
16.	Sh. RupeshPathak	Assistant	-
17.	Sh. Mahadev B. Walke	Assistant	-
18.	Sh. Sudesh Kumar	Upper Division Clerck	-
19.	Sh. Ajay Uniyal	Steno Grade III	Upto 10.08.2019 (AN)
20.	Miss. Pritam Jadhav	Technical Assistant (T-3)	23.07.2018 (FN)
21.	Mr. Abhishek Verma	Technical Assistant (T-3)	30.07.2018 (FN)
22.	Miss. Poornima Gaikwad	Technical Assistant (T-3)	05.03.2019 (FN)

### New Joining

Sl. No.	Name	Designation	Joining date
1	Miss. Pritam Jadhav	Technical Assistant (T-3)	23.07.2018 (FN)
2	Mr. Abhishek Verma	Technical Assistant (T-3)	30.07.2018 (FN)
3	Miss. Poornima Gaikwad	Technical Assistant (T-3)	05.03.2019 (FN)



## Transfers

Mr. Radhey Shyam Bhatt, AF&AO got transfer on promotion to ICAR-Central Institute for Research on Goats, Makhdoom, Uttar Pradesh on January 14, 2019.

Mr. Ajay Uniyal, Steno Grade III took transfer to ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh on August 10, 2018.

## Budget (2018-19)

The details of the Budget of ICAR-DFR including AICRP on Floriculture are tabulated as under:

S. N	Head of Account	ICAR-DFR		AICPR on Floriculture	
		Budget	Expenditure	Budget	Expenditure
<b>A. Recurring</b>					
1	Establishment charges	346.62	346.61	574.89	574.89
2	TA	15.00	15.00	9.87	9.87
3	HRD	0.25	0.25	-	-
4	Other Charges	208.94	208.94	57.60	57.60
5	SCSP	10	10	10	10
6	NEH	2	2	-	-
7	TSP	4	4	-	-
	<b>Total (A)</b>	<b>586.81</b>	<b>586.75</b>	<b>652.36</b>	<b>652.36</b>
<b>B. Non-Recurring</b>					
5	Equipment	46.50	46.50	-	-
6	Works	157.24	157.24	-	-
7	Furniture	2.00	1.96	-	-
8	Library Books & Journals	1.00	1.00	-	-
	<b>Total (B)</b>	<b>206.74</b>	<b>206.70</b>	<b>-</b>	<b>-</b>
	<b>Grand Total (A+B)</b>	<b>793.55</b>	<b>793.45</b>	<b>652.36</b>	<b>652.36</b>

# फूलों की उन्नत खेती को बढ़ावा देता आईसीएआर का पुष्प विज्ञान अनुसंधान निदेशालय



**भा. विज्ञान संस्थान** के अध्यक्ष **डॉ. के. व्ही. प्रसाद** के अध्यक्षता में आयोजित कार्यक्रम का शुभारंभ करते हुए **डॉ. के. व्ही. प्रसाद** ने **आईसीएआर** के पुष्प विज्ञान अनुसंधान निदेशालय के अध्यक्ष **डॉ. ए. ए. लाल** को **आईसीएआर** के अध्यक्ष पद का शिरोधार्य किया।

**डॉ. के. व्ही. प्रसाद** ने **आईसीएआर** के पुष्प विज्ञान अनुसंधान निदेशालय के अध्यक्ष **डॉ. ए. ए. लाल** को **आईसीएआर** के अध्यक्ष पद का शिरोधार्य किया।

**डीएफआर**  
के समर्पित वैज्ञानिक कर् रहे लगातार शोध

**रिसर्च के साथ सेवा कार्य भी**

**अनुसंधान की मुख्य विशेषताएं**

- **उन्नत खेती के लिए** उन्नत किस्मों का विकास।
- **पौधों की रक्षा** के लिए उन्नत कीटनाशकों का विकास।
- **पौधों की पोषण** के लिए उन्नत खादों का विकास।
- **पौधों की प्रजनन** के लिए उन्नत तकनीकों का विकास।

**संशोधन केन्द्र की विभिन्न विशेषताएं**

- **उन्नत खेती के लिए** उन्नत किस्मों का विकास।
- **पौधों की रक्षा** के लिए उन्नत कीटनाशकों का विकास।
- **पौधों की पोषण** के लिए उन्नत खादों का विकास।
- **पौधों की प्रजनन** के लिए उन्नत तकनीकों का विकास।

**संशोधन केन्द्र की विभिन्न विशेषताएं**

- **उन्नत खेती के लिए** उन्नत किस्मों का विकास।
- **पौधों की रक्षा** के लिए उन्नत कीटनाशकों का विकास।
- **पौधों की पोषण** के लिए उन्नत खादों का विकास।
- **पौधों की प्रजनन** के लिए उन्नत तकनीकों का विकास।



पुणे : फूलों की उन्नत खेती को बढ़ावा देता आईसीएआर का पुष्प विज्ञान अनुसंधान निदेशालय

## फूल प्रक्रियेसाठी उद्योग उभारण्याची गरज डॉ. लाखनसिंग; शेवंती दिनानिमित्त कार्यक्रमाचे आयोजन

**पुणे (प्रतिनिधी) :** पारंपरिक फुलसुधारण प्रकल्प अंतर्गत पुणे येथील पुष्प प्रक्रियेसाठी उद्योग उभारण्याची गरज आहे, याबाबत डॉ. लाखनसिंग यांनी म्हणले आहे. शेवंती दिनानिमित्त आयोजित कार्यक्रमात डॉ. लाखनसिंग यांनी याबाबतचे मत मांडले आहे. डॉ. लाखनसिंग यांनी म्हणले आहे, फुल प्रक्रियेसाठी उद्योग उभारण्याची गरज आहे, याबाबत डॉ. लाखनसिंग यांनी म्हणले आहे.

**मन राखमनां प्रवर्तमानं धारते**

**पराश्रुद्धिं स तु पुरुगुलसु निवारिंचाली**

**अंगोवन**

मांजरी, जि. पुणे : पुष्प संशोधन संचालनालयाच्या प्रोफेसर बहारलेले शेवंतीचे विविध वाण.

## पुष्प संशोधन संचालनालयाच्या वतीने मंगळवारी शेवंती दिन प्रदर्शनात होणार १५० वाणांचे सादरीकरण

**पुणे (प्रतिनिधी) :** पुष्प संशोधन संचालनालयाच्या वतीने मंगळवारी (ता.११) शेवंती दिनचे आयोजन करण्यात आले आहे. या निमित्ताने मांजरीजवळील (हडसर) प्रोफेसर विविध फुलांच्या लागवडीचे प्रदर्शन आयोजित करण्यात आले असून, यामध्ये विविधवाणी शेवंतीचे सुमारे १५० वाण सादर केले जाणार आहेत. या निमित्ताने शेतकऱ्यांना मार्गदर्शन देण्यात येणार आहे.

## स्पायडर लिलीचे विविधवाणी वाणावर संशोधन : प्रसाद

**पुणे (प्रतिनिधी) :** स्पायडर लिलीचे विविधवाणी वाणावर संशोधन करण्यासाठी पुणे येथील पुष्प प्रक्रियेसाठी उद्योग उभारण्याची गरज आहे, याबाबत डॉ. लाखनसिंग यांनी म्हणले आहे. शेवंती दिनानिमित्त आयोजित कार्यक्रमात डॉ. लाखनसिंग यांनी याबाबतचे मत मांडले आहे. डॉ. लाखनसिंग यांनी म्हणले आहे, फुल प्रक्रियेसाठी उद्योग उभारण्याची गरज आहे, याबाबत डॉ. लाखनसिंग यांनी म्हणले आहे.



Aerial View of ICAR-DFR Farm



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