

वार्षिक प्रतिवेदन
Annual Report
2015-16



भा.कृ.अनु.प.- पुष्प विज्ञान अनुसंधान निदेशालय
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ICAR-Directorate of Floricultural Research
College of Agriculture Campus, Shivajinagar, Pune-411 005, Maharashtra, India

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Preface

I have great pleasure in presenting the Annual Report 2015-16 of the ICAR-Directorate of Floricultural Research, Pune. During the year ICAR-DFR strived its best to fulfill the mandate assigned by the Indian Council of Agricultural Research. Accomplishments in research, post graduate education and outreach programmes of the Directorate are highlighted in this Annual Report.



The ICAR-DFR is reestablishing itself at Pune after relocation from New Delhi during 2014-15. The germplasm of gladiolus (45 cultivars), chrysanthemum (110 cultivars), tuberose (11 cultivars) and turf grasses (20 accessions) were relocated from New Delhi to Pune.

Thirty cultivars of gladiolus were evaluated based on their morphological and flowering traits to assess their suitability under Pune conditions. Cultivars suitable for better spike qualities and earliness were identified.

Forty eight spray type, five pot mums and nine standard type chrysanthemum were evaluated for their growth and flowering parameters under Pune condition.

On the basis of first year evaluation cultivar Arka Nirantara and Prajwal performed better in respect of spike length, rachis length, number of florets per spike and floral diameter.

In order to intensify the breeding programme in tuberose, pod setting and germination behavior was studied in four single cultivars namely Arka Nirantara, Mexican Single, Phule Rajani and Sikkim Selection. Seed setting was found to be season specific with maximum pod and seed setting during June to October in all the four cultivars.

Survey was conducted to record the incidence of insect pests infesting commercial flower crops in Maharashtra, Gujarat, Telangana and Andhra Pradesh. Incidence of thrips and bud borers in important flower crops was documented.

Survey on the incidence of viral and phytoplasma diseases in major flower crops namely tuberose, marigold, China aster, chrysanthemum, annual chrysanthemum, jasmine in open field conditions and rose, gerbera and carnation in protected units was undertaken. Incidence of diseases in foliage and indoor plants, and potted flowering plants in nursery units were also documented.

Electron Microscopy (EM) and PCR based diagnostics of Potyvirus associated with mottling and colour breaking in gladiolus, tuberose and amaryllis has been done. Identification of Cucumovirus and Badnavirus from Jasmine was also studied through Electron Microscopy (EM) and PCR based diagnostics.

Survey on nematode incidence in flower growing areas of Pune region indicated severe incidence of root-knot nematode infestation in tuberose under open field conditions and gerbera under protected cultivation.

Post-harvest packaging of tuberose and jasmine loose flowers practiced by the farmers and post harvest losses due to traditional practices were studied. Further, CFB package for packaging of tuberose loose flower was designed by using Auto CAD.

ICAR-DFR has participated in exhibitions such as Krishi Unnati Mela at ICAR-IARI, New Delhi, Udyan Mela at Venkataramannagudam, (AP), Farmer's Day at ICAR-IARI Regional Station, Pune (MH), Kisan Mela in KVK, Narayangaon (MH) and Kharif Kisan Sammelan and Horticulture Exhibition-2015 at KVK, Bagahara, Muzaffarnagar (UP) etc and displayed the technologies for the benefit of all flower growers.

Most of the scientists participated and presented their research findings in one or more national conference, symposia and seminar etc. Directorate has also published popular articles, technical/extension bulletins and research article for the benefit of end users.

All the institution activities i.e. IRC, RAC, Annual Group Meeting of AICRP (Floriculture), Hindi Workshop and DFR Foundation Day were held timely. All ICAR and Government of India programmes such as Swachh Bharat Abhiana, Mera Gaon Mera Gaurav, Vigilance Awareness Week, World Soil Health Day and Jai Kisan Jai Vigyan Week were organised successfully.

ICAR-DFR got land at two locations namely college of Agriculture campus Shivajinagar (9.44 ha) and Manjri farm, Hadapsar (25.71 ha) which were acquired and final land transfer (7/12 extracts) obtained in the name of ICAR-DFR during February 2016 for the establishment of Directorate.

The Government of Andhra Pradesh has allotted 10.77 acre of land in Vemagiri Village of Kadiyam Mandal for the establishment of ICAR-DFR Regional Research Station, accordingly the Directorate has taken the physical possession of the land and obtained land delivery certificate during November 2015.

During the year 2015-16, ICAR-DFR got three Extramural funded projects from ICAR to bolster the research infrastructure and manpower.

ICAR-DFR places on record its deep sense of gratitude on Dr. T. Mohapatra, Hon'ble Secretary-DARE and Director General, ICAR for his constant support and encouragement in all our endeavours.

I take this opportunity to profusely thank Dr. N. K. Krishna Kumar Honble DDG for guiding ICAR-DFR in research orientation, able guidance and remarkable stewardship.

Dr. T. Janakiram, ADG (HS) and all the members of the Horticulture Division at ICAR including Dr. Ranvir Singh, Dr. B. K. Pandey, Dr. Manish Das, Dr. Vikramaditya Pandey are pillars of strength in all our endeavors. We are indebted to each one of them.

My sincere appreciation goes to the editorial team Dr. Tarak Nath Saha, Dr. Prasanna Holajjer, Dr. Ganesh B. Kadam, Mr. Girish K.S and Dr. Shilpa Shree for their painstaking efforts in compiling the annual report. Team DFR comprising of Dr. Krishan Pal Singh, Dr. Prashant G. Kavar, Dr. Prabha, K., Er. Rahul S. Yadav, Ms. Shephalika Amrapali and Ms. Nitika Gupta deserve all the compliments for discharging various responsibilities while preparing the document. The support and cooperation received from the administration is duly acknowledged.

The financial support received from the ICAR is duly acknowledged.


(K.V.Prasad)

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Executive Summary

Crop Improvement

- The ICAR-DFR is maintaining 110 chrysanthemum, 45 gladiolus, 11 tuberose and 20 turf grass germplasm.
- Thirty cultivars of gladiolus were evaluated based on their morphological and flowering traits to assess their suitability under Pune conditions. Cultivars Jester, Snow Princess, White Prosperity Yellow Stone, Punjab Dawn, Priscilla, Chemistry and Purple Flora were found to be superior for spike qualities under Pune conditions. Cultivars Chandani, Punjab Dawn, Rosiebee Red and Purple Flora were identified as early flowering cultivars.
- Gladiolus hybrids developed by IARI were evaluated under Pune conditions and it was found that hybrids (P-16-1 x Eurovision and Melody Open) performed well in terms of plant height and number of florets per plant.
- Forty promising gladiolus hybrids were identified from the crosses attempted during previous years. Hybrids Chandni x Pricilla, Ocilla x Purple Flora, Ocilla x Verona and Plumtart x Forta Rosa were found promising in respect of morphological and flowering characters. Four hybrids namely Chandni x Pricilla, Ocilla x Purple Flora, Ocilla x Verona and Plumtart x Forta Rosa were found suitable for cut flower production.
- Forty eight spray type, five pot mums and nine standard type chrysanthemum were evaluated for their growth and flowering parameters under Pune condition. Among the spray type cultivars White Queen, Basanti, Ramlal Dada and Sunny were found to be suitable where as among pot mums cultivar Liliput is found to be suitable with respect to dwarfness, compactness and good number of flowers per plant. Among standard type, cultivars Thai-Chen-Queen, Pusa Centenary, White Star and Yellow Star were found to be suitable.
- Seven tuberose cultivars were evaluated for their growth and flowering parameters under Pune condition. On the basis of first year evaluation cultivar Arka Nirantara and Prajwal performed better in respect of spike length, rachis length, number of florets per spike and floral diameter.
- The pod setting and germination behavior in tuberose was studied under Pune conditions and it was found that profuse pod setting during June-August in single cultivars namely Arka Nirantara, Mexican Single, Phule Rajani and Sikkim Selection.

Crop Production

- Influence of different bulb size of tuberose on growth and flowering characteristics was studied and it was found that large size bulbs measuring more than 3.5 cm in diameter and/or 2.5 to 3.5 cm in diameter are optimum for planting of tuberose.
- Performance of improved tuberose cultivars namely Sikkim Selection, Shringar, Phule Rajani, Hyderabad Single, Prajwal and Arka Nirantara under Pune conditions were documented for bulb production parameters. Cultivar Arka Nirantara recorded maximum average weight of bulb, average diameter of bulb, total weight of bulbs per clump, average weight of bulblets and total weight of

bulbets per plant. However, Cv. Phule Rajani recorded maximum number of bulbs per clump followed by Cv. Hyderabad Single.

Crop Protection

- Survey was conducted to record the incidence of insect pests infesting commercial flower crops in Maharashtra, Gujarat, Telangana and Andhra Pradesh.
- Thrips incidence to the tune of 18.0 - 65.0 per cent damage was recorded from October, 2015 - February, 2016 on tuberose Cv. PhuleRajani.
- Marigold thrips, *Neohydatothrips samayunkur* incidence was recorded to a tune of 0.67 - 3.33 thrips per top three leaves from August - December, 2015 on marigold Cv. Pusa Narangi Gainda.
- Incidence of bud borer, *Helicoverpa armigera* was high on rose (30 - 40%), followed by China aster (10 - 20%), carnation (5 - 10%), marigold (5 - 10%), gaillardia (5 - 10%), and tuberose (3 - 5%).
- Survey on the incidence of viral and phytoplasma diseases in major flower crops namely tuberose, marigold, China aster, chrysanthemum, annual chrysanthemum, jasmine in open field conditions and rose, gerbera and carnation in protected units was undertaken. Incidence of diseases in foliage and indoor plants, and potted flowering plants in nursery units were also documented.
- Symptomatology of Phytoplasma, *Tospovirus*, *Carlavirus* and *Chrysanthemum stunt viroid* (CSVd) in spray and standard type of chrysanthemum was studied. Symptomatology of yellows phytoplasma in dimorphotheca, saponeria and dianthus was also studied.
- Etiology of necrosis symptoms on chrysanthemum was confirmed through infectivity assay of tospovirus on indicator host cowpea.
- Electron Microscopy (EM) and PCR based diagnostics of *Potyvirus* associated with mottling and colour breaking in gladiolus, tuberose and amaryllis has been done. Identification of *Cucumovirus* and *Badnavirus* from Jasmine was also studied through Electron Microscopy (EM) and PCR based diagnostics.
- Forty one cultivars of gladiolus were evaluated for natural incidence of virus symptoms, disease incidence and percent disease index (PDI). Cultivars Argentina, Flavo Savar and Snow Princess showed highest incidence level along with high PDI, while Amsterdam showed the severe infection among all with highest PDI.
- Seven cultivars of gladiolus were evaluated to know the incidence of various storage pathogens. Infections of *Fusarium oxysporum*, *Aspergillus* sp. and *Penicillium* species were found. Further morphological and molecular characterization of *Fusarium oxysporum* f.sp. *gladioli* has been carried out up to species level.
- Survey on nematode incidence in flower growing areas of Pune region indicated severe incidence of root-knot nematode infestation in tuberose under open field conditions and gerbera under protected cultivation. The incidence ranged from 50 to 70% in tuberose and 5-10% in gerbera.
- Twelve gladiolus cultivars were evaluated for their resistance to root-knot nematode, *Meloidogyne incognita*. Among them, five cultivars Nova Lux, Snow Princess, Chemistry, Rosebeeibak Red and Priscilla recorded 30-45 % reduction in final nematode population in the soil.
- Effect of initial population density of root-knot nematode, *M. incognita* and nematode population development in China aster was studied and found significant reduction plant height even at initial

population density of 100J2/100cm³ soil. Increasing the initial densities of the nematodes increased root-knot disease severity.

Post-harvest Management And Value Addition

- Post-harvest packaging of tuberose and jasmine loose flowers practiced by the farmers and post harvest losses due to traditional practices were studied. Further, CFB package for packaging of tuberose loose flower was designed by using Auto CAD.

Outreach Programmes

- ICAR-DFR has participated in exhibitions such as Krishi Unnati Mela at ICAR-IARI, New Delhi, Udyan Mela at Venkataramannagudam, (AP), Farmer's Day at ICAR-IARI Regional Station, Pune (MH), Kisan Mela in KVK, Narayangaon (MH) and Kharif Kisan Sammelan and Horticulture Exhibition-2015 at KVK, Bagahara, Muzaffarnagar (UP) etc in different part of the country and displayed the technologies for the benefit of all flower growers.

Other Activities

- All the scientists participated and presented their research findings in one or more national conference, symposia and seminar etc. Directorate has also published popular articles, technical/extension bulletins and research article for the benefit of end users.
- All the institution activities i.e. IRC, RAC, Annual Group Meeting of AICRP (Floriculture), Hindi Workshop and DFR Foundation Day were held timely. All ICAR and Government of India programmes such as Swachh Bharat Abhiana, Mera Gaon Mera Gaurav, Vigilance Awareness Week, World Soil Health Day and Jai Kisan Jai Vigyan Week were conducted successfully.
- ICAR-DFR got land at two locations namely College of Agriculture Campus, Shivajinagar (9.44 ha) and Manjri farm, Hadapsar (25.71 ha) which were acquired and the final land transfer (7/12 extracts) obtained in the name of ICAR-DFR during February 2016 for the establishment of Directorate.
- The Government of Andhra Pradesh has allotted 10.77 acre of land in Vemagiri Village of Kadiyam Mandal (Sy. No. 356/1, 357 & 358) for the establishment of regional research station, accordingly the Directorate has taken the physical possession of the land and obtained land delivery certificate during November 2015.

Introduction

Floriculture is a multifaceted enterprise in India. It is characterized by growing traditional flowers (loose flowers) and cut flowers under open field conditions and protected environment conditions respectively. India also has a strong dry flower industry, with substantial contribution (>70%) to floricultural exports. Other floricultural segments like fillers, indoor plants, landscaping plants, seeds and planting material, turf grass and value added products also contribute their share in the overall growth of the sector.

The traditional flower cultivation, comprising of growing loose flowers mostly for worship, garland making and decorations, forms the backbone of India floriculture, which is mostly in the hands of small and marginal farmers. About 2.44 lakh ha of area is under loose flower cultivation producing 1840000 MT of flowers annually (2014-15). The major production comes from Karnataka, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Rajasthan, West Bengal, Bihar, Jharkhand, Kerala and Telangana while the major markets are in Chennai, Bengaluru, Kolkata, Hyderabad, Kadiyam, Pune, Mumbai and Delhi. The marketing network for loose flowers comprises of growers, middlemen, wholesalers, retailers and the consumers. The marketing yards for flowers are mostly on the pavements with primitive infrastructure for postharvest care and processing leading to poor shelf life. A small portion of loose flowers is being exported to Middle East, UK and USA for the expatriate Indians.

Loose flowers cultivation under open cultivation forms the backbone of Indian floriculture and hardly 1.5% flowers are grown under greenhouse cultivation for cut flower purpose. West Bengal, Karnataka, Uttar Pradesh, Maharashtra, Gujarat, Himachal Pradesh, Uttaranchal are the major producers of cut flowers. In the domestic markets, dedicated marketing infrastructure for cut flowers is in place in Bangalore in the form of a flower auction center. Such flower auction centers are in place in Noida and other metros.

Floricultural exports from India comprise of fresh cut flowers (to Europe, Japan, Australia, Middle East and USA) loose flowers (for expatriate Indians in the Gulf) cut foliage (to Europe) Dry flowers (to USA, Europe, Japan, Australia, Far East and Russia) Potted Plants (Limited to Middle East) besides seeds and planting material. Dry flowers alone contribute nearly Rs.322 crores (70%) of total exports valued at Rs.460 crores (2014). India's position as an exporting country for cut flowers stands at 29 among the flower exporting countries with a value of 8227(000USD) which translates to a percentage share of 0.31%. On the other hand India imports flowers worth Rs. 38.25 crores from Thailand, the Netherlands and People's Republic of China.

The demand for the flowers in India is constantly increasing especially among the metros. This trend has encouraged the Indian traders to import some of the exotic flowers for decoration and floral arrangements. Major flowers that are being imported and sold in Indian markets include Proteas, orchids, Iris, Cala Lily, Heliconia etc. Thailand is the major exporter of tropical flowers especially orchids to India followed by the Netherlands.

India has a sizeable nursery industry with major hubs located in Kadiyam (Andhra Pradesh), Kalimpong (West Bengal), Pune (Maharashtra), Gajrola and Shaharanpur (Uttar Pradesh), Bengaluru (Karnataka).

India is a leading producer and exporter (Rs 322 crores) of dry flowers in the world. The product mix comprises of forest produce, farm residue, seeds, pods and fruits besides specific flowers that are dried. The major production centers are in Tuticorin, Cochi and Kolkata.

The cultivation and use of cut greens and foliage has increased in recent times. Open cultivation of fillers and cut greens attained commercial proposition in Karnataka, Uttaranchal, Kerala, Maharashtra, Andhra Pradesh and North Eastern States.

With the research support, from 21 AICRP centers from across the country representing different agro climatic regions, ICAR-DFR is poised to address the researchable issues of the existing and emerging avenues in floriculture independently and also in a collaborative mode.

About The Directorate

ICAR-Directorate of Floricultural Research (DFR), as an Institute under Indian Council of Agricultural Research was formally launched on 10th December, 2009 during the XIX Group Meeting of All India Coordinated Research Project on Floriculture held at Indian Agricultural Research Institute (IARI), New Delhi to promote and strengthen floricultural research and enhance the technological base in floriculture. The Directorate is the first of its kind in the country. Initially it was established in IARI campus on temporary basis. Recently, the Directorate has been shifted to its new location i.e. College of Agriculture Campus, Shivajinagar, Pune. Presently AICRP on Floriculture is an integral part of the ICAR-DFR, having 21 Centres comprising of 15 budgetary, four institutional and two voluntary centres.

Considering the research needs and potential of floriculture in India, the mandate of the ICAR-DFR has been revised to provide the technological support to the growers and entrepreneurs that help in providing employment generation and prosperity to the rural youth.

Vision

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

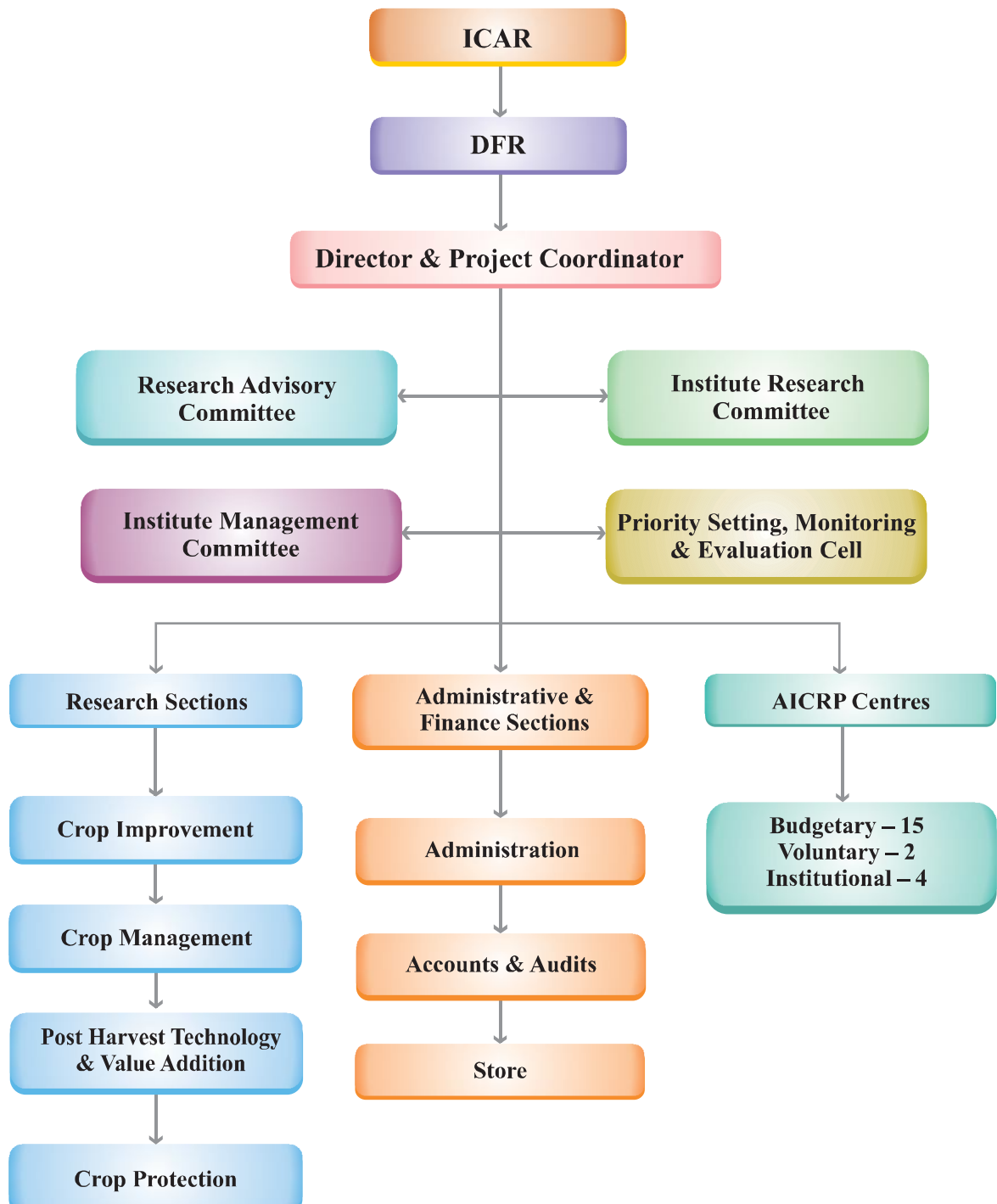
Mission

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.

Mandate

- 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.
- Coordinate research and validation of technologies through AICRP on Floriculture.

Organizational Structure of ICAR-Directorate of Floricultural Research, Pune



Research Achievements

1. Crop Improvement

1.1 Project 01 (ICAR Project Code: IXX07529): Breeding of Gladiolus for Quality and Yield

1.1.1 Germplasm Evaluation

The gladiolus corms of 45 genotypes were planted and data on morphological traits were recorded for the 30 genotypes. Cultivars Jester, Snow Princess, White Prosperity Yellow Stone, Punjab Dawn, Priscilla, Chemistry and Purple Flora were found to be superior for spike qualities under Pune conditions. The maximum plant height was recorded in cultivars Plumtart, Invitatie and White Prosperity. Early flowering was observed in cultivars Chandani, Punjab Dawn, Rosiebee Red and Purple Flora. Gladiolus hybrids developed by IARI were evaluated under Pune conditions and found that hybrid (P-16-1 x Eurovision and Melody Open) performed well in terms of plant height and number of florets per plant (Table 1.1.1).

1.1.2 Evaluation of Hybrids

The hybrids (crossing attempted in year 2011-12, 2012-13 and 2013-14) planted at Katrain were further evaluated and some of the promising hybrids were identified and evaluated for morphological traits. Total 40 hybrids were identified with promising traits and data was collected for morphological traits. Hybrids Chandni x Pricilla, Ocilla x Purple Flora, Ocilla x Verona and Plumtart x Forta Rosa were found promising in respect of morphological and flowering characters. Hybrid Chandni x Pricilla produces red coloured florets (22 florets per spike) with long spike length (74.7 cm) and suitable for cut flower production. Hybrid Ocilla x Purple Flora produces white coloured florets (19.5 florets per plant) with long spike length (96.2 cm), good plant height (140.5cm) making it suitable for cut flower production. Another hybrid Ocilla x Verona produces light pink coloured florets (19.5 florets per plant) with long spike length (91.5 cm), good plant height (135.0cm) making it suitable for cut flower production. Hybrid Plumtart x Forta Rosa produces light pink coloured florets (18.5 florets per plant) with long spike length (81.0 cm), good plant height (114.2 cm) making it suitable for cut flower production (Fig.1.1.2). Other hybrids were also found promising in terms of spike length, number of florets per plant and florets colour (Table 1.1.2)

1.1.3 Hybridization

Hybridization work was initiated at the new location and crossing was attempted in selected parents. But accelerated flower opening, rapid drying of stigma and sudden bursting of pollen was observed due to which most of crosses failed to set the seeds. Increased temperature during the spike initiation could be the reason since planting was done in the month of November.



Parents: Ocilla x Purple Flora

No of florets: 19.5

Spike length: 96.2 cm

Rachis length: 82.0 cm

Plant height: 140.5 cm

Floret colour: White



Parents: Rosiebee Red x Novalux

No of florets: 17.5
Spike length: 87.7 cm
Rachis length: 68.0 cm
Plant height: 125.7 cm
Floret colour: Orange



Parents: Plumtart x Forta Rosa

No of florets: 18.5
Spike length: 81.2 cm
Rachis length: 69.5 cm
Plant height: 114.2 cm
Floret colour: Light pink



Parents: Pricilla x Yellow Stone

No of florets: 14.5
Spike length: 70.5 cm
Rachis length: 51.0 cm
Plant height: 112.0 cm
Floret colour: Yellow



Parents: White Prosperity x Purple Flora

No of florets: 17.7
Spike length: 79.5 cm
Rachis length: 69.2 cm
Plant height: 118.5 cm
Floret colour: Light pink petals with dark pink blotch (bicolour)



Parents: Yellow Stone x Blues

No of florets: 14.5
Spike length: 76.2 cm
Rachis length: 60.0 cm
Plant height: 113.5 cm
Floret colour: Off white with light yellow blotch



Parents: Flavo Sovenior x Haunting Song

No of florets: 16.0
Spike length: 82.0 cm
Rachis length: 61.0 cm
Plant height: 113.0 cm
Floret colour: Yellowish orange



Parents: Rosibee Red x Yellow Stone

No of florets: 14.2
Spike length: 81.5 cm
Rachis length: 61.0 cm
Plant height: 125.5 cm
Floret colour: Red



Parents: Invitatie x Ocilla

No of florets: 16.5
Spike length: 69.0 cm
Rachis length: 49.2 cm
Plant height: 103.2 cm
Floret colour: Light pink

Fig. 1.1.2. Promising hybrid selections

Table 1.1.1. Evaluation of gladiolus varieties for growth and flowering traits at Shivajinagar Research Farm

Sl. No.	Variety	Plant height (cm)	No. of leaves per plant	Leaf width (cm)	No. of tillers per plant	Spike length (cm)	No. of florets/ Spike	Rachis length (cm)	Internodal length (cm)	No. of florets open at a time	Floret dia (cm)	Days to spike initiation	Days to 1 st floret opening
1	Punjab Lemon Delight	71.60	5.2	3.1	2.8	66.0	10.4	38.00	3.7	4.8	7.0	96.60	110.20
2	Pusa Kiran	74.30	6.4	3.2	1.8	64.5	13.2	35.50	3.2	2.6	8.6	112.60	124.80
3	IIHR-G-11	66.80	5.4	2.7	4.0	62.0	12.6	32.80	3.0	4.4	8.1	101.20	116.00
4	Purple Flora	69.10	4.6	3.0	2.2	61.1	10.6	29.30	3.2	3.6	8.0	81.80	90.20
5	Jester	91.48	6.0	2.9	1.4	83.6	15.8	48.40	4.3	5.4	10.4	115.60	129.40
6	Pricilla	59.80	6.0	2.9	2.0	59.8	10.2	32.12	4.1	4.8	9.6	98.60	116.80
7	Punjab Dawn	74.20	5.2	1.9	2.8	65.0	12.4	32.30	3.4	3.6	8.7	90.20	103.60
8	Chandani	64.80	5.2	2.0	2.8	59.0	9.4	20.20	3.4	2.8	7.6	86.40	96.80
9	Melody Open	93.40	6.8	3.2	2.4	86.1	15.2	41.60	3.4	3.6	9.7	110.20	119.20
10	Jester Gold	78.80	5.4	2.9	2.0	69.56	12.2	36.90	4.2	4.4	8.2	111.40	120.80
11	Punjab Glance	66.20	5.6	2.6	3.0	55.26	11.00	33.50	3.4	3.8	9.7	119.40	128.20
12	New Wave	69.74	5.2	2.2	2.2	60.84	10.2	30.26	4.6	1.6	8.6	91.20	98.80
13	Invitatie	93.79	6.0	2.5	1.0	83.56	12.4	38.90	4.9	4.2	9.9	102.80	113.00
14	Rosiebee Red	81.04	6.0	2.8	1.2	72.06	13.4	41.82	5.0	2.4	9.9	83.20	96.60
15	Yellow Stone	81.20	6.2	3.3	1.4	72.9	11.8	35.86	3.9	4.4	9.8	94.00	108.20
16	Forta Rosa	76.88	6.8	2.7	2.0	66.50	12.4	33.50	4.3	3.8	8.9	111.80	123.40
17	Traderhorn	89.14	6.2	4.6	1.4	81.28	15.4	47.24	5.0	4.8	8.6	96.00	109.20
18	Snow Princess	96.56	6.0	4.5	2.0	89.88	16.2	52.18	5.5	5.4	10.3	101.40	120.80
19	Prince Maragrate Rose	106.30	7.3	3.7	1.6	76.53	12.5	81.70	4.9	5.7	7.7	106.20	122.00
20	Charisma	79.10	6.6	3.5	1.2	75.14	13.2	36.40	4.9	2.6	9.8	110.40	119.20
21	Flavo Amico	66.61	7.0	1.5	1.8	61.69	15.5	36.18	4.1	5.4	6.00	102.80	116.80
22	Cha-Cha	76.00	7.4	3.2	2.0	67.92	13.2	42.70	3.7	5.4	8.4	108.00	121.40
23	Plumtart	104.86	8.7	2.7	1.4	91.38	14.1	41.60	4.4	4.2	10.6	96.20	108.80
24	Chemistry	96.54	8.5	4.0	1.8	84.75	17.6	53.40	6.1	4.8	10.2	104.40	119.60
25	San Remo	88.96	7.4	3.6	1.8	78.56	13.8	41.08	4.9	3.2	10.1	112.80	122.60
26	BTS	89.34	7.4	3.6	2.4	69.92	11.2	46.44	3.5	5.0	8.9	106.60	119.00
27	Deepest Red	105.04	7.2	2.9	1.8	95.58	17.00	45.52	3.6	5.2	9.8	109.20	120.80
28	Bangladesh	87.12	7.0	2.4	2.6	80.14	17.06	40.60	4.3	4.6	8.8	98.40	117.60
29	Novalux	99.38	7.4	3.6	1.8	84.30	12.00	49.28	4.1	5.8	8.4	116.20	126.00
30	White Prosperity	109.80	7.4	2.7	1.4	103.90	16.2	61.16	4.1	5.8	10.3	108.80	121.60

Table 1.1.2. Evaluation of promising gladiolus hybrids for growth and flowering traits

Sl. No.	Hybrids	Plant height (cm)	No. of leaves	No. of florets	Rachis length (cm)	Flower diameter (cm)	Spike length (cm)	Days to flowering	Colour
1.	No.14 (2L) Yellow Stone X Blues	113.5	7.0	14.5	60.0	9.7	76.2	82.0	Off white and light yellow
2.	No.100 (1L) Fota Rosa X Ocilla	111.2	8.25	17.5	64.5	10.7	84.2	78.2	Light orange
3.	No.34 5L Rosibee Red X Yellow Stone	124.5	8.0	16.0	67.0	10.9	86.0	80.7	Creamy red
4.	No.31 (2L) Novalux X Pricilla	115.0	7.0	15.2	61.2	9.4	77.5	76.5	Light yellow
5.	No.25(8) 1L Flavo Amico X Ocilla	83.7	8.0	14.5	43.7	7.2	58.7	77.5	Pink with white throat
6.	No.32 (2L) Novalux X Big Time Supreme	125.2	8.25	15.0	55.7	9.7	78.0	79.0	Yellow
7.	No.87 (1L) Flavo Sovenor X Haunting Song	103.0	9.0	17.0	63.0	10.3	67.0	77.0	Yellowish orange
8.	No.39 (2L) Chandni X Pricilla	101.0	7.0	13.2	51.2	11.0	70.0	76.5	Pink with red throat
9.	No.36(1L) Rosibee Red X Ocilla	95.25	8.0	15.7	62.0	9.9	74.7	82.5	Light pink
10.	No.39 Chandni X Pricilla	148.0	9.5	22.0	73.2	10.2	94.0	84.0	Red
11.	No.56-1L White Prosperity X Purple Flora	113.0	8.0	16.0	61.0	10.8	82.0	83.0	Very light pink with pink throat
12.	No.56 White Prosperity X Purple Flora	118.5	7.0	17.7	69.2	10.9	79.5		Pink
13.	No.4(7)-1L Yellow Stone X Pricilla	121.5	7.7	15.7	62.2	9.4	79.7	83.7	Yellow
14.	No.35-1L Rosibee Red X Novalux	125.7	9.0	17.5	68.0	11.1	87.7	83.0	Orange with yellow throat
15.	No.57 (1L) White Prosperity X Rosibee Red	113.0	7.0	14.7	67.7	8.8	87.0	74.5	
16.	No.87-3L Fota Rosa X Pricilla	104.5	6.7	14.0	65.5	9.2	70.7	72.0	Orange
17.	No.104(purple flora) X Flevo Amico	86.0	7.0	14.0	42.7	8.4	60.5	76.2	Purple
18.	No.42-1L Chandni X Purple Flora	83.0	7.0	14.7	46.5	7.4	52.7	84.7	Maroon
19.	No.70-1L(Ocilla x Purple Flora)	140.5	7.0	19.5	82.0	9.8	96.2	76.5	White
20.	No.89(1L) Ocilla X Verona	135.0	10.0	19.5	72.2	11.1	91.5	83.0	Light pink
21.	No. 36 (2L) Rosibee Red X Ocilla	122.0	9.2	16.0	61.2	12.1	75.0	78.2	Light orange
22.	No. 23 (3) 3L Flavo Laguna X Pricilla	118.7	8.5	17.5	72.2	9.0	87.0	76.2	Pink
23.	No. 74 (5L) Pricilla X Yellow Stone	112.0	7.25	14.5	51.0	10.2	70.5	75.2	Yellow
24.	No. 78 (1L) Haunting Song X Ocilla	95.75	7.5	15.5	53.0	9.1	62.7	79.5	Light orange
25.	Purple Flora x Estabonita (2L)	108.75	8.0	17.2	59.7	9.3	77.0	74.0	Purple
26.	No.90(2L) Mascagani X Verona	148.0	7.0	13.7	73.7	10.3	93.2	72.0	Light pink with yellow throat
27.	No.34 (2L) (Red) Rosibee Red X Yellow Stone	125.5	9.0	14.2	61.0	10.2	81.5	79.0	Red

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Sl. No.	Hybrids	Plant height (cm)	No. of leaves	No. of florets	Rachis length (cm)	Flower diameter (cm)	Spike length (cm)	Days to flowering	Colour
28.	Block 2, No.58 (yellow) White Prosperisty X Navalux	109.7	8.0	12.0	52.2	10.6	76.7	77.5	Yellow
29.	No.26 (8) 2L Flavo Amico X Yellow Stone	114.5	7.7	14.5	55.5	8.2	75.0	79.0	light pink with yellow throat
30.	No.85(pink) 2L Plum Tart X Amasterdam	119.7	8.2	13.7	60.5	8.6	65.0	74.5	Pink
31.	No.39(1L) Chandni X Pricilla	109.0	7.7	13.5	60.5	8.6	65.0	74.5	Pink with yellow throat
32.	No.46(2L) Yellow Stone X Pricilla	102.0	8.0	13.7	50.2	10.7	68.7	78.7	Pure yellow
33.	No.2(7) 2L Invitatie X Ocilla	103.2	8.2	16.5	49.2	10.1	69.0	78.7	Light pink
34.	No.80 (2L) Fota Rosa X Yellow Stone	121.7	8.2	17.2	62.7	9.8	80.0		Orange
35.	No.93(2L) Plum Tart X Yellow Stone	124.7	8.0	17.5	46.7	9.2	83.0		--
36.	No.40 Chandni X BTS	129.5	7.0	15.5	59.7	10.4	79.7	81.0	Light yellow
37.	No.39-3L Chandni X Pricilla	109.5	7.7	16.2	64.0	10.4	78.5	75.5	Light yellow
38.	No.1(15)-4L Invitatie X Yellow Stone	103.0	7.0	17.2	64.0	9.0	72.5	73.2	Violet
39.	No.96(red)-1L Yellow Stone X Verona	110.5	8.0	16.5	55.0	10.2	81.0		Red
40.	No.23(seed)-1L Flavo Laguna X Pricilla	113.0	7.0	14.2	57.2	10.2	73.7		Pink with yellow throat
41.	No.34 Rosibee Red X Yellow Stone	118.2	8.0	16.2	61.5	9.8	80.0		Light orange with yellow throat
42.	Plumtart x Forta Rosa-1L	114.2	8.0	18.5	69.5	10.2	81.0	78.0	Light pink
43.	No.51(1L) Jester X IHR-G-11	91.5	8.0	12.2	44.2	7.8	65.7	73.0	Light orange
44.	Purple Flora x Flevo Amico	68.7	7.0	15.2	44.7	8.3	64.0	71.0	Purple

1.2 Project 02 (ICAR Project Code: IXX07506): Breeding of Chrysanthemum for Quality Flowering and Pot Mums

1.2.1 Germplasm Enrichment and Evaluation

62 cultivars of chrysanthemum were collected from ICAR-IARI, New Delhi during the month of July and planted in the Shivajinagar farm. In addition to this, 110 germplasm including newly developed open pollinated lines were relocated from New Delhi. The evaluation of 62 germplasm (Fig 1.2.1) were undertaken for growth and flowering parameters to identify suitable cultivars for different types (spray, pot mums and standard) under Pune condition.

Spray Type: Among the spray type, 48 cultivars were evaluated for various growth and flowering traits. The results (Table 1.2.1.1) revealed that the cultivar Gauri (57.00cm) exhibited maximum plant height followed by White Queen (55.67cm) and Arka Ravi (49.33cm). Plant spread was maximum in cultivar White Queen (66.50cm) followed by Basanti (58.83 cm) and Yellow Gold (57.33 cm). The variations in vegetative characters were attributed to genetic factors as well as environmental conditions. Regarding yield attributing traits, cultivar Basanti (155.00), Ramlal Dada (136.00), Sunny (128.00) and Crocon Small (125.33) counted appreciable number of flowers per plant. The flowers of Ravi Kiran (6.20cm), Maghi White (6.07 cm), Flirt (5.57 cm) and White Queen (5.17 cm) were larger in size, whereas Kundan (1.77 cm) and Swet Shringar (2.07 cm) exhibited smaller flower size. On the basis of evaluation, the cultivars White Queen, Basanti, Ramlal Dada and Sunny were found suitable as spray type cultivars under Pune conditions.

Table 1.2.1.1. Evaluation of spray type chrysanthemum cultivars under Pune conditions

Variety	Plant height (cm)	Plant spread (cm)	Primary branches (number)	Secondary branches (number)	Flowers per plant (number)	Flower diameter (cm)
Ajay	29.00	21.50	2.00	8.67	27.00	3.33
Anmol (PAU)	36.67	45.17	2.00	11.33	83.33	3.10
Aprajitha	38.67	33.33	1.33	17.67	62.67	3.27
Arka Ravi	49.33	27.67	1.33	9.33	10.33	4.13
Autumn Joy	33.00	10.83	1.33	10.33	15.33	3.23
Basanti	29.67	58.83	1.67	14.67	155.00	2.23
Birbal Sahni	28.00	15.86	1.00	8.33	19.33	3.20
Classic	27.67	25.83	2.00	6.67	21.33	2.53
Crocon Small	33.67	34.50	1.33	10.33	125.33	3.13
Discovery	22.33	12.17	1.67	10.00	14.33	2.53
Dolly Orange	27.10	29.67	1.67	11.67	46.67	3.20
Flirt	40.33	23.00	1.67	9.33	53.33	5.57
Garden Beauty	35.00	40.67	2.33	15.67	64.00	4.17
Gauri	57.00	47.00	1.67	11.00	88.33	4.47
Gulmohar	42.00	42.00	2.67	15.00	31.00	5.17
Haldi Ghati	41.00	33.33	1.33	12.67	48.33	2.20
Himanshu	24.33	39.33	2.00	11.67	105.33	4.07
Jayanti	33.33	17.00	1.00	6.33	41.00	2.37
Jubilee	36.23	13.50	1.33	10.00	19.67	3.63
Jyotsna	36.63	39.50	1.00	15.67	44.00	5.20
Kamhil	48.33	42.00	2.33	12.67	95.33	3.60
Kundan	41.00	54.00	1.67	17.00	65.00	1.77
Lal Pari	31.33	26.67	1.33	11.33	56.00	5.10
Lalit	39.00	36.67	1.00	11.67	81.67	4.17
Maghi Orange	43.00	36.50	1.00	6.67	41.67	3.50
Maghi White	33.10	27.00	2.33	15.33	47.00	6.07
Mallika Yellow	37.00	51.33	1.00	13.00	87.00	2.40
Mother Teresa	20.00	27.83	1.00	10.33	50.67	2.27
Neelima	33.33	13.83	1.67	7.00	32.33	3.37
Pusa Aditya	25.67	30.17	1.67	14.33	81.67	4.17
Pusa Chitraksha	41.33	57.33	1.67	16.00	105.33	3.57

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Variety	Plant height (cm)	Plant spread (cm)	Primary branches (number)	Secondary branches (number)	Flowers per plant (number)	Flower diameter (cm)
Ramlal dada	33.67	44.00	1.67	13.00	136.00	3.30
Ravi Kiran	43.00	30.00	1.33	11.33	38.33	6.20
Red Stone	35.00	49.00	1.67	21.33	91.67	3.30
Sadwin Yellow	33.33	43.33	3.00	9.67	81.67	3.37
Shanti	32.00	14.17	1.00	7.67	13.33	3.60
Shyamal	40.00	38.83	1.00	16.67	67.00	2.67
Sunny	32.67	52.17	2.00	10.00	128.00	4.63
Swet Shringar	35.13	11.83	1.00	10.33	14.00	2.07
Teri	30.00	30.33	1.33	13.67	78.00	2.40
Texas Gold	30.33	31.17	1.00	10.67	45.00	2.53
Vasanthika	45.67	32.50	2.00	10.00	69.00	2.53
Vijay Kiran	24.33	34.17	1.33	9.00	23.33	2.27
White Prolific	28.10	35.17	1.00	11.00	41.33	2.67
White Queen	55.67	66.50	1.67	14.33	81.33	5.17
Yellow Gold	44.33	57.33	1.67	26.67	118.00	4.17
S.E.M.	3.58	4.97	0.33	1.30	8.35	0.15
LSD (p<0.05)	10.06	13.95	0.93	3.67	23.45	0.41

Pot Mums: Five genotypes of pot mums were evaluated (Table 1.2.1.2) for their suitability under Pune conditions and based on statistical analysis all the cultivars showed significant differences for the traits studied, except number of primary branches. The cultivars Liliput and Little Orange were dwarf with plant height of just 15 cm. However regarding plant spread, the cultivars Liliput (52.33 cm) and Pink Cloud (43.33 cm) exhibited maximum spread. Similarly the cultivars Liliput (16.67) and Little Orange (9.67 cm) showed

Table 1.2.1.2. Evaluation of pot mums cultivars under Pune conditions

Variety	Plant height (cm)	Plant spread (cm)	Primary branches (number)	Secondary branches (number)	Flowers per plant (number)	Flower diameter (cm)
Liliput	15.00	52.33	1.67	16.67	64.33	1.23
Little Orange	15.00	33.33	1.33	9.67	40.67	3.27
Pink Cloud	31.67	43.33	1.33	6.67	59.33	3.97
Pusa Sona	23.33	12.00	1.00	7.33	21.67	2.17
Sadbhawna	25.00	20.17	1.33	8.33	47.67	2.23
S.E.M.	1.55	5.23	0.30	1.09	5.76	0.10
LSD (p<0.05)	4.88	16.49	NS	3.42	18.15	0.30

maximum secondary branch (which resulted in dwarf and compact plant). Regarding number of flowers per plant, the cultivars Liliput (64.33) and Pink Cloud (59.33) exhibited maximum number of flowers. However the cultivars Pink Cloud (3.97 cm) and Liliput (3.27 cm) showed larger flower diameter. Based on the above evaluation (i.e. dwarfness, compactness and number of flowers per plant) the cultivar Liliput is highly suitable for pot mums production.

Standard Type: Among the nine standard cultivars evaluated (Table 1.2.1.3), significant differences were noticed among the traits studied except for the number of primary branches per plant. The cultivar Pink Star (91.33 cm) was the tallest among the group, followed by Yellow Star (45.00cm) and Pusa Centenary (41.63 cm). The cultivar Yellow Reflex (50.83 cm) was highly bushy followed by Yellow Star (32.33 cm) and Johan Baber (30.50 cm). Regarding the number of flowers per plant Thai-Chen-Queen (57.33) produced maximum number of flowers per plant followed by Yellow Star (55.33) and Pusa Centenary (48.00). The flower size exhibited by cultivar Thai-Chen-Queen (6.10 cm) was largest followed by Pusa Centenary (5.63 cm), White Star (5.27 cm) and Yellow Star (5.13 cm). Thus, based on the evaluation, the cultivars Thai-Chen-Queen, Pusa Centenary, White Star and Yellow Star were found suitable for the agro-climatic condition studied.

Table 1.2.1.3. Evaluation of standard type chrysanthemum cultivars under Pune conditions

Variety	Plant height (cm)	Plant spread (cm)	Primary branches (number)	Secondary branches (number)	Flowers per plant (number)	Flower diameter (cm)
Johan Baber	33.33	30.50	2.00	11.00	43.00	3.53
Pink Star	91.33	11.83	1.00	9.00	14.33	1.50
Pusa Centenary	41.63	28.17	2.00	14.00	48.00	5.63
Pusa Keshari	35.67	28.33	1.00	5.33	15.67	4.73
Tata Century	35.67	19.17	2.00	6.67	25.67	4.00
Thai-Chen-Queen	34.33	18.00	1.33	11.67	57.33	6.10
White Star	27.60	19.00	1.33	7.67	12.67	5.27
Yellow Reflex	40.00	50.83	1.33	10.67	46.00	2.50
Yellow Star	45.00	32.33	1.67	10.33	55.33	5.13
S.E.M.	3.43	4.14	0.44	1.72	7.18	0.21
LSD (p<0.05)	10.19	12.29	NS	5.11	21.33	0.62



Fig. 1.2.1. Field view of Chrysanthemum germplasm

1.3. Project 03 (ICAR Project Code: IXX07530): Breeding of Tuberose for Novel Colour and Oil Recovery.

1.3.1 Germplasm Collection

Ten cultivars namely Prajwal, Arka Nirantara, Sikkim Selection, Mexican Single, Sikkim Selection, Phule Rajani, Pearl Double, Vaibhav, Rajat Rekha and Swarna Rekha were relocated from New Delhi, two (Hyderabad Single and Hyderabad Double) were collected from DrYSRHU, Hyderabad. In addition to this Phule Rajani was also collected from NARP (MPKV), Ganeshkhind (Fig. 1.3.1).



Fig. 1.3.1. Field view of tuberose germplasm



Fig. 1.3.2. Different cultivars of tuberose

1.3.2 Evaluation of Tuberose Germplasm

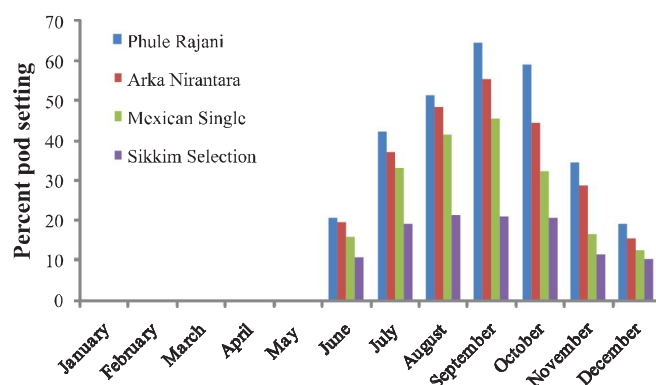
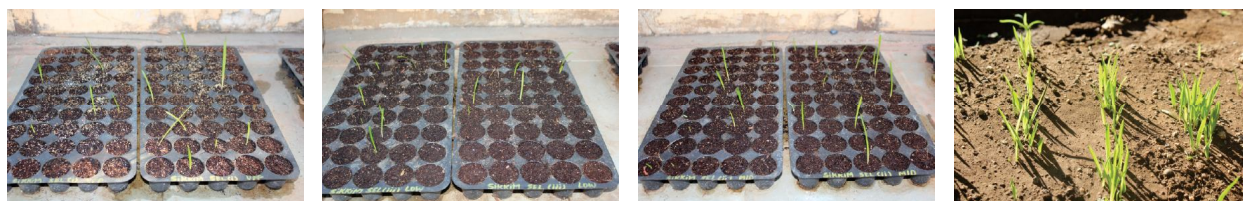
Seven cultivars were planted at Shivajinagar farm for the assessment of growth and flowering parameters (Fig. 1.3.2). Significantly longer spike length (88.68 cm) was observed in Cv. Sikkim Selection followed by Cv. Prajwal (82.17 cm). Non-significant difference was observed in respect of plant height, number of leaves per clump and floret length. However, Cvs. Arka Nirantara and Prajwal produced better rachis length (29.47 and 29.25 cm respectively), number of florets per spike (58.40 and 54.67, respectively) and floral diameter (4.25 and 4.11 cm, respectively) compared to other cultivars. On the basis of first year evaluation Cvs. Arka Nirantara and Prajwal performed better in respect of spike length, rachis length, number of florets per spike and floral diameter compared to other cultivars under Pune conditions (Table 1.3.2).

Table 1.3.2. Evaluation of tuberose germplasm

Cultivars	Plant height (cm)	No. of leaves per clump	Spike length (cm)	Rachis length (cm)	No. of florets per spike	Floral diameter (cm)	Floret length (cm)
Mexican Single	34.73	31.17	77.80 ^{cd}	21.45 ^a	36.53 ^{ab}	3.15 ^a	5.61
Sikkim Selection	37.59	25.60	88.68 ^e	21.47 ^a	30.33 ^a	3.13 ^a	5.52
Shringar	31.85	29.20	49.32 ^a	25.39 ^b	41.60 ^b	3.28 ^{ab}	5.03
Phule Rajani	34.72	28.66	71.93 ^c	22.77 ^{ab}	36.16 ^{ab}	3.19 ^{ab}	5.39
Hyderabad Single	31.95	32.47	60.41 ^b	23.07 ^{ab}	44.47 ^b	3.72 ^{bc}	5.53
Prajwal	38.70	35.33	82.17 ^{de}	29.25 ^c	54.67 ^c	4.11 ^{cd}	5.49
Arka Nirantara	38.50	32.40	74.57 ^c	29.47 ^c	58.40 ^c	4.25 ^d	5.96
C.V. (%)	11.65	13.48	5.92	7.14	12.00	8.74	7.53
S.E.M.	2.39	2.38	2.46	1.05	3.19	0.19	0.24
S.E.D.	3.38	3.37	3.48	1.49	4.52	0.26	0.34
LSD (p<0.05)	NS	NS	7.47	3.19	9.69	0.56	NS

1.3.3 Pod Setting and Germination in Tuberose

The pod setting behavior in tuberose cultivars was studied under Pune conditions. Profuse pod setting (June-October flowering period) was observed in single cultivars namely Arka Nirantara, Mexican Single, Phule Rajani and Sikkim Selection (Fig. 1.3.3 & 1.3.4). However the double cultivars did not set pods at all. During other period of flowering pod setting was sparse in all the cultivars.

**Fig. 1.3.3. Pod setting in tuberose****Fig. 1.3.4. Seed germination- Sikkim Selection**

The matured pods were harvested and germination percentage was recorded in the cultivars Arka Nirantara, Mexican Single, Phule Rajani and Sikkim Selection. The pods were obtained from rachis by dividing into upper, lower and mid segment. The seeds were planted in plug trays and beds for germination. The germination percent was found maximum in the pods obtained from lower segment of rachis (Table 1.3.3).

Table 1.3.3. Germination behaviour in tuberose

Sl. No.	Cultivars	Spike segment	Germination (%)
1	Phule Rajani	Lower	39
		Mid	22
		Upper	16
2	Sikkim Selection	Lower	50
		Mid	36
		Upper	21

1.4. Project 05 (ICAR Project Code: IXX09573): Improvement of Lawn Grasses for Turf

The lawn grass germplasm was shifted from ICAR-Directorate of Floricultural Research, New Delhi to the ICAR –DFR, Shivaji Nagar, Pune during September, 2015. Around 20 accessions of lawn grass germplasm comprising of mutants, selections and local types of Bermuda grass were planted in replications and successfully established under Pune conditions. Two accessions namely Bermuda grass no-1 (seeds) and selection -1 (sod) were acquired and planted in the pots. Different species of grasses viz *Cynodon dactylon*, *Axonopus* spp, *Stenotaphrum secundatum verigatum*, *Zoysia japonica*, *Agrostis stolonifera*, *Pensacola* (Fig.1.4.1-1.4.6) and one ground cover *Dichondra repens* (Fig.1.4.7) which are commonly used for lawn purpose are being multiplied and maintained in pots.

Seeds of Kentucky blue grass, Creeping bent grass, Perennial rye grass and Bermuda grass (Cv Blackjack) were sown in pots in three replications for germination testing. Out of four species only Kentucky blue grass germinated (Fig. 1.4.8).

Samples of weeds which are commonly found in lawn grass fields and some common annual flower crops were collected and press dried for the preparation of herbarium (Fig. 1.4.9).



Fig. 1.4.1. *Cynodon dactylon*



Fig. 1.4.2. *Stenotaphrum secundatum verigatum*



Fig. 1.4.3. *Zoysia japonica*



Fig. 1.4.4. *Axonopus* spp



Fig. 1.4.5. *Pensacola bahia*



Fig.1.4.6. *Agrostis* spp



Fig.1.4.7. *Dichondra repens*



Fig. 1.4.8. *Poa pratensis*



a. *Comellina benghalensis* (Day flower)



b. *Eremochloa* spp (Centipede grass)



c. *Digitaria* (Crab grass)



d. *Cyprus rotundus*

Fig. 1.4.9 a-d. Common weeds of lawn grass identified and collected for herbarium



e. *Trianthema portulastrus* (Horse purslane)



f. *Digeria arvensis* (Kunjru)



g. *Setaria glauca* (Yellow foxtail millet)



h. *Dinebra retroflexa* (Lona)



i. *Eragrostis major* (Love grass)



j. *Tridax procumbens* (Ekdundi)



k. *Dactyloctenium aegyptium* (Egyptian grass)



l. *Euphorbia hirta*

Fig. 1.4.9 e-l. Common weeds of lawn grass identified and collected for herbarium

2. Crop Production

2.1 Project 02 (ICAR Project Code: IXX08409): Production Technology of Tuberose

2.1.1 Influence of Bulb Grades on Growth and Flowering in Tuberose

An experiment was conducted to find out the influence of different bulb sizes of tuberose bulbs on growth and flowering characteristics. Study was conducted using cultivar Phule Rajani to know the response. Four bulb sizes (above 3.5 cm in diameter, 2.5 to 3.5 in diameter, 1.5 to 2.5 cm in diameter and below 1.5 cm in diameter) and mother bulb of tuberose (Cv. Phule Rajani) were used to study the growth and flowering characteristics under the field condition at research farm of ICAR-Directorate of Floricultural Research, Pune (Table 2.1.1). The study revealed that increase in bulb size resulted in increase in plant height, number of leaves per clump, spike length, rachis length, number of florets per spike and floret length. Significantly longer rachis length and number of leaves per clump was observed in the plants with bulb size measuring above 3.5 cm in diameter. The longer spike length (65.20 cm) and more number of florets per spike (35.50) was observed in the bulb size measuring more than 3.5 cm in diameter followed by the bulb size measuring 2.5 to 3.5 cm in diameter (61.67 cm, 31.25 respectively) which was significantly higher than bulb size measuring less than 2.5 cm in diameter and mother bulb. There is no significant difference in plant height, floral diameter and floret length was observed due to different bulb size of tuberose. Hence, large size bulbs measuring more than 3.5 cm in diameter and/or 2.5 to 3.5 cm in diameter are optimum for planting of tuberose.

Table 2.1.1. Influence of bulb grades on growth and flowering in tuberose (Phule Rajani)

Bulb diameter	Plant height (cm)	No. of leaves per clump	Spike length (cm)	Rachis length (cm)	No. of florets per spike	Floral diameter (cm)	Floret length (cm)
Above 3.5	36.59	39.15 ^c	65.20 ^c	30.43 ^d	35.50 ^c	3.85	5.52
3.5 to 2.5	35.48	26.40 ^{ab}	61.67 ^c	25.06 ^c	31.25 ^{bc}	3.77	5.18
2.5 to 1.5	33.95	22.35 ^a	55.15 ^b	19.76 ^b	29.55 ^b	3.81	5.09
Below 1.5	32.51	17.25 ^a	45.76 ^a	17.28 ^a	21.18 ^a	3.77	4.84
Mother Bulb	32.39	35.60 ^{bc}	50.92 ^{ab}	15.40 ^a	28.75 ^b	3.60	5.00
S.E.M.	1.51	3.25	1.75	0.78	1.84	0.16	0.25
LSD (p<0.05):	NS	9.81	5.26	2.34	5.56	NS	NS

2.1.2 Evaluation of Tuberose Cultivars

Evaluation of tuberose cultivars under Pune conditions was done for bulb production parameters, the cultivar Arka Nirantara recorded maximum average weight of bulb (37.01 g), average diameter of bulb (3.29 cm), total weight of bulbs per clump (361.53 g), average weight of bulblets (4.53 g) and total weight of bulblets per plant (56.0 g). However, Cv. Phule Rajani recorded maximum number of bulbs per clump (23.87) followed by Cv. Hyderabad Single (18.00). In most of the vegetative and bulb production parameters Cv. Sikkim Selection recorded minimum fresh weight of leaves (119.93), width of leaves (1.21 cm), number of tillers per clump (5.33), number of bulbs per clump (9.67), average weight of bulb (15.41 g), total weight of bulbs per clump (g) and total weight of bulblets per clump (g). However Sikkim Selection yielded maximum number of bulblets per plant (24.27) followed by Cv. Arka Nirantara (23.87). On the basis of vegetative and bulbs parameters, Cv. Arka Nirantara performed well under the climatic conditions of Pune (Table 2.1.2).

Table 2.1.2. Evaluation of tuberose cultivars under Pune conditions (10 months DAP)

Cultivars	Plant height (cm)	No. of leaves per plant	Fresh wt of leaves	Width of leaves	No of tillers per clump	No. of bulbs per plant	Avg wt of bulb	Avg diam of bulb (cm)	Total wt of bulb per plant (g)	No. of Bulblets per plant	Avg wt of bulblets (g)	Total wt of bulblets per plant (g)
Mexican Single	55.85	162.47	346.27	1.48	18.60	11.60	16.13	2.36	234.07	20.27	4.05	54.33
Sikkim Selection	49.91	62.53	119.93	1.21	5.33	9.67	15.41	2.46	201.47	24.27	2.31	38.80
Shringar	55.07	118.60	242.40	1.58	11.60	13.73	17.65	2.52	238.07	13.20	2.55	25.73
Phule Rajani	50.21	87.13	287.53	1.67	13.33	23.87	24.67	2.94	356.47	18.27	3.08	31.53
Hyderabad Single	49.93	85.13	138.80	1.45	11.33	18.00	20.44	2.63	208.07	20.13	3.65	49.73
Prajwal	62.27	108.53	311.93	2.35	11.40	14.73	28.56	3.18	283.67	15.87	3.52	39.93
Arka Nirantara	60.62	119.27	284.33	1.65	11.00	12.87	37.01	3.29	361.53	23.87	4.53	56.00
S.E.M.	1.93	7.00	25.96	0.08	0.67	2.27	3.35	0.10	20.02	3.69	0.41	8.80
LSD (p<0.05)	5.85	21.22	78.74	0.24	2.04	NS	10.16	0.31	60.72	11.21	1.25	NS

3. Crop Protection

3.1 Project 01 (ICAR Project Code IXX08410): Insect-Pest Management in Commercial Flower Crops

3.1.1 Survey for Insect Pests Affecting Flower Crops

Survey was conducted to record the incidence of insect pests infesting commercial flower crops in Maharashtra, Gujarat, Telangana and Andhra Pradesh. The salient findings are summarized in Table 3.1.1.1.

Table 3.1.1.1. Incidence of insect and non-insect pests on commercial flower crops.

Village	Crops	Pests	% damage
Malegaon, Maharashtra	Carnation	Red spider mite, <i>Tetranychus urticae</i>	5 %
	Marigold	Thrips (unidentified)	5 %
		Red spider mite, <i>Tetranychus urticae</i>	2 %
Chambali, Maharashtra	Rose (open field)	Bud borer, <i>Helicoverpa armigera</i>	25 %
		Thrips, <i>Scirtothrips dorsalis</i>	10 %
		Scale insects (unidentified)	5 %
Sorpatwadi, Maharashtra	Rose (polyhouse)	Thrips, <i>Scirtothrips dorsalis</i>	5 %
	Gerbera	Leaf miner, <i>Liriomyza trifolii</i>	10 %
		Red spider mite, <i>Tetranychus urticae</i>	5 %
		Thrips (unidentified)	5 %
	Rose (open field)	Thrips, <i>Scirtothrips dorsalis</i>	30 %
Shindavane, Maharashtra		Bud borer, <i>Helicoverpa armigera</i>	25 %
	Carnation	Thrips (unidentified)	30 %
		Bud borer, <i>Helicoverpa armigera</i>	5 %
	Gerbera	Leaf miner, <i>Liriomyza trifolii</i>	10 %
		Thrips (unidentified)	15 %
	Rose (open field)	Thrips, <i>Scirtothrips dorsalis</i>	40 %
		Bud borer, <i>Helicoverpa armigera</i>	15 %
	Jasmine	Web worm, <i>Hendecasis duplifascialis</i>	< 2 %
Kadiyapulanka, Andhra Pradesh	<i>Alstonia scholaris</i>	Psyllid, <i>Paurophylla tuberculata</i>	50%
Venkataramannagudam, Andhra Pradesh	Chrysanthemum	Bihar hairy caterpillar	1%
Hyderabad, Telangana	Chrysanthemum	Chrysanthemum leafhopper, <i>Eupteryx</i> sp.	1 – 2%
	Crossandra	Whitefly	5%
Navsari, Gujarat	Orchids	Flower midge	20%
	Gerbera	Thrips (unidentified)	25%
	Heliconia	Aphids (unidentified)	5%
	Spider lily	Indian lily caterpillar, <i>Polytela gloriosae</i>	50%

In Maharashtra among insect pests of commercial flower crops, thrips (*Scirtothrips dorsalis*) (Fig. 3.1.1.1a&b) on rose under open field condition was found to be the major constraint in marketable flower production followed by bud borer (*Helicoverpa armigera*) (Fig. 3.1.1.2). On carnation, thrips were major constraint and on gerbera, leaf miner (*Liriomyza trifolii*) (Fig. 3.1.1.3) was recorded as major problem in attaining commercial flower production. Minor incidence of red spider mite (*Tetranychus urticae*) (Fig. 3.1.1.4) was recorded in rose and carnation during the period of survey.



Fig. 3.1.1.1a. Thrips, *Scirtothrips dorsalis* damage on rose flower bud



Fig. 3.1.1.1b. Thrips, *Scirtothrips dorsalis* damage on rose foliage



Fig. 3.1.1.2. Bud borer, *Helicoverpa armigera* on rose



Fig. 3.1.1.3. Leaf miner, *Liriomyza trifolii* damage on gerbera



Fig. 3.1.1.4. Red spider mite, *Tetranychus urticae* damage on carnation

At Kadiyapulanka in Andhra Pradesh, psyllid (*Pauropsylla tuberculata*) (Fig. 3.1.1.5 a&b) on *Alstonia scholaris* saplings was found to be the major problem under nursery production of devil's tree. At Navsari Gujarat, orchid flower midge (Fig. 3.1.1.6) was major problem for production of commercial cut flowers and Indian lily caterpillar (*Polytela gloriosae*) (Fig. 3.1.1.7 a&b) was major problem under spider lily.



Fig. 3.1.1.5a. Psyllid, *Pauropsylla tuberculata* damage on *Alstonia scholaris*



Fig. 3.1.1.5b. Psyllid, *Pauropsylla tuberculata* damage on *Alstonia scholaris*



Fig. 3.1.1.6. Orchid flower midge damage



Fig. 3.1.1.7a. Indian lily caterpillar, *Polytela gloriosae* egg mass on spider lily



Fig. 3.1.1.7b. Indian lily caterpillar, *Polytela gloriosae* on spider lily

3.1.2 Incidence of Insect Pests on Tuberose

Among the various insect pests affecting tuberose, thrips are found to be predominant. Therefore the incidence of thrips was recorded on Cv. Phule Rajani. The incidence ranged from 18.0 – 65.0 per cent damage from October, 2015 – February, 2016.

The incidence was low during 40th standard week which peaked to about 65 per cent during 48th standard week (Fig. 3.1.2.1).

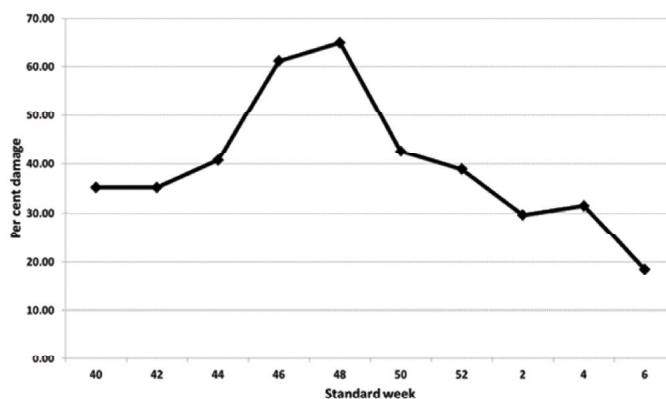


Fig. 3.1.2.1. Incidence of thrips on tuberose Cv. Phule Rajani

Incidence of mealybug, *Phenacoccus solenopsis* (Fig. 3.1.2.2) on seven tuberose cultivars (Vaibhav, Suvasini, Swarn Rekha, Prajwal, Shringar, Arka Nirantara and Phule Rajani) was recorded. The incidence varied from 50 – 80 per cent across the cultivars tested. Mealybug parasitoid, *Aenasius bambawalei* (Fig. 3.1.2.3) was recorded on the mealybugs. Upto 80 per cent parasitization was recorded in all the cultivars.



Fig. 3.1.2.2. Mealybug, *Phenacoccus solenopsis* on tuberose

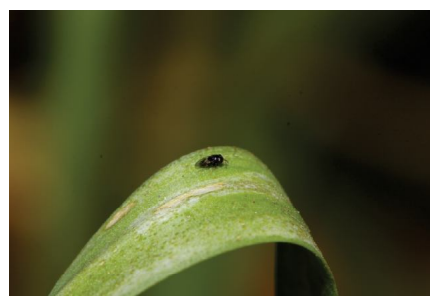


Fig. 3.1.2.3. Mealybug parasitoid, *Aenasius bambawalei*

3.1.3 Incidence of Insect Pests on Charysanthemum, China Aster and Marigold

Incidence of thrips (*Neohydatothrips samayunkur*) (Fig. 3.1.3.1a&b) was recorded on marigold Cv. Pusa Narangi Gaiinda.



Fig. 3.1.3.1a. Marigold thrips *Neohydatothrips samayunkur* damage on marigold



Fig. 3.1.3.1b. Marigold thrips *Neohydatothrips samayunkur*

The incidence of thrips was noticed from seedling till flowering stage. The incidence ranged from 0.67–3.33 thrips per top three leaves from August – December, 2015. However, damage was more during November and December months (Fig. 3.1.3.2).

Incidence of red spider mites, *Tetranychus* spp. (Fig. 3.1.3.3) on marigold Cv. Local from December, 2015 – February, 2016 was recorded. The population density ranged from 2.5 - 20.0 mites per top three leaves.

Incidence of chrysanthemum leafhopper, *Eupteryx* sp. (Fig. 3.1.3.4) was recorded on twenty five genotypes of chrysanthemum. Leafhopper incidence was noticed from October – March and population ranged from 1.75 – 2.50 hopper per leaf.

Incidence of mirid bug, *Lygus* sp. (Fig. 3.1.3.5) was observed on chrysanthemum and China aster flower buds from October – January. The nymphs and adults of these bugs were found to be feeding on developing flower buds. The incidence of bugs ranged from 0.75 – 2.50 bugs per flower bud.

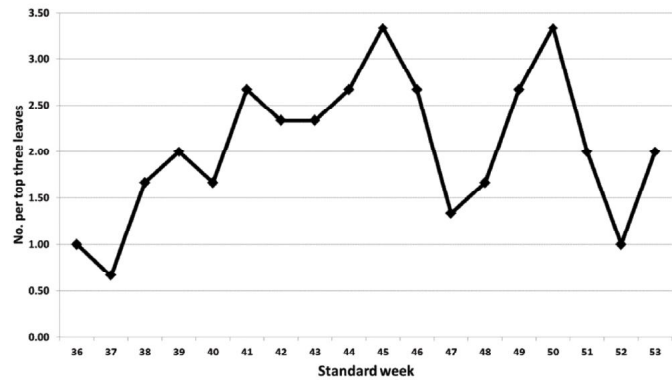


Fig. 3.1.3.2. Incidence of thrips, *Neohydatothrips samayunkur* on marigold

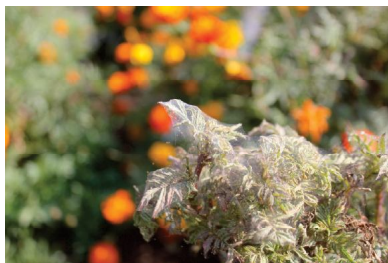


Fig. 3.1.3.3. Red spider mites, *Tetranychus* spp. on marigold

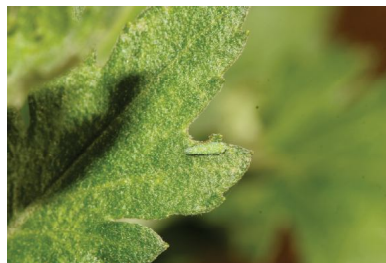


Fig. 3.1.3.4. Chrysanthemum leafhopper, *Eupteryx* sp. on chrysanthemum



Fig. 3.1.3.5. Mirid bug, *Lygus* sp. on chrysanthemum

3.1.4 Incidence of Natural Enemies of Insect Pests on Commercial Flower Crops.

Chrysanthemum aphids were found to be infested with hymenopteran parasitoids (Fig. 3.1.4.1). A predatory mirid bug (Fig. 3.1.4.2) was recorded on thrips and mites on marigold.



Fig. 3.1.4.1. Mummified aphids on chrysanthemum

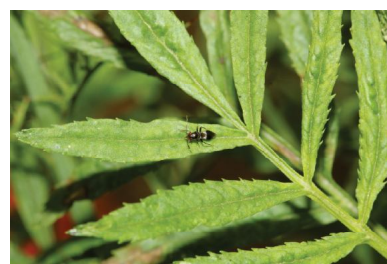


Fig. 3.1.4.2. Predatory mirid bug on marigold

3.2 Project 02 (ICAR Project Code IXX11705): Investigations on Virus and Phytoplasma Diseases of Commercial Flower Crops

3.2.1 Survey of Incidence of Viral and Phytoplasma Diseases in Major Flower Growing Areas

A detailed survey was undertaken to determine the incidence of viral and phytoplasmal infections in flower crops grown in protected structures and open field conditions. Similarly nursery plants grown in open and shadenet houses were also surveyed and diseases were documented. The areas of survey included Village

Shindavne and nearby villages of Haveli Taluka, Alandi, Narayangaon for open cultivation. About six protected cultivation units in Floriculture park, Talegaon and in the Taluka Haveli were surveyed. About 11 nurseries were surveyed. The methodology was simple random sampling from individual fields or individual polyhouse or individual nursery units of specified crops and disease incidence calculated based on number of infected plant/total number of plants multiplied by 100. During the survey, other fungal bacterial diseases and pests were also recorded.

In open field conditions, peduncle blight has been found to be serious in tuberose. Yellows, phyllody (Fig. 3.2.1.1) and witches broom symptoms of phytoplasma infections were found severe in China aster. *Cercospora* leaf spot (Fig. 3.2.1.2) was found in jasmine under open cultivation along with stem proliferation and phyllody symptoms of Phytoplasma infections (Table 3.2.1.1). In marigold Stolbur (Fig. 3.2.1.3) was the major symptom in open field conditions. In case of annual chrysanthemum virescence was predominant (Fig. 3.2.1.4).

Table 3.2.1.1. Incidence of diseases observed in the open field

Crops	Disease symptoms observed	Incidence
Tuberose	Leaf spot, stem rot, mild mottle	<1%
	peduncle blight, herbicide injury	5-10%
Marigold	Flower blight	3-5%
	Phyllody, stunting and witches broom- Stolbur	2-3%
China aster	Yellows, stunting, phyllody and flower malformations, bacterial wilt	10-20%
Bird of Paradise, Spider Lily	Leaf blight	1-2%
Chrysanthemum	Mosaic, ring spots, leaf malformation, flower colour break	60%
Annual Chrysanthemum	Withches broom and virescence	2-3%
Jasmine	Yellow ring spot, stem proliferation/ fassiation	5%
	<i>Cercospora</i> leaf spot	10%



Fig. 3.2.1.1. China Aster-Phyllody



Fig. 3.2.1.2. Jasmine – Cercospora leaf spot

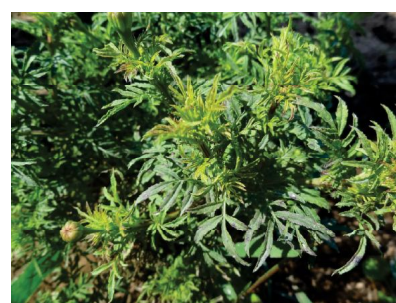


Fig. 3.2.1.3. Marigold – Stolbur



Fig. 3.2.1.4. Annual chrysanthemum – virescence

Under protected conditions, crown gall was found to occur in most of the rose plantations with 80-90% incidence with higher incidence in older plantations. Powdery mildew is the most common disease found in all the crops like rose, gerbera, carnation grown under protected cultivation (Table 3.2.1.2). Among phytoplasma diseases little leaf (Fig. 3.2.1.5) is predominant in rose plantations, virescence in gerbera (Fig. 3.2.1.6) and witches broom in carnation (Fig. 3.2.1.7).

Table 3.2.1.2. Incidence of diseases observed in the protected units

Sl. No.	Crop	Disease symptoms observed	Incidence
1.	Rose	Crown gall	80-90%
		Powdery mildew	30-40%
		Anthrachnose	5-10%
		Mosaic and Flower colour breaking	3-5%
2.	Gerbera	Phyllody and Flower malformation	1-2%
		Powdery mildew	10%
		Leaf blight	1-2%
3.	Carnation	Bud blight, Witches broom	1%



Fig. 3.2.1.5. Rose – Little leaf



Fig. 3.2.1.6. Gerbera - Virescence



Fig. 3.2.1.7. Carnation – Witches broom

About 11 nursery units were surveyed, which are located in a stretch along the side of Pune-Solapur highway from Manjri to Loni and the names were coded as unit number 1,2 3 etc. Most of the nurseries are growing mostly foliage plants, ornamental palms, ficus etc and a few were selling potted plants. Cuscuta, a parasitic weed has been found dominating all over the foliage crops in most of the nurseries (Fig. 3.2.1.8). Leaf and flower malformation, yellows, little leaf and witches broom symptoms of phytoplasma infections were found to occur in most of the nursery units and some of them were misinterpreted as variant plant types. Some of the major manifestations include Yellows in Petunia (Fig. 3.2.1.9), Yellows and Malformations in Ixora (Fig. 3.2.1.10), Virescence in Hydrangea (Fig. 3.2.1.11), leaf and flower malformation in hibiscus (Fig. 3.2.1.12), stem proliferation in Jasmine (Fig. 3.2.1.13) and little leaf in Murraya (Fig. 3.2.1.14). Fungal diseases like leaf spots and leaf blight were also observed in many cases but the intensity is less due regular sprays of fungicides. The details of the observations are given in Table 3.2.1.3.

Table 3.2.1.3. Details of the nursery units surveyed and the diseases or pest observed

Nursery unit number	Major Plants grown	Diseases/Pests observed
1	Foliage plants like Croton, Ficus and different types of Palms were the majority	Fungal leaf blight on Palms.
2		Yellows on Areca Palms.
3		Bacterial leaf spot on foliages.
4		Witches broom and leaf malformations on croton.
5	Other than above plants, Crinum Lily was grown	Severe infestation of cuscuta on foliage plants like Croton. Crinum Lily plants were severely affected with fungal leaf blight.
6	Other than above plants, zinnia local, geranium and Schefflera	Schefflera plants severely affected with Psyllid galls.
7	Pot plant like Dianthus, hibiscus, petunia, rose, pot gerbera, vinca rosea, and indoor plants like mother in laws tongue (Sansevieria),diphenbechia, Aglonema and foliage plants like Asparagus, Aralia, coleus and	Erwinia leaf rot on Deifenbechia and Aglonema plants. Aralia plants showed little leaf and severe incidence of Cusuta

Continued...

Nursery unit number	Major Plants grown	Diseases/Pests observed
	croton were seen. Other than ornamental plants, they grow seedlings and plantlets of medicinal plants as well	On Rose symptoms of viral infection like mosaic was observed.
8	Potted plants like Rose, Gerbera, they are also propagating vegetable seedlings mainly	Leaf spots and blight were observed
9	Most of the common garden plant types are available including orchids, Most of the foliage they maintain mother stocks. Jasmine, Croton, Ixora, Pagoda tree (Plumeria), Tabernaemontana, Eranthemum, Murraya exotica, Poinsettia, garden ficus etc	Hydrangia flowers showed virescence- indicating infection of phytoplasma, Ixora plants showed leaf malformations, yellowing and bunching of leaves, Jasmine and Murraya showed stem proliferation and phyllody, Mealy bug incidence was severe on eranthemum
10	Most of the above plants, Adenium etc	Leaf blight and flower blight, Mealy bugs in eranthemum
11	Open condition they have grown Rose, Dianthus, Pot gerbera, Petunia, Hibiscus and Canna in large scale, Under polyhouse indoor plants are maintained like Aglonema, Dracena, Deiffenbechia etc	In rose mosaic was pominant, Dianthus plants showed phyllody, Hibiscus leaves and flowers were showing extreme malformation like crinkling, cupping making suspicion of viral infection along with Mealy bug infestation. Canna leaves and flowers showed blight symptoms. Indoor plants were healthy looking

The cropwise incidence of major diseases observed in nurseries is summarized in Table 3.2.1.4. Among the foliage potted plants crotons and aralia exhibited phytoplasma induced manifestations to an extent of 60-80 percent. The higher incidence is understandable as the plants were severely infested by cuscuta which is one of the major modes of transmission of phytoplasma. Bacterial leaf spot in ficus, leaf rot in diffenbechia and aglonema are some of the bacterial diseases observed. Among fungal diseases leaf blight was common in palms, crinum lily, diffenbechia followed by anthracnose in dracaena, leaf spots in coleus and dieback in asparagus. Among potted plants, the manifestation of phytoplasma infections varied from virescence and phyllody in dianthus and hydrangea, yellows in petunia and stem proliferation in jasmine while in hedge plants like Murraya stem proliferation and fassiation was observed.

Table 3.2.1.4. Incidence of diseases in the nursery units

Major Plants grown	Diseases/Pests observed	Incidence
Foliage and indoor plants		
Croton	Witches broom and leaf malformations and Cuscuta	60-80%
Ficus	Bacterial leaf spot	10%
Palms	Leaf blight, Yellows on Areca type Palms	10%
Crinum Lily	Leaf blight	30%
Schefflera	Schefflera plants were severely affected with Psyllid galls	90%
Diphenbechia	Erwinia leaf rot , Leaf blight	2-3%
Aglonema	Erwinia leaf rot , Leaf spot and Blight	2-3%
Asparagus	Die back	2-3%
Dracena	Anthracnose	2-3%
Aralia	Little leaf and Cuscuta	60-70%
Coleus	Leaf spots	2-3%
Eranthemum	Mealybug and leaf malformations	30-40%

Continued...

Major Plants grown	Diseases/Pests observed	Incidence
Potted flowering plants		
Dianthus	Virescence and Phyllody	2-3%
Hydrangea	Virescence and Phyllody	2-3%
Petunia	Yellows	5-10%
Hibiscus	Flower and leaf malformations, crinkling, cupping of leaves, little leaves and mealy bug infestation	30-40%
Rose	Rose mosaic	2-3%
Pot gerbera	Flower blight, Leaf yellowing and vein banding	2-3%
Ixora	Leaf malformations, yellowing and bunching of leaves	10%
Murraya exotica and Jasmine	Stem proliferation and Fasciation	2-3%
Canna	Leaf blight and flower blight	5-10%



Fig. 3.2.1.8. Croton - Cuscuta infestation



Fig. 3.2.1.9. Petunia - Yellows



Fig. 3.2.1.10. Ixora - Yellows and leaf malformation



Fig. 3.2.1.11. Hydrangeia - Virescence



Fig. 3.2.1.12. Hibiscus - Leaf and flower malformation



Fig. 3.2.1.13. Jasmine - Stem proliferation



Fig. 3.2.1.14. Murraya - Little leaf

3.2.2 Evaluation of Morphological Manifestations of Yellows Phytoplasma Infection in Saponeria

Saponeria plants grown in ICAR-DFR farm exhibited 40% incidence of phytoplasma infection. The symptoms included stunting, bunching and withces broom malformation of inflorescence, phyllody in the inflorescence where floral parts turned to leafy structures (Fig. 3.2.2). The phytoplasma infected branches failed to set seeds. The samples have been found positive for the infection of phytoplasma confirmed through nested PCR using 16srDNA. The study was done in collaboration with the Division of Plant Pathology, IARI, New Delhi.



Fig. 3.2.2. Saponeria plants showing symptoms of phytoplasma infections
 1. Healthy saponeria bearing normal flowers, 2. Bunching and withces broom malformation of inflorescence,
 3. Phyllody in the inflorescence– floral parts turned to leafy structures

3.2.3 Symptomatology of *Candidatus Phytoplasma*, *Tospovirus*, *Carlavirus* and *Chrysanthemum stunt viroid* (CSVd) in Spray and Standard Chrysanthemum

Chrysanthemum plants in the research farm of ICAR- DFR exhibited yellow spots, leaf cupping, vein clearing, stunting, vein necrosis, irregular flowering, flower colour breaking, leaf malformations (loss of pinnation and narrowing), purple discolouration, phyllody, little leaf and die off. 28% Incidence of the symptoms observed in standard type of chrysanthemum (Fig. 3.2.3). A similar incidence was observed in spray cultivars but severity of symptoms was more in standard cultivars. The symptoms indicated that the symptoms could be due to infections of *Candidatus Phytoplasma*, *Tospovirus*, *Carlavirus* and *Chrysanthemum stunt viroid* (CSVd).



Fig. 3.2.3. Chrysanthemum plants with various symptoms of mixed infections of virus, viroid and phytoplasma infections
 A. Leaf malformation B. Vein yellowing and yellow ring spot C. Yellows D. Vein necrosis and E. Flower colour breaking

3.2.4 Evaluation of Seasonal Variation in Symptoms of Phytoplasma Infection in *Dimorphotheca*

The dimorphotheca plants in the research field of ICAR-DFR have been showing the characteristic symptoms of phytoplasma infections throughout the life stages. During the winter (Jan to March) when temperature varied from 23-31°C the plant was in the initial stages of growth, rubbery looking dark green

leaves with thickened veins was observed in infected plants. Towards the development of flower primordia, the malformed leaves at the growing tips were coalesced to form funnel shaped structures putting an end to the growth of such shoots. Later on in April-May when temperature ranged from 36-40°C, the whole leaves turned yellow, malformations like fasciated flowering stalk, rudimentary floral structures, purple discoloration of stem and accelerated auxillary bud growth throughout the plant from the crown region was observed (Fig. 3.2.4). The roots of the infected plants also showed increased number of lateral roots while restricting the tap root growth.

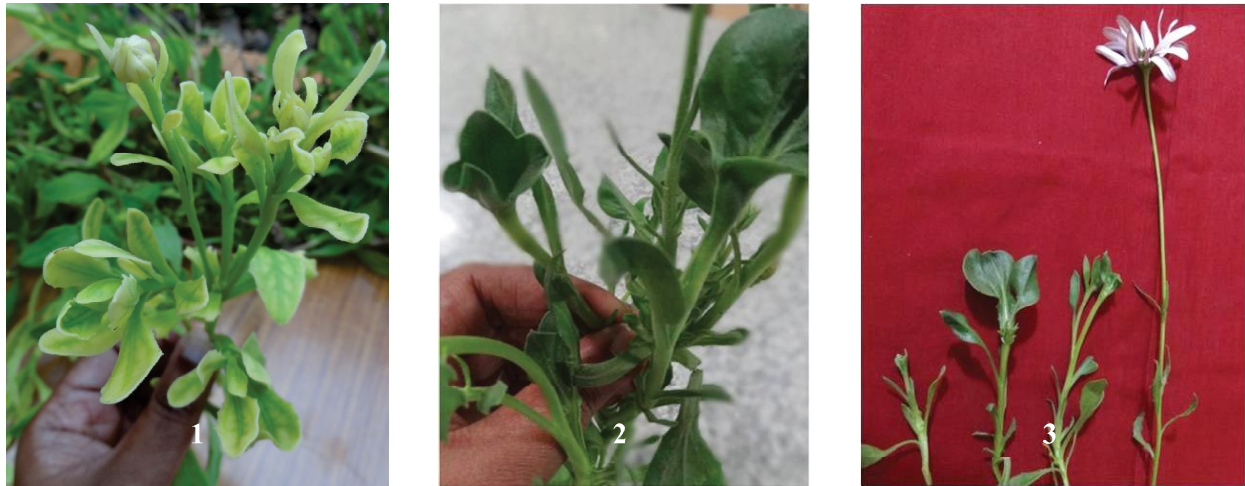


Fig. 3.2.4. Dimorphotheca plants showing symptoms of phytoplasma infection

1. Yellows and leaf malformation, 2. Leaf turned into funnel shaped structure 3. Malformation of flowering stalk in comparison with healthy stalk

3.2.5 Morphological Diagnostic Features of Phytoplasma Infections in *Dianthus*

The potted dianthus plants grown in a nursery in Pune area showed characteristic symptoms of phytoplasma infections which included yellows, high axillary bud growth and flower malformations, phyllody and virescence where stamens were intact while the pistils have been turned to vegetative leafy structures (Fig. 3.2.5). Even though there were symptoms of stunting, leaf bunching and malformations, Flower virescence and phyllody is found to be the most confirmatory symptoms of phytoplasma infections in *Dianthus*, as other symptoms are contributed by various other stresses as well. The incidence was meager approximately 1-2% but the severity of infection in infected plants was high.



Fig. 3.2.5. *Dianthus* plants showing symptoms of phytoplasma infection

1. *Dianthus* plant healthy and infected, 2. *Dianthus* plants showing yellows 3. A branch of infected plant showing high axillary bud growth and flower malformations

3.2.6 Infectivity Assay of *Tospovirus* for Biological Characterization

In order to confirm the tospoviral etiology of necrosis symptoms on chrysanthemum, an infectivity assay has been undertaken on propagative and indicator host cowpea. Cowpea is reported to be a local lesion host for *Groundnut bud necrosis virus* (GBNV), a *Tospovirus* reported to infect chrysanthemum in India. The infection of GBNV will produce hyper sensitive reaction on the mechanically inoculated cowpea plants. Mechanical inoculation of chilled extract of the symptomatic plant sap (showing stem and vein necrosis) was done through rubbing on the cowpea leaves at two leaf stage. Controls were plants inoculated with distilled water and uninoculated plants. Out of the three mechanically inoculated plants, two exhibited necrotic lesions indicative of the presence of GBNV, while uninoculated and water inoculated plants didn't show the characteristic necrotic lesions (Fig. 3.2.6).



Fig. 3.2.6. Infectivity assay of *Tospovirus* on cowpea plants
A. Cowpea plants at two leaf stage used for inoculation, B. Hypersensitive lesion on the inoculated plants at 21 DPI

3.2.7 Electron Microscopy (EM) and PCR based diagnostics of *Potyvirus* Associated with Mottling and colour breaking in Gladiolus

Gladiolus plants from the field of ICAR-DFR where showing mottling and flower colour breaking were subjected to electron microscopy (IARI, New Delhi) and flexuous particles observed indicating the presence of *Potyvirus*. To confirm the occurrence of *Potyvirus* PCR was undertaken using primers from Nib region and expected amplicon of 350bp was obtained. For further confirmation primers based on CP region of amplicon size 800bp was amplified and sequenced from the same sample (Fig. 3.2.7). The sequence analysis revealed the virus to be *Bean yellow mosaic virus* (BYMV).

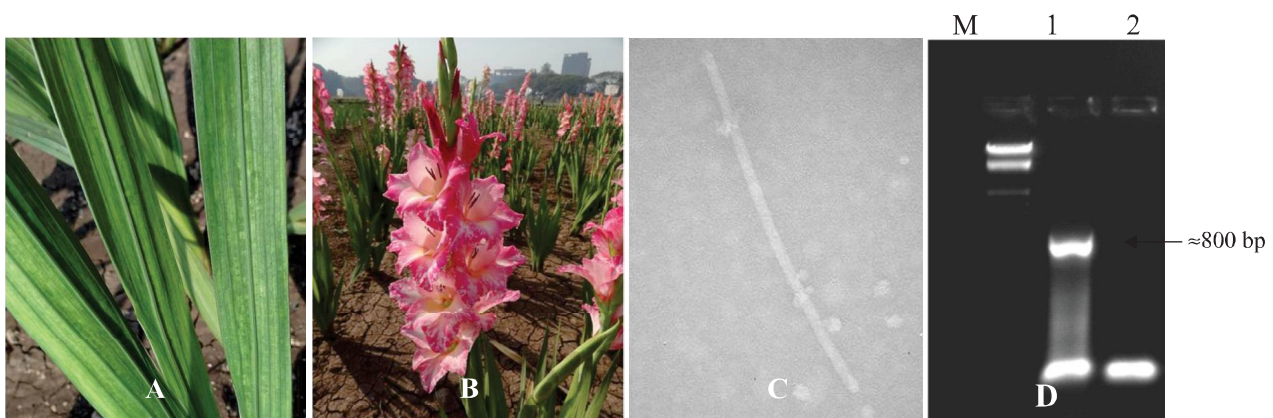


Fig. 3.2.7. *Potyvirus* infected Gladiolus showing leaf mottling and flower colour breaking
A. Gladiolus leaves – mottling, B. Flower colour breaking C. Electron micrograph of Flexuous particles of Potyvirus, D. M-Marker, Lane 1: Gladiolus, Lane 2: Negative control

3.2.8 Identification of *Cucumovirus* and *Badnavirus* from Jasmine

Jasmine leaves showing yellow ring spot like symptoms were subjected to electron microscopy and both isometric and bacilliform particles were observed. RT-PCR using Cucumber mosaic virus (CMV) specific primers gave the expected amplicon of 1.2kb indicating the presence of CMV. To confirm the presence of Bacilliform DNA virus (*Badnavirus*) degenerate primers were used and expected amplicon of 500bp was obtained. In both the cases non symptomatic plants didn't show any amplification confirming the presence of viruses in infected plants (Fig.3.2.8). This work was undertaken in collaboration with IIHR, Bengaluru.

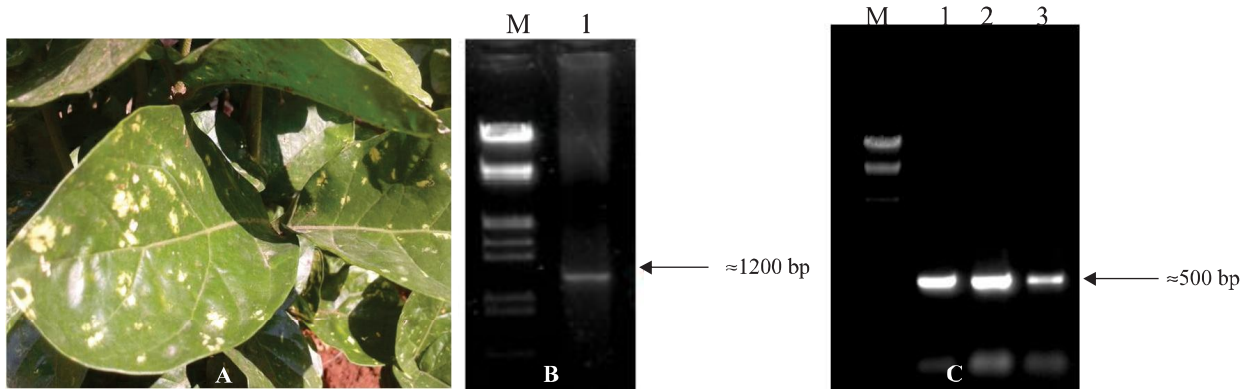


Fig.3.2.8.A. Jasmine leaves showing ring spots, B. Gel electrophoresis showing 1.2kb amplicon of CMV from jasmine – M is the marker, C. Gel electrophoresis showing 500bp amplicon of Badnavirus from Jasmine – M Marker, Lane 1 and 2 Jasmine, Lane 3 – Positive control.

3.2.9 Identification of *Potyvirus* from Tuberose and Amaryllis

Tuberose and amaryllis plants (Fig. 3.2.9.1) showing mottling symptoms were subjected to EM and flexuous particles were observed suspecting presence of *Potyvirus*. To confirm the same RT-PCR using genus specific primers based on Nib region gave expected 900bp amplicon indicating the association of *Potyvirus* with the mottling of Tuberose and Amaryllis (Fig. 3.2.9.2). This work was undertaken in collaboration with IIHR, Bengaluru.



Fig. 3.2.9.1. Amaryllis and Tuberose leaves exhibiting mild mottle and leaf mottling respectively

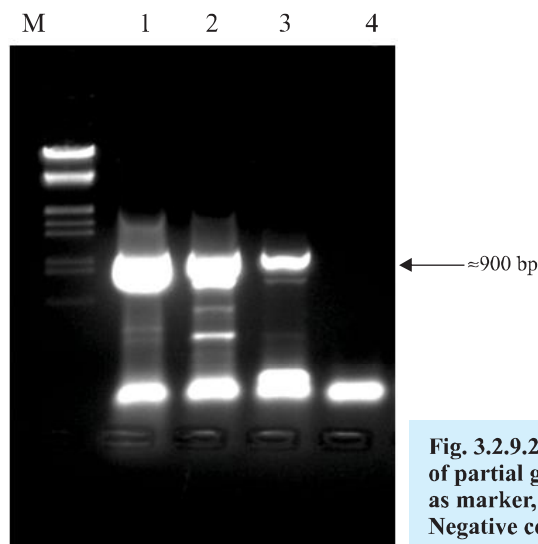


Fig. 3.2.9.2. Agarose gel electrophoresis showing specific RT-PCR amplification of partial gene NIB Lane M: Lambda DNA digested with EcoRI and Hind III as marker, lane: 1, 2, 3 sample from Gladiolus, Tuberose, Amaryllis, Lane 4: Negative control

3.2.10 Development of Severity Score and Evaluation of Gladiolus Germplasm for Natural Incidence of Virus Symptoms

41 varieties of gladiolus were evaluated for the natural incidence of virus symptoms and the disease incidence and Percent Disease Index (PDI) were calculated. A 0 to 5 scale was developed based on the area of infection to evaluate PDI ie 0: no infection, 1:0-20 %, 2: 20-40%, 3: 40-60%, 4: 60-80% and 5: 80-100%. Variety Chima Rosa showed the lower disease incidence with lowest severity as well. Cultivars Flavo Amico and Bea Jowr showed lowest incidence while the severity of the infection was higher. Cultivars Argentina, Flavo Savar and Snow Princess exhibited highest incidence level along with high PDI, while Amsterdam showed the severe infection among all with highest PDI (Fig. 3.2.10).

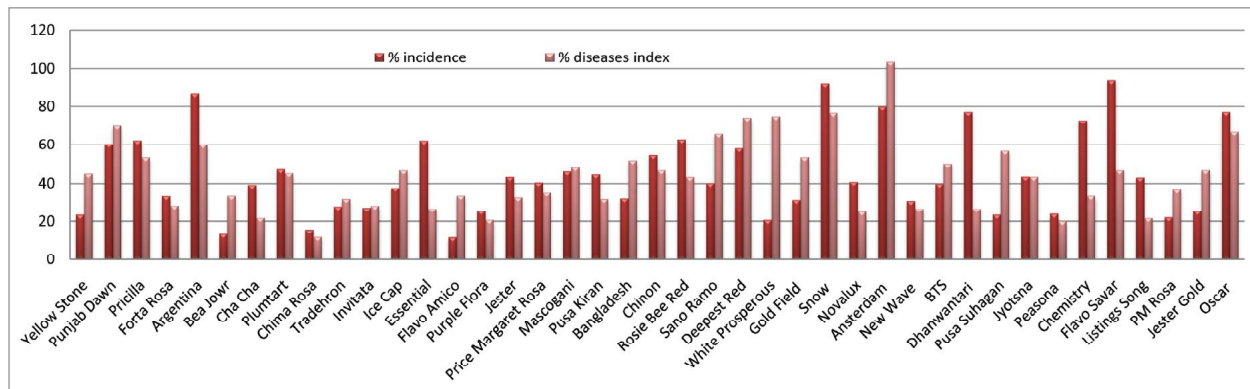


Fig. 3.2.10. The percent incidence and PDI of virus diseases in Gladiolus

3.2.11 Evaluation of Gladiolus Bulbs for Storage Diseases

Corms of seven varieties of gladiolus were subjected to low temperature under refrigerated conditions (4-8°C) to record the incidence of various storage pathogens. Infection of *Fusarium oxysporum*, *Aspergillus* sp. and *Penicillium* species based on the morphology were recorded. All the varieties showed different degrees of corm rot (Fig 3.2.11.1) and was highest for the variety Purple Flora while it was less for Pricilla variety (Fig. 3.2.11.2). Incidence of higher rate of corm rot is correlated to the late harvest of bulbs and the virus infected plants like Pricilla showed lesser incidence of rot which needs to be further investigated.



Fig. 3.2.11.1. Gladiolus corms showing storage rot

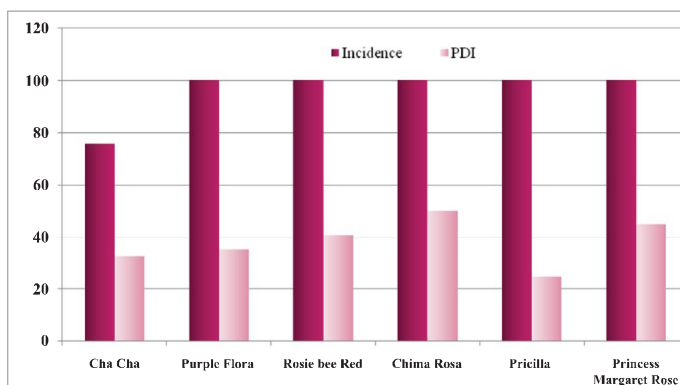


Fig. 3.2.11.2. Incidence and severity of corm rot due to multiple infections in different gladiolus cultivars

3.2.12 Morphological Characterization of *Fusarium oxysporum* f. sp. *gladioli*

An incidence of severe yellows was observed under Pune condition in *Gladiolus* in 2014-2015. To understand the etiology the samples were collected and stored. Yellows in *gladiolus* is a most prevalent disease caused by *Fusarium oxysporum*. Based on the symptomatology observed in field (Fig. 3.2.12.1A & B), infection of *F.oxysporum* was suspected and for confirmation morphological and molecular characterization of the fungi was undertaken.

The fungus *Fusarium oxysporum* f. sp. *gladioli* (Massey) Synder and Hansen produces aerial mycelium which is hyaline, branched, septate, well-developed and cottony in appearance (Fig. 3.2.12.1C). The culture is slightly purple or pinkish white in colour on Potato Dextrose Agar (PDA) medium. The fungus produces abundant conidia in culture, and conidia are of two types; micro and macro conidia (Fig. 3.2.12.2) on a thick mycelia mat (Fig. 3.2.12.3).



Fig. 3.2.12.1. A. and B. *Fusarium* infected corms of *gladiolus*, C. Culture plate of FOG

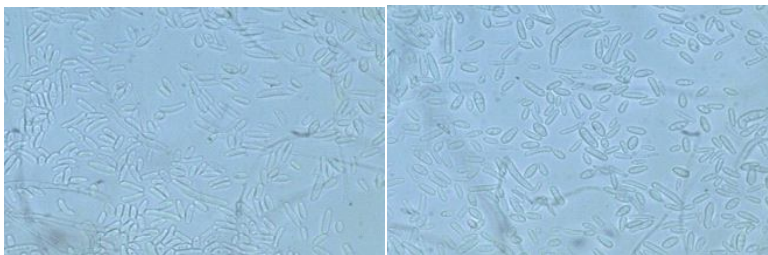


Fig. 3.2.12.2. Photograph of micro and macro conidia of FOG

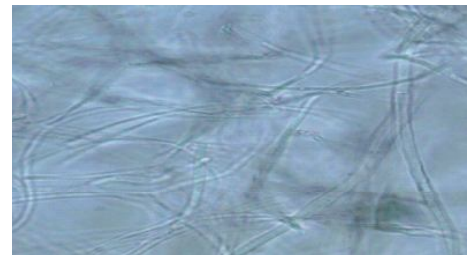


Fig. 3.2.12.3. Mycelial mat of FOG in *Gladiolus*

3.2.13 Molecular Characterization of *Fusarium oxysporum* f. sp. *gladioli*

Fungal DNA was extracted and purified from lyophilized mycelium using the N-cetyl-N,N,N-trimethyl ammonium bromide (CTAB) extraction method. PCR was done using ITS and Tef gene specific primers, which showed a specifically amplified band of ~600 bp and ~300 bp respectively in agarose gel (Fig. 3.2.13) from one isolate of Pune and two isolates from IIHR.

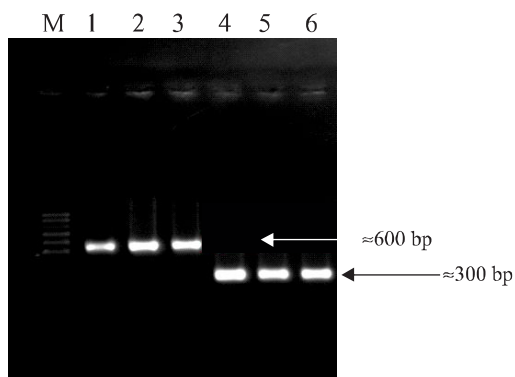


Fig. 3.2.13. Agarose gel amplification of ITS and Tef 1 genes respectively. Lane M: 100 bp DNA ladder, Lane 1,2,3: 600 bp amplification and Lane 4,5,6 : 300 bp amplification

Purified PCR products corresponding to the specific genes were cloned. Selected clones were sequenced. Sequence analysis of ITS region and Tef 1 α region revealed closest relationship with the sequence referred to as *Fusarium oxysporum* (Accession: FJ605247) from Brazil from *Scuticaria irwiniana* plant and *Fusarium oxysporum* f.sp. *gladioli* (Accession: FJ664916) from the Netherlands from *Freezia* plant respectively. The sequence of ITS region (under study) has been submitted to NCBI GenBank under the accession no - KU721005.

3.3 Project 03 (ICAR Project Code: IXX11708): Assessment Nematode Infestation in Major Commercial Flower Crops and Management of Root-Knot Nematode in Tuberose

3.3.1 Incidence of Root-Knot Nematode, *Meloidogyne* spp in Tuberose and Gerbera

Survey on nematode incidence in flower growing areas indicated severe incidence of root-knot nematode infestation in tuberose under open field conditions and gerbera under protected cultivation. The incidence ranged from 50 to 70% in tuberose growing areas of Pune region. Of the eight villages (Sortapwadi, Shindwane, Yavat, Chambali, Bhandgaon, Arvi, Kusur and Gunjalwadi), highest root-knot nematode incidence of 70% was recorded in Arvi village followed by 65% in Shindwane. The lowest incidence (50%) was recorded in Yavat Village. The severity measured in terms of root-knot index on 0-10 scale with 0 representing no galls, 5 representing 50% infestation and 10 representing severe infestation with all the root system knotted. Based on root-knot index, severity or infestation level is very high (100% of root knotted) in tuberose fields of Bhandgaon and Shindwane villages and 50-80% in tuberose fields of remaining villages. The effected plants showed severe stunted growth with reduced number of flower stock (Fig. 3.3.1.1 & 3.3.1.2). The 5-10% incidence of root-knot nematode was also recorded in gerbera grown under protected cultivation in Shindwane and Sortapwadi villages with the infestation level of 23-30% (Fig. 3.3.1.3).



Fig. 3.3.1.1. Stunted growth and reduced number of spikes of tuberose due to root-knot nematode

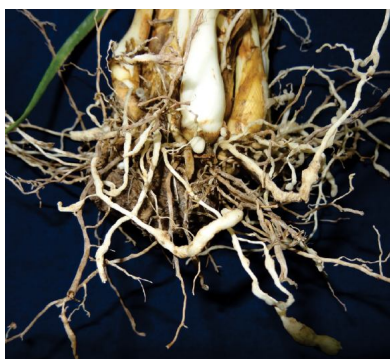


Fig. 3.3.1.2. Galls on tuberose roots due to root-knot nematode



Fig. 3.3.1.3. Yellowing of gerbera leaves due to infection by root-knot nematode

3.3.2 Evaluation of Tuberose Cultivars for Disease Reaction to Root-Knot Nematode, *M. incognita*

Nineteen tuberose cultivars (Vaibhav, Pearl Double, Suvasini, Hyderabad Double, STR-505, Swarn Rekha, Hyderabad Single, Prajwal, GKT- C4, Shringar, Arka Nirantara, Phule Rajani, Mexican Single, Bidhan Rajani – 1, Bidhan Rajani – 2, Bidhan Rajani – 3, Arka Sugandhi, GK-TS-L1P4 and GK-TD-L1P1) were screened for their tolerance/resistance to root-knot nematode, *Meloidogyne incognita*. Disease reaction of these genotypes for root-knot nematode was recorded on the basis of number of root-galls on each genotype per plant and plant growth characteristics. Genotypes, Shringar, Arka Nirantara, Bhidhan Rajani-2, Suvasini and Hyderabad Single were found to be susceptible whereas the remaining tested genotypes were found to be highly susceptible. Observations on plant height, spike length and rachis length were taken at 70 days after planting found to be significantly reduced.

3.3.3 Evaluation of Gladiolus Cultivars for their Disease Reaction to Root-Knot Nematode, *M. incognita*

Gladiolus cultivars namely Nova Lux, Jester, Chandani, Snow Princess, Punjab Dawn, Chemistry, Traderhorn, Forta Rosa, Rosiebee Red, Oscar, Priscilla and Cha Cha were evaluated for their tolerance/resistance to root-knot nematode, *M. incognita*. 30-45 % reduction in final nematode population was observed in the cultivars, Nova Lux, Snow Princess, Chemistry, Rosiebee Red and Priscilla. Cultivars, Jester, Chandani, Punjab Dawn, Traderhorn, Forta Rosa, Oscar and Cha Cha recorded the galls in the range of 15 to 25 per plant (Fig. 3.3.3).

3.3.4 Influence of Pre-planting Initial Population Density of the Root-Knot Nematode *M. incognita* on China Aster

Pot experiment was conducted to examine the effect of initial population density of root-knot nematode, *Meloidogyne incognita* on China aster and nematode population development. The root-knot nematode infested soil is mixed with healthy soil to get a pre planting initial population density of 100, 200, 500 and 1000 J2/100 cm³ soil before filling in to the 15 cm diameter earthen pot. Seventy days after planting, observation on plant height, number of galls and nematode multiplication rate was recorded. All the level of pre planting density caused significant reduction in plant height (<25cm) compared to uninoculated control (36cm) and severe galling on the roots were observed with high initial population density (Fig. 3.3.4). The increase in initial population density resulted in increase in root-knots on China Aster. Significantly higher numbers of galls (155.67/plant) were observed in the initial population density of 1000J2/100 cm³ soil followed by 500J2/100 cm³soil (150.33 galls/plant) compared to 93.33 and 66.67 galls/plant in initial population density of 200 and 100 J2/ cm³soil respectively. An inverse relation was found between initial population density and nematode multiplication rate. Maximum multiplication rate (4.97-fold) was found in lowest initial population density (100 J2/ cm³soil) and minimum (1.76-fold) in highest population density (100 J2/cm³soil).



Fig. 3.3.3. Galls on gladiolus roots due to root-knot nematode



Fig. 3.3.4. Severe galling on the roots of China aster due to root-knot nematode

4. Post-Harvest Management

4.1 Project 04 (ICAR Project Code: IXX12322): Standardization of Post-Harvest Packaging Technology for Tuberose and Jasmine

4.1.1 Technology for Tuberose and Jasmine Packaging

Studies on post-harvest packaging of tuberose and jasmine loose flowers were undertaken. Survey was conducted in farmer's field of Bhor, Daund and Purandar tahshil of Pune district to assess the post-harvest loss and packaging methods for loose flowers. After carrying out detailed survey on farmer's field, it was found that the farmers of Pune region packed tuberose and jasmine loose flowers traditionally in gunny bags, urea bags and news papers (Fig. 4.1.1.1). Farmers are not using any modern packaging system for packaging of tuberose loose flowers. Due to lack of proper packaging, the weight of loose flowers is reduced by 20-30 % of their original weight, after 12 hrs of harvesting.



Fig. 4.1.1.1. Traditional methods of loose flowers packaging

By considering all the problems associated with post harvest packaging of tuberose flowers, a CFB package (30x20x10cm) for packaging of tuberose loose flower by using Auto CAD (Fig. 4.1.1.2) was designed. CFB box was designed by considering the four basic standards: Board styles, Flutes, Dimensions and Edge crush test. Double or triple wall board style with a combination of different fluting, such as A-flute and C-flute between the liners were taken into consideration. Edge Crush Test (ECT) is the standard by which box strength is measured. We have also considered Aluminum-foils and butter paper for inner lining of box.

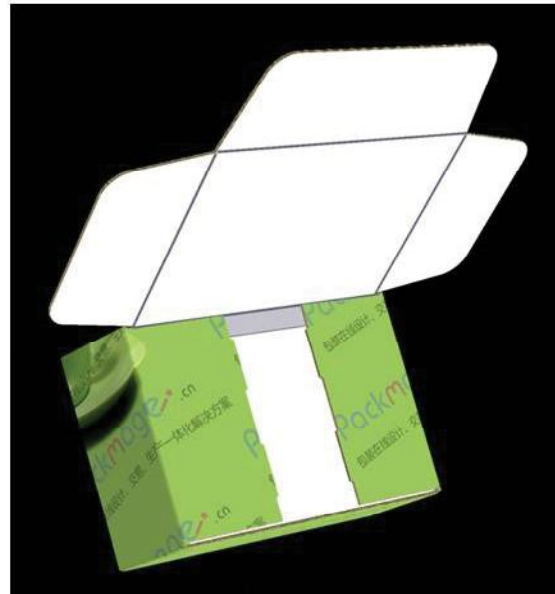
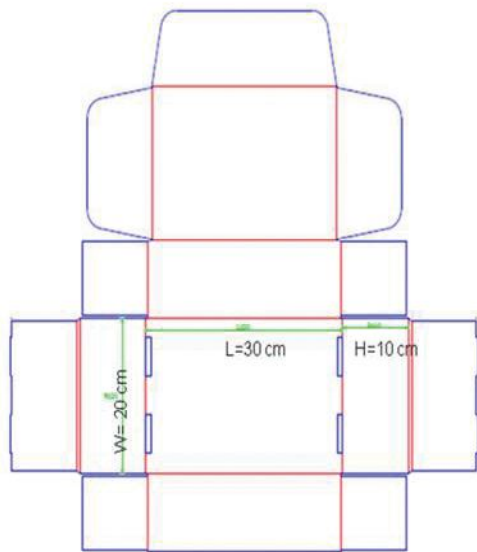


Fig. 4.1.1.2. Detailed drawings of packaging with dimentions

4.1.2 Development of Loose Flower Harvester

In India Loose flowers are used for making garlands for worship, religious function and extraction of pigments. Generally these flowers are harvested manually and require more labour. There is need of mechanization in harvesting of flowers to minimize the dependence on limited resources such as labour, time and reducing the cost of production for enhancing farm income. So considering all these factors manually operated loose flower harvester has been designed particularly for marigold and chrysanthemum. Dimensions of the harvester are 30x25x15cm (Fig. 4.1.2). The flower harvester consists of cutting mechanism, a flower collector and a handle.

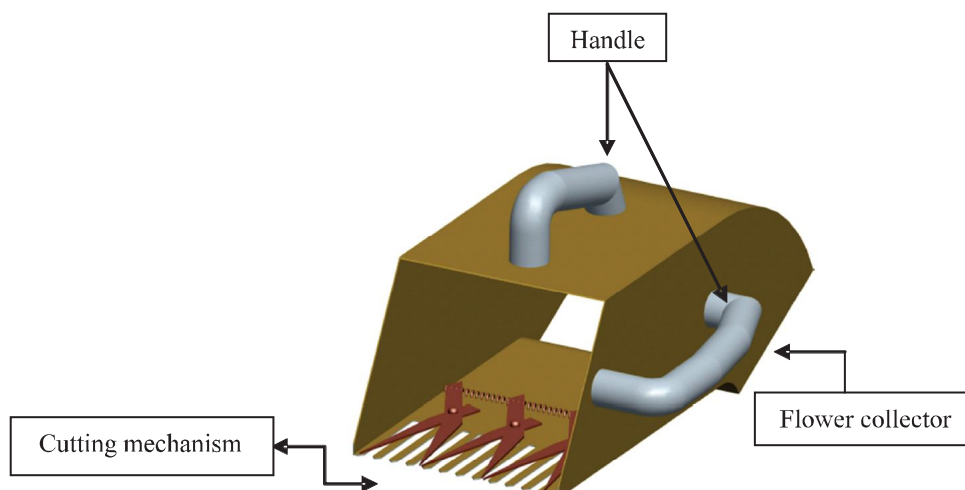


Fig. 4.1.2. Loose flower harvester

5. Externally Funded Projects

Project 1. Consortia Research Platform (CRP) on Borers in Network Mode

- Survey was undertaken on incidence of bud borer in rose, China aster, carnation, marigold, gaillardia, tuberose and jasmine in different villages of Maharashtra.
- Incidence of bud borer, *Helicoverpa armigera* was more in rose (30–40%), followed by China aster (10–20%), carnation (5–10%), marigold (5–10%), gaillardia (5–10%), and tuberose (3–5%).
- Minor incidence (< 1%) of jasmine bud borer, *Hendecasis duplifascialis* was recorded in only one field (Shindawane, Pune dist.)
- Population dynamics of *H. armigera* was studied on China aster, marigold, tuberose and gaillardia.
- Population density was higher in China aster followed by marigold, gaillardia and tuberose.
- Natural enemies were not found in any of the crops studied.

1.1 Biodiversity and Geo-mapping

Survey was undertaken in Maharashtra for the incidence of bud borer, *Helicoverpa armigera* both under polyhouse and open field condition. The incidence was found to be higher in rose (30–40%) (both under open field and polyhouse), followed by china aster (10–20%), carnation (5–10%), marigold (5–10%), gaillardia (5–10%) and tuberose (3–5%) (Fig. 1.1.1–1.1.5) (Table 1.1.1 and Table 1.1.2). Survey was also undertaken for the incidence of bud borers in jasmine, however the crop was under vegetative phase during the period of survey.

Minor incidence of jasmine bud borer, *Hendecasis duplifascialis* (Fig. 1.1.6a&b) was recorded in one field (Shindawane, Pune dist.).



Fig. 1.1.1a. Bud borer eggs on rose flower bud



Fig. 1.1.1b. Bud borer damage on rose flower buds

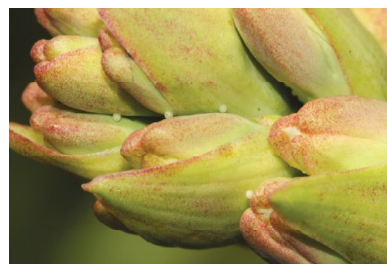


Fig. 1.1.2a. Bud borer eggs on tuberose spike

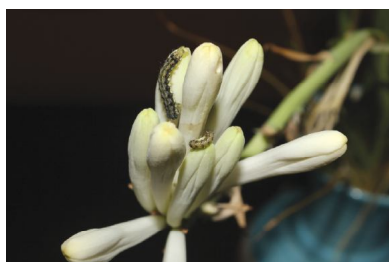


Fig. 1.1.2b. Bud borer feeding on tuberose spike



Fig. 1.1.3a. Bud borer eggs on marigold



Fig. 1.1.3b. Bud borer feeding on marigold



Fig. 1.1.4. Bud borer damage on carnation



Fig. 1.1.5. Bud borer feeding on tuberose spike



Fig. 1.1.6a. Jasmine bud borer, *Hendecasis duplifascialis* damage



Fig. 1.1.6b. Jasmine bud borer, *Hendecasis duplifascialis* larva

Table 1.1.1. Incidence of bud borer, *Helicoverpa armigera* on crops under polyhouse

Sl. no.	Crops	Insect pests	Infestation or damage (%)
1	Carnation	Bud borer, <i>Helicoverpa armigera</i>	5.0 – 10.0
2	Rose	Bud borer, <i>Helicoverpa armigera</i>	30.0 – 35.0

Table 1.1.2. Incidence of bud borer, *Helicoverpa armigera* on crops under open field condition

Sl. No.	Crops	Insect pests	Infestation or damage (%)
1	Rose	Bud borer, <i>Helicoverpa armigera</i>	30.0 – 40.0
2	China aster	Bud borer, <i>Helicoverpa armigera</i>	10.0 – 20.0
3	Marigold	Bud borer, <i>Helicoverpa armigera</i>	5.0 – 10.0
4	Gaillardia	Bud borer, <i>Helicoverpa armigera</i>	5.0 – 10.0
5	Tuberose	Bud borer, <i>Helicoverpa armigera</i>	3.0 – 5.0
6	Jasmine	Jasmine bud borer, <i>Hendecasis duplifascialis</i>	< 1.0

1.2. Host-Plant Resistance

China aster, gaillardia, marigold and tuberose were screened for the natural incidence of bud borer, *Helicoverpa armigera* under field condition. The level of infestation and population dynamics were recorded in these crops (Table 1.2.1 and Fig. 1.2.1).

Table 1.2.1. Incidence of bud borer, *Helicoverpa armigera*

Sl. No.	Crop	No. of larvae per plant
1	China aster	2.5 – 4.0
2	Gaillardia	2.0 – 3.5
3	Marigold	2.5 – 5.0
4	Tuberose	1.5 – 2.0

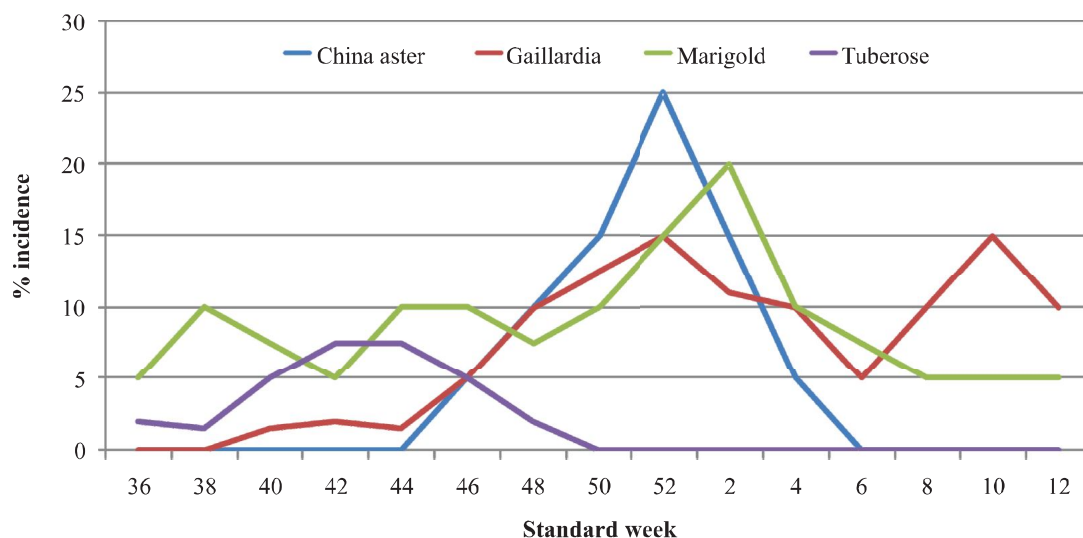


Fig. 1.2.1. Incidence of bud borer, *Helicoverpa armigera* on different flower crops

1.3 Studies on Biological Control

Different stages of the bud borer was collected and brought to the laboratory for the emergence of natural enemies, however none of the natural enemies were emerged from the samples. Under field condition also no natural enemies were recorded in the infested plants.

Project 2. New Initiative Project on Protected Horticulture

Protected horticulture project is ICAR funded project started in four centres with nodal centre at IIHR, Bangalore. The experiment was laid out on gerbera in the temporary structures (with temporary covering of existing glasshouse with shade net). All the required inputs (pots, fertilizers, media, covering material, etc.) for experiment were procured and the trial was laid out. The required irrigation and fertigation is followed as per standards. The observations are being recorded as per the technical programme.

Project 3. Studies on Male Sterility Systems to Increase the Efficiency of F₁ Hybrids in Horticultural Crops (Marigold)

3.1 Germplasm Enrichment

11 genotypes of marigold were collected from the different places.

- | | |
|--|---|
| i. Pusa Narangi Gainda (African Marigold) | vii. Local Selection 3 (French Marigold) |
| ii. Pusa Basanti Gainda (African Marigold) | viii. Thuljapur local A (French Marigold) |
| iii. Bidhan Marigold 1 | ix. Thuljapur local B (French Marigold) |
| iv. Bidhan Marigold 2 | x. Thuljapur local C (French Marigold) |
| v. Local Selection 1 (French Marigold) | xi. Thuljapur local D (French Marigold) |
| vi. Local Selection 2 (French Marigold) | |

3.2 Hybridisation

Extensive (105) crosses were attempted among Bidhan Marigold 1 & 2. The seeds of these are harvested. Thirty reciprocal crosses Thuljapur local A & B were attempted and seeds were harvested. The flowering time of Thuljapur local A & B were almost same. The Thuljapur local C and D are late in flowering and reciprocal crosses were also made.

Project 4. Phytonematode in Floriculture: Identification, Occurrence, Distribution and GIS Mapping

Nematode problem diagnosis and sampling form has been prepared including instruction for collecting soil and plant/root sample from the field and protected units. The check list comprising of soil type, crop information including cropping history, distribution of symptoms, and type of planting and nematode management practices followed has been prepared. Preliminary survey was undertaken in Maharashtra (Pune region) in open field and protected units and field symptoms are documented. Soil and plant sample are also collected, processed and identified the nematodes affecting flower crop. Severe infestation of root-knot nematode on tuberose was found in tuberose crop and protected units. Occurrence of lance (*Hoplolaimus*), lesion (*Pratylenchus*) and reniform (*Rotylenchulus*) nematodes were also found in some samples but their populations were significantly lower. Occurrence of root-knot nematode was also observed in China aster.

Project 5. Indian Floriculture Industry: Production, Marketing and Export Dynamics

In order to survey the production and marketing, detailed questionnaires are developed that include questionnaires meant for farmers growing loose flowers, cut flowers and wholesale market vendors. The data was collected based on the questionnaires.

One of the major markets in Western India Mumbai was surveyed and the data on product mix, arrivals, system of marketing of loose flowers, cut flowers, exotic flowers, cut greens was collated. The Dadar market in Mumbai is an unorganized market that opens at 3.00 am and concludes at 7.30 am mostly on the pavements on either side of the main Dadar road. The market has no infrastructure in place except for few cold storages with the exotic flower importers.

The loose flowers, cut foliage, fillers, value added floral products like garlands and veni are sold in the open on the pavements. Data on month wise and area wise arrivals of different flowers was recorded. Data on import of flowers from some of the specialized vendors was also collected. Information on floral accessories like oasis foam, containers, papers, vase solutions, artificial dyes that are used in the florist trade have been documented.

Project 6. Characterization and Natural Spread Sources of Phytoplasmas Affecting Major Floricultural Crops of India

To understand the natural spread sources of phytoplasma disease in chrysanthemum, common weeds occurring in chrysanthemum field were recorded and symptomatology for phytoplasma infections was done. Among the weed stand in field, partheniums were found to harbor symptoms of phytoplasma infections and the incidence was very high from 30-40 percent. Various symptoms shown by parthenium were recorded and the samples were collected for further confirmation of phytoplasma infections.

A survey of insects occurring in the chrysanthemum field was done by installing yellow sticky traps, to understand the potential vectors of phytoplasma in chrysanthemum. Among the various insects observed, Chrysanthemum leaf hopper was found prevalent in chrysanthemum field which may be acting as a vector for the spread of phytoplasma. The vector status of the leafhopper is yet to be confirmed.

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 have been identified as the faculty for Post-Graduate teaching and research guidance in College of Horticulture, Pune. A first semester course on "Breeding of Ornamental and Flower Crops" (2+1 Credit) was offered to Dr. Ganesh B. Kadam, Scientist, ICAR-DFR. ICAR-DFR Scientists are also involved as a member of Research Advisory Committee of Post-Graduate students of College of Horticulture, Pune.

Outreach Programmes

Krishi Unnati Mela

ICAR - DFR actively took part in Krishi Unnati Mela organized by the Department of Agriculture and Co-operation, Ministry of Agriculture and Farmers Welfare GoI, ICAR and CII during 19th - 21st March 2016 at IARI, New Delhi. Dr. Tarak Nath Saha, Dr. Prasanna Holajjer, Dr. Ganesh Kadam and Director Dr. K.V. Prasad represented ICAR- DFR in this 3 day mela. The technologies developed by ICAR - DFR and AICRP centers were showcased for the benefit of farmers.



Mr. Ganesh Bochare, Village- Kusur, Tal- Junnar Dist- Pune receiving "Innovative Farmers Award"

Udyana Mela at Dr. Y. S. R. Horticultural University

In order to bring awareness among the farmers of Andhra Pradesh about the establishment of Regional Research Station of ICAR - DFR at Vemagiri village of Kadiyam mandal, ICAR - DFR actively participated in the Udyana Mela organized by Dr. Y.S.R. Horticultural University on 30th & 31st of December, 2015. Mr. Girish K.S., Er. Rahul Yadav and the Director Dr. K.V. Prasad represented ICAR - DFR in Udyana Mela. Speaking of the occasion Dr. B.M.C. Reddy, Hon'ble Vice Chancellor, Dr. Y.S.R. Horticultural University welcomed the decision of ICAR for establishing the Regional Research Station at one of the most appropriate places i.e. Kadiyam.



Participation of ICAR-DFR at Udyana Mela held at Dr. Y.S.R. Horticultural University

Krishi Mela, KVK, Narayangaon

The team DFR comprising of Director Dr. K. V. Prasad, Dr. Tarak Nath Saha, Dr. Prabha K., Dr. Prasanna Holajjer, Dr. Ganesh Kadam, Mr. Girish K. S., Mrs. Shephalika Amrapali, Mr. Rahul Yadav, Mrs. Nitika Gupta, Dr. Shilpa Shree K. G. represented ICAR- DFR in 3 day Krishi Mela organized by KVK, Narayangaon during 6th to 8th December, 2015. The technologies generated at ICAR - DFR, live specimens, bio control agents, alternate media sources etc were displayed for the benefits of the farmers. The event was organized on the eve of International Year of Soils and World Soil Day on 5th December, 2015. Hon'ble Union Minister of State for Agriculture Shri. Mohan Bhai Khundariya inaugurated the event.



DFR stall during Krishi Mela at KVK, Narayangaon

World Soil Day

As FAO has declared 2015 as the International Year of Soils, it has been decided by Government of India that soil health cards should be issued to farmers on the occasion of World Soil Day on 5th December. The soil health card contained information on macro as well as micro nutrients. In this context Directorate had collected 50 soil samples and 50 soil health cards were distributed to farmers from Shindawane, Waghapur, Sortapwadi, Talegaon, Pande, Sasurve and Chiroli villages.

Soil analysis data indicated that pH of soil samples ranged from acidic (5.1) to highly alkaline (8.7), electrical conductivity ranged from normal (0.105 dS m⁻¹) to harmful (6.19 dS m⁻¹) for plant growth and soil organic carbon status was observed to be in the range of low (0.05 %) to high (1.31 %). About 12 %, 2% and 16 % of the total soil samples analyzed were low, 82 %, 16 % and 22 % were medium and 6%, 82 % and 62 % of the total soil samples analyzed were high in nitrogen, phosphorous and potassium status respectively. Nitrogen, phosphorous and potassium contents of soils ranged from 156.8 to 564.48 kg ha⁻¹, 13.41 to 802.96 kg ha⁻¹ and 41.44 to 459.56 kg ha⁻¹ respectively. It was also observed that all the soil samples analyzed contained excess quantities of sulphur. Among micronutrients, iron deficiency was prominent in the analyzed soil samples (56 %) followed by manganese (54%), copper (42%), zinc (12 %) and boron (2%). In addition to soil nutrient status, quantities of micronutrients to be applied in case of deficiency and quantity of gypsum to be applied to correct the soil reaction was also suggested in each soil health card.



Celebration of World Soil Day at KVK, Narayangaon



Distribution of Soil Health Card to farmers

According to the nutrient status of each soil sample, fertilizer recommendations in terms of quantities of urea, SSP and MOP to be applied to obtain reference yield of crops like tuberose, marigold, chrysanthemum and gladiolus was also suggested in each soil health card.

The event was organized in association with the Krishi Vigyan Kendra, Narayangaon, Maharashtra. The soil health cards were distributed by Hon'ble Union Minister of State for Agriculture Shri. Mohan Bhai Khundariya.

Farmer's Day

Team DFR actively participated in the Farmer's Day organized by ICAR-IARI, RS, Pune on 19th October, 2015. The event was inaugurated by Dr. Hegde, Chairman, BAAF, Pune. The technologies developed by ICAR-DFR and technologies from AICRP, live specimens were displayed for the benefit of the farmers.



Interaction with farmers at ICAR-DFR Stall



Dr. K. V. Prasad, Director, ICAR-DFR addressing the farmers



Dr. N. G. Hegde visiting ICAR-DFR Stall

Jai Kisan Jai Vigyan Week

The ICAR - DFR celebrated Jai Kisan Jai Vigyan week from 23rd December to 29th December on the birth anniversary of former prime ministers Shri. Atal Bihari Vajpayee and Late Shri. Choudhary Charan Singh. During this week ICAR-DFR participated in two awareness programmes organized by Syndicate Bank, Shivajinagar branch at Talegaon on 23rd December, 2015 followed by a detailed awareness programme covering crop production and crop management at KVK, Narayangaon on 29th December, 2015. Both the awareness programmes were well received by the flower growers.



Celebration of Jai Kisan Jai Vigyan week at Talegaon



Celebration of Jai Kisan Jai Vigyan week at KVK, Narayangaon

Mera Gaon Mera Gaurav

Under the flagship programme of the Prime Minister of India titled "Mera Gaon Mera Gaurav" (MGMG), a scheme to make scientists adopt villages to promote the best farming practices was initiated in our directorate during October, 2015. All the scientists of the directorate are involved in this programme and Kusur village under Junner taluka in Pune district was selected. The total number of families selected as beneficiaries accounts to 500 families and the total area under this programme is 1,090 ha. Baseline survey was conducted in the selected village and data was collected on the socio-economic demography. The planting materials of marigold and chrysanthemum were supplied to the farmers and the training was given on package of practice.

Institution Building

Much of the energies are channelized towards creating the required infrastructure and devising enabling measures for smooth conduct of research and outreach programmes. Common laboratory facility has been setup with equipments brought from Delhi. Similarly repair of glass houses at Shivajinagar campus was sanctioned to CPWD. Digital survey of DFR land at Hadapsar farm, Pune has been completed. Topographical, hydrological and geographical studies at Shivajinagar and Hadapsar campus to facilitate irrigation facilities have been sanctioned to CPWD. For the construction of compound wall at Shivajinagar campus, detailed drawings and estimates were submitted to the ICAR works division for technical vetting, administrative and financial approvals.

In order to overcome the prevailing adhocism efforts were made to streamline the functioning of the ICAR-DFR by adopting the rate contract for labour, chemicals, glassware, transport from ICAR sister institutes besides floating tenders specific for ICAR-DR needs. Tenders have been notified for purchase of various laboratory equipments, Expressions of Interest (EOI) are floated for registration of vendors, Applications have been invited for the recruitment of three T-3 and four Young Professionals and 3 Senior Research Fellows. Issue of rent for office space was resolved with MPKV and request for additional space, renovation of the rooms given for the ICAR-DFR are pending with MPKV.

Purchase of Equipments

Farm equipments like tractor and tractor mounted farm implements (Reversible plough, two furrow ridger and cultivator) have been purchased and are presently being used for the developmental activities at the research farm.

Acquisition of Land at Pune

ICAR-DFR got land at two locations namely College of Agriculture Campus, Shivajinagar and Manjri farm (Keshavnagar), Hadapsar which were acquired and 7/12 extracts obtained in the name of ICAR-DFR during February 2016 as per details given below:

Place	Area of Land	Khasara No. / Plot No. as per Revenue Dept. / Municipal Record
Village: Shivajinagar (Bhamburda) Taluka : Pune City	9.44 Hectare	43-A/1/1
Village: Manjari Budruk Taluka: Haveli	17.06 Hectare	123+124+173+177+178
Village: Manjari Budruk Taluka: Haveli	2.26 Hectare	125B
Village: Hadapsur Taluka: Haveli	5.26 Hectare	188/1B
Village: Mundawa Taluka: Haveli	1.13 Hectare	28B

3.77 ha area of research farm at College of Agriculture campus, Shivajinagar, Pune has been brought under cultivation and presently growing the mandate crops like chrysanthemum, tuberos, marigold and gladiolus.

Acquisition of Land at Kadiyam

The Government of Andhra Pradesh has allotted 10.77 acre of land in Vemagiri Village of Kadiyam Mandal (Sy. No. 356/1, 357 & 358) accordingly the Directorate has taken the physical possession of the land on 15th November, 2015 and obtained land delivery certificate. The process of alienation is pending with Government of Andhra Pradesh. An estimate is also received from CPWD for carrying out the digital survey and soil testing of the land.

Meetings of Research Advisory Committee/Institute Research Committee/Institute Management Committee

Research Advisory Committee Meeting

The ICAR - DFR organized the Research Advisory Committee meeting on 26th March 2016. The RAC comprised of Dr. V. A. Parthasarathy as the Chairman and Dr. Deshpande, Dr. T. M. Rao, Dr. T. Janakiram, Mr. Jafar Naqvi as the members. Other members Dr. J. S. Arora, Dr. S.P.S. Raghava and Mrs. Megha Bhorse could not attend due to prior commitments. The RAC members visited research fields and reviewed the research work carried out by ICAR - DFR and made very useful recommendations for the consideration of ICAR. The Chairman and RAC members appreciated the efforts made by team DFR to create an enabling atmosphere for the smooth functioning of ICAR-DFR, Pune.



RAC Meeting in Progress



Field visit by RAC team



Operationalisation of newly acquired farm machinery by Chairman, RAC



Monitoring of research activities by RAC members

Composition of Research Advisory Committee

Name		Designation
Dr. V. A. Parthasarathy	Former Director, ICAR-Indian Institute of Spice Research, Calicut, Kerala	Chairman
Dr. T. Janakiram	Assistant Director General (Horticulture Science), ICAR, Krishi Anusandhan Bhawan-II, Pusa, New Delhi -110012	Members
Dr. K. V. Prasad	Director, ICAR-Directorate of Floricultural Research, College of Agriculture Campus, Shivajinagar, Pune 411005, Maharashtra	Members
Dr S. P. S. Raghawa	Former Professor, Discipline of Horticulture, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi 110012	Members

Dr. J. S. Arora	Former Professor and Head, Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana, Punjab	Members
Dr. T. Manjunath Rao	Former Director (Acting), ICAR-Indian Institute of Horticultural Research, Hesaraghatta Lake Post, Bengaluru-560089, Karnataka	Members
Dr. A. A. Deshpande	Head, Vegetable Seed Research, JK Agri Genetics Ltd., Bengaluru, Karnataka	Members
Mrs. Megha Borse	President, Floriculture Association, First Floor Nadkarni Chambers, Vakildadi, Nasik - 422001, Maharashtra	Members
Mr. S. Jafar Naqvi	Chief Editor, Floriculture Today, Media Today Pvt. Ltd, T -30, First Floor, Khirki Extension, Malviya Nagar, New Delhi-110078	Members
Dr. Tarak Nath Saha	Scientist, ICAR-Directorate of Floricultural Research, College of Agriculture Campus, Shivajinagar, Pune 411005, Maharashtra	Member Secretary

Composition of Institute Management Committee

The ICAR has constituted the Institute Management Committee comprising of following members on different dates during 2015-16

Name		Designation
Dr. K. V. Prasad	Director, ICAR-Directorate of Floricultural Research, College of Agriculture Campus, Shivajinagar, Pune 411005, Maharashtra	Chairman
Dr. S. S. Adsul	Director of Horticulture, Commissionerate of Agriculture, Maharashtra State, Shivaji Nagar, Pune- 411005, Maharashtra	Members
Dr. A. N. Sabalpara	Director of Research, Navasari Agricultural University, Navasari – 396450 Gujarat	Members
Dr. S. A. Ranpise	Head, Deptt. of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri , Taluk – Rahuri, Dist. Ahmednagar – 413 722 Maharashtra	Members
Mrs. Megha Borse	President, Floriculture Association, Maharashtra, 1 st Floor, Nadkarni Chambers, Vakildadi, NASIK – 422 001 Maharashtra	Members
Mr. S. Jafar Naqvi	Chief Editor, Floriculture Today, Media Today Pvt. Ltd, T - 30, First Floor, Khirki Extension, Malviya Nagar, New Delhi -110078	Members
Dr. Jyoti Sharma	Principal Scientist (Plant Pathology), ICAR - National Research Centre on Pomegranate, NH -65, Sholapur-Pune Highway, Kegaon, Solapur – 413 255 Maharashtra	Members
Dr. Vijay K. Mahajan	Principal Scientist (Horticulture), ICAR - Directorate of Onion & Garlic Research, Rajgurunagar District, Pune – 410 505 Maharashtra	Members
Dr. R. G. Somkuwar	Principal Scientist (Horticulture), ICAR -National Research Centre for Grapes, Post Bag No. 3, Manjari Farm PO, Sholapur Road, Pune – 412 307 Maharashtra	Members
Dr. Ashok Kumar	Principal Scientist, Germplasm Evaluation Division, NBPGR, Pusa Campus, New Delhi-110012	Members
Dr. Vikramditya Pandey	Principal Scientist (Horticulture), Division of Horticultural Sciences, ICAR, KAB-II, Pusa, New Delhi - 110 012	Members
Mr. A. Narasimha Murthy	Finance and Accounts Officer, IIMR (DSR) Hyderabad, Telangana	Members
Senior Administrative Officer	ICAR - Directorate of Floricultural Research, College of Agriculture Campus, Shivaji Nagar, Pune – 411 005 Maharashtra	Member Secretary

IRC Meeting

The meeting of Institute Research Committee were held on 22nd July, 2015 and 10th September, 2015. The meeting was chaired by Dr. K. P. Singh, Chairman, IRC and Director, ICAR-DFR, Pune. During the meeting, project wise progress of research work was reviewed and the technical programmes were finalized. The PIs of various research projects presented the work done in their respective projects and then presented the future plan of work. The plans of work were discussed thoroughly and modified wherever required before being approved by the house.

Research Projects

In-House Research Projects

Sl.No.	Mega Projects	PI	Co-PI	Remarks
01	Improvement of Commercial Flower Crops	Dr K. P. Singh <i>w.e.f.</i> 24.04.2015 in place of Dr. A. K. Tiwari		
	Project 01 (Project IXX07529): Breeding of Gladiolus for Quality and Yield	Dr. Ganesh B. Kadam	Dr. Tarak Nath Saha (Dr. A. K. Tiwari up to 23.04.2015)	Extended up to 31.03.2017
	Project 02 (Project IXX07506): Breeding of Chrysanthemum for Quality Flower and Pot Mum Production	Dr. Tarak Nath Saha	Dr. Ganesh B. Kadam	Extended up to 31.03.2017
	Project 03 (Project IXX07530): Breeding of Tuberose for Novel Colour and Oil Recovery	Dr. Tarak Nath Saha	Dr. K. P. Singh (Dr. A. K. Tiwari up to 23.04.2015.)	Extended up to 31.03.2017
	Project 04 (Project IXX07531): Improvement of Flowering Annuals	Dr. Gunjeet Kumar (up to 28.10.2014)	Dr. Tarak Nath Saha and Dr. Jayti Mujumdar (up to 20.06.2014)	Concluded
	Project 05 (Project IXX09573): Improvement of Lawn Grasses for Turf	Mrs. Shephalika Amrapali <i>w.e.f.</i> 24.04.2015 in place of Dr A. K. Tiwari	Mr. Girish, K. S. and Dr. K. P. Singh	Running
02	Standardization of Production Technology in Commercial Flower Crops	Dr. K. P. Singh		
	Project 01 (Project IXX07533): Standardization of Agro-Techniques for Improving Quality Production in Gladiolus, Chrysanthemum & Annuals	Dr. Gunjeet Kumar (up to 28.10.2014)	Dr. Tarak Nath Saha, Dr. Ganesh B. Kadam, Mrs. P. Sellam (up to 06.12.2014), Dr. Babita Singh (up to 06.12.2014) and Mr. Girish, K. S.	Concluded
	Project 02 (Project IXX08409): Production Technology of Tuberose	Dr. K. P. Singh	Dr. Prasanna Holajjer and Dr. Tarak Nath Saha (included <i>w.e.f.</i> 22.07. 2015)	Running
03	Post-Harvest Management and Value Addition	Dr. A. K. Tiwari (up to 23.04.2015)		
	Project 01 (Project IXX07534): Development of Ready to Serve Floral Preservatives for Commercial Flower	Dr. Babita Singh (up to 06.12.2014) Dr. A. K. Tiwari (from 06.12.2014 to 26.03.2015)	Dr. A. K. Tiwari (up to 06.12.2014), Mrs. P. Sellam (up to 06.12.2014) and Dr. Puja Rai (up to 06.12.2014) Dr. Ganesh B. Kadam (<i>w.e.f.</i> 11.12.2014)	Concluded
	Project 02 (Project IXX07535): Standardization of Drying Technique for Flower and Greens	Mrs. P. Sellam (up to 06.12.2014)	Dr. Jayoti Mujumdar (up to 20.06.2014)	Concluded
	Project 03 (Project IXX08412): Nutraceuticals Studies on Flower Crops	Dr. Jayoti Mujumdar (up to 20.06.2014)	Mrs. P. Sellam (up to 06.12.2014), Dr. Puja Rai (up to 06.12.2014), Dr. Babita Singh (up to 06.12.2014)	Concluded

	Project 04 (Project IXX12322): Standardization of Post - Harvest Packaging Technology for Tuberose and Jasmine (<i>w.e.f.</i> 1 st June, 2015)	Er. Rahul S. Yadav	Dr (Mrs). S. S. Deshpande (From 10.08.2015 to 21.11.2015)	Running
04	Plant Protection of Commercial Flower Crops	Mr. Girish, K. S.		
	Project 01 (Project IXX08410): Insect Pest Management of Commercial Flower Crops	Mr. Girish, K. S.	Dr. Ganesh B Kadam and Dr. Prasanna Holajjer	Running
	Project 02 (Project IXX11705): Investigation on Viral and Phytoplasmal Diseases of Major Flowering Crops in India	Dr. Prabha K.	Mr. Girish, K. S., Dr. K. P. Singh and Mrs. Nitika Gupta (included <i>w.e.f.</i> 2 nd Sept, 2015)	Running
	Project 03 (Project IXX11708): Assessment of Nematode Infestation in Major Commercial Flower Crops and Management of Root Knot Nematodes in Tuberose	Dr. Prasanna Holajjer	Mr. Girish, K. S. and Dr. K. P. Singh (Dr. Prabha K. up to 22 nd July, 2015)	Running

Externally Funded Projects

Sl. No.	Project Title	Sponsored by	PI/ CC PI
1	New Initiative Project on Protected Horticulture	ICAR	CC PI: Dr. Ganesh B. Kadam, Co- PI: Er. Rahul S. Yadav
2	ICAR Consortia Research Platform for Management of Borers in Horticulture Crops	ICAR	CC PI: Mr. Girish, K. S.
3	Studies on Male Sterility to Increase the Efficiency of F ₁ Hybrids in Horticultural Crops (Marigold)	ICAR	CC PI: Dr Tarak Nath Saha
4	Indian Floriculture Industry: Production, Marketing and Export Dynamics	ICAR Extramural Research Project. (<i>w.e.f.</i> 01.01.2016)	PI: Dr. K. V. Prasad Co-PI: Dr. Ganesh B. Kadam
5	Phytonematodes in Floriculture: Identification, Occurrence, Distribution and GIS Mapping	ICAR Extramural Research Project. (<i>w.e.f.</i> 01.01.2016)	PI: Dr. Prasanna Holajjer Co-PI: Mr. Girish, K. S.
6	Characterization and Natural Spread Sources of Phytoplasmas Affecting Major Floricultural Crops of India	ICAR Extramural Research Project. (<i>w.e.f.</i> 01.01.2016)	Co-PI: Dr. Prabha, K.

Inter Institute Project

Sl. No.	Project Title	Collaborative programme	PI
1	Studies on "Phytoplasma and Viroids in <i>Duranta erecta</i> : Maladies Induced in Orchards and Landscapes" under collaborative Project IXX11705: Investigation on Viral and Phytoplasmal Diseases of Major Flowering Crops in India	Collaborative project with ICAR-NRCG, Pune	Dr. Prabha, K. (<i>w.e.f.</i> 06.02.2016)

Publications

Research Papers

1. Tiwari, A. K., Kumar, R., Kumar, G., Kadam, G. B., Saha, T. N. and Girish, K. S. (2015). Comparing digital image analysis and visual rating of gamma ray induced Kentucky bluegrass (*Poa pratensis*) mutants, *Indian Journal of Agricultural Sciences*, 85(8) 93-96.
2. Bharti, H., Singh, K. P. and Singh, M. C. (2015). Morphological characterization of tuberose (*Polianthes tuberosa*) germplasm using DUS testing. *Progressive Horticulture*. 47(2): 280 - 287.
3. Tiwari, A. K., Kumar, G., Tiwari, B., Kadam, G. B. and Saha, T. N. (2016). Genetic diversity among turf grasses by ISSR markers. *Indian Journal of Agricultural Sciences*, (accepted).
4. Tiwari, A. K., Kumar, G., Kadam, G. B. and Saha, T. N. (2016). Optimization of ISSR-PCR system and assessing genetic diversity amongst turf grass, *Cynodon dactylon*, mutants. *Indian Journal of Agricultural Sciences*, (accepted).

Technical/ Popular Articles

1. Prabha K., Holajjer, P. and Singh, K.P. (2015). 'Phytobiosecurity and floriculture': Are we prepared to meet the challenges? *Floriculture Today*. May 2015: 19(2) 18-25.
2. Singh, K. P. and Tiwari, A. K. (2015). Floriculture Industry: Rehabilitating in North Eastern States. In: *Souvenir of National Seminar on Sustainable Horticulture Vis-à-vis Changing Environment* held at SASRD, Nagaland University, Medziphema, Nagaland during 26-28th February, 2015, pp. 39-46.
3. Singh, K. P., Sheikh, M. Q. Bhat, Z. A., Saha, T. N. and Holajjer, P. (2015). Glimpse of 24th Annual Group Meeting of AICRP on Floriculture held at SKUAST-(K), Srinagar. *Floriculture Today*. June: 48-49.
4. Jyothi, R. and Singh, K. P. (2016). Gamma irradiation: Powerful tool to induce genetic variability in tuberose. *Floriculture Today*. March: 30 - 33.
5. Ganesh B. Kadam and Yadav, R. S. (2016). Open field cultivation of roses. In souvenir: 34th All India Rose Convention and Show held at The Maharashtra Rose Society, Impress Garden, Pune from 22-24th January 2016: 36-38.
6. Yadav, R. S. (2016). High Tunnels: boon for floral crop production. In <http://www.krishisewa.com/articles/protected-agriculture/678-high-tunnels.html>

Technical Bulletins/ Books

1. Singh, Prem Jit., D. S. Kakade, N. Majumder, V. Sridhar, Girish, K. S., Prabha, K., K. P. Singh and Prasanna Holajjer (2015). Disease and Pest Management in Flower Crops under Polyhouse. ICAR-Directorate of Floricultural Research, College of Agriculture Campus, Shivajinagar, Pune-411005 (Maharashtra), India. 1-57.
2. Sheikh, M.Q., Z. A. Bhat, M. A. A. Siddique, K. P. Singh and T. N. Saha (2015). Present Status and Prospects of Floriculture in Jammu and Kashmir. Published by Director, ICAR-Directorate of Floricultural Research, Pune-411005 (Maharashtra), India. 1-40.
3. Sheikh, M.Q., Z. A. Bhat, M. A. A. Siddique, Tarak Nath Saha, K. P. Singh, Mast Ram Dhiman and Sita Ram Dhiman (2015). Daffodil. Published by Director, ICAR-Directorate of Floricultural Research, Pune-411005 (Maharashtra), India. 1-19.
4. Sheikh, M.Q., Z. A. Bhat, M. A. A. Siddique, Tarak Nath Saha, K. P. Singh and Mast Ram Dhiman (2015). Lilium. Published by Director, ICAR-Directorate of Floricultural Research, Pune-411005 (Maharashtra), India. 1-28.

5. Tiwari, A. K., K. P. Singh, Shephalika Amrapali, Girish, K. S. and Prem Jit Singh (2015). Lawn Management. Published by Director, ICAR-Directorate of Floricultural Research, Pune-411005 (Maharashtra), India 1-48.
6. Kannan, M., M. Jawaharlal, M. Ganga, K. P. Singh, Tarak Nath Saha, S. P. Thamaraiselvi and P. Ranchana (2015). Present Status and Prospects of Floriculture in Tamil Nadu. Published by Director, ICAR-Directorate of Floricultural Research, Pune-411005 (Maharashtra), India. 1-54.
7. Kadam, G. B., Saha, T. N. and Singh, K. P. (2015). Database on Gladiolus (2010-11 to 2013-14). AICRP on Floriculture, ICAR. Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune-411005 (Maharashtra), India. 1-276.
8. Tiwari, A. K. And K. P. Singh (2015). Database on Rose (2010-11 to 2013-14). AICRP on Floriculture, ICAR. Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune-411005 (Maharashtra), India. 1-96.
9. Singh, K. P., Tiwari, A. K. and Tarak Nath Saha (2015). Database on Tuberose (2010-11 to 2013-14). AICRP on Floriculture, ICAR. Published by Director, ICAR-Directorate of Floricultural Research, Shivajinagar, Pune-411005 (Maharashtra), India. 169.

Presentations in Conferences/Symposia/Seminar/Other

1. Prasad, K. V. (2016). Present status and challenges of of floriculture in India. In 11th International Flora Expo and International Conference on Floriculture and Landscape Gardening -Challenges and Opportunities held at Hindustan Antibiotics Exhibition Ground Pune on 27-28 February, 2016.
2. Gupta, N., Prabha, K., Kadam, G. B., Sriram, S. and Chandran, N. K. (2016). Yellows and corm rot in gladiolus: Incidence, identification and characterization of *Fusarium oxysporum* f. sp. *Gladioli*. In: 6th International conference "Plant, Pathogens and People" Challenges in Plant Pathology to Benefit Human Kind held at NASC complex New Delhi from 22 to 26th February, 2016.
3. Prabha, K., Nitika Gupta and Baranwal. V. K. (2016). 'Viroids' the hidden enemy to open and protected floriculture In: 6th International conference "Plant, Pathogens and People" Challenges in Plant Pathology to Benefit Human kind held at NASC complex New Delhi from 22 to 26th February, 2016.
4. Singh, K. P., Saha, T. N. and Holajjer, P (2016). Performance of single petalled tuberose (*Polianthes tuberosa*) cultivars under Pune conditions. In: National Confernce on Recent Advances in Diversified Agricultureal System held at CCR (PG) College Muzaffarnagar from 20 to 21st February, 2016.
5. Singh, K. P., Saha, T. N. and Holajjer, P (2016). Influence of bulb sizes on vegetative and bulb parameters in tuberose (*Polianthes tuberosa* Linn.) cultivar Phule Rajani. In: Silver Jubilee National Conference on Floriculture and Landscaping" held at ICAR-IARI, New Delhi from 28 to 29th February, 2016.
6. Singh, K. P., Saha, T. N. and Holajjer, P (2016). Response of different bulb size of tuberose as planting materials on growth and flowering characteristics. In: National Confernce on Recent Advances in Diversified Agricultureal System held at CCR (PG) College Muzaffarnagar from 20 to 21st February, 2016.
7. Singh, K. P., Saha, T. N. and Holajjer, P (2016). Evaluation of certain tuberose cultivars for vegetative, floral and bulb production parameters under Pune conditions. In: Silver Jubilee National Conference on Floriculture and Landscaping" held at ICAR-IARI, New Delhi from 28 to 29th February, 2016.
8. Kadam G. B. and Yadav, R. S. (2016). Open field cultivation of roses. In souvenir: 34th all India rose convention and show held at The Maharashtra Rose Society, Impress Garden, Pune from 22-24th January 2016: 36-38.

9. Yadav, R. S. (2016). Post-harvest management of rose. In souvenir: 34th All India Rose Convention and Show held at The Maharashtra Rose Society, Impress Garden, Pune from 22-24th January 2016.
10. Kadam G. B. (2016). Protected cultivation of roses. In 89th short term course on protected cultivation of flowers and vegetables crops held at Hi-tech Floriculture and Vegetable Project, College of Agriculture Pune-05 from 15-20th February 2016.
11. Kadam G. B. (2016). Cultivation of roses. In one day Farmers Interface Meeting organized by Agri Search Company, held at Talegoan on 02nd November 2015.
12. Gupta, N. (2016). Diseases of major flower crops. In one day Farmers Interface Meeting organized by Agri Search Company, held at Talegoan on 02nd November 2015.

Training and Capacity Building

Training Programmes Attended

1. Girish, K.S. attended training programme on "Analysis of Experimental Data" held at ICAR - National Academy of Agricultural Research Management, Rajendranagar, Hyderabad from 17 to 22nd August, 2015.
2. Singh, K.P. attended training programme on "Management Development Programme on Leadership Development (A Pre-Research Management Position Programme)" held at ICAR - National Academy of Agricultural Research Management, Rajendranagar, Hyderabad from 30th November to 11th December, 2015
3. Prasad, K. V. attended "Executive Development Programme on Leadership Development" held at ICAR - National Academy of Agricultural Research Management, Rajendranagar, Hyderabad from 21 to 25th February, 2016.
4. Kawar, P. G. attended 10th Refresher Course on "Agriculture Research Management" held at ICAR - National Academy of Agricultural Research Management, Rajendranagar, Hyderabad from 23rd February to 5th March, 2016.
5. Prabha, K. attended "International Training Programme on Leadership and Career Development for Women Scientists/technologists" from 28th August 2015-1st September 2015, held at Indian Institute of Science Education and Research, Pune.
6. Bhatt, R. S. attended training programme on "Public Procurement" held at National Institute of Financial Management, Faridabad from 30th November to 5th December, 2015.
7. Gupta, N. attended three months Professional Attachment Training from 30th May 2015 to 31st August 2015, at ICAR-IIHR, Hessarghatta, Bengaluru.
8. Gupta, N. attended CAFT Training Programme on "Functional Analysis of Pathogenicity Genes of Plant Pathogens" for 21 days from 2 to 22nd January, 2016 at Division of Plant Pathology, ICAR-IARI, Pusa Campus, New Delhi, India.

Conference/Workshops/Seminar/Symposium Attended

1. Saha, T. N., Holajjer, P., Kadam, G. B. and Girish, K. S. attended XXIV Annual Group Meeting of AICRP on Floriculture held at SAKUS&T, Srinagar from 21-23rd April 2015.
2. Prasad, K. V., Saha, T. N., Holajjer, P., Kadam, G. B., Girish, K. S. and Yadav, R. S. attended International Flora Expo and International Conference on Floriculture and Landscape Gardening -Challenges and Opportunities held at Hindustan Antibiotics Exhibition Ground Pune on 27-28th February, 2016.

3. Holajjer, P. attended the first Workshop of Nodal Officers of ICAR Research Data Repository for Knowledge Management initiative organized at NASC Complex, New Delhi during 04-05th August, 2015.
4. Girish K. S. attended workshop on "Forward Thinking for Agricultural Development in Western India" held at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat from 8-10th February, 2016
5. Prasad, K. V. and Kadam, G. B. attended "Brain Storming Session on Hail Storm" held at NRC Grapes, Pune on 21st November, 2015.
6. Kadam, G. B. and Yadav, R. S. attended 34th All India Rose Convention and Show held at The Maharashtra Rose Society, Impress Garden, Pune from 22-24th January, 2016.
7. Prasad, K. V. and Kadam, G. B. attended 10th DUS review meeting at MPKV Rahuri on 26 February, 2016
8. Prabha, K. and Gupta, N. attended 6th International Conference on "Plant, Pathogens and People - Challenges in Plant Pathology to Benefit Human Kind" held at NASC complex New Delhi from 22-26th February, 2016.
9. Holajjer, P. attended XIX Biennial Group Meeting of AICRP on Nematodes in Cropping Systems held at UAHS, Shivamogga from 8-10th February, 2016.
10. Saha, T. N. attended "Silver Jubilee National Conference on Floriculture and Landscaping" held at ICAR-IARI, New Delhi from 28-29th February, 2016.
11. Prasad, K. V., Saha, T. N., Holajjer, P., Kadam, G. B., Girish, K. S., Prabha, K., Gupta, N., Shephalika Amrapali, Yadav, R. S. and Shilpa Shree, K. G. attended one day Farmers Interface Meeting held at Talegoan on 02nd November, 2015.
12. Kadam, G. B. attended Rose Show organised by the Pune Rose Society held at Tilak Smarak, Pune from 2-3rd January 2016.
13. Prasad, K. V., Saha, T. N., Holajjer, P., Kadam, G. B., Girish, K. S., Prabha, K., Gupta, N., Shephalika Amrapali, Yadav, R. S. and Shilpa Shree, K. G. attended and organized Jai Kisan Jai Vigyan programmers held at Talegoan, Pune on 23rd December 2015 and KVK, Narayangaon on 29th December 2015
14. Prasad, K. V., Saha, T. N., Holajjer, P., Kadam, G. B., Girish, K. S., Prabha, K., Gupta, N., Shephalika Amrapali, Yadav, R. S. and Shilpa Shree, K. G. attended and organized Foundation Day lectures at ICAR-DFR, Pune on 10th December 2015.
15. Prasad, K. V., Saha, T. N., Holajjer, P., Kadam, G. B., Girish, K. S., Prabha, K., Gupta, N., Shephalika Amrapali, Yadav, R. S. and Shilpa Shree, K. G. attended "Kisan Diwas" at ICAR-IARI, Regional Station, Pune on 19th October 2015.
16. Prasad, K. V., Saha, T. N., Holajjer, P. and Kadam, G. B. participated in "Krishi Unnati Mela" at ICAR-IARI, New Delhi from 19-21st March 2016.
17. Prasad, K. V., Girish, K. S. and Yadav, R. S. participated in "Udyan Kisan Mela" organized by Dr. YSR Horticultural University at Dr. Y. S. R. Horticultural University, Venkataramannagudem from 30-31st December 2015.
18. Prasad, K. V., Saha, T. N., Holajjer, P., Kadam, G. B., Girish, K. S., Prabha, K., Gupta, N., Shephalika Amrapali, Yadav, R. S. and Shilpa Shree, K. G. participated in "Kisan Mela" organized by Gramunnati Mandal, KVK Narayangaon, Pune at KVK Narayangaon, Pune from 05-07th December 2015.
19. Prasad, K. V., Shephalika Amrapali and Yadav, R. S. attended "HortIP 2016, South Horticulture, ZTMU Annual Review Meeting" at IIHR, Bengaluru on 8th February 2016.
20. Saha, T. N. and Girish, K. S. attended "Farmers' Fair" held at KVK, Muzaffarnagar, Uttar Pradesh held on 27th July, 2015.

Awards and Recognition

1. Best poster award was conferred to Gupta, N. Prabha K., Kadam, G. B., Sriram, S. and Chandran, N. K. (2016). For the paper on “Yellows and corm rot in gladiolus: Incidence, identification and characterization of *Fusarium oxysporum* f. sp. gladioli” during 6th International Conference; Plant, Pathogens and People: Challenges in Plant Pathology to Benefit Humankind held at New Delhi, India from 23-27th February, 2016.
2. Kadam, G. B., and Yadav R. S. acted as convener in Technical Session-II at International Conference on Floriculture and Landscape Gardening –Challenges and Opportunities held at Hindustan Antibiotics Exhibition Ground, Pune on 27-28th February 2016.
3. Saha, T. N. and Holajjer, P. acted as convener in Technical Session-III at International Conference on Floriculture and Landscape Gardening –Challenges and Opportunities held at Hindustan Antibiotics Exhibition Ground, Pune on 27-28th February 2016.
4. Saha, T. N. presented the Action Taken Report (ATR) in the Technical Session I and also acted as convener in the Plenary Session on recommendations of the XXIV Annual Group Meeting Held at SKUAST, Srinagar from 17-19 April, 2015.
5. Holajjer, P. acted as convener in the Plenary Session on recommendations of the XXIV Annual Group Meeting Held at SKUAST, Srinagar from 17-19 April, 2015.

Institutional Activities

ICAR-DFR Foundation Day

ICAR – Directorate of Floricultural Research, Pune celebrated its 6th Foundation Day on 10th December, 2015. Dr. K. V. Prasad, Director, ICAR – Directorate of Floricultural Research narrated the background and genesis of ICAR-DFR and welcomed all the dignitaries. Two leading entrepreneurs in floriculture industry representing cut flower and nursery industry delivered foundation day lectures. Mr. Kamlesh Karle, CEO, M/s Essar Agrotech Limited delivered a scintillating lecture on “Protected Cultivation of Flowers: Milestones Achieved and Journey Ahead” and put forth light on international floriculture market for cut flowers and pointed out the areas where research is needed.



Mr. Kamlesh Karle, CEO, M/s Essar Agrotech Limited delivering the Foundation Day Lecture

He mentioned along with the international market for flowers, the domestic market in India has grown from \$ 2 million to \$ 135 million in 2015. He emphasized the importance of making indigenous ornamental flowers visible in international market to tap their huge potential for export. He requested the scientists of ICAR-DFR to explore the possibility of growing Indian garden rose in the greenhouse and to tap the potential of indigenous inflorescences of aesthetic value like of finger millet, heliconia, song of India, marigold, carthamus, sunflower, hill millet etc. He also mentioned the need of research to address the packaging issues and increasing shelf life for shipment of consignments to longer distance. Researchable issues that emerged from his presentation include

- i. Development of production technologies that meet international standards, which include proper and optimum use of inputs, use of new and safe molecules for IPM, use of internationally complied post harvest protocols for enhancing the exports from India.
- ii. There is a huge demand for tuberose due to its exotic fragrance, however technology for year round cultivation, efficient management of supply chain, reduced weight of spikes to make exports economical are some of the issues which needs to be addressed.
- iii. Crop specific flower foods needs to be standardized for enhancing the vase life of cut flowers rather than following a generalised post harvest protocols that are followed at present
- iv. Separate packaging standards for different flowers need to be developed to minimize the cost of packaging which comes to about 8 % at present.
- v. The industry looks forward for exploring the possibility of shipping flowers by sea route if suitable collaborations are available to do so.
- vi. Indian floriculture must innovate constantly to bring in new, novel products which are unique to India. There a huge demand for finger millets in Europe and US that are widely used in bouquet making, however the availability of finger millet is extremely short between September to November. Efforts are therefore required to increase the availability of such products and also explore the usage of new and novel native flowers.



Mr. Devendra Jagtap, CEO, Jagtap Nursery's Garden Centre delivering Foundation Day Lecture

Mr. Devendra Jagtap, CEO, Jagtap Nursery's Garden Centre delivered a thought provoking lecture on “Ornamental Plant Nursery Industry: Milestones Achieved and Journey Ahead”. He has pointed out at rethinking and channelizing our research and development efforts to address the future challenges of environmental horticulture to ensure the wellbeing of people. He gave examples of how floriculture sector can mitigate the environmental calamities like flood, drought, pollution etc by growing plants and trees

according to the climatic requirements. He suggested the research should focus to cater the requirements of the changing life style of the population, urbanization etc. He emphasized the inevitability of a scientific research in town planning with respect to the landscaping, the selection of avenue trees, planting trees along the road ways etc. He emphasized the importance of vertical gardening in the time of space constraint and the need to study the adaptation of plants and their light requirement to the indoor conditions. He requested DFR scientists to explore those plants which can decor our windowsill and at the same time purify the air around the room or absorb harsh chemicals and clean the environment around with specific example of tulsi (*Ocimum sanctum*) which is a part of culture and tradition but releases ozone to purify the indoor air was cited as specific example. Some of the researchable issues that emerged from his presentation are:

- i. Development of nursery standards for different potted plants.
- ii. Alternate media sources to minimize the usage of soil in the nursery industry.
- iii. Management of rhizosphere to improve the nursery plants .
- iv. Understand the role of potted plants in mitigating air pollution.
- v. Identification and commercialization of native species as new ornamental plants.

Dr. S. D. Sawant, Director, National Research Centre for Grapes, Dr. S. K. Sharma, In-charge, IARI, Regional Station, Pune, Dr. K. N. Bhilegaonkar, In-charge, IVRI, Regional Station, Pune, Dr. Sunil Masalkar, Associate Dean, College of Horticulture, Pune and Dr. V. S. Shirke, Director of Extension, College of Agriculture, Pune and Mr. Govind Hande, Technical officer Horticultural Export Commssionerate were present. They expressed their perspectives and congratulated the Director, ICAR-DFR for organizing such a meaningful foundation day in a successful manner. Scientific staffs from IVRI Regional Station, AICRP on Floriculture, Ganeshkhind, Pune, the faculty from the College of Horticulture, Pune, Post Graduate students of horticulture from College of Horticulture and all scientific and administrative staffs of ICAR – Directorate of Floricultural Research participated in the foundation day celebration.



6th Foundation Day Celebration of ICAR-DFR

Swachh Bharat Abhiyan

The ICAR-DFR organized Swachh Bharat Abhiyan. All the staff members including scientific, Administration and other of the Directorate were present on the occasion. After brief remarks by the Director all the staff actively participated in the cleanliness drive of office premises and adjoining areas.

Vigilance Awareness Week

The vigilance awareness week was organized during 26th to 31st October, 2016 at ICAR – DFR, Pune. Dr. S. D. Deshpande, retired Principal Scientist and Vigilance Officer of CIAE, Bhopal was invited to make a presentation on 'Preventive Vigilance as a Tool of Good Governance' on 29th October, 2015. Dr. S. D. Deshpande highlighted various issues that come under the preview of vigilance and the preventive measures that concerned officers should be taking to ensure transparency in day to day functioning of government organizations. All the scientific and administrative staff of ICAR- DFR attended the awareness programme.



Dr. S. D. Deshpande delivering the Vigilance Awareness Week Talk



Vigilance Awareness Week celebration

Hindi Workshop

ICAR-Directorate of Floricultural Research, Pune organised one day workshop on official language-Hindi on 5th February, 2016. The purpose was to promote Hindi in daily official works and improve the expertise of the staffs of ICAR-DFR. On this occasion an expert from Hindi Department of Government of India at Pune was invited for a guest lecture. Shri Rajendra Prasad Verma, Deputy Director, Hindi Training Scheme Department of Official Language under Home Ministry, Government of India was the guest faculty. Shri. Verma addressed the house and explained about the use of different computer based applications in Hindi which will make use of Hindi in daily official work easier. All the staff scientific, administrative and other supporting staff of the ICAR-DFR participated in the workshop.



Shri R. P. Verma, Deputy Director, Official Language delivering the lecture during Hindi Workshop



Celebration of Hindi Karyashala

Hindi Pakhwara

ICAR-Directorate of Floricultural Research, Shivajinagar Pune celebrated Hindi Diwas on 14th September 2015. On this occasion Hindi fortnight was organised from 14th September 2015 to 29th September 2015. During this period various competitions were organised in Hindi in order to promote use of Hindi in daily official works. All the scientific, administrative and other supporting staffs participated in all the competitions with much enthusiasm. On 29th September 2015 Hindi fortnight was concluded. On this occasion Dr. K. C. Tomar, Deputy Director, National Horticulture Board was the Chief Guest. He also distributed the certificates and prize money to all the winners and runner ups of various competition and certificate of appreciation to other participants.



Participants in various events during Hindi Pakhwara



Welcoming of Chief Guest Dr. K. C. Tomar by Dr. K. P. Singh



Distribution of certificates and prizes by Chief Guest

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 were modified accordingly. At present the Coordinated Project has 21 Centres which includes 15 budgetary, 4 institutional and 2 voluntary Centres.

List of AICRP (Floriculture) Centres

Sl. No.	Centre	Year of Start	Mandate Crops
Budgetary Centres			
1.	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur	1972	Chrysanthemum, orchids, anthurium, tuberose, gerbera, turf grass, gladiolus, marigold, china aster, landscape plants, foliage plants, dry flower
2.	Dr.Y.S. Parmar University of Horticulture & Forestry,Solan	1975	Gladiolus, carnation, tulip, daffodils, lilium, alstroemeria, specialty flowers, turf grass, marigold, china aster, native ornamentals, dry flower
3.	Kerala Agricultural University, Vellanikkara	1975	Orchids, anthurium, turf grass, specialty flowers, fillers, native ornamentals, landscape plants, foliage plants, dry flower
4.	Mahatma Phule Krishi Vidyapeeth, Pune	1975	Rose,gladiolus,carnation,tuberose,gerbera, marigold, crossandra, china aster, specialty flower
5.	Punjab Agricultural University, Ludhiana	1975	Rose, gladiolus, chrysanthemum, tuberose, fillers, turf grass, landscape plants, foliage plants
6.	Maharana Pratap University of Agricultural Sciences and Technology, Udaipur	1980	Gladiolus, chrysanthemum, tuberose
7.	Tamil Nadu Agricultural University, Coimbatore Sub-centre: Horticultural Research Station (TNAU), Ooty	1982	Chrysanthemum, anthurium, gerbera, tuberose, china aster, marigold, foliage plants, landscape plants, lilium, alstroemeria, fillers, gladiolus, carnation
8.	Uttar Banga Krishi Viswavidyalaya, Kalimpong	1985	Orchids, gerbera, alstroemeria
9.	Sri Kondalakashman Telangana State Horticultural University, Hyderabad	1987	Gladiolus, chrysanthemum, tuberose, turf grass, crossandra, china aster, marigold, carnation, specialty flowers, fillers
10.	Sher-E-Kashmir University of Agricultural Sciences & Technology, Srinagar	1987	Gladiolus, tulip, daffodils, lilium, alstroemeria, china aster
11.	Asam Agricultural University, Kahikuchi, Guwahati	2001	Orchids, Chrysanthemum, Tuberose, Gerbera, marigold, specialty flowers, fillers, native ornamentals, foliage plants, dry flower
12.	Odisha University of Agriculture and Technology, Chiplima	2011	Rose, Chrysanthemum, Marigold
13.	G. B. Pant University of Agriculture & Technology, Pantnagar	2001	Chrysanthemum, tuberose, turf grass
14.	Birsa Agricultural University, Ranchi	2001	Gerbera, rose, foliage plants
15.	Rajendra Agricultural University, Pusa, Samastipur, Bihar	2010	Tuberose, gladiolus and Marigold
Institutional Centres			
16.	Indian Agricultural Research Institute, New Delhi	1971	Rose, gladiolus, chrysanthemum, turf grass, foliage plants
17.	Indian Agricultural Research Institute, Regional Station, Katrain, Himachal Pradesh	1971	Gladiolus, tulip, daffodils, lilium
18.	Indian Institute of Horticultural Research, Hessaraghatta, Bangalore	1971	Rose, gladiolus, carnation, chrysanthemum, anthurium, tuberose, gerbera, specialty flowers, native ornamentals, landscape plants, turf grass, marigold, crossandra, china aster
19	ICAR Research Complex for NEH Region, Barapani, Shillong (Meghalaya)	1971	Orchids, gerbera

Voluntary Centres			
20.	University of Agricultural Sciences, Bangalore	1977	Fillers, foliage plants
21.	Horticultural College and Research Institute (TNAU), Periyakulam	2010	Marigold, tuberose, crossandra, native ornamentals

XXIV Annual Group Meeting of AICRP on Floriculture

The 24th Annual Group Meet of AICRP (Floriculture) was held at Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST) of Kashmir, Shalimar Campus, Srinagar, Jammu & Kashmir during 17-19th April, 2015. The Group Meeting was inaugurated by Janab Syed Muhammad Altaf Bukhari, Honorable Minister for Floriculture and Gardens & Parks, Government of Jammu & Kashmir and Chaired by Dr. Tej Partap, Vice-Chancellor of host University. Addressing the meeting, Janab Bukhari ji informed the house that there is a lot of scope for the production and export of floricultural products from Jammu and Kashmir. The Guest-of-Honour on the occasion, Dr. T. Janakiram, Assistant Director General (Horticulture Science), ICAR New Delhi highlighted the flower production scenario in the country and scope of floriculture in coming years. Dr. Tej Partap, Honorable Vice-Chancellor, SKUAST-(K), Srinagar, presided over the inaugural session. In his address he called upon the scientists to develop technologies for temperate floriculture that is unique to the state of the Jammu and Kashmir. Dr. K.P. Singh Director, DFR, Pune presented the silent achievements and recommendations made during 2012-13 under AICRP (Floriculture). The occasion was marked by the gracious presence of Dr. Shafiq A Wani, Director Research, SKUAST-(K), Srinagar and Dr. M.A.A. Siddique, Associate Director of Extension, SKUAST-(K), Srinagar.



Release of Publication by Dignitaries during XXIV Annual Group Meeting of AICRP (Floriculture)

Two technical bulletins namely “Present Status and Prospects of Floriculture in Jammu and Kashmir” and “Diseases and Pest Management in Flower Crops under Polyhouse” were released by the Chief Guest during the Inaugural Session. During this session seven floriculturists namely, Dr. S. K. Datta, Dr. T. Janakiram, Dr. (Ms) Meenakshi Srinivas, Late Dr. Foja Singh, Prof. Abdul Qadoos John, Prof. Talat Mohammad Paul and Prof. M. A. Siddique were felicitated for their valuable contributions to floriculture research, education and extension particularly in AICRP (Floriculture).



Participants of the XXIV Annual Group Meeting of AICRP (Floriculture)

Establishment of New ATARI at Pune

Council has approved the setup of a New Agricultural Technology Application Research Institute(ATARI) which has to be set up and operationalized from the Campus of College of Agriculture, Shivajinagar, Pune. Director, ATARI(V), the competent authority has also instructed ICAR-DFR to earmark a piece of land of 02 hectare (05 acre) for the establishment of ICAR-ATARI.

Personnel

Sl. No.	Name	Designation	Office Order No.
1.	Dr. K. V. Prasad	Director (06.10.2016 Forenoon)	10(6)/2014-Per.III, dated 24.09.2015
2.	Dr. K. P. Singh	Director (Acting) (upto 05.10.2015 Afternoon) & Principal Scientist	-
3.	Dr.(Ms.) Sumedha Deshpande	Principal Scientist (Home Science Extension) (From 12.08.2016 to 21.11.2015)	95(03)/2015-Per.II, dated 07.04.2015. 95(03)/2015-Per.II, dated 02.11.2015
4.	Dr. Ajai Kumar Tiwari	Senior Scientist (Horticulture-Floriculture) (upto 23.08.2015)	11-2/2015-Per.II, dated 07.04.2015
	Dr. Prashant G. Kanwar	Senior Scientist (Genetics and Plant Breeding) (w.e.f. 15.02.2016)	33(2)/2012-Per.II, dated 22.01.2016
5.	Dr. Tarak Nath Saha	Scientist (Horticulture-Floriculture)	-
6.	Dr. Prasanna Holajjer	Scientist (Nematology)	-
7.	Dr. (Ms.) Prabha, K.	Scientist (Plant Pathology)	-
10.	Dr. Ganesh Balkrushna Kadam	Scientist (Horticulture-Floriculture)	-
11.	Mr. Girish, K. S.	Scientist (Agricultural Entomology)	-
12.	Ms. Shephalika Amrapali	Scientist (Economic Botany)	-
13.	Ms. Nitika Gupta	Scientist (Plant Pathology) (w.e.f. 10.04.2015)	07(2)/2015-Per.I, dated 23.03.2015
14.	Er. Rahul Subhash Yadav	Scientist (Agriculture Structure & Environmental Management) (w.e.f. 20.04.2015)	07(12)/2014-Per.I, dated 08.04.2015
15.	Dr.(Ms.) Shilpashree, K. G.	Scientist (Soil Science) (w.e.f. 12.10.2015)	07(17)/2015-Per.I, dated 27.09.2015
16.	Mr. Anil Kumar Maithani	Administrative officer (upto 10.08.2015)	3-5/2010-Estt.I (Pt.II), dated 04.08.2015
17.	Mr. Sunil Kumar	Senior Administrative officer (Additional Charge w.e.f. 02.09.2015)	3-5/2010-Estt.I, dated 04.08.2015
18.	Mr. Radhey Shyam Bhatt	Assistant Finance and Accounts Officer	-
19.	Mr. Sandeep Gaur	Assistant (upto 17.09.2015)	5(7)/2009-P.III(Part) dated 30.07.2015
20.	Mr. Deepak Verma	Assistant	-
21.	Mr. Rupesh Kumar Pathak	Assistant	-
22.	Mr. Sudesh Kumar	Upper Division Clerk (w.e.f. 02.03.2016)	-
23.	Mr. Ajay Kumar Uniyal	Steno Grade III	-

New Joining and Transfers

Transfers from ICAR-DFR		New Joining at ICAR-DFR	
Sl. No.	Name and Designation	Sl. No.	Name and Designation
1	Dr. Sumedha S Deshpande, Principal Scientist to CIAE, Bhopal	1	Dr. K.V. Prasad, Director
2	Dr. Ajay Kumar Tiwari , Senior Scientist to DSR, Mau	2	Dr. Sumedha S. Deshpande, Principal Scientist
3	Sh. Anil Maithani, Administrative Officer to IARI, New Delhi	3	Dr. Prashant G. Kavar, Senior Scientist
4	Sh. Sandeep Gaur, Assistant to NBPGR, New Delhi	4	Mr. Sunil Kumar, Senior Administrative Officer (Additional Charge DFR)
		5	Ms Nitika Gupta, Scientist
		6	Er. Rahul Subhash Yadav, Scientist
		7	Dr. Shilpa Shree, K.G, Scientist

Promotions

Mr. Sudesh Kumar, Lower Division Clerk promoted to Upper Division Clerk w.e.f. 02.03.2016

Distinguished Visitors

Hon'ble Secretary DARE and Director General, ICAR

Dr. S. Ayyappan, Hon'ble Secretary DARE & Director General of ICAR visited ICAR – DFR on 8th December, 2015 and interacted with the scientific and administrative staff. During his visit Hon'ble DG had reviewed the research projects, infrastructure development and constraints faced. He appreciated the efforts of the administration and scientists in overcoming the impediments in making the ICAR – DFR functional at its new location, Pune.



Dr. S. Ayyappan, Secretary, DARE & DG ICAR at ICAR-DFR Pune



Dr. S. Ayyappan visit to research farm

RAC Members

The Research Advisory Committee comprising of Dr. V. A. Parthasarathy as the Chairman and Dr. T. Janakiram, Dr. Deshpande, Dr. T. M. Rao, Mr. Jafar Naqvi visited ICAR – DFR on 26th March, 2016. The members visited the research farms located at Shivajinagar campus and Hadapsar and operationalised the tractor and the implements that were purchased during March 2016.



Visit of Hon'ble RAC members



Operationalisation of newly acquired farm machinery by chairman and members of RAC

Hon'ble Deputy Director General (Horticultural Science)

Dr. N. K. Krishna Kumar, Hon'ble DDG ICAR visited ICAR-DFR along with Dr. Vikramaditya Pandey, Principle Scientist, Horticulture Division of ICAR on 20th November 2015. During his visit he reviewed the infrastructure available, research facilities at the farm and also the research projects that are in operation at ICAR – DFR. He had offered valuable suggestions to improve the functioning of ICAR – DFR.



Dr. N. K. Krishna Kumar, DDG (Horticultural Science) at ICAR - DFR, Pune



Dr. N. K. Krishna Kumar, DDG (Hort. Sci.) visiting farmers field at Kadiyam

Hon'ble, Vice- Chancellor, MPKV, Rahuri

Dr. K. P. Vishwanatha, Vice- Chancellor, MPKV, Rahuri visited ICAR-DFR and interacted with the scientific and administrative staff. During his visit he overviewd the status of DFR and facilities provided by the MPKV Rahuri for establishment of ICAR-DFR at Pune.



Visit of Dr. K. P. Vishwanatha, Vice- Chancellor, MPKV, Rahuri to ICAR-DFR, Pune

Directors of ICAR Institutes

Directors of four ICAR institutions namely Dr. S.K. Sharma, Director, CIAH, Bikaner, Dr. M.S. Ladaniya, Director, CCRI, Nagpur, Dr. Vishal Nath, Director, NRC Litchi, Muzaffargar and Dr. C.K. Narayana, Director, IIHR, Bengaluru visited ICAR–DFR on 21st November, 2015 and appreciated the efforts made by team Directorate of Floricultural Research in creating required infrastructure after relocating to Pune, Maharashtra.



Visit of Directors of ICAR institutes



Dr. N. K. Dadlani and Dr. (Ms.) Malavika Dadlani interacting with Dr. K. V. Prasad

Dr. N. K. Dadlani and Dr. (Ms.) Malavika Dadlani

Dr. N. K. Dadlani, Vice President, Asia Pacific Seed Association, Dr. (Ms.) Malavika Dadlani, former Joint Director (Research), IARI visited ICAR–DFR on 23rd November 2015 and offered valuable suggestions to take the research agenda of ICAR–DFR forward.

Budget (2015-16)

The details of the budget including AICRP on Floriculture are tabulated as under.

(Rs. in lakhs)

Sl. No.	Head of Account	Plan		Non-Plan	
		Budget	Expenditure	Budget	Expenditure
	A. Recurring				
1	Estt. Charges	303.00	303.00	150.00	150.00
2	TA	14.70	14.70	2.00	2.00
4	HRD	0.25	0.25	0.00	
5	Other Charges	70.25	70.25	34.00	32.86
	Total (A)	388.20	388.20	186.00	184.86
	B. Non-Recurring				
6	Equipment	12.55	12.55	0.00	0.00
7	Works	28.93	28.93	0.00	0.00
8	Library	0.04	0.04	0.00	0.00
9	Furniture	0.00	0.00	0.00	0.00
10	Vehicle	0.00	0.00	0.00	0.00
	Total (B)	41.52	41.52	0.00	0.00
	Grand Total (A+B)	429.72	429.72	186.00	184.86

RFD Achievement (2015-16)

Sl. No.	Objective(s)	Weight	Action(s)	Success Indicator (s)	Unit	Weight	Target/Criteria value					Achievements	Raw	Performance Weighted score	% achievements against target value of 90% col.	Reasons for shortfall or excessive achievements if applicable
							Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%					
1.	Development of on farm Research and infrastructures facilities	50	Development of research farm and office facilities.	On farm Research facilities developed	Acre	25	7.5	6	5	4	3	7.5	100	25	125.00	At new location, more area was brought under cultivation, which is essential to conduct research
				Logistic facilities created	Number	25	7	6	5	4	3	11	100	25	183.33	Logistics are required at new location
2.	Collection, Evaluation and Management of genetic resources	30	Collection and evaluation of germplasm for crop improvement/ biotic stress	Germplasm collected	Number	10	30	27	24	21	18	107	100	10	396.29	Germplasm collection is a continues process which is flexible and hence over achievement.
				Germplasm evaluated	Number	15	150	130	110	90	70	157	100	15	120.76	Large number of germplasm were collected and evaluated hence over achievement
* *	Publication/ Documentation	5	Survey for pest and diseases Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Protected units/field survey Research articles published	Number No.	5 3	30 3	26 2	22 1	18 0	14 0	30 2	100 90	5 2.7	115.38 90	Due to joining of new scientist more units were surveyed. Due to inadequate laboratory facilities, Research Papers were could not be published in high rated journal.
			Timely publication of the Institute Annual Report (2014-2015)	Annual Report published	Date	2	30.06.2015	02.07.2015	04.07.2015	07.07.2015	09.07.2015	21.07.2015	0	0	0	Due to non availability of rate contract for printing at new location, publication is delayed
*	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	87	0	0	0	Rough estimates in place of preliminary estimates were submitted by CPWD which were not accepted by IFD, ICAR. Hence part of plan fund could not be utilized.

S. No.	Objective(s)	Weight	Action(s)	Success Indicator (s)	Unit	Weight	Target/Criteria value					Achievements	Performance		% achievements against target value of 90% col.	Reasons for shortfall or excessive achievements if applicable
							Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%		Raw	Weighted score		
*	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2015-2016 for Approval Timely submission of Results for 2014-2015	On-time submission On-time submission	Date Date	2 1	May 15, 2015 May 1, 2015	May 16, 2015 May 2, 2015	May 19, 2015 May 5, 2015	May 20, 2015 May 6, 2015	May 21, 2015 May 7, 2015	30.04.2015 06.04.2015	100 100	2 1	- -	- -
*	Enhanced Transparency / Improved Service delivery of Ministry/Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC) Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of implementation of citizens' commitments in CCC Degree of success in implementing GRM	% %	2 1	100 100	95 95	90 90	85 85	80 80	100 100	100 100	2 1	- -	- -
*	Administrative Reforms	7	Update organizational strategy to align with revised priorities Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC) Implementation of agreed milestones for ISO 9001 Implementation of milestones of approved Innovation Action Plans (IAPs)	Date % of implementation % of implementation % of implementation	Date % % %	2 1 2 2	Nov.1 2015 100 100 100	Nov.2 2015 90 95 90	Nov.3 2015 80 90 80	Nov.4 2015 70 85 70	Nov.5 2015 60 80 60	July, 2015 100 100 100	100 100 100	2 1 2 2	- - - -	- - - -

Total Composite Score: 95.70

Rating: Excellent

Procedure for computing the Weighted and Composite Score

1. Weighted Score of a Success Indicator = Weight of the corresponding Success Indicator x Raw Score / 100
2. Total Composite Score = Sum of Weighted Scores of all the Success Indicators

Tribal Sub-Plan Report

Centre : Birsa Agricultural University, Ranchi

- | | | | |
|------|---------------------------|---|---|
| i. | Programme | : | Tribal Sub Plan under AICRP on Floriculture |
| ii. | Location of the Programme | : | District - Lohardaga and Ranchi (Jharkhand) |
| iii. | Name of the PI | : | Dr.Punam Horo , P.I. AICRP on Floriculture
Department of Horticulture,
Birsa Agricultural University, Kanke, Ranchi |
| iv. | Name of the University | : | Birsa Agricultural University, Kanke, Ranchi |

Details of Physical Achievements (2015-16)

On campus training programme for tribal farmers: Eight on campus one day training programmes were organised during 2015-16. Total two hundred farmers from Lohardaga and Ranchi district were participated in training. Mainly training programmes were focused on the production technology of flower crops and use of improved technologies for better income. Farmers came from different villages are Burka, Bedal, semra etc. of Bhandra block under the district Lohardaga. From Ranchi district farmers came from Semra under Bero Block and Chuchgura, Semra, Tilaksuti villages under Itki block.



Farmers from Bhandra Block of Lohardaga District



Training Programme (on campus) at Department of Horticulture: Training given to the farmers of Ranchi district, Village- Semra of Bero Block and village Chuchgura, Semra, Tilaksuti of Itki block.



Farmers of Itki Block visiting Birsa Agricultural University, Ranchi

Flower demonstration activities: 42 tribal farmers got benefited during the demonstration of flower production in an area of 4 acres.



Demonstration at farmers Field

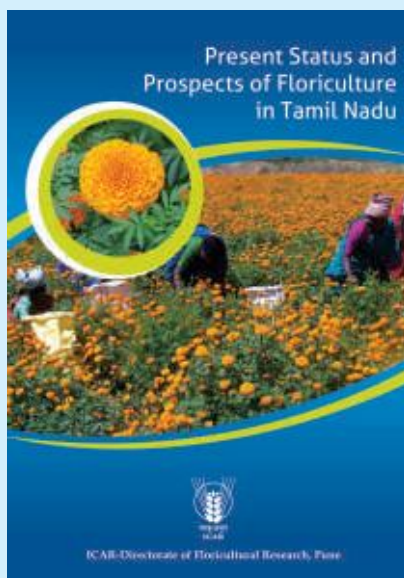
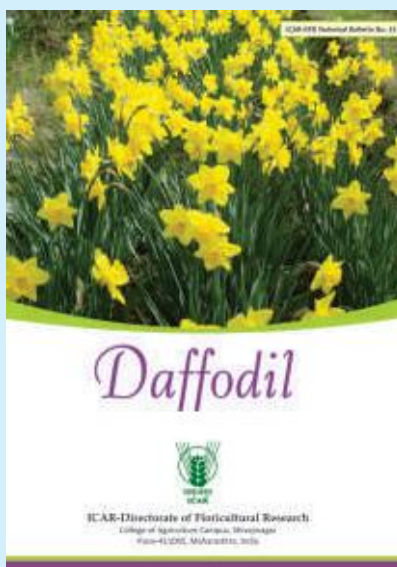
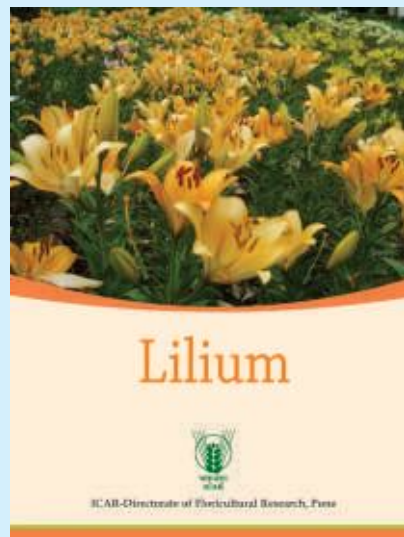
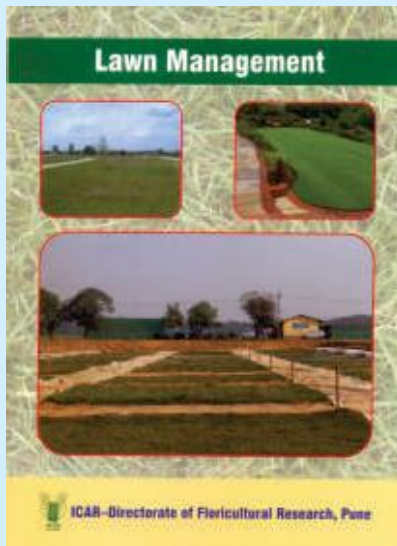
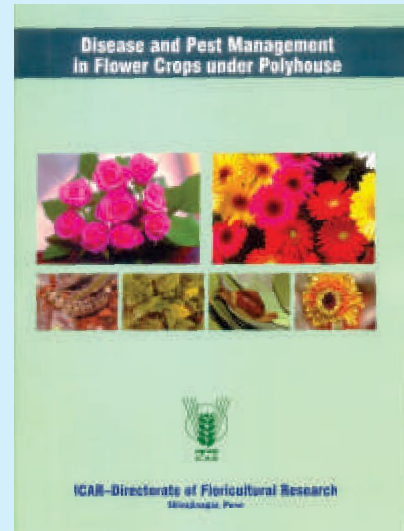
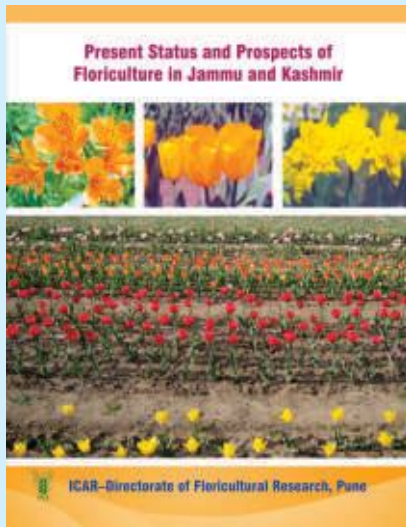
Expenditure Report Under TSP

Funds allotted to Birsa Agricultural University, Ranchi under T.S.P. during the year 2015-16

(In Rupees)

Head	Fund allotted to the centre (2015-16)	Expenditure till 31.03.2016
CNC(R)	5,20,000	4,70,000
CNC(NR)	5,40,000	1,50,000

Recent Publications





एक कदम स्वच्छता की ओर



भा.कृ.अनु.प. – पुष्प विज्ञान अनुसंधान निदेशालय

कृषि महाविद्यालय परिसर, शिवाजीनगर, पुणे-411 005, महाराष्ट्र, भारत

ICAR-Directorate of Floricultural Research

College of Agriculture Campus, Shivajinagar, Pune-411 005, Maharashtra, India

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